RESEARCH HORIZONS

In this issue

BUILDING THE FUTURE

plus news and views from across the University

UNIVERSITY OF CAMBRIDGE

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Building the future

DAN WHITE

Research of high quality does not always depend on good facilities: I dare say Wittgenstein would have been a genius with or without a fine edifice in which to work, and Newton, Darwin, Crick and Watson would doubtless be astounded by the high-specification laboratories available to today's researchers in the physical and biological sciences. I would certainly contend, however, that good buildings help research to flourish.

In my nearly seven years as Vice-Chancellor, I have had the great privilege to open (or more often to witness our Chancellor, HRH The Duke of Edinburgh, opening) new buildings that have added significantly to the research space across the University. Like those featured in this issue of Research Horizons, all are thriving examples of the spirit of endeavour and the excitement of scholarship embodied by research in Cambridge.

These new buildings are paralleled by refurbishments of existing stock: the Herchel Smith Building for Brain and Mind Sciences, and the Departments of Chemistry and Plant Sciences are major examples. Such developments are made possible by large-scale and far-sighted investment by the University, assisted by Government infrastructure funding, charitable foundations, and philanthropy both individual and corporate.

The investments continue, with new land being pressed into service: part of the research area of the Botanic Garden provided the site for the stunning new Sainsbury Laboratory opening its doors early in 2011, and West Cambridge provides space for transformative expansion, as will North-West Cambridge in the coming years.

Expansion is not something we undertake for its own sake, of course, but because areas of knowledge open up which command our attention. Last year, as part of our 800th Anniversary celebrations, and along with 799 others, I wrote a 'Letter to the Future', to be opened in 2109. We can have no thorough understanding of the research our future counterparts will be conducting then. But, through decisions we make now, and attention to quality and flexibility, we are helping to ensure that ground-breaking discoveries will continue to be made in Cambridge.

Professor Alison Richard
Vice-Chancellor

Promoting green innovation

A regional knowledge transfer project is linking the region's top plant science research with businesses wanting to develop new products.

NIGEL CATTLIN/FLPA

The InCrops Project operates as an enterprise hub across the whole of the East of England. Its aim is to accelerate commercialisation opportunities for plant-based research by linking it to companies looking to develop new products for the marketplace. The University of Cambridge is one of 13 partner institutions that form the hub, which is led by the University of East Anglia (UEA).

InCrops Director Dr John French, based at UEA, explained: 'By drawing upon the world-class research expertise that we possess across the region, we can promote green innovation, whether it's for biofuel, green fashion, construction materials, healthcare or functional foods.'

In Cambridge, researchers in six departments are involved in interactions with InCrops. The main point of contact is the Department of Plant Sciences, where the role of the InCrops Business Innovation Manager Dr Beatrix Schlarb-Ridley is to connect regional companies to relevant academic expertise in plant-related research.

One such company is CH_4Power, a start-up converting food waste via anaerobic digestion into biogas and eventually into electricity. Adrian Venni from CH_4Power said: 'The collaboration with InCrops and its academic partnership is finally making it possible to turn a vision for progress I have had for many years into reality.' In collaboration with the Algal Bioenergy Consortium in Cambridge (see page 19), the company is investigating a closed-loop system for energy generation by growing algae and duckweed in the nutrient-rich liquid digestate, fed by flue gas CO_2.

The five-year, £4 million InCrops Project is being funded by the East of England Development Agency (EEDA) and the European Regional Development Fund. Andrew Luff of EEDA added: 'By 2013, the project aims to have supported the growth of the East of England's low-carbon economy by helping small- and medium-sized enterprises to create 70 new jobs, and entrepreneurs to start 50 new businesses.'

For more information, please contact Dr Beatrix Schlarb-Ridley (b.schlarb-ridley@uea.ac.uk; bgs21@cam.ac.uk) or visit www.incropsproject.co.uk/

Cover: Selection of recent new buildings and refurbishments at the University of Cambridge

Left to right, from top: Centre for Advanced Photonics and Electronics; Sainsbury Laboratory (©Stanton Williams); Strangeways Research Laboratory; Leverhulme Centre for Human Evolutionary Studies; Centre for Mathematical Sciences; Cancer Research UK Cambridge Research Institute/Li Ka Shing Centre; Faculty of Education; Institute of Criminology; Department of Chemistry (Photo: Nathan Pitt); Institute for Manufacturing; Kavli Institute for Cosmology at Cambridge; Wellcome Trust and Cancer Research UK Gurdon Institute; Cambridge Centre for the Physics of Medicine; Department of Architecture New Studio (Photo: David Butler); Institute of Metabolic Science; Faculty of English.

Dinosaur discovery

The first evidence of a *Tyrannosaurus rex* ancestor has been unearthed in the southern hemisphere.

The identification of a hip bone of what is believed to be a smaller Australian ancestor of *Tyrannosaurus rex* was made by a team of scientists from the University of Cambridge, the Natural History Museum in London, and Australia's Monash University and Museum Victoria, as published recently in *Science*.

'This is an exciting discovery because tyrannosaur fossils had only ever been found in the northern hemisphere before and some scientists thought tyrannosaurs never made it down south,' said Dr Roger Benson from the Department of Earth Sciences, who identified the bone. 'Although we only have one bone, it shows that 110 million years ago small tyrannosaurs like ours might have been found worldwide. This find has major significance for our knowledge of how this group of dinosaurs evolved.'

While answering the question of whether tyrannosaurs lived in the southern as well as the northern hemisphere, the new find leaves another, deeper mystery: why did tyrannosaurs evolve into giant predators such as *T. rex* only in the northern hemisphere?

According to Dr Benson: 'It is difficult to explain why different groups succeeded in the north and the south if they originally existed in both places. What we need to know now is just how diverse the early radiation of tyrannosaurs was, why they went extinct, leaving only giant-sized, short-armed species like *T. rex*, and how successful they might have been in the southern hemisphere.'

For more information, please contact Dr Roger Benson (rbb27@esc.cam.ac.uk).

Computer Lab wins Google funding

A gift from Google will help Computing for the Future of the Planet.

In the first-ever round of Google Focused Research Awards, Professor Andy Hopper, Head of the Computer Laboratory, has been awarded funding towards Computing for the Future of the Planet, a research programme that has set its sights on what computing can do for the environment.

Explaining the ethos behind the research he leads, Professor Hopper said: 'Computing has had an enormous impact on the way we live and work, and a natural extension is to harness its power to solve problems facing the planet, whether it's energy consumption, pollution, congestion or sustainable living. Over the past five years, we have developed a strong interdisciplinary vision of a computer-based framework that will improve the way we live, and have been building and testing the deep-engineering technology needed to achieve it.'

Computing for the Future of the Planet has several goals: an optimal digital infrastructure, sensing and optimising with a global world model, reliably predicting and reacting to our environment, and digital alternatives to physical activities.

One research area under investigation is a personal energy meter that would enable individuals to calculate their energy use in real-time. Pulling information together from a variety of sources, the meter would calculate not only the energy being used directly by the user but also the shared energy use of, for example, the buildings they work in, public transport and even national overheads like healthcare.

Google has awarded a total of $5.7 million to 13 projects through their recent Research Awards scheme, with Cambridge being the only institution outside the USA to win funding. 'Refreshingly, the gift from Google places no restrictions on the funded research,' said Professor Hopper. 'The nature of the award is simply to stimulate and accelerate the development of new ideas and practical solutions in these innovative areas.'

For more information, please contact Professor Andy Hopper (ah12@cam.ac.uk).

'Memory wars' of Eastern Europe

A €1 million study will shed light on the role of cultural memory of the Soviet era in Russia, Ukraine and Poland.

©COLIN C

Dr Alexander Etkind, Rory Finnin and Dr Emma Widdis in the Department of Slavonic Studies have received funding of €1 million over three years to lead an interdisciplinary, multinational study entitled 'Memory at War: Cultural Dynamics in Poland, Russia and Ukraine'. The project involves academics in Cambridge, Groningen, Bergen, Helsinki and Tartu.

The Memory at War project will employ pioneering methodology to map memory events in real-time across Eastern European borders. Literature, film, new media, historical textbooks and public politics will be examined to understand how these elements can mediate memory of the traumas of the 20th century, and how such memories are promoted, revised and censored.

'Just as moments of glory and triumph provide launching pads for nation building, so do narratives of past trauma,' explained Dr Etkind. 'To what extent nations inherit tortured memories and act on them can set them apart, and this is what we are seeing today in how Poland, Russia and Ukraine remember the collapse of the USSR in 1991.'

Funding has been provided by Humanities in the European Research Area as part of a €16.5 million programme of 19 transnational, collaborative projects. The projects are aimed at deriving new insights from humanities research on major social, cultural and political challenges facing Europe.

'At the heart of the project is a conviction that Europe would benefit profoundly from an understanding of the, often subterranean, cultural trafficking of traumatic memories along the eastern border of the European Union,' added Dr Etkind. 'These memories, if left to fester, could be a destabilising influence in Eastern Europe. By bringing greater understanding to these hidden obstacles, constructive dialogue can be fostered.'

For more information, please contact Dr Alexander Etkind (ae264@cam.ac.uk).

Hauser Forum opens for business

A new complex will provide a focus for industry–academic collaboration and research commercialisation.

PHILIP MYNOTT

HRH The Duke of Edinburgh, Dr Hermann Hauser and Dr Pamela Raspe at the opening of the Hauser Forum

A prestigious new development comprising the Entrepreneurship Centre, Broers Building and Cafe Atrium was opened by the Chancellor, HRH The Duke of Edinburgh, on 20 April at the West Cambridge Site.

The Hauser Forum was funded by an £8 million gift from the Hauser-Raspe Foundation, with £2 million additional funding from the East of England Development Agency. The state-of-the-art enterprise hub has been designed to stimulate innovative collaboration between clusters of academics, start-up businesses and established industries.

Cambridge Enterprise has relocated its offices to the Entrepreneurship Centre at the Hauser Forum, as has IdeaSpace, which links entrepreneurial activities within the University and throughout the region.

The Broers Building, named in honour of the former Vice-Chancellor Lord Broers, is a pioneering development by Turnstone Estates and the University in which SMEs and international companies can lease space to work in closer partnership with researchers and commercialisation activities. The first tenants to take up leases are Nokia Research Centre, which develops nanotechnologies for mobile communication and ambient intelligence, and Base4 Innovation, a spin-out company from the Cavendish Laboratory that develops detection platforms for healthcare and the life sciences.

An enterprising year

Cambridge Enterprise's figures for 2008/09 show growth in licensing, consultancy and equity transactions.

The 2008/09 Annual Review marks two financial years for Cambridge Enterprise Ltd operating as a wholly owned subsidiary of the University. During this period, 400 new knowledge and technology transfer transactions were completed, bringing the portfolio to over 700 active licence, consultancy and equity agreements under management. Cambridge Enterprise holds equity in 72 companies on behalf of the University, many of which will have far-reaching impact on society.

During this two-year period, income exceeded £18 million, of which about £14 million was distributed to University academics and departments to encourage engagement in innovation. The remainder has been reinvested in patent assets and in supporting knowledge and technology transfer services to the University.

'Long-term support of fundamental research plays a significant role in creating ideas that will have a positive societal impact,' said Chief Executive Teri Willey. 'We are committed to finding the best partners to assist in the commercialisation of research emerging from the University's departments.'

For more information about Cambridge Enterprise, and to download the Annual Review for 2008/09, please visit www.enterprise.cam.ac.uk/

cambridge enterprise
commercialising University science

Funding to boost scientific links with Japan

Researchers in Cambridge and Japan will be working together towards a more integrated understanding of how stem cells make decisions.

Professor Austin Smith, Director of the Wellcome Trust Centre for Stem Cell Research, has received a Japan Partnering Award from the Biotechnology and Biological Sciences Research Council (BBSRC). This scheme provides funding for BBSRC-supported researchers to build and foster long-term collaborations with Japanese partners.

The award will enable Professor Smith and colleagues in Cambridge to collaborate closely with Dr Hitoshi Niwa and other researchers at the RIKEN Center for Developmental Biology in Kobe, Japan. The project also involves Dr Paul Bertone, a biocomputational expert at the European Bioinformatics Institute near Cambridge, and Dr Kathryn Lilley, Director of the Cambridge Centre for Proteomics (see page 23).

The collaborative effort is tackling an emerging area of research: the systems biology of stem cells. Systems biology integrates complex information about whole biological systems to understand how they function. Like stem cell biology, it has been a fast-growing research field over the past decade.

'Only recently has it been realistic to start bridging the two approaches in order to answer questions about the behaviour and decision-making pathways of stem cells,' explained Professor Smith. 'It's an exciting but challenging area, and it makes very good sense for researchers in Cambridge and Japan to share complementary experience, tools and resources.'

Commenting on the awards, which have been made to four research groups in the UK, Professor Douglas Kell, BBSRC Chief Executive, said: 'Modern bioscience demands international collaboration. By working together across international borders we can generate faster progress and higher quality science than we can alone.'

For more information, please contact Professor Austin Smith (austin.smith@cscr.cam.ac.uk). Professor Smith was recently awarded the prestigious 2010 Louis-Jeantet Prize for Medicine for his contributions to stem cell research.

Tackling obesity and diabetes: Institute of Metabolic Science

The rising prevalence of obesity, diabetes and related disorders is an epidemic of global proportions. Research at the Institute of Metabolic Science is aimed at understanding these disorders and translating new discoveries into better health.

According to data from the latest Health Survey for England, 60% of men, 50% of women and 25% of children will be obese by 2050 if no action is taken. The International Diabetes Federation estimates that more than 285 million people worldwide currently have diabetes and that this will increase to 438 million by 2030.

'There is little doubt that modern-day lifestyles, which promote excessive food intake and discourage physical activity, have been driving the rapid increase in these disorders,' explained Professor Nick Wareham, co-Director of the Institute of Metabolic Science (IMS) with Professor Steve O'Rahilly. 'But not everyone exposed to an obesogenic environment is obese, and some overweight people don't suffer adverse conditions like type 2 diabetes. It's our genetic make-up that determines the effect of our lifestyle.'

It is this complex interplay between genes and environment, and how the scales can be tipped towards better health, which interests researchers at the IMS. 'Work in these areas has been flourishing for some time in Cambridge and unprecedented scientific opportunities to understand these disorders have been emerging locally and internationally,' said Professor O'Rahilly. 'By creating the IMS, we have been able to focus the multidisciplinary research and to link it directly with patient care.'

The IMS is a tri-institutional partnership between the University of Cambridge, the Cambridge University Hospitals NHS Foundation Trust and the Medical Research Council (MRC). Opened in 2008, the £20 million building has within it: the MRC Epidemiology Unit, led by Professor Wareham; the University of Cambridge's cross-departmental Metabolic Research Laboratories (MRL), led by Professor O'Rahilly, which includes the MRC Centre for Obesity and Related Metabolic Diseases; and the Clinical Care Centre, incorporating the Wolfson Diabetes and Endocrine Clinic and the Weston Centre for Childhood and Adolescent Diabetes and Endocrinology. The Wolfson Foundation, Garfield Weston Foundation and The Atlantic Philanthropies were major benefactors.

Finding the 'fat' genes

The MRL houses the research groups of around 20 Principal Investigators (PIs), whose expertise ranges from genetics and biochemistry, to cell biology and physiology. In addition to undertaking basic research into processes such as insulin action and the control of energy balance, these investigators provide the expertise that is critical for improved understanding of why particular genetic defects lead to human obesity and/or diabetes. They are also working increasingly closely with basic and clinical neuroscientists to understand the

biological underpinnings of appetite and how this can be disturbed by genetic and environmental factors. The Wellcome Trust (WT) has played a particularly important role in fostering the development of the MRL through its generous support of many of its PIs and through additional strategic support.

A breakthrough in the understanding of obesity came in the 1990s when Cambridge researchers discovered an underlying genetic predisposition to gain weight. 'It was a rare, severe form of the condition that led us to identify the broken gene,' explained Professor O'Rahilly who, together with Dr Sadaf Farooqi, was the first to describe patients who lacked leptin, which normally controls food-seeking behaviour. They were able to reverse the life-threatening obesity by giving patients daily injections of synthetic leptin. Since then, the Cambridge team and others have discovered eight genes that, when broken or missing, cause devastating consequences in those affected. The most recent discovery, published in *Nature* in February 2010, showed that some morbidly obese children are missing an entire region of chromosome 16.

Gene defects as strong as these affect more than a million people worldwide. Could there also be gene variants that produce a strong drive to eat in an even greater proportion of the population? One floor down from the MRL is the MRC Epidemiology Unit, which carries out studies at the population level to look for associations with disease. In a recent international collaborative study, the genomes of 32,000 individuals were scanned to uncover genetic associations with higher body mass index. This resulted in the discovery of six variants that affect a large proportion of the population. It turns out that several of the common variants occur in and around the very same genes that the researchers in the MRL had found to be the cause of severe forms of obesity.

The influence of lifestyle

Genes are only part of the story. Many large-scale investigations on the influence of lifestyle are under way in the MRC Epidemiology Unit to find out why some people are more susceptible than others to developing diabetes or obesity, and how this might be prevented.

To do this, a large number of people need to be studied for long periods of time. The InterAct study, for instance, is a major international consortium led by Cambridge that is analysing more than 10 years of follow-up data for 500,000 people in nine European countries and India who provided information on diet and physical activity at baseline. By analysing the genetic profile of the 12,500 people who have developed type 2 diabetes, and a similar number who have remained diabetes free, the team aims to pinpoint how genes and lifestyles interact. To balance this large-scale approach, the Fenland Study, which has just recruited its 5,000th volunteer, is collecting much more in-depth information about the links between these disorders and diet, lifestyle and genetic factors for individuals in the Cambridge region.

