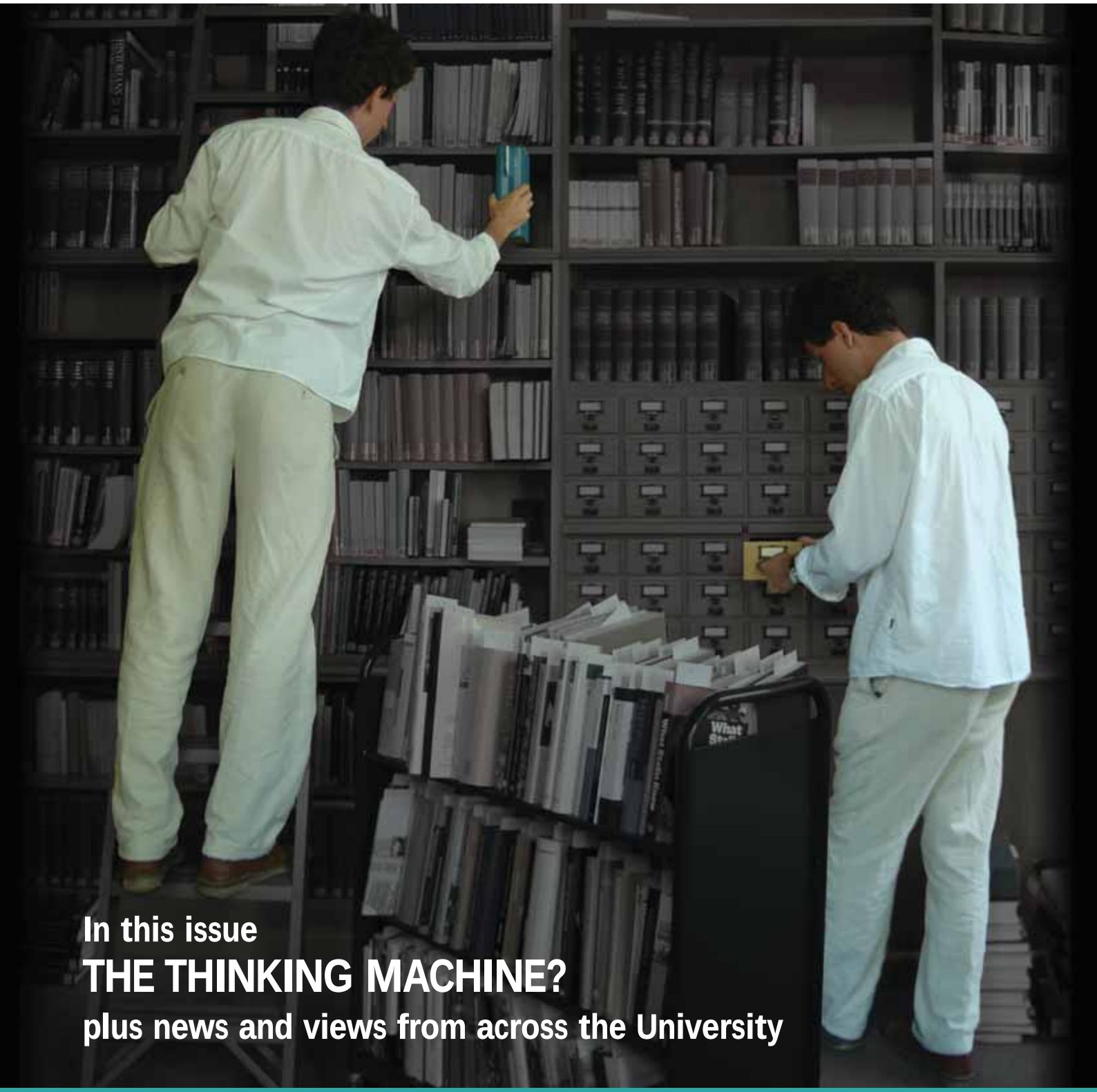
RESEARCH HORIZONS



In this issue

THE THINKING MACHINE?

plus news and views from across the University

University of Cambridge research magazine
www.rsd.cam.ac.uk
Issue 5 | Spring 2008

UNIVERSITY OF CAMBRIDGE
800 YEARS
1209 - 2009

Foreword

A Happy New Year to all of our readers and contributors! This issue coincides with a double celebration for Research Services Division, as we mark five years of Horizon Seminars and the twentieth in the series: 'The Thinking Machine?' on 18 March. Not only do these events provide a forum for showcasing interdisciplinary research at Cambridge, but also excellent networking opportunities for speakers and delegates alike.

Our front cover shows Dr Máté Lengyel from the Department of Engineering 'in search of lost memories'. In the Spotlight section, he describes how the intriguing process of memory storage and recall is being revealed by computational neuroscience. We also hear from computer scientists who are modelling how humans resolve ambiguities in language and use diagrams for reasoning. We contemplate why it has been so hard to program a computer to play the ancient Chinese game of Go. We consider how the brain orchestrates the 'daily dance' of sleep and wakefulness, and we look back a million years to ask when mankind first showed evidence of a thinking brain.

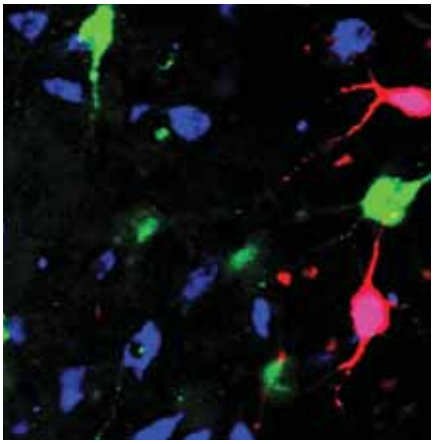
Cambridge has many examples of cross-School research initiatives that bring together the best in their field to address challenging questions of the day. We will be highlighting these initiatives in coming issues, beginning with 'Great expectations' in our Feature section this time.

Many thanks to all of this issue's contributors for their fascinating insights into their research projects: from Anglo-Irish history to ecotoxicology, archaeology to law, medicine to Greek tragedy.

We look forward in 2008 to keeping you abreast of the ground-breaking research happening across the University. Please email your comments and suggestions for future coverage to me at Research.Horizons@rsd.cam.ac.uk

Louise Walsh

Dr Louise Walsh
Editor



DR DENIS BURDAKOV

Orchestrating brain activity

COURTESY OF THE CAMBRIDGE GREEK PLAY COMMITTEE

Greek tragedy: setting the stage today

Contents

Cover photograph of Dr Máté Lengyel 'in search of lost memories' by Dr Quentin Huys and Dr Máté Lengyel, with kind permission of *Nature Neuroscience.*
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‘Rising stars’ shine on

Would you like to communicate your expertise to the public and become an ambassador for your subject?

One year on from its launch, the Rising Stars public communication course is readying itself for training a new group of inspiring undergraduates, postgraduates, post-docs and early career academics for the benefit of the wider community. The course is the first of its kind in the UK and has been organised by the University’s Office of External Affairs and Communications with funding from the Higher Education Funding Council for England (HEFCE).

The participants have been putting their new skills into practice at festivals, museums and schools, as well as in the media. ‘The Rising Stars scheme enabled me to join a community of young researchers with a passion for public communication,’ said Dr Nikiforos Karamanis, who writes for Research Horizons on page 12 of this issue. ‘It gave me the opportunity to prepare and deliver several outreach events and made me feel more confident in my ability to present my expertise to the public.’

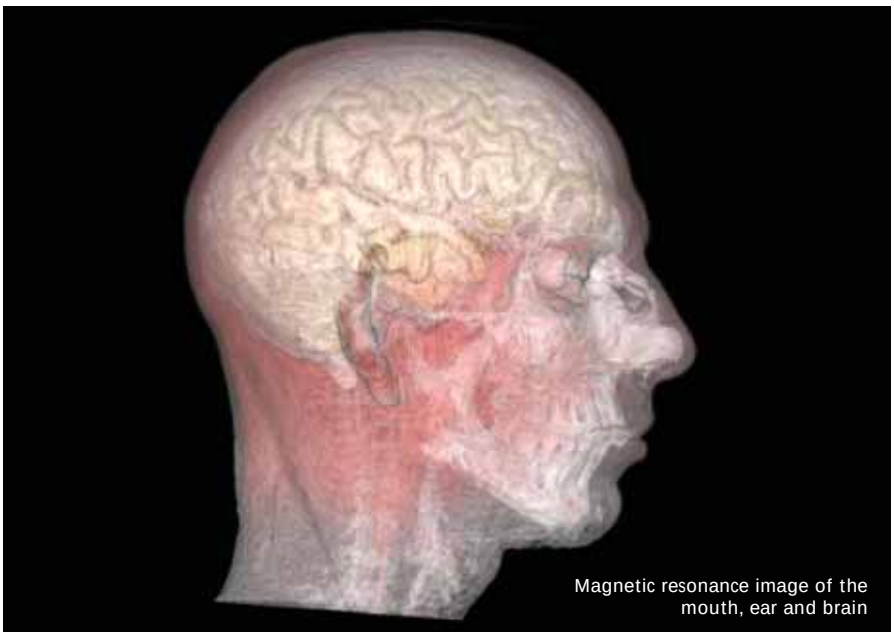
Penny Wilson, Head of Community Affairs, is delighted both with the success of the course and with the enthusiasm shown by the participants: ‘Underlying the scheme is the real need to create dialogue between the University and the wider community and to communicate research and its contribution to society. It is the young academics who make the best ambassadors for the University for many audiences, and it is they who will become the role models for the next generation.’

Rising STARS

For more information on the Rising Stars programme, please contact Emma Wenborn (emma.wenborn@admin.cam.ac.uk).

Asking ‘are you awake?’ with brain imaging

Even though we might be able to hear someone speaking, our powers for understanding what is actually being said switch off as we go to sleep.



DANIEL J MITCHELL, MRC CBU

Magnetic resonance image of the mouth, ear and brain

Using brain imaging techniques, Cambridge scientists have shown that those regions in the brain that understand sentences and form memories show reduced activity after sedation. These findings help us to understand how speech is decoded in the brain, and have clinical implications for monitoring anaesthesia and patients with brain injury.

The recently published results are the culmination of a study conducted under the lead of Dr Matt Davis at the Medical Research Council Cognition and Brain Sciences Unit (MRC CBU) and Professor David Menon at the University’s Division of Anaesthesia in the Department of Medicine.

Dr Davis, a cognitive neuroscientist, has developed a method that detects when the brain has comprehended speech, not simply heard it: ‘We look at the brain’s response to sentences containing ambiguous words. Of the most commonly used 5000 words in spoken English, over 80% change their meaning in different contexts – such as the word *shell*, which can refer to a bullet or part of a sea creature.’ Understanding these words triggers additional processing in the brain as it retrieves the different meanings and selects the one that fits the sentence context; this activity can be visualised using functional magnetic resonance imaging (fMRI).