Several research groups are investigating how to translate knowledge gained from epidemiological studies into preventive action, by assessing diet and physical activity in adults and children, and testing interventions. Better measurement of notoriously difficult-to-measure behaviours like physical activity is a key part of this translational process. The MRC Epidemiology Unit has pioneered new methods for assessing physical activity and energy expenditure, including combined heart rate and movement sensors and waveform accelerometry.

Linking basic and clinical science

Many of the scientists at the IMS are also clinicians who treat patients in the Clinical Care Centre, on the ground floor of the building, or monitor their progress at the Cambridge WT Clinical Research Facility close by. This is a vital component of the success of the IMS: 'The clinical problems presented by patients inform the research, which in turn helps us to build the clinical expertise needed to assess and handle their care,' explained Professor O'Rahilly. Indeed, IMS scientists have discovered several previously unrecognised forms of diabetes and obesity in patients referred to the Centre as part of a national referral programme.

Recently published research shows how far the practical help for patients has progressed. Dr Roman Hovorka, based in the MRL, has developed an 'artificial' pancreas for patients with type 1 diabetes that can help them to control their blood sugar levels while asleep. The recent study was carried out during overnight stays for children and teenagers with type 1 diabetes at the WT Clinical Research Facility and is a stepping stone for the next stage of testing the system at home.

Other exemplars of the link between basic and clinical science include the work of Professor David Ron, Wellcome Trust Principal Research Fellow in the MRL, who is an international authority on cellular stress, a process of great relevance to the development and progression of obesity and diabetes; and Dr Susan Ozanne, British Heart Foundation Senior Fellow in the MRL, who investigates the mechanisms whereby nutrition early in life can influence later risks of obesity and diabetes.

Future choices

Researchers at the IMS are keen to maximise the impact of their work by informing steps to reduce and prevent obesity and metabolic disorders. Key to this vision is the Institute's connection to the Centre for Diet and Activity Research, which promotes excellence in public health research, and is directed by Professor Wareham at Cambridge's Institute of Public Health. Professor Wareham explained: 'This connection is important for translating a better fundamental understanding of these conditions, gained through research at the IMS, into helping people to make the right choices to stay healthy.'

For more information about research at the IMS, please visit www.ims.cam.ac.uk/

Institute of Metabolic Science, Cambridge Biomedical Campus, Hills Road

Reading closely: Faculty of English

Close scrutiny of text is the bedrock of a research culture that spans practically the whole range of contemporary English studies.

The Faculty of English boasts one of the largest concentrations of research activity in the discipline in the UK. 'Perhaps we could be accused of being overambitious but we'd like to think that, across the 100 or so Faculty members here, our combined research areas gather together all the threads that make up the fabric of English,' said Professor Adrian Poole, Head of the Faculty.

Research ranges chronologically from the 7th to the 21st centuries; linguistically from Classical to French and German literary traditions; geographically from colonial America to post-colonial India; thematically from early Christian music to 21st-century environmentalism; intellectually from the history of the language to the history of moral philosophy; even alphabetically from Aaron's Rod to Louis Zukofsky.

'To some extent, what we're doing is preserving and keeping alive the great heritage of English Literature,' added Professor Poole. 'Of course this might take a multitude of different forms, whether it's constructing arguments for the importance of a certain poet, bringing a fresh perspective to a genre, or drawing comparisons between contemporary literature and screen media.'

Founded in 1919, the Faculty was the first in the country to encourage the study of English literature up to the present day and to approach the discipline from a 'literary' point of view, rather than as a product of the history of the language. In 2004, a new chapter began, with the opening of a £15 million building funded by the University, external donors, including major gifts from Garfield Weston Foundation, The Kirby Laing Foundation and The Atlantic Philanthropies, and the Higher Education Funding Council for England (HEFCE).

For the first time in the history of the Faculty, its research and teaching, a drama studio and 80,000 library books were together, as well as the closely linked Department of Anglo-Saxon, Norse and Celtic (ASNC) and the Research Centre for English and Applied Linguistics (RCEAL).

A close read

Great importance is attached to the ability to read literary texts closely and attentively, combining this with detailed historical research. New vistas in understanding writers and their work can be opened up by unpicking the rich historical patchwork that influences them, as Professor Helen Cooper, expert in medieval and Renaissance literature, is finding.

Professor Cooper's most recent research, due to be published later this year, investigates Shakespeare and the medieval world. 'Although we think of him as quintessentially belonging to the English Renaissance, Shakespeare's world was still largely a medieval one,' she explained. 'The cityscape of London was still medieval, his ideas about what could be staged and how it was done were carried forward from the late days of the Mystery Cycles, and half his plays have medieval roots. We can only measure what he achieved, or even see it clearly, when we recognise how much the

DR JASON SCOTT-WARREN AND DR ANDREW ZURCHER

underlying culture of the Middle Ages shaped the world's greatest playwright.'

Working in a very different period, Dr Ben Etherington, a newly arrived Faculty-funded Research Fellow, also brings together close reading with an awareness of historical context. His research focuses on post-colonial and international literatures in English, a fast-growing research area in Cambridge and elsewhere. Studying literary primitivism in the early 20th century, and reading the work of writers and intellectuals from the Anglophone and Francophone Caribbean, Britain, West Africa and France, Dr Etherington is interested in the spread of primitivist modes of writing and what this can tell us about colonialism in the early to mid-20th century.

Embracing a digital age

Members of the Faculty have been in the vanguard when it comes to embracing the changing landscape brought about by digital advances. The recently completed Scriptorium project, funded by the Arts and Humanities Research Council, has assembled a digital archive of medieval and early modern manuscripts, and teamed this up with a fully interactive online course to help scholars learn how to read these notoriously difficult texts.

A computational approach is being taken in a groundbreaking collaborative research programme in RCEAL called English Profile, supported by Cambridge University Press and Cambridge ESOL. 'The idea is to understand how English is acquired as a second language and then apply this knowledge to improving textbooks and testing,' explained Dr Henriëtte Hendriks, Acting Director of RCEAL and one of its Principal Investigators. A corpus of 26 million words taken from test sheets for speakers representing over 100 different languages is being analysed by linguists and computational linguists for the common developmental paths that learners of English follow over time. This study is just one of several RCEAL projects that are helping to solve practical problems involving the English language – in language teaching, textbook publishing and even medical diagnosis.

A pioneering study by Professor Peter de Bolla could have implications for transforming research methodologies of the future. In a project funded by the Leverhulme Trust, Professor de Bolla has been mapping how an idea, or concept, develops through literature. Rather than attempting the impossible task of reading many thousands of books, letters and manuscripts, Professor de Bolla has taken the innovative step of searching for and counting the incidence of sets of keywords in the huge digital archives that have only recently become available to scholars. It's new territory for scholars of English, forging a methodology that has the potential to reap significant academic dividends.

Anglo-Saxon gold

Recent headlines might give the impression that to strike Anglo-Saxon gold you need a metal detector but, as ASNC academics Professor Simon Keynes and Dr Rosalind Love discovered, there's still plenty awaiting the historians and literary scholars who depend on texts.

When a 14th-century compilation of historical materials that had lain undiscovered in the library of the Earl of Devon for centuries went under the hammer at Sotheby's, an eagle-eyed expert (and former ASNC graduate student) spotted that it contained a copy of a much older and incredibly rare text. It was the *Encomium Emmae Reginae*, a highly charged polemic written on behalf of Queen Emma, wife of King Æthelred the Unready and then of King Cnut, in 1041. But, unlike the only other surviving copy, it was preserved here in a version with a different ending, added after the accession of her son Edward the Confessor in 1042. Coincidentally, a related discovery was made in Oxford, where papers of a 16th-century antiquary were found to include a long-lost section from a biography of King Edward, written soon after his death in 1066.

Both 'new' texts have now been studied closely at ASNC, and interpreted in relation to each other. 'The variant ending of the *Encomium* is rather explosive in its implications for our understanding of how Edward's accession was perceived by contemporaries, spinning it as the longed-for restoration of the Anglo-Saxon royal line,' explained Professor Keynes. 'And it provides the perfect context for understanding a poem, now fully recovered, which describes a magnificent ship given to Edward at precisely that time,' added Dr Love.

The word in the world

The newest initiative for the Faculty of English has been the launch of the Centre for Material Texts, which will foster the next generation of research and teaching relating to texts of any form, from spoken words to celluloid, from manuscript to XML. As any academic in the Faculty will attest, text is the product both of its creator and a mass of worldly circumstances; unravelling how texts of many kinds have been embodied and circulated is becoming one of the most exciting areas of humanities research today, and continues a tradition at the Faculty of English of getting close to the written word.

Faculty of English, West Road

For more information about research at the Faculty of English, please visit www.english.cam.ac.uk/
RCEAL: www.rceal.cam.ac.uk/
ASNC: www.asnc.cam.ac.uk/

IfM

Cambridge has never been short of ideas but the Institute for Manufacturing is dedicated to putting ideas into action.

Making the most of ideas: Institute for Manufacturing

Turning ideas and opportunities into products and services has traditionally been seen as the role of business and industry. But all too often, new ideas have failed to make the journey to creating substantial new industries. The Institute for Manufacturing (IfM) is dedicated to bridging the gaps between academia, industry and government, to provide a more connected approach to manufacturing and industrial innovation.

From its inception in 1998, the IfM, embedded in the Manufacturing and Management Division of the Department of Engineering, has adopted a broad view of manufacturing to include understanding markets, research, design, product development, production, distribution, services and, increasingly, sustainability. The Institute brings together expertise in engineering, management and policy under one roof, and combines this broad scope within a unique structure that integrates education, research and practice.

'Introducing people to the challenge and excitement of turning ideas and opportunities into products and services is enormous fun,' said Professor Mike Gregory, Head of the IfM, 'and our new purpose-designed building is a perfect home in which to accomplish this.'

Opened in November 2009, IfM's new £15 million building was made possible by donations from philanthropist Dr Alan Reece, after whom the building is named, The Gatsby Charitable Foundation and local industry. It combines an innovation and design studio, process and automation labs, and state-of-the-art teaching facilities, all leading off a large common room for staff, students and visitors, providing the maximum opportunity for new ideas to spark and spread.

An emphasis on collaboration

Research at the IfM seeks to bring together different fields of knowledge to tackle larger-scale questions that typically lie at the interface between traditional disciplines, as Professor Gregory explained: 'Universities are great at developing new ideas and Cambridge is clearly no slouch in this regard. But, for those outside the world of academia, ideas are only as good as what you can do with them.'

The IfM started as an exciting 'experiment' in bringing theory and practice closer together; it embodies a ground-up approach to addressing some of the major challenges of the day, such as healthcare and sustainability. 'The opening of our new building marks the end of the first phase of this experiment and the work we have done so far suggests we are only at the beginning of what this configuration can achieve,' asserted Professor Gregory.

'The emphasis here is on collaboration – locally, nationally and internationally across disciplines, across centres, across the University and across industries. Indeed, informal networks are already beginning to form spontaneously – just as we hoped they might.' Professor Gregory argues that the ethos of integration and collaboration provides an excellent complement to the centres of deep expertise within the IfM, around the University and beyond.

Engagement with industry and government is a key distinguishing feature of the Institute. 'The IfM model is designed to fill a gap in the traditional University structure and allows academics to work with companies of all types and sizes – from helping start-ups and small and medium enterprises, to advising on the global configuration of major corporations,' explained Professor Gregory. Engagement with policy is just as important, as governments become increasingly focused on industrial innovation and its global context.

Themes on a global scale

'We see ourselves as a 'community centre' for all those involved with manufacturing – students, industrialists, policy makers and other academics. To engage with this community, we need to support the core interests of community members and that's reflected in our research activities [see panel] and broader themes,' explained Professor Gregory. The big themes to have emerged at the IfM over the past two years have indeed been global in their scale: Services, Industrial Innovation, Emerging Industries and Industrial Sustainability.

The IfM is already taking a national lead in Services – particularly the design and operation of complex technology-based services. In the recent S4T (Service Support Solutions: Strategy and Transition) project, the IfM headed a consortium of 10 British universities working with BAE Systems to study the continuing transformation of the UK economy towards increasing value generation from product-related services. Under the Industrial Innovation theme, another IfM-led consortium of leading businesses is seeking to identify the skills required, and the barriers that need to be overcome, to implement open innovation models.

The Emerging Industries programme is already shedding new light on the evolution of new industries and identifying ways in which the translation of ideas into action might be accelerated. And, the Industrial Sustainability theme is attracting huge interest and involvement from staff and students alike as the IfM seeks to tackle one of the vital questions of the age – how to provide people across the planet with the goods and services they need without irrevocably damaging the environment.

Inspire, engage, educate

IfM's new building is a major addition to the University's West Cambridge campus for science and technology. It joins an existing concentration of related research centres, as well as the Hauser Forum (see page 5), a focal point for entrepreneurship and technology transfer. Professor Gregory believes that new challenges and opportunities are now possible after the move to the new facilities: 'Through the generosity of benefactors Dr Reece and Lord Sainsbury, we have a wonderful platform to inspire, engage and educate people in the excitement and challenge of manufacturing and industrial innovation.'

IFM

Institute for Manufacturing, Alan Reece Building, Charles Babbage Road

Research activities at the IfM

Professor Mike Gregory, Head of the IfM, outlines the scope of research activity at the Institute:

R&D

'Understanding how R&D is conducted and how this is transformed into actual applications is important. Too often R&D is represented at the beginning of the value chain. Work at the IfM has illustrated how it can have impact all along the process.'

Design

'The IfM's Design Management Group aims to improve the ways in which design can be managed and exploited, at product, firm and national levels. The group's Design in Science project is looking at how scientists can benefit from working with designers to aid research.'

Production

'All of the IfM's research has real-world benefits. In terms of production, it's vital that industrial processes are as efficient as possible. The IfM's Inkjet Research Centre is looking at how manufacturing can be conducted using techniques familiar to anyone who has used a computer printer. Photonics researchers are looking at the impact lasers can have on manufacturing, which could lead to new industrial developments over the next 20 years.'

Distribution

'We live in an interconnected world and UK business needs to know how to operate on a global level. Our work, such as looking at supply chains in emerging firms and industries, helps facilitate this understanding.'

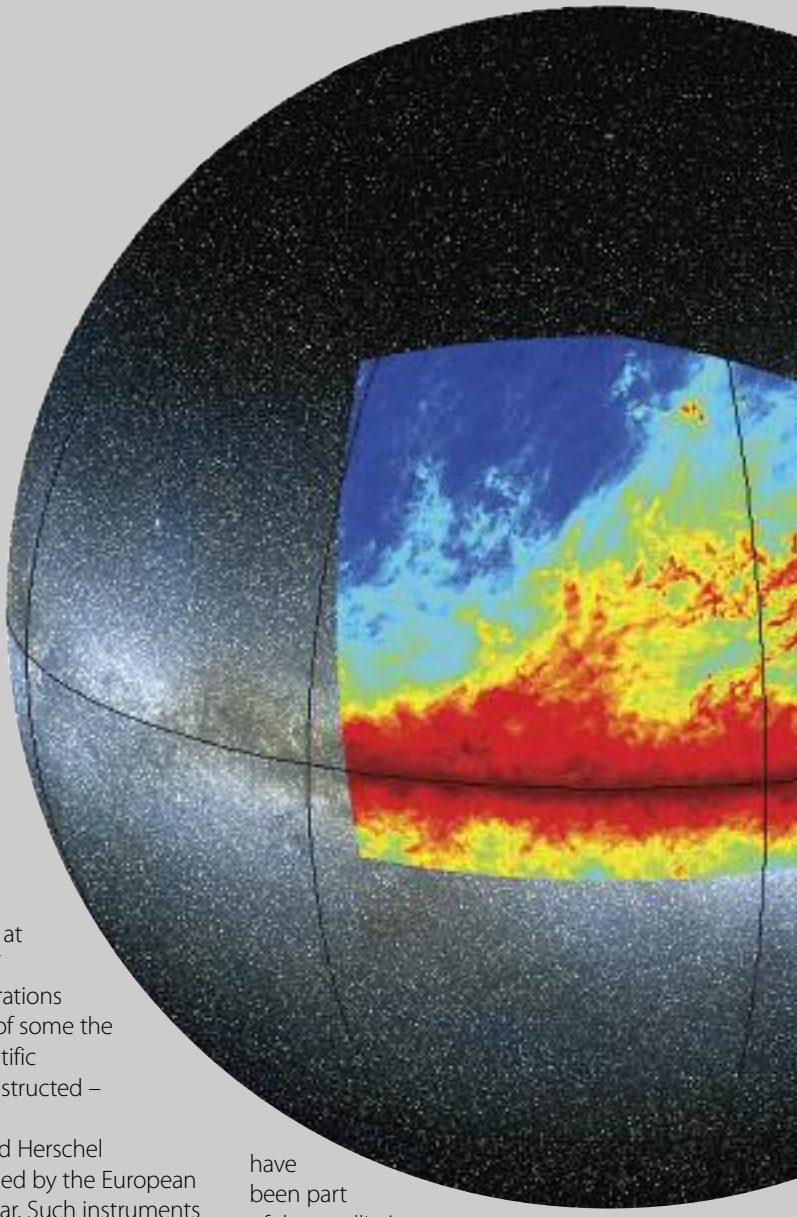
Services

'Helping companies to understand how to sell their business as a service rather than just a product is a major element of our work. Our research is helping companies understand important issues like risk and cost mitigation, and the impact of transition towards service provision, which is increasingly an integral part of manufacturing.'

For more information about research at the IfM, please visit www.ifm.eng.cam.ac.uk/

Probing the Universe: Kavli Institute for Cosmology

Scientists at Cambridge's Kavli Institute are studying how the Universe developed after the Big Bang by analysing light emitted up to 13.7 billion years ago.



It may be one of Cambridge's newest buildings but its historic roots lie in one of the University's oldest scientific research departments. The £4 million Kavli Institute for Cosmology Cambridge (KICC), opened in 2009, is built just yards from the University Observatory, where astronomical research has been carried out since the early 19th century. In the intervening years, Cambridge has developed an international reputation for ground-breaking discoveries about the origin, evolution and structure of the Universe, thanks to research in the Institute of Astronomy, the Department of Physics' Cavendish Laboratory and the Department of Applied Maths and Theoretical Physics (DAMTP).

The driving force for the new Institute was to bring together some of the groups from these departments, as Professor George Efstathiou, Director of KICC, explained: 'The spread of research across departments owes much to the natural divisions that resulted from the diverse 'tool boxes' used to study different areas of cosmology, such as the events following the Big Bang, the birth of stars, the structure of the Universe and so on. Today, though, there are increasing overlaps and it makes sense to integrate research programmes where there is common ground.'

KICC is now home to 55 scientists, including many graduate students from each department, and is also recruiting a new generation of research scientists: Drs George Becker, Ian McCarthy and Carrie MacTavish are the first Kavli Institute Fellows to be appointed, funded by an endowment from The Kavli Foundation to pursue independent research in Cambridge.

'Fossil record' of the early Universe

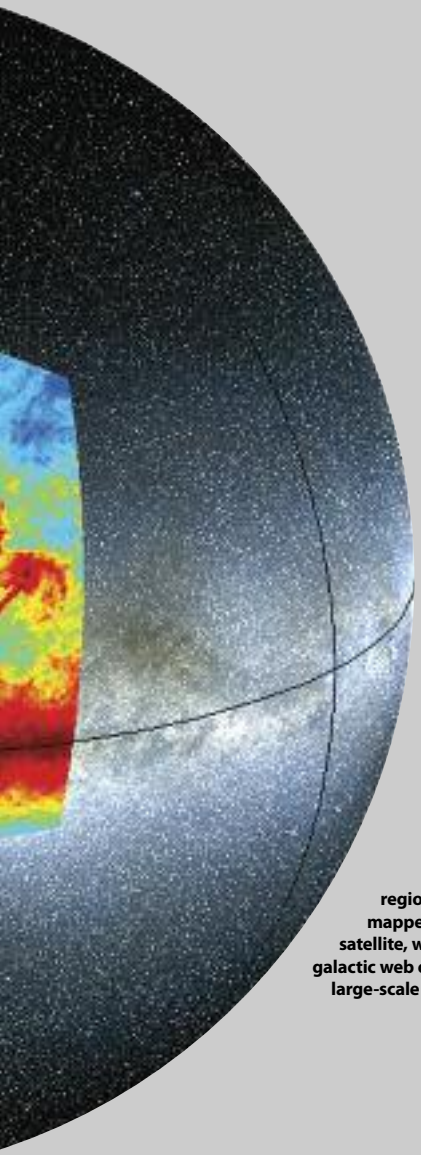
Where did our Universe come from? What is it made of? How is it evolving? To help answer some of the most fundamental questions about the Universe, researchers at KICC are members of international collaborations that are making use of some the most advanced scientific instruments ever constructed – satellites such as the £1.7 billion Planck and Herschel Observatories launched by the European Space Agency last year. Such instruments will provide insight into events that happened billions of years ago – the Universe's unique 'fossil record' – by analysing the light emitted in the distant past but which is only reaching us now.

'The furthest back we can currently detect corresponds to light that was emitted 300,000 years after the Big Bang, just under 13.7 billion years ago, when the Universe was as hot as the surface of the Sun,' explained Professor Anthony Lasenby, Deputy Director of KICC. 'When it was emitted, it was visible light, but because the Universe has expanded by a factor of over a thousand, it has stretched out and become cosmic microwave background radiation.' The Planck satellite will measure tiny fluctuations in the radiation with the highest accuracy ever achieved.

Working in partnership with over 40 institutes as part of the pan-European Planck collaboration, Cambridge scientists have been part of the satellite's scientific programme since its inception in 1993, and are now involved in analysing and interpreting the vast amounts of data delivered back to Earth. The satellite will complete a full scan of the whole sky every six months until the end of 2011, providing information to test theories of the early Universe and the origin of cosmic structure.

Shifting into the red

After the Big Bang, the first stars are thought to have formed out of a network of matter that grew from the tiny fluctuations seen in the cosmic microwave background. Dr Martin Haehnelt, Dr George Becker and others at KICC are studying the composition of this network, which is known as the intergalactic medium. 'The energy released from the first stars would have had a dramatic



Location of the region most recently mapped by the Planck satellite, which revealed a galactic web of cold dust and large-scale structure in the Milky Way

impact on the medium around them, changing the way future stars and galaxies would form,' Dr Becker explained. 'We can study the intergalactic medium from when the Universe was about a billion years old through to the present, but we'd like to go even earlier, closer to the Big Bang, because it contains the fingerprint of the initial and changing conditions needed to form what we see today.'

To do this, cosmologists are looking at the high-redshift Universe. As the Universe expands, light produced by distant stars and galaxies is stretched to longer wavelengths, changing the apparent colour of the light: the more distant the object, the redder its light becomes by the time it reaches Earth. As a result, highly redshifted objects trace the earliest phases of the Universe's evolution. Using the University's Darwin supercomputer, Dr Becker is analysing data showing the thermal and gaseous history of the Universe to understand the ingredients needed for galaxy formation.

Researchers at the Kavli are also studying the high-redshift Universe in order to catch first sight of young galaxies. By searching the sky at unprecedented levels of sensitivity, a team led by Dr Haehnelt has discovered very faint traces of long-searched-for galaxies.

Radio telescopes of the future

Kavli scientist Dr John Richer is the UK Project Scientist for ALMA, the Atacama Large Millimeter Array, a huge radio telescope sited in the Atacama Desert of northern Chile. ALMA is the result of collaboration between 17 countries worldwide. When completed in 2013, it will provide the first detailed images of the gaseous component of high-redshift galaxies; in addition, it will map the structure of the discs of material that surround newly formed stars in which planetary systems are known to form. To do this, ALMA will combine data from 66 radio antennas to construct a telescope with an effective diameter of 10 miles, using the technique of aperture synthesis that won Cambridge astronomers Sir Martin Ryle and Professor Antony Hewish the 1974 Nobel Prize in Physics.

Meanwhile, a Cambridge team led by Dr Paul Alexander is providing crucial input into the science, design and costing of the Square Kilometre Array (SKA) radio telescope; Dr Alexander leads the UK technical work on the SKA design, heading a team split between Cambridge, Manchester and Oxford. Construction of the first phase of the instrument is expected in 2015, with completion in 2020. Dr Alexander explained the importance of this new development: 'The SKA will be 100 times more sensitive than the radio telescopes of the present generation, and will be able to survey the sky up to one million times faster. This will enable us to probe the so-called 'dark ages' of the Universe before the first stars shed light, observe the formation of galaxies, test theories of gravity and study the role of cosmic magnetism.'

Writing the history of the Universe

The scientific goals of KICC are ambitious: 'The concept of reconstructing, in three dimensions, events that happened over a time span of nearly 14 billion years is no longer just a dream,' said Professor Efstathiou. 'Working with the international community, and as part of the wider Kavli family of 15 institutes worldwide, we hope to make dramatic discoveries about the history, fabric and evolution of the Universe as we reach further into the sky.'

For more information about research at the Kavli Institute for Cosmology, please visit www.kicc.cam.ac.uk/

Kavli Institute for Cosmology, Madingley Road

Criminologists in Cambridge are investigating the origins, prevention and control of crime in a fast-changing world.

***Revan*; painted by an inmate of HM Young Offender Institution Portland and now part of the Institute of Criminology's art collection, acquired through the Koestler Trust**

Challenging crime: Institute of Criminology

At a time when problems like youth violence, terrorism, prison overcrowding and fear of crime are key issues in many countries, the work of Cambridge's Institute of Criminology is as relevant as ever in its 50-year history.

At the heart of research at the Institute is a 'life-course' approach to understanding crime, as Professor Friedrich Lösel, the Institute's Director, explained: 'We're interested in what causes individuals to commit crime; which steps can be taken to prevent them from doing so; and, when crime happens, how justice is dispensed, punishment is implemented and offenders can be rehabilitated.'

Above all, this isn't ivory tower research. Central to the Institute's work is the dual importance of fundamental scholarship and real-world practical relevance. The result is a portfolio that stretches from philosophical debate on penal ethics through to testing theories of crime prevention on city streets.

Those new to the concept of criminology might regard it as a small single discipline – after all it's basically the study of criminal behaviour. But criminology is multifaceted, drawing from disciplines as diverse as law, sociology, psychology, biology, medicine, economics, political science and history. Fortunately, founding Director Sir Leon Radzinowicz had the foresight in 1959 to orchestrate a truly trans-disciplinary Institute of Criminology in the Faculty of Law. Today, within its £13.2 million home, funded by The Wolfson Foundation and into which the Institute moved six years ago, a vibrant and eclectic research community is flourishing.

Taking the long view

Research that traces the development of delinquent and criminal behaviour over many decades is a particular strength of the Institute. 'Longitudinal studies give us a remarkable degree of insight into why some youngsters are delinquent while others are not, and to what extent this continues into criminal behaviour in adulthood,' said Professor Lösel.

In fact, one of the longest running of such studies in the world continues at the Institute today. Begun in 1961, the Cambridge Study in Delinquent Development is unique in criminology not just for the length of follow-up period, but also because of the exceptionally high number (93%) of the original sample of 411 boys aged 8–9 years who are still being interviewed.

The study has determined the six most common predictors of criminal behaviour – a convicted parent, high daring, low school attainment, low family income, disrupted family and large family size. Professor David Farrington, who leads the study, explained the benefits of calculating risk scores for these predictors: 'It's clear from our study that the most persistent offenders start early, have long criminal careers and tend to produce the next generation of delinquent children. Prevention programmes targeted at the most at-risk children would help to break this cycle.'

Finding out what influences young people to break rules of conduct is a central aim of the Peterborough Adolescent and Young Adult Development Study (PADS+), funded by the Economic and Social Research Council. By 2012, PADS+ will have followed approximately 700 participants from ages 11 to 21 years, a critical period for personal and social development. 'The research is clearly showing how social environments and their moral contexts

affect young people differently depending on their personal morality and self-control,' explained Professor Per-Olof Wikström, who leads the study. 'This is crucial for understanding and preventing their crime involvement.'

The Institute is also involved in other long-running studies: the Sheffield Study (led by Professor Sir Anthony Bottoms) investigates why young adult offenders desist from crime; and studies in Zurich (Professor Manuel Eisner) and Erlangen-Nuremberg (Professor Lösel) address not only the development of delinquency but also its prevention in childhood.

'Pressure point' policing

At the Institute's Jerry Lee Centre, the world's first university centre devoted to experimental criminology, randomised controlled trials are being used to test crime prevention and criminal justice programmes.

Geographic 'hotspots' that show high levels of crime are well known at certain pressure points in cities. 'In theory, if you can prevent offenders from committing crime in these areas, it may be possible to stop them altogether,' said Lawrence Sherman, Wolfson Professor of Criminology and Director of the Centre.

Professor Sherman is working with the Greater Manchester Police to test the idea that crime might be reduced by focusing police presence in these areas 'to spoil the party for would-be offenders'. The theory is that one officer can deter more crime by policing a series of these individual hotspots, each of which may only cover a few hundred square feet, than by making less-structured patrols across a wider area.

Crime and punishment

Professor Sherman is also conducting randomised field experiments in the UK and Australia to test the idea of 'restorative justice' – a process by which the offender comes face to face with the victim to account for the crime. With 12 ongoing field experiments, involving 3,000 crime victims and offenders, this is the largest programme of randomised trials for a single crime prevention strategy. A recent independent evaluation found a 27% reduction in reconvictions of offenders two years after the restorative justice meetings. Other research in the Institute carried out by Dr Loraine Gelsthorpe addresses the practice of probation and community penalties as alternatives to imprisonment.

However, the Institute's research doesn't stop at the prison door. Work being carried out in the Prisons Research Centre (PRC), directed by Professor Alison Liebling, addresses the question of 'what shapes prison life'. A major study is evaluating public- versus private-sector prisons: their values and practices, and how these affect prison quality and outcomes. One of the results of the PRC's research has been the development of a survey-based management tool to measure prison quality or 'moral performance' objectively; prison managers are using this as a basis for strategic planning. Other research that is helping to improve the climate of prison life focuses on the central role of prison officers in using their discretion, determining prisoner wellbeing and preventing suicide in prison.

Institute of Criminology, Sidgwick Avenue

And what happens after prison? Work at the Institute follows up prisoners on release, looking for indicators of progress, and using systematic research to establish how well rehabilitation programmes are working. 'Clearly, investing in non-evidence-based rehabilitation programmes is risky for society and potential victims,' explained Professor Lösel. 'Getting to the nub of what works is a priority for informing how best to rehabilitate and reduce re-offending.'

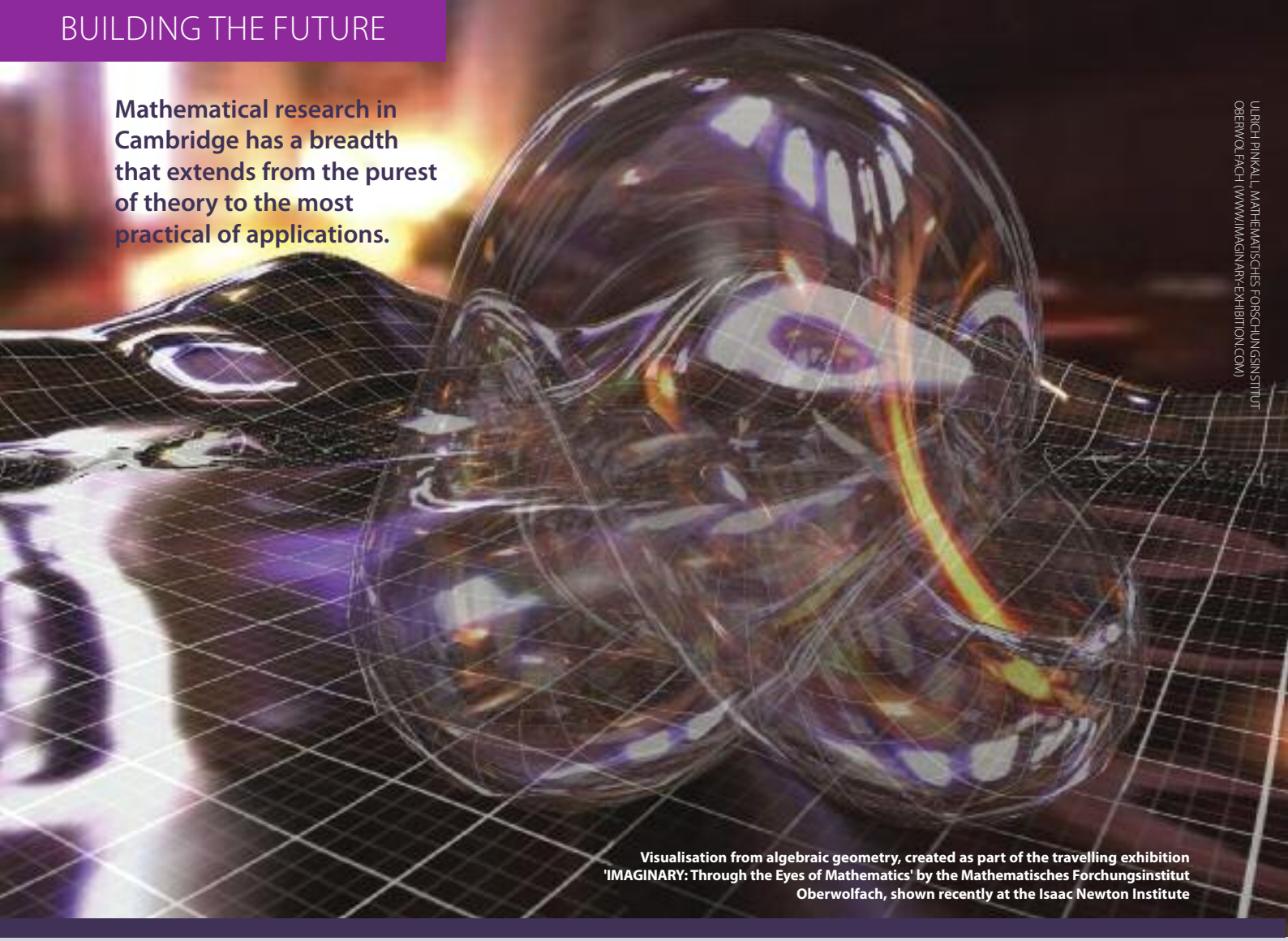
Targeting policy

As well as the many applied studies – such as evaluating the success of closed-circuit television, improved street lighting, treatment of sexual offenders, programmes against school bullying – research of a more theoretical nature happens at the Institute's Centre for Penal Theory and Penal Ethics, led by Professor Andrew von Hirsch. Scrutinising contemporary theories of criminal law, punishment and crime prevention, researchers at the Centre are considering issues such as the comparative merits of penal and restorative justice approaches to dealing with convicted criminals, and the rationale for prohibiting offensive and 'anti-social behaviour'. From a more practical perspective, Dr Adrian Grounds, a forensic psychiatrist, investigates cases of wrongful convictions in the justice system.