In this recent study, 12 anaesthetists at Addenbrooke’s Hospital volunteered to receive varying amounts of sedation to test at what level their brain could understand speech. ‘Our research showed that although brains that are sedated to the same level as in sleep are able to process sound, brain processes involved in speech comprehension are compromised even at quite low levels of sedation,’ said Professor Menon. ‘These results have important implications for our understanding of how and where anaesthetic drugs work in the brain, and what neural processes are involved in consciousness.’

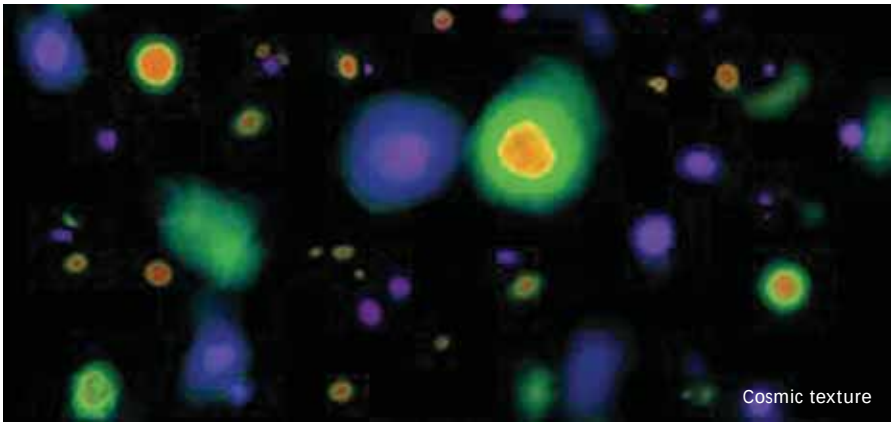
Being able to assess comprehension without spoken responses has huge resonance for two clinical settings. ‘A small proportion of anaesthetised patients report memories of events that occurred in the operating theatre,’ said Professor Menon. ‘With this methodology, we could refine our judgement of how deep anaesthesia needs to be to prevent comprehension and memory during operations. The information also helps us to understand functional imaging studies that we have undertaken in patients following brain injury – in individuals who appear to be in a coma or the vegetative state.’

For patients in the vegetative state, who are awake and yet show no outward signs of awareness, this tool is already providing important information. ‘Being able to show brain activity that indicates comprehension in the patient brings hope to carers, and might guide treatment and rehabilitation,’ said Dr Davis.

For more information, please contact Dr Matt Davis (matt.davis@mrc-cbu.cam.ac.uk) or Professor David Menon (dkm13@wbic.cam.ac.uk). This research was published in *PNAS* (2007) 104, 16032–16037.

Unlocking the secrets of the universe

Cosmic defects and adolescent galaxies – two research projects in Cambridge are bringing us closer to understanding the cosmos.


Cosmic texture

PROFESSOR NEIL TUROK

Astronomers believe that the universe was created 13.7 billion years ago following a cosmic explosion, the residual energy of which can still be detected as cosmic microwave background (CMB) radiation, which fills the universe. The matter hurled outwards from the fireball eventually cooled enough to form galaxies across the expanding universe.

Cambridge scientists working with the Institute of Physics of Cantabria in Spain may have discovered a remnant in the CMB from the Big Bang called a 'texture'. As the universe cooled and underwent transitions, physicists believe that vacuum misalignments or defects occurred. An analogy would be the defects we sometimes see in the transition of water to ice. Textures are one of the most complex of cosmic defects, and when they collapse they form 'hot' and 'cold' spots in the CMB.

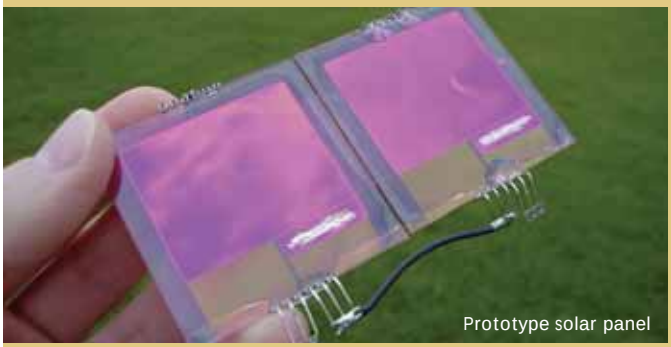
The team have analysed a large cold spot in the Southern Galactic Hemisphere and published their findings recently in *Science*. Professor Neil Turok, of the Department of Applied Mathematics and Theoretical Physics (DAMTP), and Dr Mike Hobson, of the Astrophysics Group at the Cavendish Laboratory, concluded that the properties of the cold spot are consistent with its having been formed by a texture. 'If this is the case,' said Professor Turok, 'it will revolutionise our understanding of how the fundamental symmetries between the particles and forces were broken as the universe emerged from the Big Bang.' Professor Turok was awarded the prestigious Technology, Entertainment, Design (TED) prize in November in recognition of his work in cosmology and his efforts as an education activist. The prize is awarded annually to three individuals whose work is considered to have extraordinary potential for positive influence on mankind.

About half a billion years after the Big Bang, it is thought that matter started to aggregate, eventually forming small adolescent proto-galaxies, which then merged to become bigger galaxies. Although astronomers have been able to study starlight of the progenitors of very massive galaxies, starlight from the building blocks of galaxies like our Milky Way has proved elusive. In a recent study, due to be published in March in the *Astrophysical Journal*, an international team of astronomers led by Dr Martin Haehnelt at the Institute of Astronomy were able to capture starlight from 27 adolescent galaxies about 2 billion years after the Big Bang. They pointed the world's most powerful telescopes, located in Chile, to the same patch of sky for the equivalent of 12 nights. 'It is precisely because this was the first time the sky had been searched with this level of sensitivity that we succeeded where many astronomers had failed before,' said Dr Haehnelt. The detection of these building blocks means that scientists can now study in detail how galaxies like the Milky Way have come together.

For more information, please contact Professor Neil Turok (N.G.Turok@damtp.cam.ac.uk), whose research was published in *Science* (2007) 318, 1612–1614, or Dr Martin Haehnelt (haehnelt@ast.cam.ac.uk).

Sunny times ahead for solar power

A new initiative funded by the Carbon Trust hopes to make solar power an affordable choice for homeowners within 10 years.


Prototype solar panel

©CAMBRIDGE DISPLAY TECHNOLOGY

Photovoltaic (PV) solar panels offer great promise as a source of clean and renewable electricity generation but the high cost of manufacturing the silicon-based PV panels has been a prohibitive drawback to their use. A new research and development programme led by Professor Sir Richard Friend, Dr Neil Greenham and Professor Henning Sirringhaus at the University of Cambridge's Cavendish Laboratory, in collaboration with The Technology Partnership, hopes to solve this problem. The team are using a plastic-based technology to create the solar cells. A prototype has already been built and the new funding will allow scaling up to large sheets of PV film that can be sited on windows or roofs to capture solar energy.

By 2017, the aim is for these plastic solar cells to be delivering 1GW of power, equivalent to carbon dioxide savings of more than 1 million tonnes per year. 'This is a timely opportunity to build on technology developed in the University,' said Professor Friend. 'We will capitalise on the local Cambridge strengths in taking science to manufacturing.'

The Carbon Trust is funding the initiative. Tom Delay, Chief Executive, explained the importance of the research: 'We believe this exciting new organic PV technology is our best shot at dramatically reducing the cost of solar PV to the point that, in the next 10 years, it could become as cheap as the power currently delivered to our homes.'

For more information, please contact Dr Neil Greenham (ncg11@cam.ac.uk) or the Carbon Trust (www.carbontrust.co.uk; Tel: +44 (0)20 7544 3100).

Gems of colour: pigments of the 'Colourmen'

Dragon's Blood, Purple of Cassius and Scarlet Lake – all pigments concocted by the 19th-century 'Colourmen' of Winsor & Newton artists' suppliers. Now, a painstaking and methodical analysis of their hand-written recipe books has been developed into a searchable database.

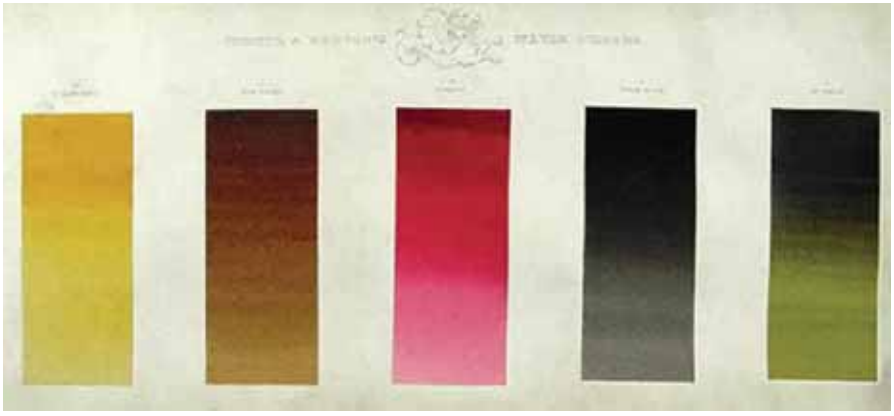


IMAGE COURTESY OF WINSOR & NEWTON

Winsor & Newton catalogue with painted samples

As pioneers of brighter, more-permanent and less-toxic pigments from 1832 to the present day, Winsor & Newton has been a driving force in developing colour chemistry for art. As part of its rich heritage, the Winsor & Newton archive boasts 85 handwritten recipe books and workshop manuscripts dating from the 1830s to 1900 – a total of 17,000 pages. Now, thanks to work carried out under the leadership of Ian McClure and Dr Mark Clarke at the Hamilton Kerr Institute, in collaboration with Dr Leslie Carlyle of Tate, a digital archive and index of the Colourmen's recipes and notes have been created.

Although the use of decorative pigments dates back tens of thousands of years, some of the most exciting developments happened in the 19th century, when scientific discoveries added dramatically to the artist's palette. Startling new pigments were developed by industrial chemists, yet traditional materials were still produced by methods originating in antiquity. 'Mummy', for instance, required the grinding of an Egyptian mummy before mixing with asphalt. Many details of innovations in this period of rapid change have been imperfectly understood until now.

The source material from the Winsor & Newton archive – from recipes for pigments and oils to watercolours and varnishes – has been made available for research purposes. Additional notes on recipes for gout and toothache, wages and costs, travel and hotel suggestions are also recorded. Words and passages in published technical literature that were previously baffling are becoming clear.

Each page has been carefully photographed and the recipes entered into an innovatively structured database that will be available in Spring 2008. The value of this work, funded by the Arts and Humanities Research Council (AHRC), lies not only in historical record, but also in technical and authenticity studies, as well as in evaluations of the deterioration of paintings.

Dr Clarke explained: 'Research into artists' materials and techniques is highly interdisciplinary and is mainly conducted by studying artists' recipe books, scientific analyses and historically accurate reconstructions. This archive affords a fascinating insight into the art and science of the innovative Colourmen.'

For more information, please contact Dr Mark Clarke (hki-admin@lists.cam.ac.uk) at the Hamilton Kerr Institute, a department of The Fitzwilliam Museum, or visit www-hki.fitzmuseum.cam.ac.uk/wn

IMAGE COURTESY OF WINSOR & NEWTON

Box for tube paints, showing the Winsor & Newton factory

'Sex, scandal and sermon' in medieval Spain

A new study of the 14th-century narrative poem *Libro de Buen Amor* explores how its earthy tales of failed love are shaped by humour.

The medieval poem *Libro de Buen Amor* ('The Book of Good Love') by Juan Ruiz tells the story of 14 failed love affairs, combined with animal fables, sacred and profane lyrics, and doctrinal matters. The ribald tales, colloquial language and vivid characters (particularly the narrator, an Archpriest 'fallen' from grace because of his amorous dalliances) have led Ruiz to be dubbed the 'Spanish Chaucer'. Its 1728 stanzas are the subject of a new analysis, which is due to be published in April 2008, by Dr Louise Haywood from the Department of Spanish and Portuguese.

The canonical work by Juan Ruiz is of great importance for its contemporary references and literary scope. It is richly evocative of medieval cultural attitudes relating to love, religion and emotion, and hence is a much-studied work among students and scholars of Iberian literature from this era. 'It is one of the most challenging and thought-provokingly diverse works in world literature,' said Dr Haywood, 'and its impact on Spanish culture continues to be felt today.'

Humour has long been recognised as an important part of Ruiz's artistry but Dr Haywood's study of the *Libro* will be the first to approach the role of humour systematically in this iconic work. 'I have re-positioned Juan Ruiz's *Libro* in relation to broader trends in 14th-century culture, with a particular focus on the relationship between humour and scholasticism, the body, and visual culture. In essence: sex, scandal and sermon.'

For more information, please contact Dr Louise Haywood (lmh37@cam.ac.uk), whose book *Sex, Scandal, and Sermon in the Fourteenth Century: Juan Ruiz's 'Libro de Buen Amor'* will be published on 1 April 2008 by Palgrave Macmillan.

Weathering storms: transforming conflict in the church

A research initiative in the Faculty of Divinity aims to train church leaders to convert the negatives of conflict into the positives of transformation.

©ISTOCKPHOTO.COM/CHRIS KRIDLER

Vociferous debates, threatened splits, division and dispute are elements that can rankle, grow and ultimately undermine the future of any large organisation unless addressed in a constructive and holistic manner. Researchers in the Psychology and Religion Research Group (PRRG) in the Faculty of Divinity are combining psychological research and practice to look at conflict in the church and how this might be transformed. Out of this has developed a multidimensional training package to enable senior church leaders to handle conflict better.

'There are various lines of conflict. Some echo debates between conservative and liberal interpretations of Scripture; these affect moral and social issues, with varying degrees of impact upon churches in different parts of the world. Other conflicts are more local, and may voice disagreements between those who wish to maintain traditional forms of worship and those who wish to develop contemporary, emerging expressions of church,' said Dr Sara Savage, who has developed the project with Dr Eolene Boyd-MacMillan. The research was commissioned by the Foundation for Church Leadership with funding from the Henry Smith Charity.

The course, which has just been launched, will be road tested and assessed while being used to train senior representatives from the Anglican, Baptist, Church of Scotland, Methodist, Roman Catholic and United Reform traditions. Over the course of three training days, the participants will cover various topics and exercises designed to foster a positive attitude towards conflict as a holistic learning opportunity, while enhancing and adding to conflict transformation skills.

Pre- and post-assessment of the effects of the course will inform the research project, and the report and resources will be fed back to the key church denominational conferences in 2008. In time, the hope is that the programme will be used to train Christians at all levels to deal with dispute – whether it be a question of church-wide importance, a parish concern, or an inter-personal disagreement – as well as by other faiths.

For more information, please contact Dr Sara Savage (sbs21@cam.ac.uk) or Dr Eolene Boyd-MacMillan (emb43@cam.ac.uk).

The great divide

Despite efforts to narrow the gender gap in the workplace in the European Union (EU), there is still 'a great divide', as reported in a recent study.

Researchers in the Department of Sociology led by Dr Brendan Burchell have been analysing data gathered by the European Commission's *European Working Conditions Survey*. The Commission's door-to-door surveys are conducted every five years in all EU member states, and ask 30,000 employed and self-employed workers about their job, their well-being and aspects of their lives outside work.

Dr Burchell's recently reported findings show that little progress has been made in reducing the workplace gender gap in the EU since the early 1990s: 75% of the EU workforce is being managed by men, with just 9% of employed men in full-time work being managed by women. In the UK, although women make up nearly 50% of the workforce, fewer than 16% of senior managers are women.

'Because women are rarely the highest earners in the household,' said Dr Burchell, 'an economic rationale seems to have developed for also making them responsible for domestic duties. The result is that women tend to have a longer working day.' Adding together time in paid employment with time spent commuting and performing domestic work, men in full-time employment work for an average of 55 hours per week; by the same method, the average working week for a woman is 68 hours if she is in full-time employment, or 57 hours for part-time employment.

Dr Burchell added: 'The best way to break the cycle would be to reduce gender inequality in employment and the household together – for instance, by encouraging men to take their parental leave entitlements or by better enforcement of the working-time directive to reduce the disproportionately longer working hours of men.'

For more information, please contact Dr Brendan Burchell (bb101@cam.ac.uk).

Translating research from bench to bedside

Recent funding of over $5 million to Dr Sabine Bahn by the Stanley Medical Research Institute (SMRI) raises diagnostic and therapeutic hopes for a group of psychiatric diseases that affects 2% of the population.

Dr Sabine Bahn's dynamic and growing research group within the newly established Centre for Neuropsychiatric Research (CCNR) in the Institute of Biotechnology has been progressing towards a greater understanding of the molecular processes that lead to schizophrenia and bipolar disorder. Current estimates suggest that 1 in 50 people in the UK are affected, many of whom are incapacitated by these disorders.

Dr Bahn, a psychiatrist and molecular biologist, aims to develop a means to diagnose and treat patients at an early stage of the disease. 'Current diagnostic methods have remained unchanged for over a century and rely on a subjective, interview-style analysis of the patient by the medical practitioner rather than a diagnostic test. Following diagnosis, some patients show no improvement with current drug regimes,' explained Dr Bahn.

The substantial support given to Dr Bahn by the SMRI is made possible through the philanthropy of Americans Theodore and Vada Stanley. With previous SMRI funding of $3.5 million, Dr Bahn's group completed an intensive study of over 150 post-mortem brains, looking for differences between patients and matched controls. They successfully identified 'disease gene signatures' and the first strong biomarkers for schizophrenia in easily testable fluids like serum and cerebrospinal fluid. The further funding of $5 million allows Dr Bahn to build on these successes with her team of neuroscientists, molecular biologists, mathematicians, statisticians and bioinformaticists.

Dr Bahn's group works closely with Psynova Neurotech Ltd, the spin-out company she founded in 2005 with Professor Chris Lowe with SMRI support. Psynova is developing and exploiting the novel biomarkers discovered by Dr Bahn, as well as initiating its own drug discovery programmes using proprietary biomarkers. In June 2007, Psynova was awarded the Medical Futures Innovation Award in Mental Health and Neurosciences Innovation.


Dr Sabine Bahn

'With the new funding, we believe that all the ingredients are in place to successfully translate high-quality research into high-value clinical advances,' said Dr Bahn. 'Using the latest biotechnological advances, we hope that this seamless interface will link fundamental research at the bench directly with the patient bedside.'

For more information, please contact Dr Sabine Bahn (s.bahn@biotech.cam.ac.uk). For investment opportunities relating to Psynova Neurotech Ltd, please contact Cambridge Enterprise Ltd (Tel: +44 (0)1223 760339).

Earth's climate: past, present and future

Through considering past climate change, a major international symposium in Cambridge hopes to create new research opportunities for the future.

The Leverhulme Climate Symposium 2008, to be held on 10–12 March in Cambridge, will explore how accurate modelling of the Earth's present and future climate might be derived from knowledge of past climate change. 'There is evidence that climate change at times in the past was very unstable. Within the space of a few decades, the North Atlantic region warmed by 10°C at the same time that smaller changes of temperature occurred over wide areas of the planet,' said symposium convener Professor Harry Elderfield from the Department of Earth Sciences. 'It is important that the models for predicting future climate can simulate these extremely rapid events.'

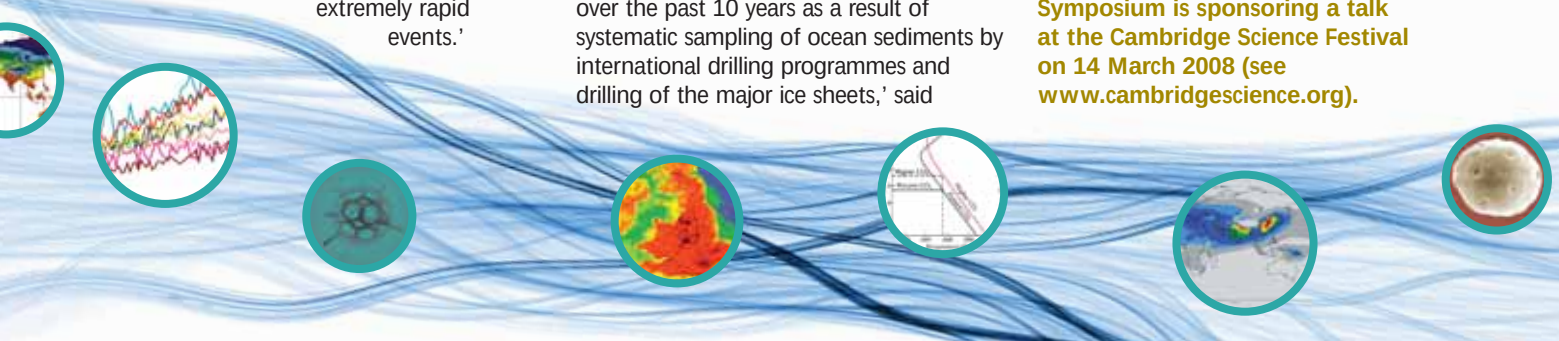
Over 100 international experts and young researchers invited from both the modelling and palaeoclimate communities will meet to share their knowledge on topics such as the effect on climate change of solar activity, changes in the Earth's atmosphere, ocean circulation, the hydrological cycle and ice sheet melting. The meeting is coordinated by the Cambridge Environmental Initiative (CEI), which supports environmental research at the University of Cambridge.