From the outset, a clear mission of the Institute has been to undertake research that contributes to evidence-based crime policy. Helping to disseminate the collective expertise of the Institute, Professors Farrington, Lösel and Sherman are part of the Campbell Collaboration Crime and Justice Group, an international network of researchers that promotes the best evidence on measures of crime prevention and control. 'The ultimate aim of the Group mirrors that of the Institute of Criminology as a whole,' commented Professor Lösel. 'The backbone of both is to create a state-of-the-art knowledge base in criminology that will help reduce crime and increase justice in society.'

For more information about research at the Institute of Criminology, please visit www.crim.cam.ac.uk/

Mathematical research in Cambridge has a breadth that extends from the purest of theory to the most practical of applications.



ULRICH PINKALL, MATHEMATISCHES FORSCHUNGSINSTITUT OBERWOLFACH (WWW.IMAGINARY-EXHIBITION.COM)

Visualisation from algebraic geometry, created as part of the travelling exhibition 'IMAGINARY: Through the Eyes of Mathematics' by the Mathematisches Forchungsinstitut Oberwolfach, shown recently at the Isaac Newton Institute

Spanning application and abstraction: Centre for Mathematical Sciences

Mathematics has been studied in Cambridge for much of the past 800 years. Its history includes Robert Recorde, credited with inventing the equals sign in the 16th century, and Sir Isaac Newton, the great 17th-century mathematician, physicist and holder of the Lucasian Professorship of Mathematics.

Today, the Faculty of Mathematics comprises two Departments: Applied Mathematics and Theoretical Physics (DAMTP) and Pure Mathematics and Mathematical Statistics (DPMMS), both now housed in the magnificent £61.4 million Centre for Mathematical Sciences (CMS). Officially opened in 2005, the CMS has been designed to encourage synergy between the Departments and to exploit new possibilities for collaboration. 'The new buildings are giving us the opportunity to learn and benefit from each other in a place that fosters creativity, ideas and the possibilities they represent,' said Professor Martin Hyland, Head of DPMMS. 'New research and teaching activities have begun, and more are sure to follow as old boundaries disappear.'

The complex comprises seven large pavilions grouped around a grass-roofed central building containing communal areas, lecture theatres and a laboratory. It also incorporates the Betty and Gordon Moore Library, named in honour of its benefactors, and the Isaac Newton Institute, which is a national and international visitor research centre.

Mathematics might be an historic subject for Cambridge, but it is also a discipline concerned with the modern world, as Professor Peter Haynes, Head of DAMTP, explained: 'Mathematics lies at the centre of a vast range of practical and fundamental questions, whether it's calculating the probability of risk, assessing change in our atmosphere, predicting avalanches or modelling viral epidemics.'

Earth and beyond

What makes sense of mathematical research is that it tells a story. For some mathematicians their stories derive from the real world and for others they come from the realms of abstract thought. Some of the most striking contrasts in mathematical process can be found in areas that, at their heart, are concerned with understanding the fundamental forces of nature.

On the one hand, some of the more applied aspects of research at the CMS are centred on the mechanics of fluids and solids. Mathematicians have joined forces with researchers in the Departments of Chemistry and Geography, forming the Centre for Atmospheric Science, to study the changing atmosphere. Similarly, the Institute of Theoretical Geophysics, a joint venture with the Department of Earth Sciences, is focusing on the physics of volcanoes, the Earth's core and mantle, and sliding of the giant glaciers over

land, which have applications in the oil industry and carbon capture. 'In all of these areas, great skill is required in deploying the best mathematical techniques to interpret and simulate what we see in nature,' said Professor Haynes. 'Similar expertise is also being used in a host of other areas, such as noise from jet engines, improved ink-jet printing technology and nutrient transport in organisms.'

On the other hand, Professor Michael Green, newly elected Lucasian Professor, looks beyond Earth to develop theories of the Universe. This is the 'Wild West' frontier of mathematical physics, where imaginative ideas take shape about how the Universe might be. Professor Green is known internationally as a pioneer in string theory, which describes how the Universe is composed of tiny vibrating strings of energy. Like Professor Stephen Hawking, former Lucasian Professor and now a Director of Research in DAMTP, who discovered that black holes are not actually black, Professor Green maintains the Cambridge tradition of deriving radical ideas from elegant mathematics.

Purely maths

Some study mathematics because it is involved in everything around us, but others are simply fascinated by the subject itself. 'Pure maths is driven by the endlessly absorbing rigour and beauty of compelling questions for their own sake,' explained Professor Hyland. 'The challenge comes when there is no obvious way to proceed.'

Some recent highlights, such as Dr Caucher Birkar's work on the minimal model programme and Professor Nick Shepherd-Barron's work on the Sato–Tate conjecture, involve ideas accessible only to the mathematical specialist. Other advances, such as those of 1998 Fields Medallist Professor Tim Gowers on Szemerédi's theorem and Professor Ben Green on arithmetic progressions in primes, address problems that can be readily appreciated by the layman, even if the method of solution cannot. The common feature is that the solutions involve some remarkable new ideas.

'Often, it is not so much the answer to the problem but the process of solving it that's extraordinary,' said Professor Hyland. 'There is enormous value to mankind not only in developing the mathematical skills to solve significantly hard problems but also in simply adding to the body of knowledge about the mathematical universe.'

Reaching out

Mathematics is increasingly playing a significant role in many disciplines beyond the physical sciences. In biology, for example, enormous amounts of complex data are produced through genome sequencing, medical imaging, microscopy and other sources, and mathematics holds the key to exploiting these data. One of the newest developments within DAMTP is the Cambridge Computational Biology Institute (CCBI), which was set up to promote research requiring mathematical and computational biology. CCBI's broad research interests stretch from microbial evolution to human disease.

Dr Julia Gog, for instance, specialises in the mathematics of infectious diseases, working with scientists in Departments including Pathology and Veterinary Medicine on the dynamics of diseases such as influenza. Dr Stephen Eglen models the development of the nervous system, in particular the structural and functional development of the visual system. Professor Ray Goldstein combines mathematics, physics and biology in theory and laboratory experiments to understand how self-propelled bacteria and algae move through fluids and what physical factors might have stimulated the evolutionary transition to multicellularity.

The Statistical Laboratory within DPMMS is concerned with probability and statistics, and their applications. It too addresses the increasing need for mathematical know-how within diverse fields of application, not only in biology, but also in engineering and finance. In 2006, the Engineering and Physical Sciences Research Council (EPSRC) awarded the University £2.3 million to develop core and methodological statistics and to foster stronger links to application areas. This resulted in the Cambridge Statistics Initiative, which today is providing the necessary bridge in Cambridge between statistical theory and practice.

Building the future

As well as progressing long-established research areas and developing fresh applications for mathematics, the CMS also has an eye on equipping the next generation of mathematical minds. The Cambridge Centre for Analysis, funded by EPSRC, opens at the beginning of the coming academic year to train PhD students in mathematical analysis. Directed by Professors James Norris and Arieh Iserles, this Centre for Doctoral Training is a major joint venture between DAMTP and DPMMS and will provide students with interdisciplinary research opportunities as well as broad training in vital aspects of modern mathematics.

It is this spirit of opportunity that embodies Cambridge mathematics, as Professor Hyland explained: 'Part of our inheritance is the intellectual range that makes possible connections between seemingly unrelated phenomena and enables independent ideas to take flight. These opportunities will blossom here. In 50 years' time, I believe that people will look back and say that moving the Departments together to form the CMS was a watershed for mathematics in Cambridge.'

For more information about research at the CMS, please visit www.cms.cam.ac.uk/
Major benefactors of the CMS: The Atlantic Philanthropies, Charles N. Corfield, Dr Martin C. Faulkes, The Märit and Hans Rausing Charitable Foundation, Garfield Weston Foundation and The Wolfson Foundation.

GARETH MARLOW

Centre for Mathematical Sciences, Wilberforce Road


PROFESSOR ALISON SMITH


DR BEVERLEY GLOVER

Seeding growth: plant sciences

The study of plants is blossoming in Cambridge, with new facilities, new research and soon a major new institute.

Increasingly, plants are recognised as being at the heart of sustainable solutions to many global concerns, whether it's the need to secure food supplies, develop biofuels or tackle environmental issues. 'Plant-related research is now much more prominent as a result of this new awareness,' said Professor Sir David Baulcombe, Head of the Department of Plant Sciences and first incumbent of the newly created Regius Professorship of Botany. 'We want to be in a position in Cambridge to step up to the mark and generate the understanding and applications needed to meet these challenges.'

Fortunately, Cambridge has a strong record in the study of plants, a record that is being strengthened by funding for new facilities and research in the Department of Plant Sciences, and by the ongoing construction of the Sainsbury Laboratory in the University's Botanic Garden.

A long-term refurbishment programme within the Plant Science buildings in the centre of Cambridge has seen the addition of wet and dry research laboratories on two floors of the building. Three new Royal Society Research Fellows in the Department have been funded by £2 million from The Gatsby Charitable Foundation, which has also provided £2 million support for Professor Baulcombe's research.

Added to this are the two new buildings. A £6 million Plant Growth Facility situated in the Botanic Garden, funded by the Science Research Investment Fund and The Gatsby Charitable Foundation, has provided much-needed space for cultivating and studying plants under controlled environmental conditions. Due for completion later this year is the magnificent Sainsbury Laboratory, which has been made possible through a gift by The Gatsby Charitable Foundation of £82 million, the largest single gift received by the University since the launch of the 800th Anniversary Campaign.

From forests to fragments

The study of plants has been transformed by the resources now available to biologists. In the Department of Plant Sciences, engineering principles are being applied to plant development and behaviour; computer modelling yields vast datasets on the spread of plant viruses or of genetically modified crops; sophisticated genetic tools and high-volume DNA sequencing are giving insight into how plant cells function and how they can be modified; and refined chemical approaches are opening up new routes for generating energy from plants.

The exceptional breadth of research doesn't reach just from genetics to biochemistry, and from evolution to ecology, but also from gigantic to miniscule. One example of the larger-scale research being undertaken in the Department is Dr Ed Tanner's work on the Panamanian rainforest. For the past decade, Dr Tanner's group has been looking at the effects of climate change on carbon and nutrient fluxes in lowland tropical rainforest.

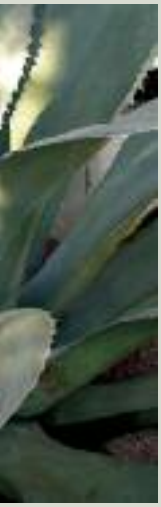
Elevated CO_2 in the atmosphere increases the growth of trees, which produce more leaves that eventually fall from the canopy to the forest floor. Dr Tanner's research group has demonstrated that this additional leaf fall has the net effect of mobilising carbon that was stored in the soil. 'These data have environmental implications since they show that carbon in tropical soil is in dynamic equilibrium and that additions of carbon can destabilise some of the soil organic matter, causing increased release of CO_2.'

At the other end of the size range, many research groups aim to understand how plant cells work at the molecular scale. For example, research in Professor Baulcombe's group investigates how plants regulate gene expression, and in particular the molecular mechanisms that enable plants to become disease resistant. 'We have shown how the presence of small fragments of the genome of an infecting virus in a plant cell guide a plant protein to newly infecting virus genomes and silence them, stopping the plant from being re-infected by the same virus.'

Professor Baulcombe's work on this mechanism of gene silencing, and the small interfering RNA molecules that achieve it, has been honoured several times over: the 2008 Lasker Award for Basic Medical Research, and this year's Wolf Foundation Prize in Agriculture and the Harvey Prize. As well as providing new opportunities for engineering disease resistance in plants of agricultural value, gene silencing offers a tool for turning genes on and off in plants to help determine their function.

Plants for food and fuel

The United Nations Food and Agricultural Organization has forecast that global food


PROFESSOR HOWARD GRIFFITHS


DR TIM UPSON


DR EMMA SAYER AND DR ED TANNER


DR JIM HASELOFF

production will need to increase by over 70% by 2050 to feed the growing population. As more emphasis is placed on the role of plant science in providing long-term, sustainable answers, Cambridge researchers are investigating diverse areas that have applications in food security: how plant yields can be improved; how disease and pests can be controlled; and how plants can be re-modelled, for instance to adapt to growing in new environments.

Dr Julian Hibberd, named last year by *Nature* magazine as 'one of five crop researchers who could change the world', is working with a worldwide consortium of experts whose goal is to re-engineer rice to increase yields dramatically. With funding from the Bill & Melinda Gates Foundation, Dr Hibberd's team is taking the pioneering approach of attempting to change the photosynthetic pathway used by rice into a more efficient pathway found in plants such as maize.

The procedure is challenging but could reap great dividends, as Dr Hibberd explained: 'It's likely that dozens of genetic alterations will be needed to change the biochemistry, anatomy and biology of rice, but if we can produce higher-yielding rice this could dramatically alleviate potential food shortages of the future.'

Plants are also important as part of the spectrum of future energy resources. In the search for plant-based solutions, Cambridge's Algal Bioenergy Consortium (ABC) is turning to algae, simple aquatic organisms from which the first land plants evolved 400 million years ago. 'On many levels, algae make an excellent choice as a source of biofuel,' explained Professor Alison Smith, one of the founders of the ABC. 'Many species grow rapidly, can produce high levels of fuel molecules, and they are not a food crop.'

The ABC is bringing together Cambridge-based algal physiologists and molecular biologists with engineers and chemical engineers, and is also working with industrial partners to test ideas that arise at the laboratory bench. One area of current investigation is the use of photovoltaic cells that 'steal' electrons from the algal photosynthetic process as a source of energy.

A new development: the Sainsbury Laboratory

The Sainsbury Laboratory will provide state-of-the-art laboratory facilities for 120 scientists and 30 support staff dedicated to finding out how complex plants develop from a single egg cell, and to understanding how the information coded in their DNA leads to their growth and form – fundamental knowledge for understanding evolution and for improving crops. Together, research in the Laboratory and the Department of Plant Sciences will afford an enormously broad and integrated understanding of plants in Cambridge.

The Laboratory will also provide a new home for the University Herbarium, a unique collection begun by Professor John Stevens Henslow in 1821 and now containing a million specimens of historic and current research value. 'In effect,' said Professor John Parker, Curator of the Herbarium and Director of the Botanic Garden, 'the Herbarium is returning home, to the Botanic Garden that was founded by Henslow over 160 years ago.'

At the ground-breaking ceremony for the new Laboratory last year, Lord Sainsbury, founder of The Gatsby Charitable Foundation, said: 'This is one of the most exciting projects with which my Charitable Foundation has been involved. It combines an inspirational research programme, an historic site in the Botanic Garden and a beautiful laboratory designed by Stanton Williams, and I believe it will soon become a world-class centre of excellent plant science.'

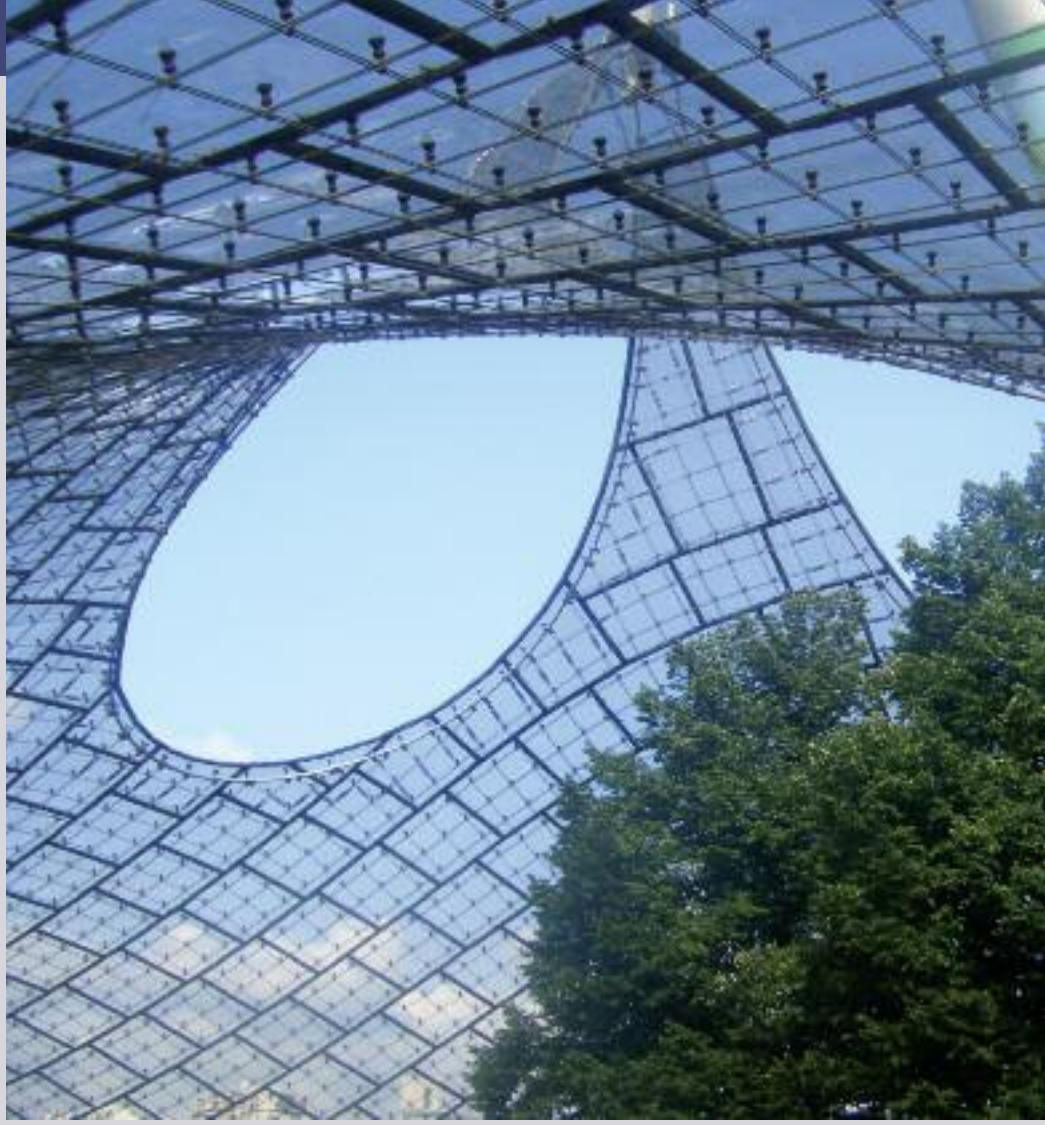
'The new developments represent wonderful research opportunities,' said Professor Baulcombe. 'Not just for plant scientists in Cambridge but for underpinning much-needed information for progress in agriculture, energy and the conservation of biodiversity.'