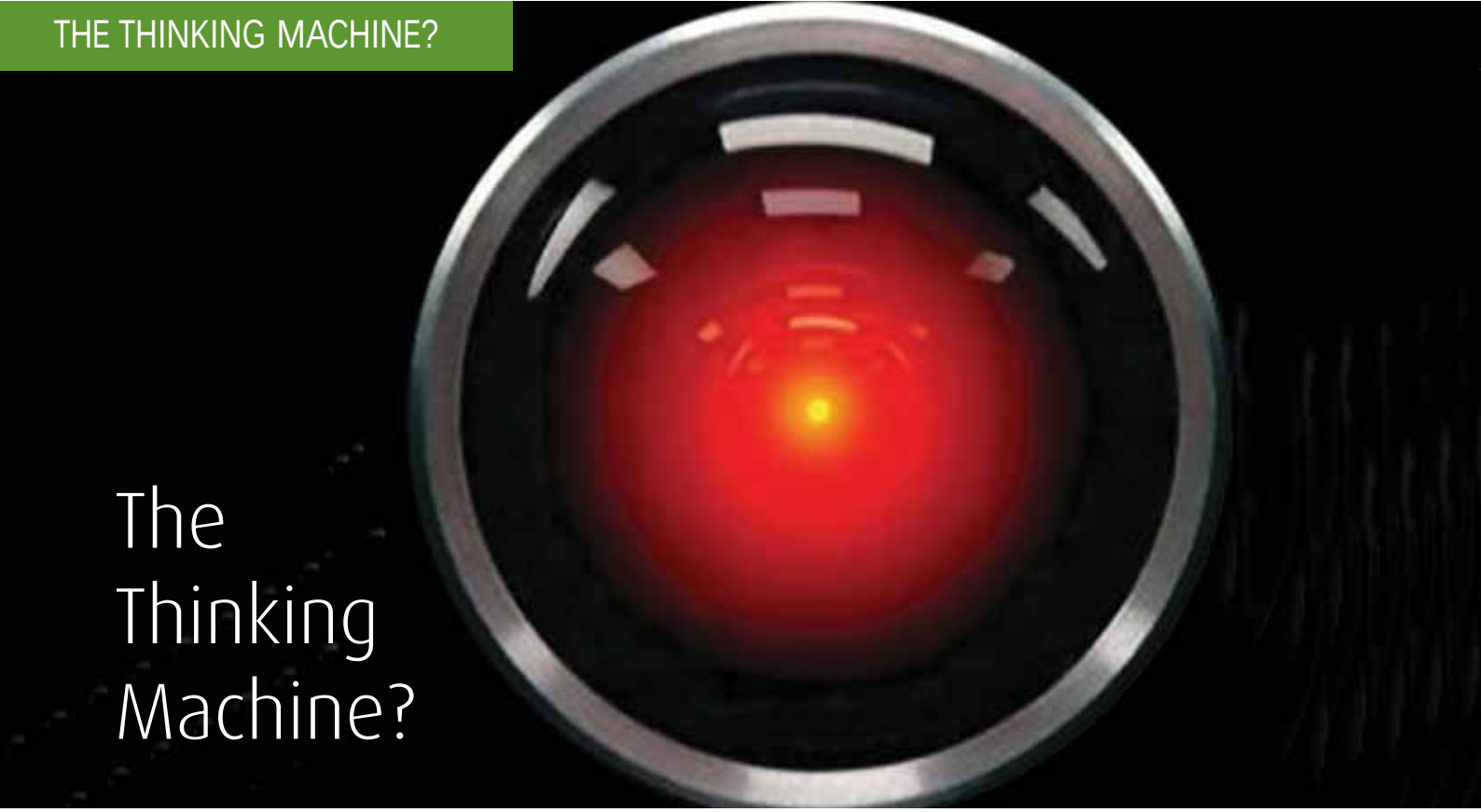
It is hoped that by bringing these two research communities together, new joint research areas will emerge in Cambridge and beyond. 'Information on past climate and its variability has increased enormously over the past 10 years as a result of systematic sampling of ocean sediments by international drilling programmes and drilling of the major ice sheets,' said Professor Elderfield. 'The aim now is to define the potential risks of climate change better, as well as to identify strategies we might take to minimise them.'

The symposium will conclude with a meeting and exhibition at the Royal Society in London on 13 March to which the general public, policy makers, their advisers and the media are invited.

For further information, please go to www.leverhulmeclimatesymposium.org

If you would like the opportunity to hear more about past climate change and how it impacts on future climate predictions, the Leverhulme Climate Symposium is sponsoring a talk at the Cambridge Science Festival on 14 March 2008 (see www.cambridgescience.org).





The Thinking Machine?

The Horizon Seminar 'The Thinking Machine?' takes place on 18 March 2008 at Emmanuel College, Cambridge, and will showcase the latest Cambridge research in cognition and statistical machine learning.

Our understanding of the process of cognition in human beings – how we perceive, think and process information about our environment – is highly developed. Research in areas such as psychology, neuroscience, linguistics, engineering, philosophy and computer science has taught us a great deal about the nature of learning, decision-making, perception and thought. At this event we will explore the cross-disciplinary research taking place in Cambridge and attempt to answer the questions: is intelligent human behaviour merely the result of pre-programed activity and can cognitive processes be modelled by machines?

For more information about the Horizon Seminar series, please go to www.rsd.cam.ac.uk/events/horizon or email horizon@rsd.cam.ac.uk

LEARNING

The ability to learn continuously about our environment, through experience and education, is a major advantage that sets humans apart from present-day machines. In this session we will explore how machines can be endowed with sophisticated learning mechanisms and ask what insights into biological learning are revealed by these new developments in machine learning.

Professor Zoubin Ghahramani
Dept of Engineering
Dr Máté Lengyel
Dept of Engineering
Professor Seth Grant
Wellcome Trust Sanger Institute

DECISIONS

We make decisions of many kinds, often subconsciously – from where to place our hands in order to catch a thrown object, to adapting our behaviour to different situations, to planning ahead. What are the elements involved in this process and can they be replicated artificially?

Professor Daniel Wolpert
Dept of Engineering
Professor Christopher Bishop
Microsoft Research Cambridge
Professor Nicola Clayton
Dept of Experimental Psychology

PERCEPTION

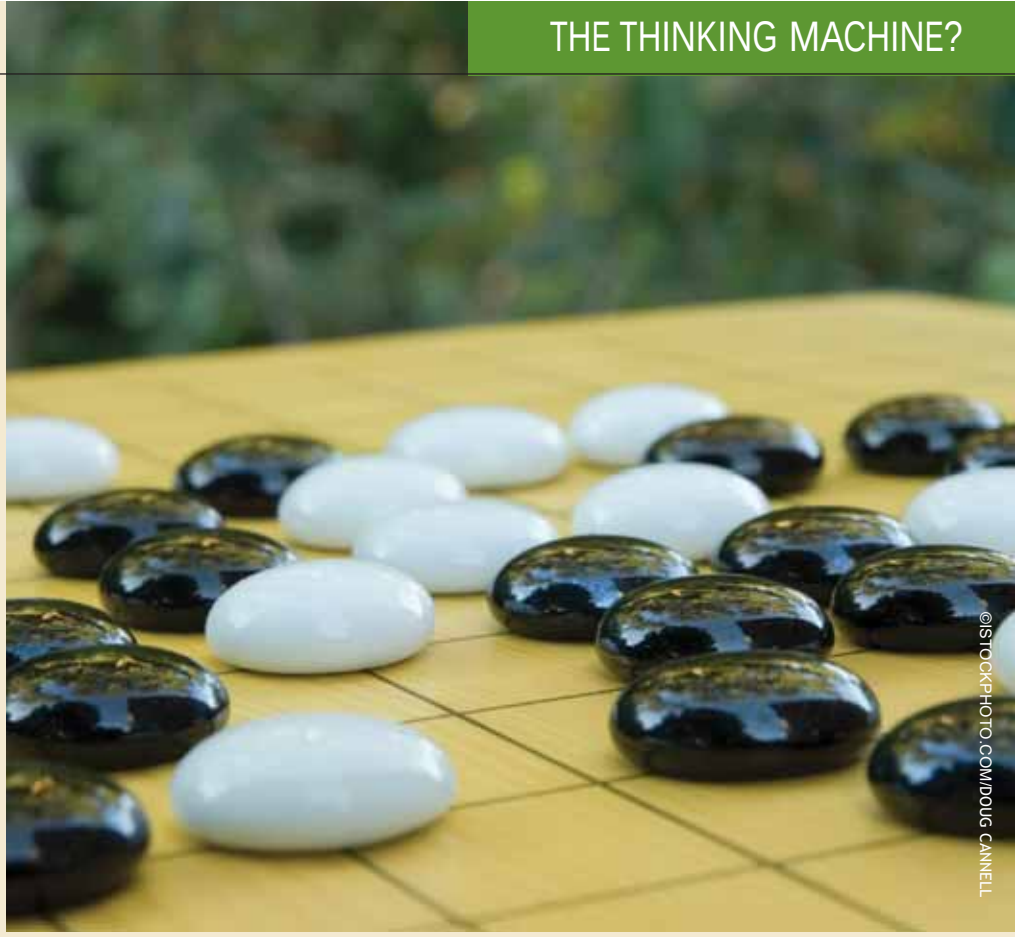
What we make of the world is dictated by the information we have about it, and human brains are exceptionally good at modelling their own universe. Here we examine the ways in which machines are able to perceive their surroundings and we explore whether machines shape their own environment like us.

Professor Roberto Cipolla
Dept of Engineering
Dr Mateja Jamnik
Computer Laboratory
Professor Ted Briscoe
Computer Laboratory

REFLECTION, CONSCIOUSNESS AND THINKING

Panel discussion

Modelling uncertainty in the game of Go



Cambridge researchers have analysed millions of patterns of potential moves to model the uncertainty of play in the ancient game of Go.

The ancient Chinese two-player strategy game Go is presenting a 'grand challenge' to current artificial intelligence (AI) research. At first sight it appears straightforward: the players take it in turns to place black and white 'stones' on a grid with the aim of gaining control of the most territory. However, the game that emerges from these simple rules has defeated all attempts by AI researchers to program a computer to play it. Indeed, there is currently no Go program that can play better than a beginner on the full-size board.

Tree of possible futures

It might seem surprising that Go is so difficult to model, given the notorious defeat of World Champion Garry Kasparov by the chess computer Deep Blue in 1997. The trouble with Go is that the brute force technique that proved so successful for chess simply cannot be applied. Deep Blue worked by considering billions of possible future move sequences (searching about 12 moves into the future) and estimating the strength of the resulting game positions. This fails when applied to Go for two main reasons. First, the tree of possible futures is too big to explore usefully (on average, there are 220 legal moves for each turn in Go compared with about 35 in chess). Second, it is difficult to estimate the strength of a Go position: in chess we can sum the point values of the pieces on the board but no such simple heuristic exists for Go (all of a player's stones are identical and take on their value from their relationship with surrounding stones).

Predicting human play

Go is an excellent test-bed for new techniques in AI because it is well defined by a set of simple rules yet remains sufficiently complex to challenge the state of the art. Also, a wealth of data exists about how humans play, in the form of records of historical games.

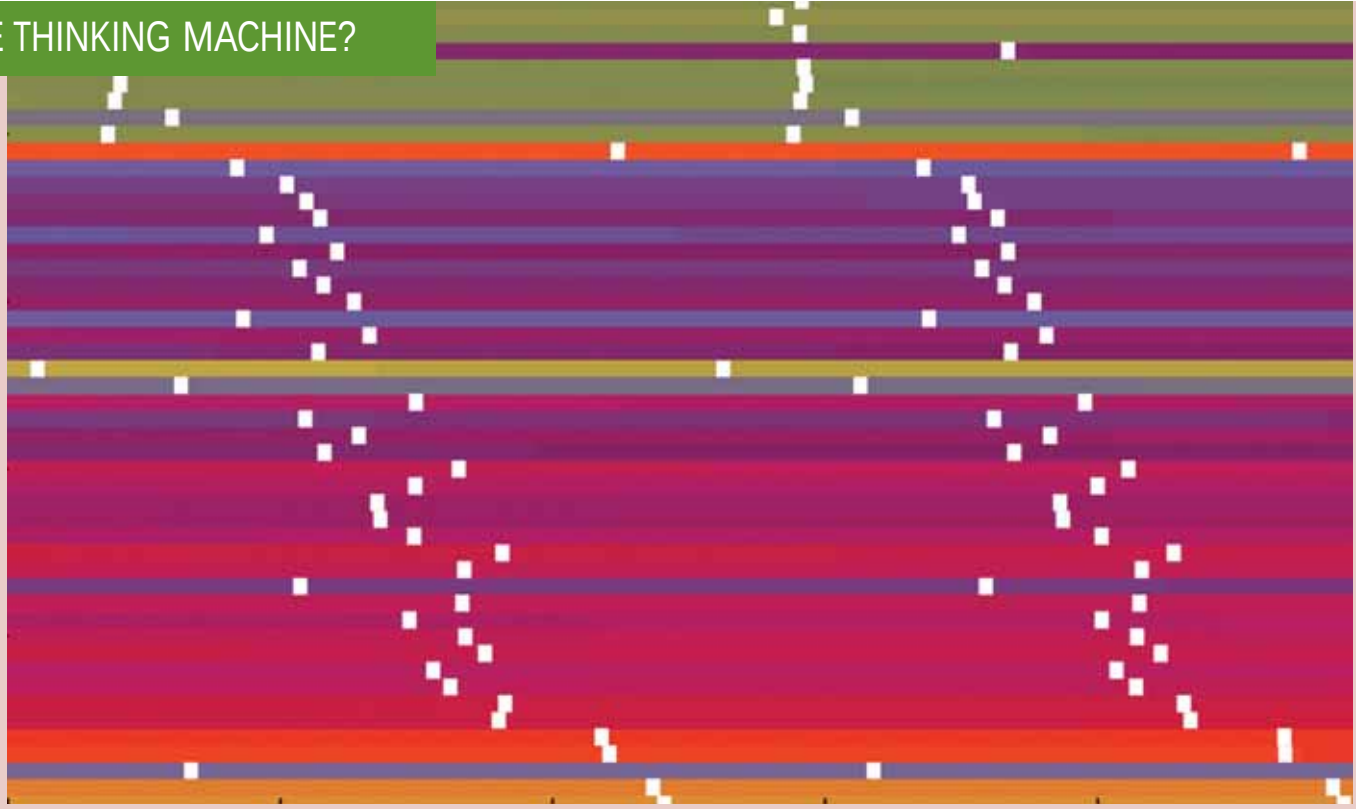
Professor David MacKay's Inference Group at the Cavendish Laboratory, in collaboration with Dr Thore Graepel of the Applied Games Group at Microsoft Research, has focused on applying probabilistic modelling techniques to Go. By modelling the play of human experts, the aim is to predict human moves in the game records. One successful approach has been to represent each potential Go move by the pattern of stones surrounding the move location. Millions of these patterns were automatically harvested from 180,000 records of historical games. The decisions made by the players in all the game records were then used to determine the relative value of each of the patterns. This is possible because each recorded game position contains a set of legal moves, one of which we know was selected by the player, so we can infer that one move was more valuable than all of the other moves in that position. After being trained on all the game positions, the resulting system was able to predict the moves of human players more accurately and much more rapidly than other published results and was capable of playing the game surprisingly well.

Way to Go

We are still a long way from producing professional-level Go play. Formidable challenges remain, leading some researchers to argue that a strong Go-playing computer is still decades away. However, the fact that humans learn the game with relative ease provides tantalising evidence that, one day, it will be possible to create a strong Go program and, in so doing, perhaps increase our understanding of human intelligence.

For more information, please contact the author David Stern (dhs26@cam.ac.uk) at the Cavendish Laboratory, or visit the Inference Group website (www.inference.phy.cam.ac.uk/is) or the Applied Games Group website (http://research.microsoft.com/mlp/apg). This work was supported by a grant from Microsoft Research through the PhD scholarship program (www.research.microsoft.com/ero/phd).

David Stern



In search of lost memories

'I raised to my lips a spoonful of the tea in which I had soaked a morsel of the cake. […] And suddenly the memory returns.'
***À la Recherche du Temps Perdu*, Marcel Proust.**

Recalling events from our past is a task we need to accomplish several times every day – even if the form it takes is usually not nearly as dramatic as Marcel Proust describes in his famous novel, in which a mere taste evokes memories long buried. For centuries, artists and philosophers have been intrigued by the process of memory storage and recall. More recently, psychologists, neuroscientists and cognitive scientists have begun to unravel some of the principles of 'remembrance of things past'. And now, a branch of neuroscience that works on quantitative models of the nervous system – computational neuroscience – is also contributing to the quest.

Dr Máté Lengyel, at the Computational and Biological Learning Lab in the Department of Engineering, is borrowing ideas from machine learning to elucidate the principles of memory recall. One particular challenge in memory research is to unfold the sequence of events happening at the level of nerve cells (neurons) that leads to the retrieval of a memory. Not only is this a fundamental question in neuroscience, but it has also provided some of the finest examples of how collaboration between theoretical and experimental approaches can be especially fruitful for understanding the brain.

Attractor networks – attractive theories

A commonly held view in modern neuroscience is that most forms of memories are stored in the nervous system because of the changing way that connections (or synapses) are made between neurons – a phenomenon known as 'synaptic plasticity'.

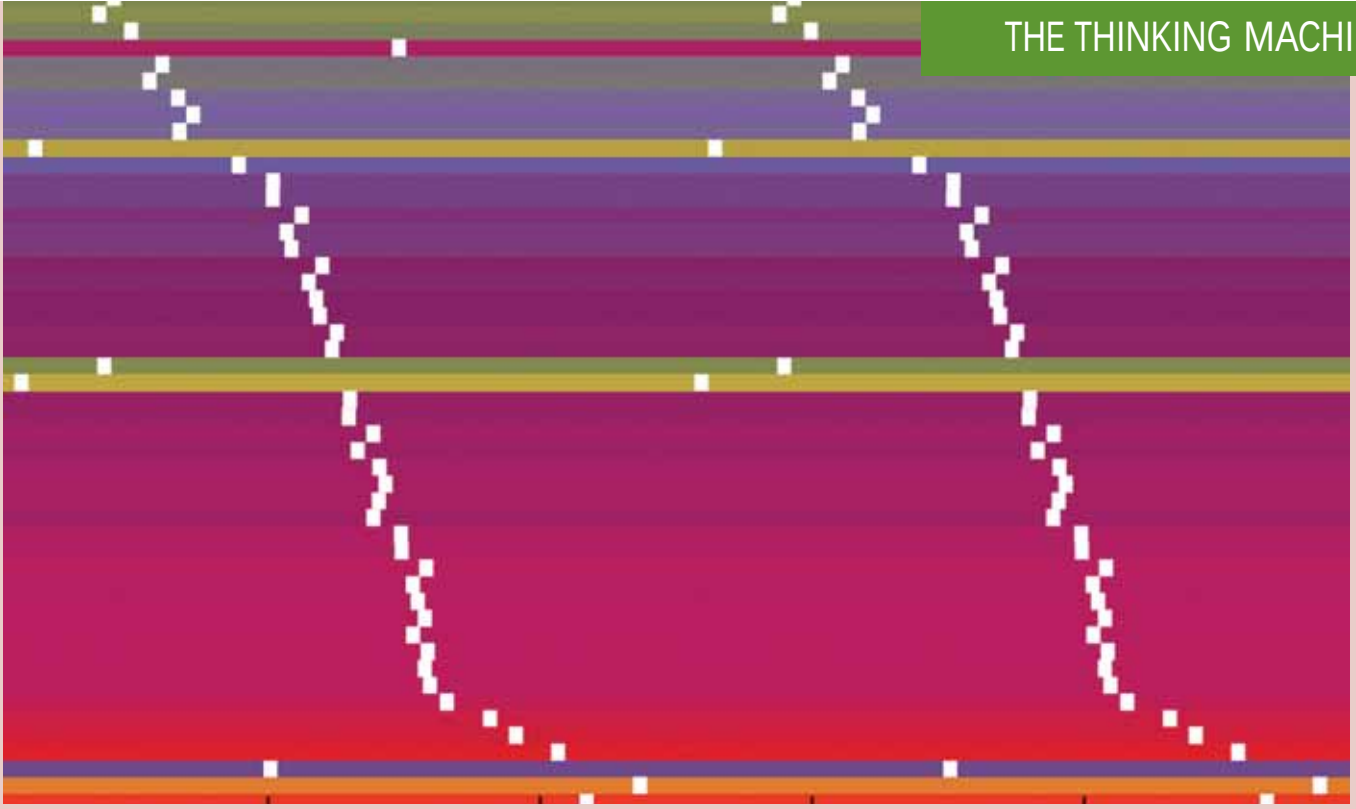
Once a memory trace has been laid down in a set of synapses it has to be recalled by neurons interacting with each other through these synapses. The first coherent picture about how this might happen was proposed by theorists who developed a specific class of neural network models called 'attractor networks'. This theory has provided an elegant mathematical formulation of how a network of neurons gradually reconstructs a complete memory trace starting from only partial information – just as in Proust's novel, the narrator recalls an entire scene starting from only the taste of cake soaked in tea.