For more information about research at the Department of Plant Sciences, please visit www.plantsci.cam.ac.uk/


©STANTON WILLIAMS

The Sainsbury Laboratory will provide a state-of-the-art plant research facility within the Botanic Garden

The 1972 Munich Olympics and the Making of Modern Germany



A new analysis of the Munich Games of 1972 places the event at the very centre of modern German history, as Dr Chris Young explains.

The staging of an Olympic Games is both a formidable task and an exciting opportunity, not least because it firmly places the host nation on the world stage. Take the 2010 Olympic Winter Games in Vancouver, Canada – an event that was viewed by some 3.5 billion people, more than half the world's population. In effect, the event is a chance for the host country to promote itself globally.

Perhaps one Games above all others in the last century was imbued by a particular eagerness to present a national identity afresh to the world and to erase past memories: the 1972 Olympic Games in Munich. As events transpired, it is almost exclusively remembered for a very different reason – the murder of 11 members of the Israeli Olympic team by the terrorist group Black September. Yet, this tragedy is only part of the story of the Munich Games.

Although some aspects of the 1972 Games have received academic attention, most notably from scholars of terrorism, there has been a major gap in research that uses the Games as a case study to highlight broader historical currents in Germany. As a topic, the Munich Games lies neatly at the intersection between my research interests in Germany and in sports history and so, a few years ago, I set out with historian Dr Kay Schiller from the University of Durham to provide the first cultural and political history of the Munich Olympics. The resulting book, *The 1972 Munich Olympics and the Making of Modern Germany*, seeks not only to explain the significance of the event in modern German history, but also to ask why such great store was set on hopes for its success.

Archives and oral histories

With funding from the British Academy, the Alexander von Humboldt Foundation and the Arts and Humanities Research Council (AHRC), I was able to delve into documents, most of which had only recently become available, held in archives around the world.

The research reached from the federal archives in Koblenz and Berlin to the Bavarian State Archives and the city archive in Munich, from the research libraries at the International Olympic Committee (IOC) in Lausanne to the Amateur Athletics Foundation in Los Angeles, and even to the archive held at the University of Illinois relating to Avery Brundage, the IOC President who controversially decided to continue the Munich Games following the terrorist attack.

Supplementing the investigations was an array of oral history sources gained from interviews of political and societal figures involved with the planning and staging of the Games. These included Hans-Jochen Vogel, the Mayor of Munich at the time, members of the Organizing Committee for the Games, participating athletes, an Israeli survivor of the terrorist attack and the now deceased Markus Wolf, formerly the head of foreign operations at the East German Stasi security service.

Showcasing a modern Germany

Much of the research focused on the years leading up to the '72 Games. The Federal Republic of Germany was at a crossroads in the mid-1960s, still under the shadow of World War II but viewing the future with optimism. In the seven years between

Roof of the main stadium and indoor arenas built for the 1972 Munich Olympic Games

being chosen as host and staging the event itself, Germany experienced favourable economic conditions and a belief in technocratic optimism, but was equally marked by national and international debate and dispute. Public conflicts arose over political ideology, culture and the legacy of the German past, and foreign policy shifts impacted in intricate ways on East–West German relations.

Against this background, the symbolic potential of the Games did not escape the organisers of the Munich Olympics, who took just one month in 1965 to secure promises of funding from the city of Munich, the Bavarian State and the Federal Government. Hosting the Games was deemed to be of immense importance. As Chancellor Willy Brandt put it succinctly, Munich 1972 was to serve as a 'showcase of modern Germany', a chance to replace memories of the Third Reich with images of a thriving and prosperous Federal Republic, an opportunity to present an optimistic Germany to the world through its 'Happy Games' – its official motto.

In the end, the hopes were shattered by the horrific terrorist attack in the early hours of 5 September. As on 11 September 2001, the world had been caught off-guard and unawares, and the Munich organisers, from the chief committee members down to the hundreds of stadium hostesses who had welcomed the international community to Germany, saw the life seep out of their Games overnight. Years of effort now left a dubious legacy and, more immediately, the Federal Republic was plunged into months of diplomatic firefighting with Israel and the Arab world.

Into the melting pot

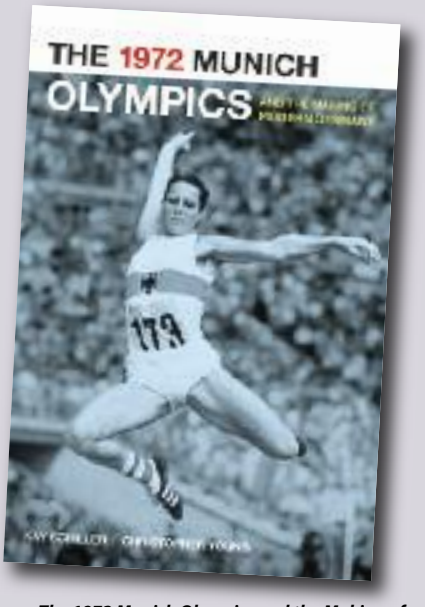
It's impossible to write such a book without combining perspectives of political, social, cultural and urban history. As a result, *The 1972 Munich Olympics and the Making of Modern Germany* is really about a nation's handling of a melting pot of issues: Germany's urban, regional and national identity; intergenerational conflict and social transformation; ideologies of the past; political and diplomatic disputes; architectural visions and ceremonial imaginations; terrorism and security; East and West Germany; and Israeli–Arab relations.

At the same time, however, it's a book about sport or, more accurately, about sport's slippery nature as a phenomenon that is both apolitical and deeply rooted in political discourse. To take one example: even for an event that claimed its legitimacy through an Olympic tradition reaching back to antiquity, it was impossible to make a complete break with the political past – 'Hitler's Games' of 1936 loomed large over the '72 Games.

A question of sport

Until this research project, apart from the extensively studied inaugural Athens Games of 1896 and the Nazi-influenced Berlin Games of 1936, there had been virtually no attempt within sports historiography to write comprehensively about the impact of individual Games on their respective host nations. Remarkably, there has also been no general account of the modern history of European sport from a comparative and international perspective. This is the case despite sport being such a central cultural feature of European life, both as a participant activity and as a spectator entertainment.

To remedy this situation, an AHRC-funded Network entitled Sport in Modern Europe has begun the first comprehensive historical analysis in this area. The overarching aim of the research network, which is led by Cambridge,



***The 1972 Munich Olympics and the Making of Modern Germany* by Dr Kay Schiller and Dr Christopher Young will be published by the University of California Press.**

together with academic partners at the University of Brighton and De Montfort University, is to establish the central themes for the writing of a history of modern European sport. At a series of three international workshops, colleagues from around the world have been looking both comparatively and chronologically at sport, encompassing the elite diffusion of British sport in the late 19th and early 20th centuries as well as its modern-day democratisation, and exploring the problems associated with defining a distinctive European model of sport.

For me, moving from an in-depth analysis of the Munich Games to a broader outlook on European sport has been an enriching *tour d'horizon* – and the work is only just beginning.

Dr Chris Young

For more information, please contact the author Dr Chris Young (cjy1000@cam.ac.uk) at the Department of German and Dutch, or visit the Sport in Modern Europe Network (www.sport-in-europe.group.cam.ac.uk/).

BBSRC
bioscience for the future

The Biotechnology and Biological Sciences Research Council (BBSRC) is the UK's principal research funder across the biosciences. Its current Chair is Sir Tom Blundell, who is also Director of Research and Emeritus Professor in Cambridge's Department of Biochemistry.

Over the past decade, BBSRC has helped achieve a step change in bioscience. Descriptive, single-problem research is increasingly being replaced by generic, predictive and systems approaches, informed by the physical, computational and social sciences. The result is that the UK has kept its world-lead in fundamental bioscience, and enhanced its capability to generate the new knowledge needed to tackle global challenges such as food security, sustainable energy and healthier ageing.

BBSRC research at Cambridge exemplifies this combination of excellence and impact. A grants and fellowships portfolio of over £50 million supports research in more than 20 departments, ranging from predictive modelling of disease epidemiology, the role of short interfering RNAs in cell regulation, data standards and software for macromolecular analysis, to mechanisms of predator vision and defensive colouration in birds. BBSRC also funds around 100 postgraduate research students including some registered with the University at the Babraham Institute.

Cambridge hosts one of six programmes that comprise the BBSRC Sustainable Bioenergy Centre, which is a £26 million investment bringing together academics and industry to investigate sustainable methods for producing biofuels. Dr Paul Dupree in the Department of Biochemistry leads the Cambridge programme, with partners at Newcastle University and Novozymes A/G, which seeks to improve the release of sugars from plant cell walls. An important resource for the Dupree lab, and many others across Cambridge, has been the protein-analysis capabilities of the **Cambridge Centre for Proteomics** (see panel), a long-term recipient of BBSRC funding.

Research projects requiring 'big' science approaches and longer timescales are supported by BBSRC under its strategic longer and larger (LoLa) grant scheme. One such grant to develop a pig super-vaccine was recently awarded to a consortium of researchers based at five universities, including **Cambridge's Department of Veterinary Medicine** (see panel).

Ways to improve the manufacturability of viral vectors for therapeutics are currently being pursued with funding from the BBSRC-led Bioprocessing Research Industry Club.

BBSRC-funded research at Cambridge has also turned into notable innovations. One example is the massively parallel Solexa sequencing technology invented by Professor Shankar Balasubramanian and Professor David Klenerman in the Department of Chemistry, resulting in the spin-out company Solexa, which was purchased by Illumina for $600 million in 2007. The technology is revolutionising bioscience by improving the cost and speed of DNA sequencing by 1,000–10,000 fold on previous technologies. In recognition of this work, Professor Balasubramanian was recently named BBSRC Innovator of the Year 2010.

For more information and to download the BBSRC 2010–2015 Strategic Plan, please visit www.bbsrc.ac.uk/

Towards a 'super-vaccine' for swine bacterial diseases

A new multidisciplinary research programme aims to develop a single vaccine that will combat four major respiratory pathogens of pigs.

Among the most serious diseases in pigs are those that are caused by bacteria that live in their throats, airways or tonsils and can cause severe lung infections such as pneumonia. Infected animals either die quickly or fail to grow normally, resulting in substantial economic costs to the worldwide pig industry and adding to food security concerns. Because the infections are difficult to diagnose, and current vaccines have limited efficacy, antibiotics are now in widespread use in efforts to reduce infection.

A new five-year, £5.6 million BBSRC grant awarded under the longer and larger (LoLa) grant scheme aims to develop a new vaccine and a diagnostic tool to combat the four most common bacteria that cause infections in pigs. The grant has been awarded to a consortium of researchers at the University of Cambridge, Imperial College London, the London School of Hygiene and Tropical Medicine, and the Royal Veterinary College, as well as Huazhong Agricultural University in China, and involves three UK government-funded agencies. The consortium also receives support from Pfizer Animal Health.

'This combined expertise has generated a new opportunity that is highly synergistic and where real progress is possible,' said Professor Duncan Maskell, Head of the Department of Veterinary Medicine and leader of the

Location, location, location: finding out where proteins live and with whom

The Cambridge Centre for Proteomics is internationally recognised for pioneering technology that helps us to understand what proteins do inside cells.

BBSRC has been a long-term funder and supporter of the Cambridge Centre for Proteomics (CCP) since the beginnings of this cross-departmental facility almost a decade ago. The large-scale study of proteins, called proteomics, was still in its infancy when CCP first opened its doors to the research community, offering a range of services to separate, identify and quantify proteins in complex samples.

'Working out what the limitations were with the technology, and solving them, has always been a major consideration,' explained Dr Kathryn Lilley, who headed the team that set up CCP and is its Director. 'In fact, two-thirds of the lab focuses on the development of methods, influenced by projects that can't be handled by the high-throughput pipelines we have in place. In turn, the technical advances benefit the core facilities.'

Techniques being used at CCP are able to identify changes in a cell's proteins under different conditions, helping colleagues in many university departments including Biochemistry, Genetics, Pathology, Pharmacology and Plant Sciences to answer complex biological questions. The expertise at CCP also underpins research at the Cambridge Systems Biology Centre, and complements imaging methods under development at the Centre for the Physics of Medicine.

In a decade, the technology has progressed immeasurably from the early days of simply providing a catalogue of as many proteins as possible in a sample. Today, more sophisticated approaches such as Localization of Organelle Proteins by Isotope Tagging (LOPIT), developed by CCP, enable the accurate determination of the subcellular location of proteins, and rely heavily on the use of complex statistical methodologies.

'LOPIT provides a snapshot of spatial information,' explained Dr Lilley. 'From this, we are beginning to tell where proteins live, who with, and how this changes depending on what's happening to the cell. In the foreseeable future, with integration of complementary technologies, we will be able to build three-dimensional dynamic maps of the cell's proteins, helping us to understand more fully how cells work.'

Dr Kathryn Lilley

For more information, please contact Dr Kathryn Lilley (ksl23@cam.ac.uk) at the Cambridge Centre for Proteomics (www.bio.cam.ac.uk/proteomics/).

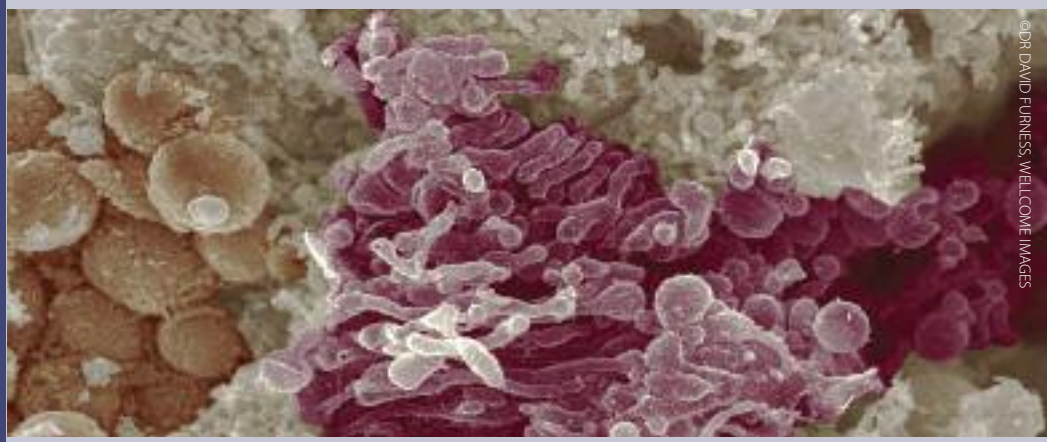
Cambridge component. 'It's also a perfect marriage between fundamental biological research and applied clinical outcomes.'

'As a first step, we are isolating bacteria from pigs and assembling the largest ever sequenced collection of these types of bacteria,' explained co-investigator Dr Dan Tucker. 'From this, we'll design and assemble appropriate super-vaccines and single-platform diagnostic tests. Crucially, these will immunise and test pigs for all four pathogens at the same time.' In the final year of the project, field trials will be carried out in China, where dedicated facilities for this type of work are already set up.

Commenting on the timeliness of the BBSRC funding, Professor Maskell added: 'Technical innovations and the availability of genome data have progressed to such an extent, and continue to do so, that only recently has it become possible to embark on this type of programme to find effective vaccines and diagnostics.'

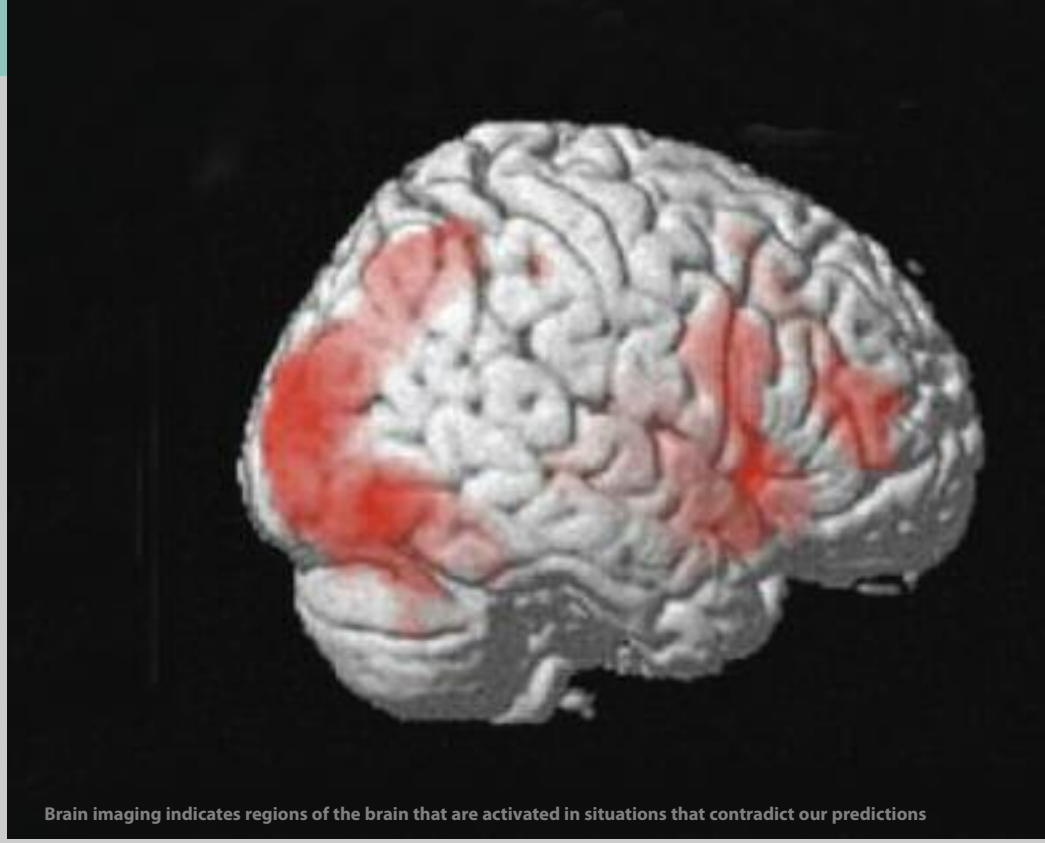
Professor Duncan Maskell

For more information, please contact Professor Duncan Maskell (djm47@cam.ac.uk), Marks & Spencer Professor of Farm Animal Health, Food Science and Food Safety at the Department of Veterinary Medicine (www.vet.cam.ac.uk/).



Mitochondria, cytoplasm and Golgi – some of the subcellular locations of proteins

Beliefs, predictions and shortcuts in the deceitful brain



Brain imaging indicates regions of the brain that are activated in situations that contradict our predictions

Professor Paul Fletcher believes that exploring how the brain makes predictions about the world will help us to understand mental illness.

It is tempting, and perhaps comforting, to believe that our senses provide us with an accurate picture of the world. But they don't. Rather, what we perceive, and how we perceive it, is often determined by what we anticipate and what fits most comfortably with our prior expectations and biases.

The everyday experience of taking in data from the world, weighing it up and drawing conclusions implies that information flows exclusively in one direction: from perception to belief. Actually, it is a two-way street. It's just that our beliefs about what is normal, predictable or logical may prevent us from experiencing the perceptions that violate our assumptions. This simple fact – that what we expect determines what we experience – has long been recognised by psychologists.

Professor Paul Fletcher, the Bernard Wolfe Professor of Health Neuroscience in the Department of Psychiatry, is investigating the ways in which we form beliefs about our environment, and how we use these to make predictions and decide what actions to take. Knowing how the brain normally does this may help us to understand why, under conditions of mental illness, people entertain perceptions and beliefs that may seem unusual and illogical. It may also tell us why we so frequently engage in behaviours that are detrimental to our overall health.

Deceiving ourselves

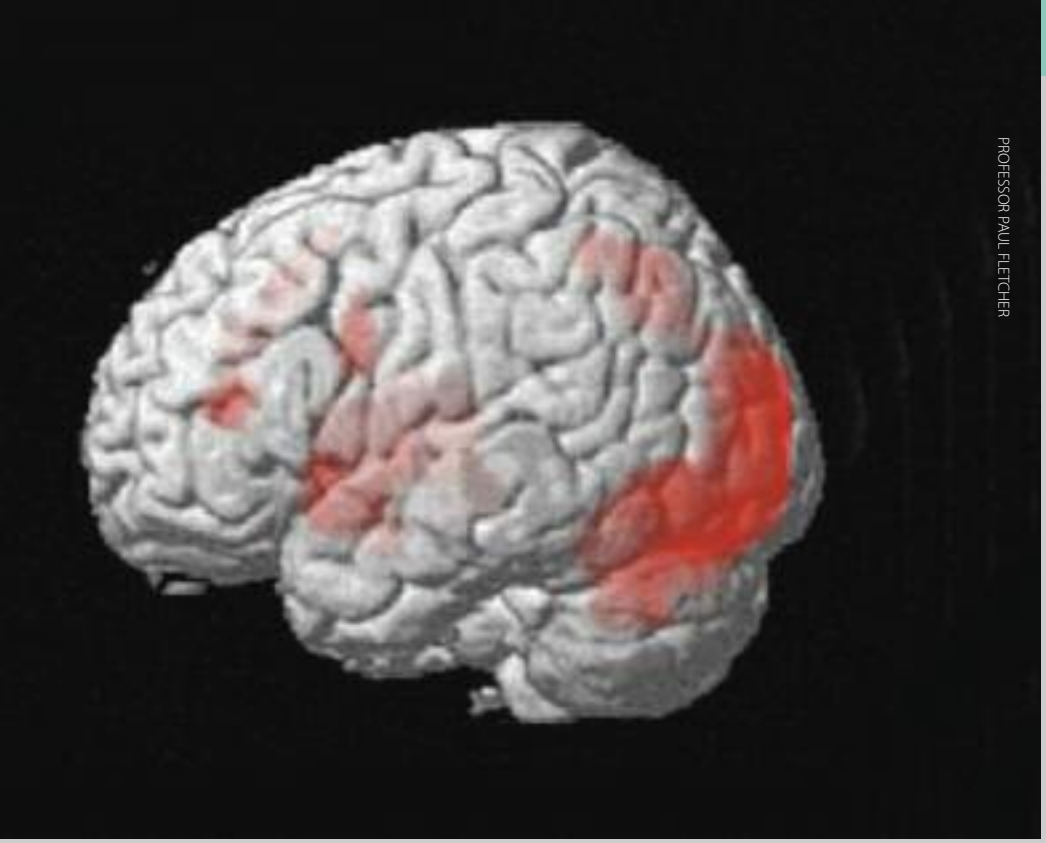
Why would our brain be so ready to refine, distort, add or remove sensory information when constructing our picture of the world? Perhaps it is because survival and success are not necessarily related to how accurately we represent the world but rather to how efficiently we can predict it.

If our brain tried to represent everything as accurately as possible, we would be paralysed by information. Since our aim must be to interact with our environment decisively, to gain reward and avoid pain, it seems better to sacrifice a detailed portrait of our surroundings in favour of quick snapshots of the important things, gleaned from a mixture of current information and prior experience. Allowing our knowledge to inform our perceptions helps us to achieve this while reducing the brain's workload.

The implications of this view of perception and belief go well beyond the psychological laboratory. Our perceptions do not just represent our world, they create it: a self-conscious teenager hears ridicule in the innocent laughter of a passing group; an anxious man sees the outline of a bush as a waiting assailant; and wine from an expensively labelled bottle tastes better. In some mental illnesses, these perceptions can create a very frightening and bizarre world, one in which voices make critical and threatening comments and unseen persecutors control thoughts and actions. What happens in the brain to cause these altered perceptions?

Abnormal prediction

Advances in cognitive neuroscience have helped to understand how the brain learns about, and predicts and responds to, the world; this has begun to offer clues as to the processes that may be disrupted in mental illness. One process that Professor Fletcher believes may be particularly



PROFESSOR PAUL FLETCHER

affected is the brain's response to a mismatch between a predicted and an actual outcome: so-called 'prediction error'.

Because prediction error effectively signals that we must learn something new about the world, it's very useful in preventing us from becoming stereotyped, inflexible and unable to adapt to a changing environment. Persistent and inappropriate prediction error signal, though, would be detrimental. Imagine a world in which everything seemed to violate your expectation, everything vied for your attention because of its novelty and strangeness, even your own actions and thoughts. Such a world could rapidly become perplexing and threatening. Perhaps the only way of explaining such a change to yourself would be to conclude that you were the victim of some powerful persecutor – a common belief in some mental illnesses.

Professor Fletcher's group, in collaboration with Professor Tony Dickinson, a learning expert based in the Department of Experimental Psychology, and Dr Philip Corlett at Yale University, has been studying the brain's response to prediction error and examining the possibility that mental illnesses can be understood in terms of abnormal prediction error signals in the brain. Funded by the Wellcome Trust, they have been using functional brain imaging in patients and drug-induced, transient, psychosis-like experiences in healthy volunteers.

The results show that brain responses to violated expectations are indeed abnormal in psychosis and that the degree of abnormality seems to correlate well with the unusual beliefs and experiences that characterise the illness. It is even possible to predict in healthy volunteers undergoing brain imaging what sorts of symptoms they will experience when they subsequently receive a drug that disrupts prediction error signal. The work therefore provides evidence that a disrupted prediction error signal changes the relationship between prior beliefs and perceptions. This change could underlie some symptoms of mental illness.

Quest for reward

The symptoms of mental illness are one setting in which we might fruitfully examine changes in the relationships between perception and belief. But this framework also maps directly onto another domain that is core to human experience: the quest for reward.

Humans have evolved to be remarkably sensitive to the potential of any given environment to yield food. They respond to, and are motivated by, any stimulus that is predictive of such a reward. Indeed these stimuli, though not in themselves rewarding, may come to be valued and to enhance pleasure almost as much as the actual foods that they portend. The sights and smells of food and food-related stimuli drive behaviour very powerfully. In responding to foods, just as in trying to comprehend our environment, we remain reliant upon the complex interaction between our perceptions and our prior experience. Recognising this link could help us to understand the emergence of health-harming behaviours relating to food.

Professor Fletcher is therefore extending his work in collaboration with the Institute of Metabolic Science (IMS), and is working with Dr Sadaf Farooqi and Professor Steve O'Rahilly, leaders in the study of the genetics of obesity (see pages 6–7). This work, which is supported by the Bernard Wolfe Health Neuroscience Fund, sets out to examine how the brain's ability to predict reward, and how the behaviours that emerge as a result of such predictions, may be useful to understanding overeating and its attendant health problems.

Once again, the use of functional brain imaging, informed by cognitive neuroscientific advances in our understanding of reward learning, is providing new information with potentially therapeutic value. Having explored the brain changes elicited by a widely prescribed anti-obesity drug, the researchers have taken the observations further to examine anti-obesity drugs of the future.

The potential of this approach has been recognised by the development of a unique 'Academic Incubator' involving GlaxoSmithKline, Professors Ed Bullmore and Fletcher in the Department of Psychiatry, Professors Barry Everitt and Trevor Robbins in the Department of Experimental Psychology, and Professor O'Rahilly in the IMS. This collaboration is investigating novel therapeutic drugs for obesity and addictive disorders. It represents a new way of capitalising on academic expertise in testing potential drug treatments and will allow a more direct route from basic cognitive neuroscience research through to practical benefits to patients.

Professor Paul Fletcher

For more information, please contact the author Professor Paul Fletcher (pcf22@cam.ac.uk) at the Department of Psychiatry. **Research described here takes place within the Behavioural and Clinical Neuroscience Institute (www.research.psychol.cam.ac.uk/~bcni/), which is jointly funded by the Medical Research Council and the Wellcome Trust.**

Cultural heritage after conflict

Ceiling of the Casa de Juntas, Gernika, showing the tree that has long been a symbol of the civil liberties of the Basque people

A collaborative study led by Cambridge is examining the impact on society of the destruction and reconstruction of cultural heritage.

Cultural heritage is frequently damaged or destroyed during periods of war and violence. But this is not always an accidental by-product – in some cases, sites of cultural heritage have been deliberately targeted as a means of inflicting pain and societal trauma. A community's shared sense of belonging is often rooted in its heritage sites and landscapes, giving such places particular social significance. And the impact on society doesn't stop with the breaking down, destruction, defaming or neglecting of such sites; it continues post-conflict, through the political and psychological impacts of the decisions made during reconstruction.

The complexities of the relationship between post-conflict scenarios, heritage and identity are increasingly recognised, but with this recognition has come an awareness of how little we actually understand about its nature. What role does cultural heritage play during post-conflict reconstruction? What is the impact of reclaiming and rebuilding on people's sense of identity? By investigating these relationships, we might learn more about how heritage can be harnessed to both personal and political agendas. On this basis, research in this area can help to guide crucial decisions by policy makers and regional practitioners regarding the reconstruction of cultural heritage.

CRIC

A four-year interdisciplinary project on Cultural Heritage and the Reconstruction of Identities after Conflict (CRIC), now midway through its research programme, aims to shed light on these issues. Dr Marie Louise Stig Sørensen in the Department of Archaeology leads the €1.2 million project, which is funded through the European Union Seventh Framework Programme and brings together researchers in Spain, France, Sweden, Germany, Cyprus, Bosnia and the UK. Her research interests and those of her team in Cambridge – archaeologist Dr Dacia Viejo Rose and social anthropologist Dr Paola Filippucci – lie in examining the link between heritage, identity and social memory. Collectively, the project is drawing on strengths in archaeology, social anthropology, history, human geography, sociology, political sciences and psychology.

Case by case

Five case studies provide the backbone of CRIC. Each focuses on physical cultural heritage – from landscapes to monuments, churches to bridges – damaged during civil war, ethnic violence and World War. Geographically, the studies cover Spain,

KIM-MICHAEL SØRENSEN

Bosnia, France, Cyprus and Germany, and give insight into the recovery of rural landscapes as well as urban centres or whole towns. The project covers historical scenarios that range from recent conflicts in Bosnia and Cyprus, to the planting of forest over the First World War battlefield of Verdun in France, with its muted metaphors of covering and healing.

In Bosnia and Cyprus, case studies highlight the importance of comparing processes of destruction and reconstruction. Although both are ethnic conflicts, the fate of cultural heritage within the two areas differs substantially. In Bosnia, heritage is being re-shaped, as exhibitions and monuments are given new interpretations. Different agencies have sponsored the rebuilding of religious buildings and, in the process, have altered the traditional cultural landscape. Denominations of churches have changed, new minarets have been added to mosques – all representing departures from local architectural and cultural history. In Cyprus, on the other hand, differences in the intensity of development on either side of the divided city of Nicosia have resulted in substantial variation in the preservation of traditional buildings. In the north of the city, little has changed; yet in the south, old buildings have either been replaced by modern development or have seen changes in use.

The case studies also illustrate different types of urban reconstruction projects, with Dresden in Germany exemplifying the faithful, apparently accurate, reconstruction of selected parts of the city centre, bombed during the Second World War, within an otherwise much-modernised city. In Spain, reconstruction of the Basque town of Gernika, bombed in the Spanish Civil War, exemplifies Franco's architectural vision of the 'New' Spain. This vision was based on an idealised version of historic Spain and brought together several architectural forms and elements to be used throughout the country in its reconstruction.

DR DACIA VIEJO ROSE

The Tree of Gernika – propagated through generations – still standing on the traditional spot in front of the Assembly House

In all, the CRIC project looks back over almost a century of European history. Each study has been designed to track the sequences of historical events that led to the destruction of cultural heritage, to investigate what effect this has had on communities and their sense of identity, and to identify how different perceptions of the event emerge and are affected by the form of the reconstruction. This makes it possible to trace specific examples of reconstruction as they unfold, pinpointing similarities and differences among them.

Memorials and meaning

When efforts are made to reconstruct cultural heritage, a new fabric of meaning and memory can be woven into the result. The findings of the research project are helping to identify what factors are important for understanding the impact of reconstruction, including how they can change the way that events are perceived, or can even become yet another means of conflict.

One thread of the research has therefore been the recording and analysis of anniversary events, both archival and current. This has demonstrated how the staging of memorials can manipulate the manner in which past events are remembered and what they are used for. A reconstruction of the sequence of commemoration events that have happened on 13th February, the anniversary of the 1945 bombing of Dresden, include those under the communist regime and following the recent appearance of neo-fascist groups. This reconstruction has shown how, even from very early on, the memorial events involved both those who mourned and those who used the anniversary for political ends.

In Gernika, the 26th April anniversary of the 1937 bombing first became a public event after the death of Franco. The project has traced the acceleration in the anniversary's international status, and the tensions and competition for control between local groups and regional government, as well as between the church and secular groups. Even recently established anniversary events, such as those at the Srebrenica memorial site in Bosnia and Herzegovina, appear far from uncomplicated, as some groups see the anniversary as a provocation or a reminder, whereas others see it as an opportunity to mourn and simultaneously express rights.