Despite the success of attractor networks as a theoretical framework that guides many scientists' thinking about the neural bases of memory storage and recall, there are several questions that the original theory is unable to address. Is it important just that a neuron is active or not, or is it the graded level of activation that bears information about the original memory trace? If we take it a stage further, do neurons only communicate through the average rate of the transient electrical impulses they emit, called spikes, or is it the precise timing of these impulses that are important?

It is well established, for instance, that the *graded* activity level of neurons and their spike *timings* play a central role in the functioning of the hippocampus, a brain structure in the medial temporal lobes that is crucial for an intact memory. Yet, traditionally, the theory of attractor networks assumes that memories are *binary* and based on the *rate* of spiking, and it has proved notoriously difficult to bridge this gap between theory and biological reality.

Bits and brains

Rather than following the more traditional path that starts from known biological properties of single neurons and synapses, and proceeds by analysing the emergent network behaviour they give rise to, Dr Lengyel is taking a different approach to understanding how memory processing is achieved by neuronal networks. This approach, pioneered by Professor David MacKay at the Cavendish Laboratory, first studies the task posed by memory recall as a special case of 'statistical inference', a mathematical theory forming the foundations of many of today's most powerful machine learning applications. The core idea is that storing



DR MÁTÉ LENGYEL

Recall of a memory represented by spike times (white ticks) in a simulated network of neurons: recall starts from a noisy representation (left), which is then gradually 'cleaned up' (right)

memories in the synapses that connect a set of neurons is formally equivalent to data compression – something we are all familiar with, for example, when storing music as an MP3 file on an audio player. Memory recall then becomes an act of 'decompressing' the information previously stored in these synapses.

The next step is to take the position of an engineer who needs to construct a device that achieves the highest possible performance given the constraints provided by biology. This allows one to attempt to predict the properties of neurons and synapses that would be optimal for retrieving memories. Using the mathematical analogy between memory storage in neural networks and data compression, it has become possible to address the question of how neurons could implement the optimal decompression algorithm for recalling memories if the memories are represented by the graded activities of neurons using precise spike timings.

With recent funding from the Wellcome Trust, Dr Lengyel, together with Professor Peter Dayan at the Gatsby Computational Neuroscience Unit, University College London, is pursuing this direction of research. They work closely with Dr Ole Paulsen at the University of Oxford, whose group conducts experiments to test the predictions of the model in the neural networks of the hippocampus, and has already successfully confirmed some of the precepts of the theory.

The aim is to understand how the changing connections between the brain's neurons maximise the information that is stored, providing the brain with the ability to remember. The aim also is to show how different rates of neural spiking might represent the level of certainty that a memory being recalled is correct. Both of these issues are important if one wants to design a device that presents an optimal solution to the task of memory recall, and allows us to ask whether nature has designed our brains in such a way.

DR GERGŐ ORBÁN

Dr Máté Lengyel

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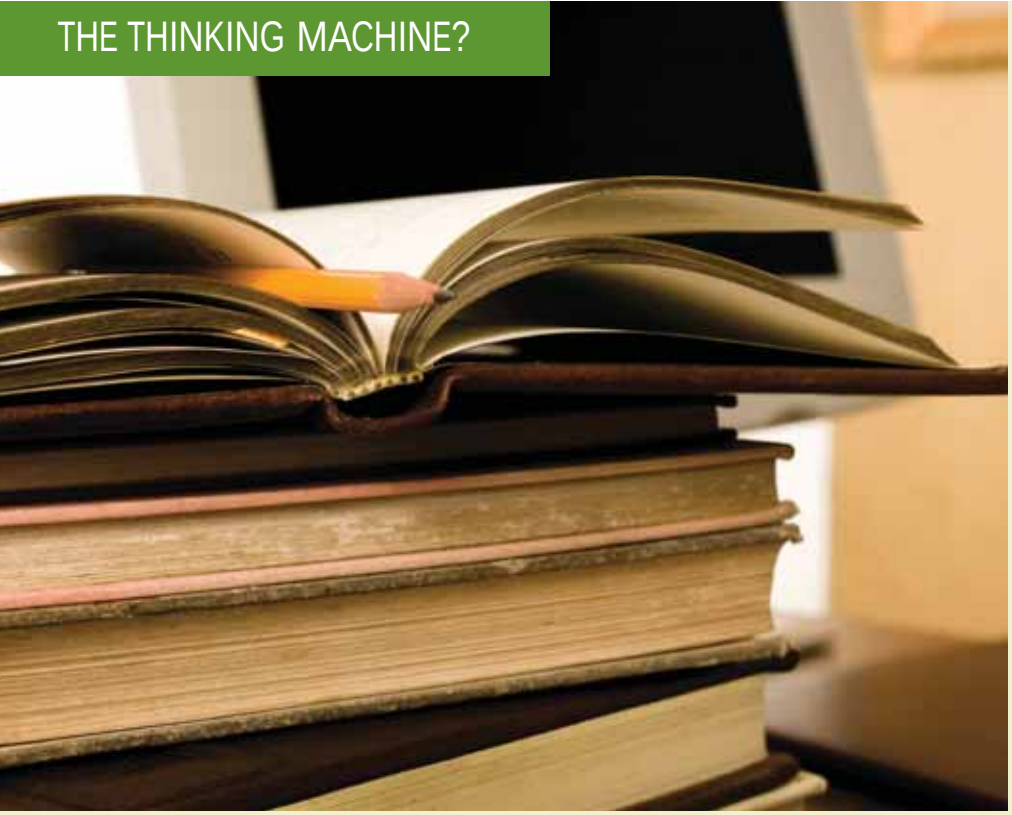
Minds and machines

The same mathematical and engineering principles that can be used to understand learning in the human brain can also be used to build artificial learning systems. This interplay between human and machine learning is the main research focus of the recently established Computational and Biological Learning Lab (CBL) at the Department of Engineering. CBL was founded in 2006 with the arrival of Professor Daniel Wolpert and Professor Zoubin Ghahramani in Cambridge, and has rapidly grown to include Dr Carl Rasmussen, Dr Máté Lengyel and over 20 PhD students and postdoctoral researchers. CBL is investigating the computational principles underlying human sensorimotor control, the design of computer algorithms that learn, adaptive reinforcement learning controllers, statistical theories of learning, and how networks of neurons can perform computations.

For more information, please contact Professor Zoubin Ghahramani (zoubin@eng.cam.ac.uk) or visit http://learning.eng.cam.ac.uk



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Can machines read?

Enabling computers to understand language might help users to overcome online information overload.

Searching for information on the internet has become second nature. Yet, many searches return too many documents and it takes time to examine each one and find the information we need. Scientists are particularly familiar with this problem when searching the scientific literature. How can professional curators, trained to identify information in a scientific article and enter it into a database, mine the text more efficiently? A multidisciplinary team in Cambridge led by Professor Ted Briscoe in the Natural Language and Information Processing (NLIP) group at the Computer Laboratory has been investigating whether computerised methods for analysing the language of scientific articles can facilitate database curation.

Dr Nikiforos Karamanis

Resolving ambiguity in language

Language is ambiguous: in the phrase 'I saw Bill with the telescope', who is holding the telescope – you or Bill? To resolve these ambiguities, people use the surrounding text and their knowledge of the world. But this is much harder for a computer to do and has been a long-standing challenge in computer science. Natural language processing (NLP) provides a way for the computer to treat each word as a piece of a puzzle. Each piece is combined with other pieces using knowledge about the structure of English in the context of the subject. Although not an exact science, NLP can be exploited to ameliorate tasks such as curation by attempting to overcome ambiguity in phrasing and draw out relationships between words.

FlySlip

The NLIP group has teamed up with the FlyBase-Cambridge curation team in the Department of Genetics, one of the three members of the international FlyBase consortium that provides the largest database repository of genetic information on the fruit fly. The result, FlySlip, is funded by the Biotechnology and Biological Sciences Research Council (BBSRC) with the aim of developing text information extraction tools to assist FlyBase curators.

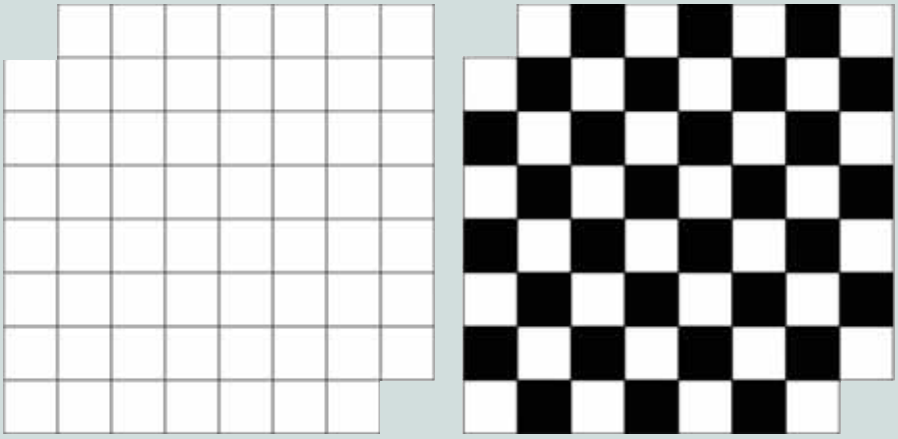
There is a strong need to develop such tools not only because of the enormous publication rate in genetics but also because of the particular difficulties associated with automatic recognition of fruit fly gene names. New gene names are constantly being introduced in the literature and many are the same as common English words such as 'not', 'an', 'was' and 'if'. Andreas Vlachos and Caroline Gasperin, PhD students in the NLIP group, have been investigating the use of statistical NLP techniques for recognising gene names and for disambiguating expressions such as 'this gene'.

The NLIP group has also been the first to investigate what is the most useful way of presenting the NLP analyses to curators. Dr Ian Lewin and Dr Nikiforos Karamanis have been working on the design and evaluation of a unique curation interface. The interface uses automatically recognised gene names and disambiguated expressions as mechanisms to navigate the text. FlyBase curator Dr Ruth Seal has provided them with domain-specific expertise.

Beyond FlyBase curation

The FlySlip team has demonstrated that the NLP-powered interface enables curators to interact with articles quickly and efficiently. Worldwide, more than 80 curated databases similar to FlyBase exist, and similar approaches are likely to be adopted by other curation groups. In the future, NLP technology may also be used to support everyday tasks such as internet searches. So, next time you feel overwhelmed by the online 'data deluge', remember that a solution might be on the way.

For more information, please visit the NLIP group website (www.cl.cam.ac.uk/research/nl). The author, Dr Nikiforos Karamanis (nk304@cam.ac.uk), is a participant on the Rising Stars scheme (see page 3).



Can machines reason?

Humans often use diagrams for reasoning, but can computers do the same?

Some of the deepest and greatest insights in reasoning have been made using mathematics. It's not surprising therefore that emulating such powerful reasoning on machines – and particularly the way humans use diagrams to 'see' an explanation for mathematical theorems – is one of the aims of artificial intelligence.

Diagrams for reasoning

Drawing pictures and using diagrams to represent a concept is perhaps one of the oldest vehicles of human communication. In mathematics, the use of diagrams to prove theorems has a rich history: as just one example, Pythagoras' Theorem has yielded several diagrammatic proofs in the 2500 years following his contribution to mathematics, including that of Leonardo Da Vinci's. These diagrammatic proofs are so clear, elegant and intuitive that with little help even a child can understand them.

The concept of the 'mutilated' checkerboard is another useful demonstration of how intuitive human reasoning can be used to solve problems. If we remove two diagonally opposite corners, can the board still be covered with dominoes (rectangles made out of two squares)? The elegant solution is to colour the checkerboard with alternative black and white squares, like the chessboard, and do the same with the dominoes so that a domino is made of one white and one black square. The solution then immediately becomes clear: there are more white squares than black squares, and so the mutilated checkerboard cannot be covered with dominoes. This problem is very easy for people to understand, but no system has yet been implemented that can solve it in such an intuitive way.

As these reasoning techniques can be incredibly powerful, wouldn't it be exciting if a system could learn such diagrammatic operations automatically? So far, few automated systems have attempted to benefit from their power by imitating them. One explanation might be that we don't yet have a deep understanding of informal techniques and how humans use them in problem solving. To advance the state of the art of automated reasoning systems, some of these informal human reasoning techniques might have to be integrated with the proven successful formal techniques, such as different types of logic.

From intuition to automation

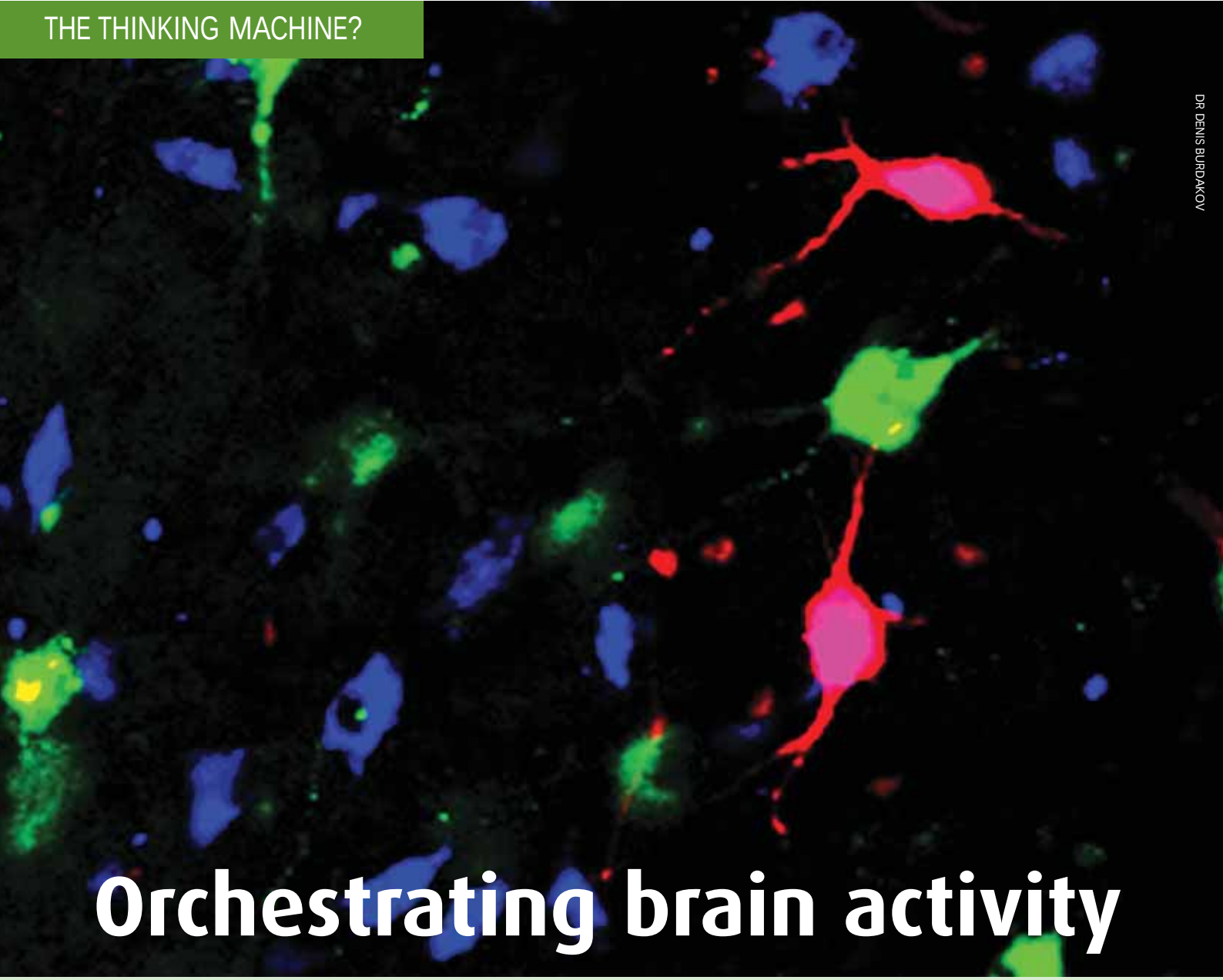
There are two approaches to the difficult problem of automating reasoning. The first is cognitive, which aims to devise and experiment with models of human cognition. The second is computational – attempting to build computational systems that model part of human reasoning.

Steps along the computational approach are being taken by Dr Mateja Jamnik in the Computer Laboratory with funding for an Advanced Research Fellowship from the Engineering and Physical Sciences Research Council (EPSRC). While at the University of Edinburgh, Dr Jamnik built Diamond, a program that uses diagrammatic reasoning to prove mathematical concepts. However, there are theorems like the mutilated checkerboard that might require a combination of symbolic and diagrammatic reasoning steps to prove them. In Cambridge, Dr Jamnik is now investigating how a system could automatically reason about such 'heterogeneous' proofs. This requires combining diagrammatic reasoning in Diamond with symbolic problem solving in an existing state-of-the-art automated theorem prover. The way forward is to give heterogeneous reasoning frameworks access to intelligent search facilities in the hope that the system will not only find new and more intuitive solutions to known problems, but perhaps also find new and interesting problems.

Automated diagrammatic reasoning could be the key to making computer reasoning systems more powerful, as well as to providing the necessary tools to study and explore the nature of human reasoning. We might then have a new means to investigate the amazing ability of the human brain to solve problems.

For more information, please contact the author Dr Mateja Jamnik (Mateja.Jamnik@cl.cam.ac.uk) at the Computer Laboratory.

Dr Mateja Jamnik



DR DENIS BURDAKOV

Orchestrating brain activity

Orexin neurons (red/pink) in their native network surrounded by other neural types (blue and green)

New research in Cambridge is deciphering neural control signals that create the right brain state for the right situation.

It would be reasonable to think of the brain as the most complex machine known, given the diversity and sophistication of the tasks it can perform. It perceives and organises multisensory information about the world, makes split-second decisions based on this information, and controls sophisticated movements to put these decisions into action. It also generates seemingly infinite combinations of thoughts and feelings to solve abstract problems and create works of art. What's more, it can get better at all of this through learning and practice.

This vast range of powers is truly impressive, but poses a serious control problem. How does the brain ensure that all of these feelings and actions happen at the right time and don't clash with each other? Recent studies suggest that this may not be as random and whimsical as it often seems. Well-defined neural networks appear to keep a close watch on overall brain activity and help consciousness flow smoothly from one state to the next.

The daily dance of brain states

We are all familiar with two most strikingly different states of consciousness: sleep and wakefulness. Most of us take wakefulness for granted and can assume that we won't suddenly fall asleep in the midst of talking and laughing. Not so for people suffering from narcolepsy, a sleep disorder causing irresistible attacks of sleep and paralysis that suddenly intrude into normal wakefulness. Here, laughter is definitely NOT the best medicine – bizarrely, severe narcoleptic attacks can be triggered precisely by positive emotional states such as laughter. For many years, the cause of narcolepsy was a mystery but it is now known to be due to a lack of brain proteins called orexins that are made by a few thousand neurons located deep in the brain's hypothalamus.

Orexin neurons appear to be critical for the smooth flow of brain states in all mammals. Loss of these cells in humans, dogs, mice and rats causes narcoleptic

fragmentation of consciousness, with abnormally frequent and rapid transitions between sleep and wakefulness. How do orexin neurons promote stable wakefulness? Even though they are few in number, orexin neurons extend their axon arms throughout the brain. Release of orexins from these axons turns on brain regions involved in cognitive arousal and attention. Somehow our brain state is prone to instability, and the orexin system often steps in to prevent loss of wakefulness, by orchestrating a burst of activity throughout the brain. Orexin neurons also seem to be critical for normal orchestration of wakefulness-dependent behaviours such as reward seeking and food consumption.

Sweet dreams

The evidence linking orexin neurons to brain state control is so strong that this cell type is especially attractive to researchers like Dr Denis Burdakov at the Department of Pharmacology who want to understand the neural basis of behaviour. By studying the properties of single orexin neurons, it might be possible to get a glimpse of the molecular machinery underlying brain state control.

Dr Burdakov's group has shown that orexin neurons act as intrinsic generators of wakefulness-promoting electrical signals, and that the frequency of these electrical impulses is fine-tuned by the environment. Strikingly, orexin neurons appear to be specialised in detecting changes in key physiological variables such as sugar levels. This research has shown that glucose opens special pores in the membranes of orexin neurons known as potassium ion channels, thereby blocking their electrical signals.

This mechanism is striking in its sensitivity – the activity of orexin neurons can accurately track even the tiny changes in sugar levels that occur in the brain between breakfast and lunch. Orexin neurons become activated when energy levels fall, stimulating wakefulness and activity to ensure an animal seeks out food when hungry. In turn, their block by glucose is perhaps the strongest candidate mechanism for after-meal sleepiness.