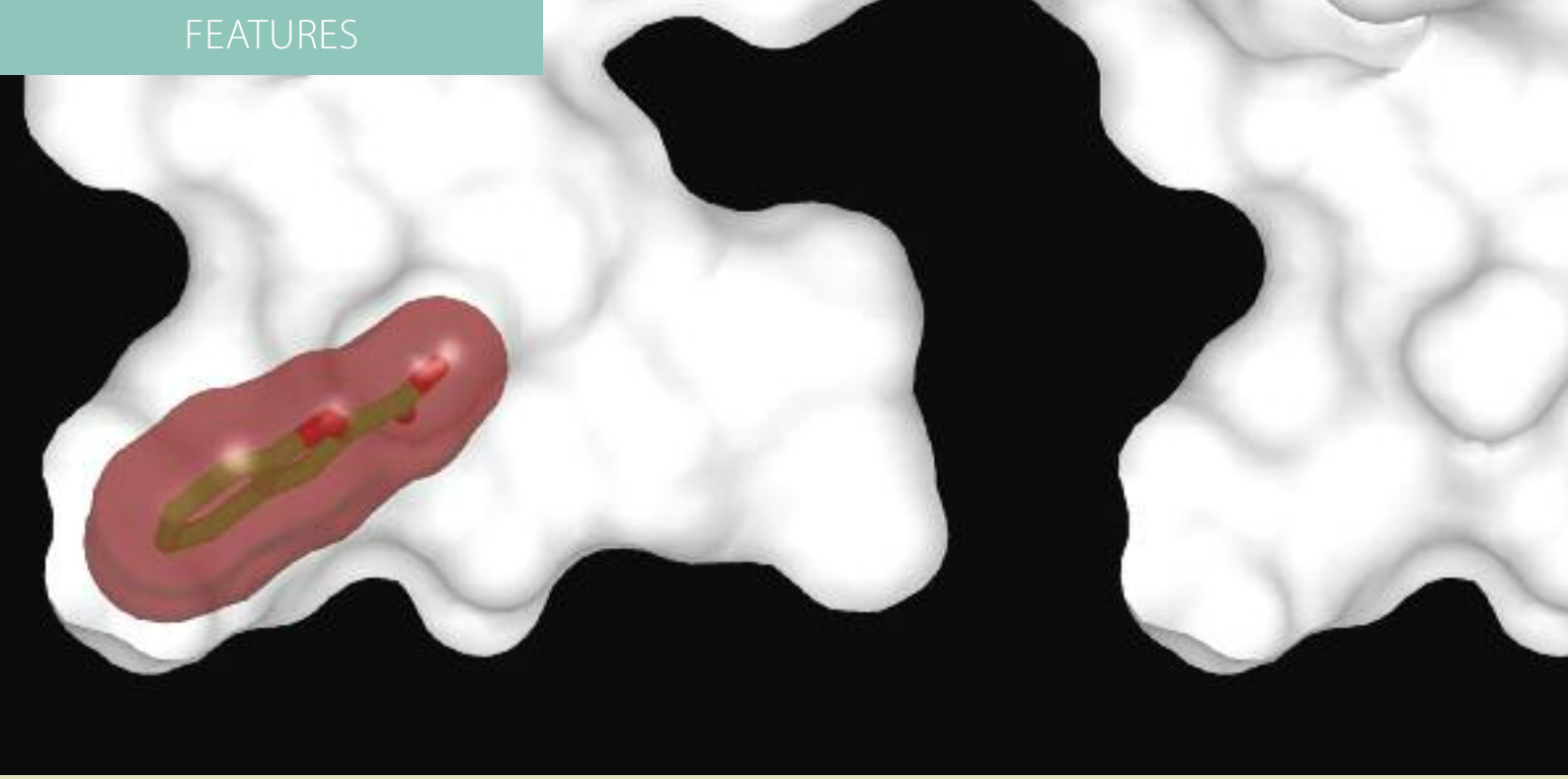
Anniversary events are only part of the equation. CRIC research shows that contributing to the complex mix are also such factors as the role of national and international communities involved in reconstruction, and how memories are transmitted from one generation to the next. Symbols too play an important role, both at the mundane level of mass culture and as part of public rituals. This is seen for example in Gernika, where the traditional symbol of the oak tree represents the historic civil liberties bestowed on the region since the Medieval period. The current tree – propagated through generations – still stands on the same spot, but the symbol also appears today in many other contexts such as advertisements.

Societal impact

The CRIC research programme provides a much-needed understanding of the main characteristics of post-conflict reconstruction processes and their implications for society. Not only does this help us to understand how we behave socially and culturally, but it is also highly relevant to policy makers and organisations involved with reconstruction efforts. Too often, despite the best intentions, reconstruction efforts have been found to prolong conflicts and tensions simply because their impacts are not properly understood.

Ben Davenport, Dr Marie Louise Stig Sørensen (centre) and Dr Dacia Viejo Rose

For more information, please contact the author Dr Marie Louise Stig Sørensen (mlss@cam.ac.uk) at the Department of Archaeology, or Ben Davenport, CRIC Administrator (bkd20@cam.ac.uk; www.cric.arch.cam.ac.uk/). Images collected as part of the CRIC project are stored at DSpace (www.dspace.cam.ac.uk/), the institutional repository of the University of Cambridge.



Small is beautiful in drug discovery

Cambridge scientists are employing fragment-based drug discovery approaches – a technique that involves 'growing' potent drugs from tiny chemical fragments – to tackle tuberculosis and cancer.

In the ongoing search for novel drugs to add to the armoury against disease, scientists are making use of new approaches to drug discovery that aim to increase the rate of success, decrease the development timeline and minimise the cost.

Conventional drug discovery approaches involve high-throughput screening of up to millions of large compounds to find those that inhibit the activity of the target, usually a protein. Although many drugs have been discovered this way, the technique is expensive and resource intensive, and there is a high attrition rate of hits failing to progress through the development process to medicines.

In recent years, a complementary approach has been developed that involves screening fewer numbers of small chemical compounds (fragments) to find those that bind to the target, and then using structure-guided chemistry to 'grow' these fragments into potent drug molecules by linking fragments together or modifying them synthetically.

Cambridge has been at the forefront of this new school of thinking. Over a decade ago, Professor Chris Abell (Department of Chemistry), Professor Sir Tom Blundell (Department of Biochemistry) and Dr Harren Jhoti (formerly Glaxo Wellcome) co-founded Astex Therapeutics, a company that pioneered and is now world leading in fragment-based approaches to drug discovery. Since then, these approaches have gained widespread recognition and are now being used throughout the pharmaceutical industry. Even in this relatively short space of time, Astex has used its technology to develop several compounds against cancer that are now in clinical trials.

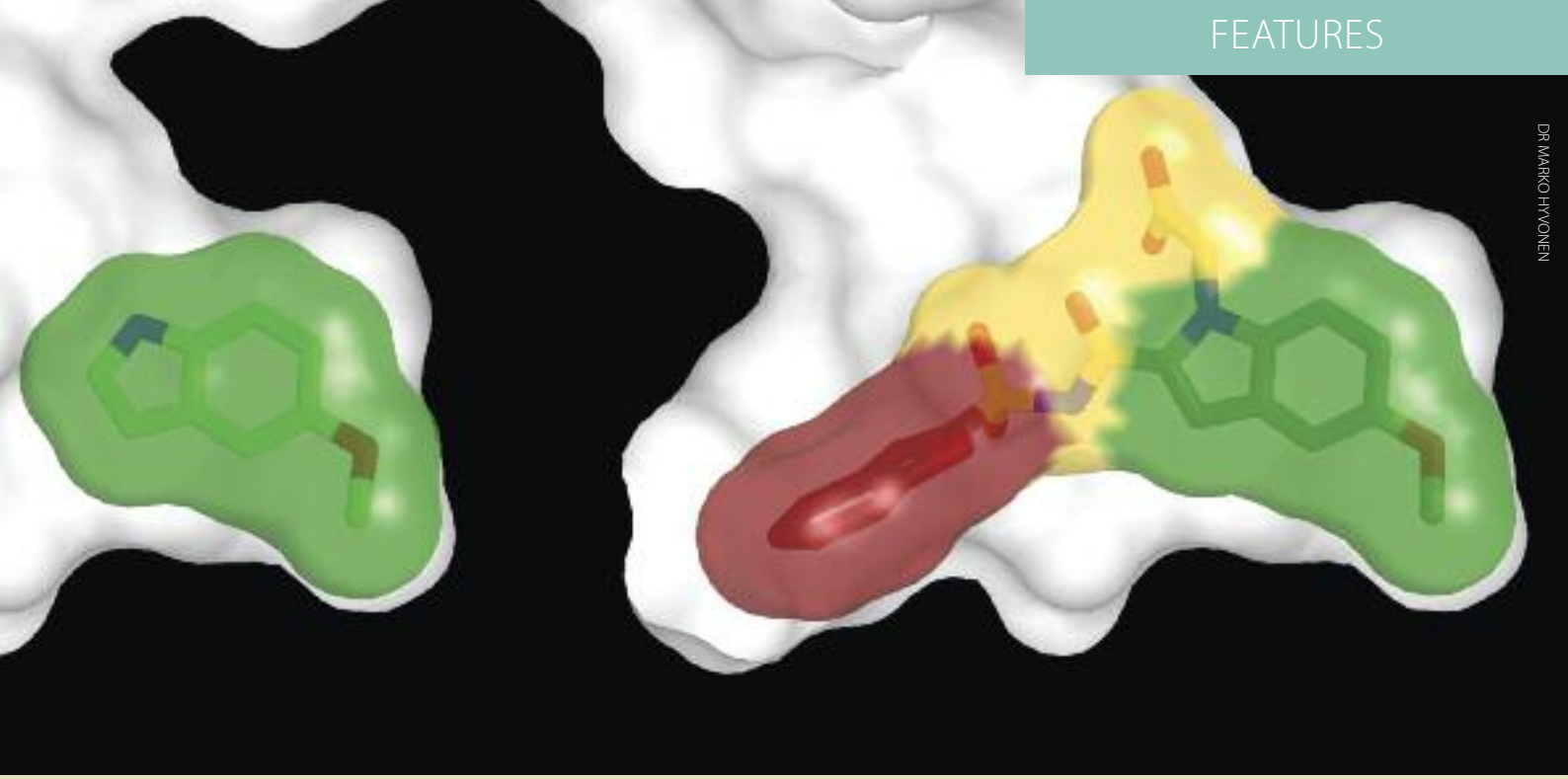
Targeting tuberculosis

Several years ago, funding from the European Community and the Bill & Melinda Gates Foundation enabled Professor Blundell and Professor Abell to establish a programme of fragment-based drug discovery methods in the University, with collaborators in South Africa, India and the USA. The first target was tuberculosis (TB), a major cause of death in India and Africa. It has been estimated by the World Health Organization that over a third of the world's population is infected with the TB bacterium, and that someone is newly infected every second. Despite this, no new drugs have been introduced against the bacterium for over 40 years. Fortunately, the field has received new impetus, in no small part due to the Bill & Melinda Gates Foundation, and groups in both academia and industry are working collaboratively to find new solutions and drugs.

Building on fundamental studies of vitamin biosynthesis pathways initiated by Professor Abell and Professor Alison Smith (Department of Plant Sciences), the scientists have focused on several key enzymes required by the *Mycobacterium tuberculosis* bacteria to infect lung tissue. Fragments that inhibit the enzymes' active sites – essentially the heart of their functional activity – have been isolated and their potency improved by structural modification. 'Preliminary data indicate that these drugs can kill the pathogen,' said Professor Abell. 'There is great excitement within the TB research community about the potential for this technology to make inroads into a neglected disease area.'

A new terrain

Meanwhile, the scientists are casting the net wider in drug discovery by employing fragment-based approaches to search for a particularly challenging class of drugs. Professor Abell and Dr David Spring (Department of Chemistry), Professor Blundell and Dr Marko Hyvonen (Department of Biochemistry) and Professor Ashok Venkitaraman and Dr Grahame McKenzie (Hutchinson/Medical Research Council (MRC) Research Centre), all key members of the Cambridge



DR MARKO HYVONEN

Small chemical fragments (red and green) binding to the active site of an enzyme from *Mycobacterium tuberculosis*; joining the two fragments together chemically (yellow) creates an inhibitor with better binding affinity

Molecular Therapeutics Programme (www.cmtp.cam.ac.uk/), are making use of this new paradigm to search for drugs that interfere not with the active site of a protein but with the interaction of proteins with each other.

Protein–protein interactions are of vital importance to almost every pathway and process in living cells, and there is much interest in targeting the interfaces between two or more interacting proteins for therapeutic purposes. 'However, the characteristics of these interfaces make this a particular challenge,' explained Professor Abell. 'Unlike the deep, pocket-like active sites of many proteins, which are the more usual targets of drug discovery, typical protein–protein interaction sites are large and relatively flat terrains, with shallower pockets. Considered too difficult to target, such interactions had largely been ignored by the pharmaceutical industry.' Fragment-based methods, however, seem to have some advantages, in part because they bind to key hotspots on the surface, maximising the available binding interactions.

As a model system, a project coordinated by Dr Hyvonen and funded by the Wellcome Trust is investigating the interaction between human RAD51 and BRCA2 proteins, which work together to help cells repair damage to their DNA. When this process goes wrong, as found in individuals who inherit a faulty version of the BRCA2 gene, there is a greater chance of the cell becoming cancerous: indeed, defective BRCA2 is associated with a higher incidence of breast, ovarian and prostate cancer. Unravelling the mechanism underlying the activity of BRCA2 is an area of long-standing expertise of Professor Venkitaraman at the Hutchinson/MRC Research Centre.

The team is interested in finding a drug to block the interaction between mutated BRCA2 and RAD51, explained Dr Hyvonen: 'By inhibiting this repair process, the cells will become more sensitive to DNA damaging agents and radiation, and a drug targeting this interaction could therefore be used to enhance current cancer treatments, radiation therapy in particular.' Fragments have now been discovered that can inhibit the BRCA2–RAD51 interaction. X-ray crystallography of fragment–protein complexes has been used to guide chemical synthesis, growing the fragments in order to extend further into the same or to nearby pockets. The result is a fast, efficient and low-cost route to developing potential new cancer drugs.

Seeding new drugs

On the basis of these proof-of-concept studies, the Cambridge researchers have recently been awarded two major grants from the Wellcome Trust to develop small molecules that modulate protein–protein interactions.

The first award is a five-year Strategic Award (led by Professor Venkitaraman) to ask fundamental questions about how to target different kinds of protein–protein interactions. The second is an award from the Seeding Drug Discovery (SDD) initiative for a project led by Professor Abell to develop potent and specific compounds against a particular protein–protein interaction that may have value in the treatment of cancer.

'The Strategic Award presents us with a great opportunity to improve the technology underlying this approach, and complements the SDD initiative's specific milestone-driven focus on a project that has the potential to deliver therapeutic benefit,' explained Professor Abell. 'We hope that this work will draw the attention of the pharmaceutical industry and encourage them to look for new therapeutic targets for the development of novel medicines of the future.'

Dr Marko Hyvonen (left) and Professor Chris Abell

For more information, please contact Professor Chris Abell (ca26@cam.ac.uk) at the Department of Chemistry and Dr Marko Hyvonen (marko@cryst.bioc.cam.ac.uk) at the Department of Biochemistry.

Children's literature comes of age

A new Centre for Children's Literature is providing a focus for research on how children are shaped by early encounters with books and film.

***Alice's Adventures in Wonderland* (1866), Lewis Carroll, illustrated by John Tenniel**

Understanding the messages and ideas that children pick up from books is an important part of understanding children's education, as Professor Maria Nikolajeva, Director of Cambridge's new Centre for Children's Literature, explained: 'Children can struggle with fundamental questions of life and death, good and evil, what it means to be a human being, and many will carry ideologies they pick up from picturebooks, fairytales, novels, animation and poetry through to adulthood. Any starting point that has the capacity to shape young people's development deserves serious consideration.'

'Children frequently perceive literature and art differently from their parents and teachers, who may have lost the open, immediate and joyful experience of the world that children have,' added Professor Nikolajeva. 'A better understanding of the significance of children's literature and other cultural sources in broad terms can be used to improve children's education and development.'

The Cambridge/Homerton Research and Teaching Centre for Children's Literature has been launched to consolidate and focus the research on children's books and other cultural sources that has been ongoing for more than 30 years at Homerton College and later at the Faculty of Education. This long tradition has earned both institutions a strong national and international profile as a children's literature research community of excellence.

Rich seams of investigation

The goal of research at the Centre is to understand the ideas that children garner through books and other media in these early years, and to use this understanding to help educators make the best use of their materials. This can only be achieved through serious and thorough studies of the texts themselves, their history, themes, structures and social context.

Children's literature is investigated with the same approaches used by academics studying any other type of literature or art. Indeed, research at the Centre draws on ideas from many areas, including literary criticism, art criticism, childhood studies, cultural studies, psychology, sociology and pedagogy. This richness of approaches and materials makes children's literature a particularly exciting area of study.

'Yet the specific characteristics of children's literature compared with other literature cannot be ignored,' said Professor Nikolajeva. 'Books, films and other cultural media are produced by one social group, the adults, for another social group, the children, and often have educational and instructive purposes. It thus becomes a vehicle of power, a socialisation device that has been employed by adults for centuries. Understanding these mechanisms is a cornerstone of any inquiry into children's literature.'

Children's literature is also an important part of our cultural heritage, something that is shared not only between children and adults, but also with people all over the world, as the best children's books are translated and cross national borders. In recent years, the rising number of books that appeal both to children and adults, such as Philip Pullman's *His Dark Materials* trilogy, is offering a new dimension for analysing the characteristics of books that are able to bridge this divide, a phenomenon that was last prominent in the 16th and 17th centuries.

Fresh approaches

The Centre comprises about a dozen academics whose collective research covers texts that represent the widest possible span of reading ages and genres, from picturebooks through to teenage fiction, from fairy tales and fantasy to school stories and adventure, as well as film, comics, graphic novels and video games. In addition to this unique portfolio, the Centre combines theoretical expertise with empirical research in the field, mostly in schools.

Current research topics range from Victorian poetry to the role of nature in Walt Disney's animation; from what girls read in the 19th century to young children's understanding of visual texts; from early science books for children to adaptations of Shakespeare; and from young readers' literature preferences in Lebanon to the image of adolescence in contemporary film. Graduate students also bring their own insights and innovative approaches to the field, as do visiting scholars from all over the world.

The aim is for the Centre's research to underpin educational thinking, policy and practice in relation to the importance of children's literature. The scholars are confident that their endeavours can make a difference. 'At the heart of what we do,' said Professor Nikolajeva, 'is a desire to understand how we can best help future generations of children to learn.'

Professor Maria Nikolajeva

For more information about the Centre, please contact Professor Maria Nikolajeva (mn351@cam.ac.uk) at the Faculty of Education or visit www.educ.cam.ac.uk/centres/childrensliterature/ The Centre for Children's Literature is seeking additional funding for research.

PLACE in the wider Faculty

The Faculty of Education is one of the leading departments of education internationally, and has been repeatedly evaluated as the best nationally, for its commitment to teacher education, development of research-based policy and practice, and educational research of the highest quality.

Its academic staff, numbering more than 80, work within five academic groups that focus on many aspects of understanding and improving education, whether it's redesigning school science and mathematics teaching, conducting the Cambridge Review of Primary Education, understanding the neuroscience of learning difficulties, evaluating the contribution made to learning by different types of leaders, or investigating how education affects the lives of people living in poorer communities around the world.

The recently launched Centre for Children's Literature is hosted by the Pedagogy, Language, Arts and Culture in Education (PLACE) academic group. This multidisciplinary group brings together specialists in arts and creativity, drama and media, modern and second language learning, history, English, geography, philosophy and religious studies. As Professor Maria Nikolajeva, Chair of PLACE, explained, this breadth is significantly benefitting collaborations. 'In finding synergy between interests and expertise, we are discovering a new research space that can answer questions in different ways.'

An example of this activity is an interdisciplinary research project involving specialists in children's literature, English, the curriculum and geography, which is investigating how children perceive their identities through the place they live in, using a variety of activities such as reading, creative writing, studying local history and map drawing.

Two schools in East Anglia are taking part in the study. 'Although only 10 miles from each other, they are worlds apart,' said Professor Nikolajeva. 'The urban school has a 95% Pakistani intake and the rural school has many pupils from families that have gone to the same school for generations. This research should raise fascinating differences and similarities in how children understand and learn about their own sense of belonging.' The project builds on recent moves in the statutory curriculum to re-emphasise a cross-curricular approach to classroom teaching; research results will feed back into teaching practice.

For more information about research at the Faculty of Education, please visit www.educ.cam.ac.uk/research/


MARY ANN STEANE

Libraries and light


MARY ANN STEANE

Research in the Department of Architecture aims to reveal the creative potential of light in the design of contemporary libraries.

Architectural design involves making choices and identifying opportunities, and the best buildings are arguably those in which the various roles of architecture – social, environmental, functional, aesthetic – are positively combined and mutually inclusive. Yet current lighting design guidance, with its emphasis on quantitative criteria such as the recommended levels of illumination, generally fails to take this into account. A three-year study led by Professor Koen Steemers and Mary Ann Steane in the Department of Architecture, and funded by the Arts and Humanities Research Council, aims to redress this balance in a particular type of building – libraries.

Libraries are the subject of much current debate. The UK Government is formulating its vision for the future of public libraries, and a recently completed consultation phase invited comment on the need to reconsider what kinds of places they should be and what kinds of environments they should provide. Issues such as the commissioning, updating, designing and operating of library buildings are likely to come under scrutiny in response to changing expectations. How libraries are lit, both naturally and artificially, is a major consideration when renovating or designing new libraries because it is intrinsically connected to aspects such as user comfort, energy consumption and use of space.

Library visits

The aim of the 'Designing with light in libraries' project has been to create new understanding of the factors that influence the opportunities, and the dilemmas, of lighting strategies, and to marry this with an exploration of how users experience the environment around them. In providing an analysis of how daylighting is being successfully integrated (or not) with other design ambitions, the project will be of interest to librarians and architects alike.

Eight recently completed libraries were visited, seven in the UK and one in Ireland, plus one 1960s 'benchmark' library building in Finland, whose designer was the celebrated master of daylighting, Alvar Aalto. The eight contemporary libraries represent a range of uses and lighting strategies, and have all won prizes for aspects of their design. User questionnaires were completed at seven of these buildings and, wherever possible, current librarians were probed on operational issues, and the original designers on their ambitions for daylight.

Let there be light

What is 'good reading light'? The phrase conjures up an image of a reader near a window, book to hand, the page in question turned towards the light. What the image implies is that the relationship of the reader to the light, the book and the room is important – in other words, that good conditions for reading are a matter of spatial geometry as well as sufficient illumination.

The situation of private reading in a public space is not an issue that is particularly well addressed by current lighting guidelines, which focus more on quantitative than qualitative aspects. To gain knowledge in this area, the project examined the role of 'good reading light' in libraries, comparing the contemporary libraries with data gathered by PhD student Oriel Prizeman on late 19th- and early 20th-century libraries, built when daylight was the principal source of task light. In these older libraries, the overall lighting arrangements have typically been informed by considerations of spatial geometry; the library designs ensure that readers are located and oriented to make the most of the natural light.

Analysis of the more recent libraries demonstrated just how complex an issue 'good reading light' is, and the extent to which it involves a broad appreciation of people's response to, and interaction with, buildings. With the availability of artificial light, it has become possible to design library buildings that are larger and can be open for longer. The consequence is that intelligent daylighting has frequently been ignored – the very availability of artificial light seems to be prompting its conspicuous consumption. In fact, having all the lights

Quincentenary Library, Jesus College, Cambridge (Evans and Shalev Architects)

Brighton Jubilee Library (Bennetts Associates Architects)

on in a public building like a library has now come to signal 'openness' to such a degree that even buildings designed to be predominantly day-lit are being artificially lit throughout the day. The project therefore underlines the need for consideration of lighting designs that make better sense in daylighting terms: in other words, lighting that consumes less energy yet maintains adequate – and stimulating – lighting conditions as day turns to night.

Room with a view

In any project of this type, it's important to ask the users themselves what their opinion is of the lighting in their library through user questionnaires. In the course of the project, new ways of monitoring and recording lighting of the interior spaces have been developed to examine the 'lightscape' and the design principles at play, and to help the team interpret the responses from the user questionnaires.

A range of qualitative aspects of lighting are being considered by team members, such as mood, lightness and access to view. As an example, one finding has been the fact that users now expect to have access to a view from the library. They may not necessarily be clear about whether the light they enjoy is daylight or artificial light, but they seem to appreciate the additional visual interest and feeling of spaciousness that views can induce. Where libraries did not meet this criterion, users were considerably less positive, even if an interior was potentially well day-lit through narrow side windows, or through larger, high-level windows or roof lights. It would seem that users value the visual release from focused studying provided by low-level windows of any orientation. Effectively, libraries, whether public or institutional, are now ideally a room – or perhaps several rooms – with a view.

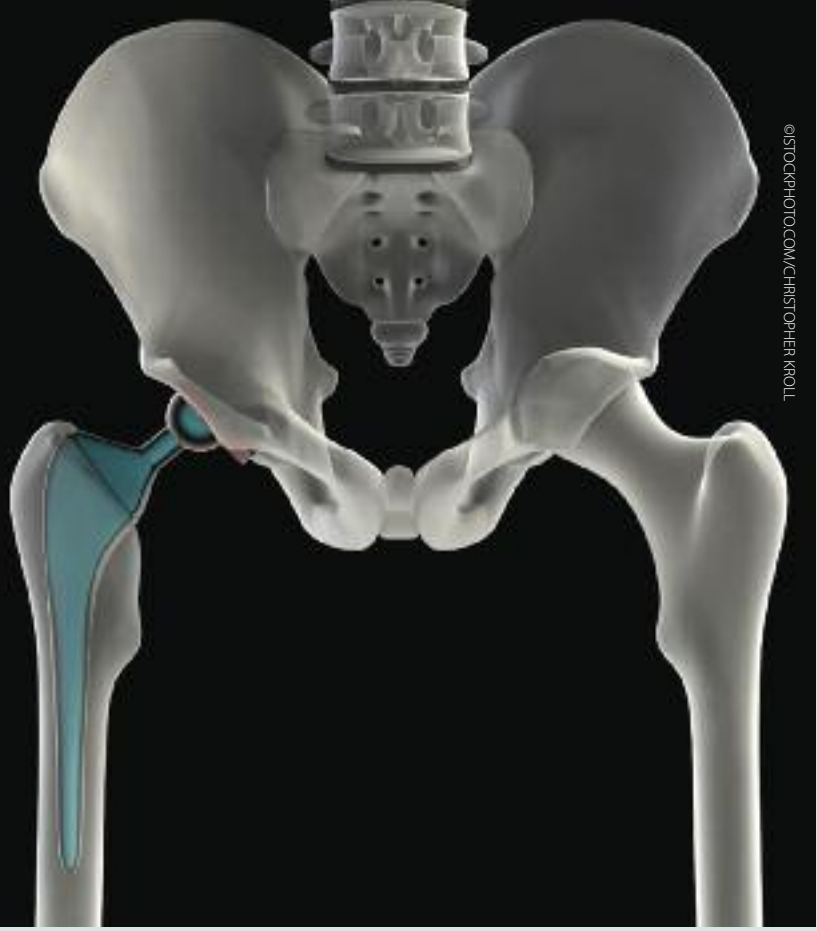
On this account, the 1960s Finnish benchmark library, which lacks a view, turned out to be less well liked by its users than the more recent buildings. However, another explanation for this lack of enthusiasm might also be the fact that the library has clearly outgrown the space for which it was originally designed. This illustrates an important dilemma for any library designer aiming to make the most of daylight: in the Finnish library, what was once a generous if highly introverted space is now both gloomier and more constricted in terms of space and light in which to browse.

Future change, future lighting

In seeking longevity, should designers give the potential need for flexibility of library spaces a high priority? A future change of use – or change of layout – could undermine lighting strategies adopted in the original design. This is why assessment of the benefits and drawbacks of flexible spatial arrangements, and potential strategies for expansion, deserve close consideration early in the design process. 'Designing with light in libraries' aims to act as a catalyst for higher quality design, guiding how design can be reframed to make the most of light.

Professor Koen Steemers and Mary Ann Steane

For more information, please contact the authors Professor Koen Steemers (kas11@cam.ac.uk) and Mary Ann Steane (mas58@cam.ac.uk) at the Department of Architecture.



Magneto-active porous materials get close to the bone

The most common cause of artificial joint failure is loosening of the prosthetic implant. Dr Athina Markaki is designing materials to anchor them securely.

Prosthetic implants provide long-term pain relief for many millions of people worldwide – in the UK alone, 160,000 hip and knee replacement operations were carried out in 2009 – and, as people live longer, the demand will continue to grow. Typical lifetimes of artificial joints are only about 10–15 years, with the most common cause of failure being loosening of the prosthesis stem from where it embeds into the bone. Once a joint becomes loose, wear debris tends to form and cause damage. Therefore, ensuring that the bond between bone and implant remains strong is an important objective.

An innovative solution that is being investigated by Dr Athina Markaki in the Department of Engineering may provide an answer. The aim is to promote early bone ingrowth into the surface of the prosthesis and anchor it securely.

Bare bones of the matter

Bone is an active material, responding to stresses and strains within. It's long been known that mechanical strain, such as occurs during exercise, encourages bone modelling (formation) and remodelling (resorption). In fact, this forms the basis of the physiotherapeutic exercise commonly applied after implantation. However, in cases where the patient requires complete immobilisation, such treatments are clearly impossible, and drugs are often the only alternative. If a therapy could be devised in which controlled levels of mechanical strain are induced directly within ingrowing bone via the prosthesis itself, this would improve the bonding between prosthesis and bone, and avoid the danger of loosening caused by premature excessive exercise.

Engineering solutions

Dr Markaki's project focuses on a novel concept called magneto-mechanical actuation, which arose from work she carried out with Professor Bill Clyne at the Department of Materials Science and Metallurgy in Cambridge, funded by the Cambridge-MIT Institute. It involves a porous surface layer made of ferromagnetic fibres that is attached to a conventional prosthesis and promotes ingrowth of bone so as to anchor it more fully and rapidly. Porous metal implants are not new. The innovative concept here is that mechanical strain is generated in the bone by applying a magnetic field. This causes the network of ferromagnetic fibres to move so as to align with the field, imposing strains on bone cells as they grow into the network.

Modelling of the phenomenon has shown that the degree of strain is determined by the geometry of the network – in other words, the prosthesis can be coated with material that is tailor-made to impart the optimum strain on ingrowing bone to promote growth. Once the optimum exposure regimes have been established, the idea is to apply a magnetic field during the post-operative period to the region of the implant. The strength of the field would be lower than that currently used for diagnostic purposes, such as in magnetic resonance imaging, but would be sufficient to cause the fibres to move.

Thanks to a recent award of a €1.5 million European Research Council Starting Investigator grant, Dr Markaki has embarked on a five-year programme to progress this concept to application. The work will be carried out in close collaboration with Dr Roger Brooks at Cambridge's Department of Surgery (Orthopaedic Research Unit). The hope is that the technique will yield a new generation of longer-lasting and more durable prosthetic implants, reducing the painful and costly need for replacements.

Dr Athina Markaki

For more information, please contact Dr Athina Markaki (am253@cam.ac.uk) at the Department of Engineering.

Professor Sharon Peacock

On returning to the UK after seven years in Thailand researching infectious diseases, Cambridge's new Professor of Clinical Microbiology, Sharon Peacock, has taken up with an 'old friend': she resumes her long-standing research interest in the bacterium *Staphylococcus aureus*, particularly the MRSA strains that have become resistant to the antibiotic drug methicillin. The increasing incidence of antibiotic resistance in such bacteria is a global health threat. Her expertise is helping to drive a programme of research that will track and block routes of transmission for these 'superbugs'.

Now based within the Departments of Medicine and Pathology, and working closely with the Health Protection Agency and the Wellcome Trust Sanger Institute, Professor Peacock has recently returned from the Mahidol-Oxford Tropical Medicine Research Unit in Thailand. There, she directed a wide-ranging programme of bacterial disease research focused on prevalent diseases in South-East Asia. This included clinical treatment trials, diagnostic test development and the molecular epidemiology of several bacteria.

Professor Peacock has also had a long-term interest in MRSA, which over the past four decades has spread around the world and is resistant to many of the antibiotics commonly used in hospitals. 'Tracking how MRSA spreads can be likened to playing detective since it's all about trying to identify and follow specific strains of bacteria as they move globally, between countries and between individuals,' she explained. 'It's important that we can do this because measures can then be introduced to further reduce transmission in settings where the bacteria pose the greatest problem such as hospitals.'

Through a collaboration with the Wellcome Trust Sanger Institute, her research has already had a dramatic impact on moving forward the detective story: in 2004, the genome of the MRSA strain that is a common cause of hospital-based infection in the UK was sequenced; and in January 2010, a new method for tracking transmission routes based on the rapid sequencing of genetic differences between strains was published in *Science*. Her focus now is to translate these research tools from the laboratory into the clinical setting, so that preventive interventions can then be targeted with precision and according to need.

What's the best piece of advice you've ever been given?
'Make it hard, but make it look easy'; in other words, challenge yourself, but don't let on that it's so difficult. I've always tried not to settle into a comfort zone for very long before I'm looking for the next challenge, and the one after that.

Have you ever had a Eureka moment?
Yes – when I realised that what I really wanted to be was a doctor. But, at the time, I was six months into student nurse training, having left school at 16 almost empty-handed and without the O-levels I needed to study medicine. It was only when I saw how enthralling the whole diagnostic process was – taking a history, examining the patient, carrying out investigations and reaching a diagnosis – that I knew that's what I wanted to do. I had a very long way to go to achieve it. I did my O-levels at night school, then my A-levels part time while working as a nurse to fund myself. It was quite difficult to get into University to study medicine because of this unusual background, but Southampton University gave me the opportunity. I haven't really had a Eureka moment since – I've just been trying to achieve what I set out to do all those years ago!

If you could wake up tomorrow with a new skill, what would it be?
Wouldn't it be good to wake up and realise you could run a marathon? I'm a very keen spinner – it's a fitness regimen using a specially designed stationary bike – and I'd love to have the fitness of a marathon runner.

What is your favourite research tool?
There's no doubt that access to information on the scale the internet provides has revolutionised the way we do our work. It's hard to imagine that, when I was a medical student, finding scientific articles involved a trip to the library and locating the right volume of Index Medicus *on a bookshelf, all to provide what PubMed does at the touch of a button. The other major research tool for me is the advent of high-throughput sequencing technology, and the speed with which we can now sequence genomes and tell individual strains of bacterial pathogens apart, some of which may only differ at a few bases of DNA. It's an incredibly powerful tool in the battle against the spread of bacteria.*

What will the future look like in 2050?
Antibiotic resistance in bacteria is a result of the widespread use of antibiotics over recent decades. Unless we embark on a better global vision for conserving the efficacy of current drugs by limiting their use, this will be a major problem in the future. However, by 2050, we'll have a better genetic understanding of bacterial pathogens and based on this I hope that we'll be able to identify weaknesses that can be targeted with a new generation of antibiotics. And, crucially, many of the technologies that are now becoming available for diagnosing and tracking disease will be translated into cost-effective clinical tools. Even in the face of rising antibiotic resistance, we'll have the front-line measures to understand and reduce bacterial transmission and limit the spread of infection.

Your way into Cambridge

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