Glucose sensing by orexin neurons represents an unusual physiological pathway through which sugar may affect sleep and appetite, and could provide an attractive target for pharmacological intervention in body weight disorders. The importance of research in this new area was recently recognised by the Biotechnology and Biological Sciences Research Council (BBSRC), who awarded Dr Burdakov a three-year research grant to unravel molecular steps in the regulation of orexin neurons by sugar.

Awake and hungry

How do orexins stimulate appetite? Dr Burdakov's research has shown that orexins inhibit the activity of a key population of neurons that suppress appetite – the melanocortin neurons of the arcuate area of the hypothalamus.

The activity of every neuron in the brain is set by a push–pull balance between synaptic excitation and inhibition. In the appetite-suppressing melanocortin neurons, which like many brain cells are innervated by orexin-containing nerve fibres, orexins tip this balance in favour of inhibition, thereby silencing the melanocortin cells. This mechanism may help ensure that alertness, attention and appetite are appropriately synchronised: when energy levels fall, cognitive arousal and appetite will be stimulated together, increasing the likelihood of successful food seeking. Conversely, when food is eaten, then appetite, arousal and activity may be turned off together to create optimal conditions for converting the food into fat stores. A potential downside is that the activity of orexin neurons during wakefulness may also drive hunger, which would fit in with the well-known association between insomnia and obesity.

Neurons on acid

Considering the widespread connections of orexin neurons, it is hardly surprising that more and more behavioural roles for these cells are being discovered. One of the latest is their role in breathing – orexin neurons provide an excitatory stimulus to key brainstem areas involved in ventilation. This seems especially important when breathing needs to be increased, for example to get rid of excess carbon dioxide in the body. In mice with a deficient orexin system, these vital breathing responses are reduced by as much as 50%.

How do orexin neurons 'know' when to stimulate breathing? Dr Burdakov's team found that rising levels of acid, such as those that occur during sleep apnoea (a pause in breathing), release an electrical 'brake' in orexin neurons. This allows the neurons to fire faster. Similar to the effects of glucose, this brake consists of potassium pores in the orexin cell membrane – when open, they stop neurons from firing. Rising acidity shuts them down, making orexin neurons fire very fast; falling acidity opens the pores, silencing the firing. In the body, rises and falls in acidity are controlled by breathing. Acid is constantly made by the body's metabolism, but is normally prevented from building up because we breathe out 'acidic' carbon dioxide. During sleep apnoea, the breathing stops, leading to a dangerous build up of acid in the brain. Acceleration of orexin firing by acid dissipates this threat by causing awakening and increased breathing.

Beyond appetite and arousal

In just a few recent years, orexin neurons have emerged as a powerful, multitasking control system of the brain, important for coordinating vital adaptive behaviours such as wakefulness, appetite, reward and breathing. The aim now is to unravel how orexin cells control multiple interacting circuits by acting as polymodal sensors of their environment and how these circuits 'talk back' to orexin neurons in different behavioural states.

For more information, please contact the author Dr Denis Burdakov (dib22@cam.ac.uk) at the Department of Pharmacology.

Dr Denis Burdakov

The thinking hominid

The discovery in southern India of a well-preserved quarry dating from a million years ago is helping researchers to answer: how intelligent were our ancestors?

We are a species capable of remarkable technological and cultural achievements thanks to our big brains and our extended cooperative social networks. Of course, it has not always been this way. Our first upright, ape-like ancestors lived between 7 and 6 million years ago, and perhaps a half dozen human-like species with increasing cognitive abilities span the evolutionary period to the present-day *Homo sapiens*.

Palaeoanthropologists like Dr Michael Petraglia in the Department of Biological Anthropology are interested in documenting and explaining our evolutionary history, and particularly in examining the cognitive and behavioural changes that have occurred along the way. One fundamental question has always been: how did advanced levels of human cognition evolve in our early ancestors? In searching for clues, Dr Petraglia is using the artefactual record left behind by early hominids.

DR MICHAEL PETRAGLIA

Acheulean tools dating from a million years ago found at the Isampur Quarry, India

Acheulean tools

One particular period, known as the Acheulean, has fascinated palaeoanthropologists and archaeologists alike because it is the longest enduring time of technology and manufacture, and therefore of comparatively rich artefactual record, in our evolutionary history. Beginning in Africa at about 1.6 million years ago, and lasting until about 250,000 years ago, the Acheulean is characterised by the manufacture of pear- and oval-shaped stone handaxes and cleavers. Often found in association with animal carcasses, these tools were probably used as efficient cutting devices for detaching and slicing meat for food.

During the prolonged period of this dominant technology, Acheulean tool users migrated from Africa and colonised Eurasia. Examples of tools have been found from Arabia to Asia, and in Europe from the Mediterranean to central Britain.

DR MICHAEL PETRAGLIA

Excavating the Isampur Quarry, India

Dr Michael Petraglia

Discovering debris

The long-lasting and supposedly unchanging technological tradition of the Acheulean has been thought of as demonstrating a period of biological and cultural stasis. But did it also denote a mentally and behaviourally conservative Acheulean mind? Since the mid-1990s, Dr Petraglia has been looking at new ways of evaluating the evolution of cognition in Acheulean hominids by closely analysing the evidence of their manufacturing and landscape practices used to create these tools.

An opportunity to do this presented itself when he and Professor K Paddayya of Deccan College (Pune, India) discovered a well-preserved Acheulean site in the semi-arid Hunsgi Valley of southern India. The Isampur Quarry was uncovered when the local Irrigation Department cleared much of the metre-deep thick black silt; extensive excavations since that time have exposed an extremely well-preserved Acheulean quarry, the first to be discovered on the Indian subcontinent.

Crucially, the site was found to be littered not just with tools but with tool-making debris: here was a rare chance to examine tool-making procedures and landscape behaviours of a million years ago.

The quarriers' tale

Our ancestors came to the quarry to prise up the limestone bedrock to make their handaxes and cleavers. Research is showing that the tools they made were not the end result of chance and serendipity but were the outcome of intention, thought, planning and memory.

The quarriers understood the mechanical properties of their materials and they approached the natural rock slabs with specific goals in mind: handaxes were crafted from tabular slabs; cleavers from flakes struck from large boulder-sized slabs. As they worked, the remnants of their endeavours littered the occupation area, some 60 square metres in excavations, as chipped stone cores, flakes and chunks. They planned and anticipated events – making cleavers from large flakes needed complex procedures to achieve the desired result; hammerstones of different sizes and raw materials had to be brought into the quarry from sources more than a kilometre away. All of this suggests the hominids were capable of deliberate calculation, adjusting techniques to circumstances, remembering activities and solving problems. Intriguingly, what it also suggests is that socially learned and transmitted behaviours were passed from individual to individual: in short, some form of communication was occurring.

Interestingly, though, these hominids practised behaviours that are unfamiliar – once tools were used, they were quickly abandoned. Stone tools found at sites away from the quarry showed limited evidence of resharpening. It seems that early humans made tools, carried them across the landscape for an intended goal, and then discarded them. This discard behaviour has few analogies among modern foragers, who typically retain and repair their toolkits over the long-term.

Thinking hominids

Acheulean hominids lived in a range of ecological settings with an assortment of different resources available to them – limestone, flint, quartzite, and so on. A comparison of Indian tool-making procedures and landscape behaviours with other sites around the globe shows that groups adapted to novel circumstances in different ways and yet still employed the same technology. Such evidence implies a learned behaviour revolving around a set of conventions or rules in tool-making. Some of the abilities that we see in the artefactual record are also found in the tool-making and tool-using capabilities of some primates and certain bird species. However, there are also relative differences in tool-using behaviours, suggesting that early hominids had an extended ability for planning beyond the immediate future, relying on abstraction and memory for satisfying future needs over space and time. While this may be the case, the hominids were not as innovative as we might expect, producing similar tool forms over hundreds of thousands of years, perhaps lacking the planning depth to anticipate conditions in the far-off future.

Comparative research should allow us to interpret how the mind evolved in hominids and how their behaviour diverged from other intelligent animals. Further detailed archaeological and palaeoanthropological studies of the Acheulean record will continue to shed light on cognition in these early hominids, whose brains were three-quarters the size of our own.

For more information, please contact the author Dr Michael Petraglia (mp341@cam.ac.uk) at the Leverhulme Centre for Human Evolutionary Studies (www.human-evol.cam.ac.uk).

Greek tragedy: setting the stage today

With the curtains just closed on the 40th Cambridge Greek Play since the 1880s, Greek classicist Simon Goldhill reflects on how this creative genre still speaks to a modern audience.

Every three years since 1882, University of Cambridge students have brought ancient Greek tragedies to life again through their performances in the Cambridge Greek Play, a showcase of theatrical and academic expertise that is spoken entirely in the original language.

The first play – Sophocles' *Ajax* – was, as the publicity of 1882 boasted, the first full performance of a Greek tragedy in ancient Greek in the modern world, and the show roused extraordinary interest. It was reviewed in all the national newspapers, and special trains had to be put on from London to bring the *fashionistas* up to Cambridge to see the event of the season. England was still in the grip of an intense 'philhellenic' love of all things Greek; classics took up 80% of the curriculum at the best schools and universities; the neo-classical paintings of Lawrence Alma-Tadema and Frederic Leighton drew crowds of thousands; Greek love was the 'dirty secret' of the fin-de-siècle decadents. For Victorian England, the Cambridge Greek Play represented a rare chance to see an art form that featured vividly in the cultural imagination.

Archaeological accuracy really mattered to the Victorian audience – the play had to embody the best scholarship, the most recent research. In 1882, this was ensured by the involvement of the world-famous Greek scholar Sir Richard Claverhouse Jebb, Regius Professor of Greek. This connection with research continues today, with a thriving academic interest that both feeds into and benefits from the performances. What can the surviving plays tell us of ancient Athenian society? How can we know how to pronounce a long-dead language? How can the ancient world inform our understanding of the modern world? What is at stake when Greek tragedy is staged in the theatre today, and how are its most difficult problems to be faced? It is this final question that has been of particular interest to me – how audiences might see ancient Greek theatre accurately realised on stage again, 2500 years after it was born in Athens.

Resurging interest

That first astounding show in 1882 heralded one of the most surprising developments in modern western theatre. Since the turn of the 20th century, ancient Greek plays have become part of the repertoire of all modern theatres and, since the 1970s, there has been the most remarkable explosion of performances of Greek tragedy across the world – not just in Europe and the USA, but also in Japan and Africa and Russia. In London, Paris and New York, almost no year goes by without a revival of one of these classics. In 2001 alone, there were 17 productions of Aeschylus' great trilogy the *Oresteia* in the USA, which is more than there were in the whole world in the first 65 years of the 19th century. In London, three separate productions of Sophocles' *Electra* were staged over a few months. When theatre director Peter Sellars wanted to stage his anguish at the Gulf War in the early 1990s, he turned to Aeschylus' *Persians* – in California, Edinburgh and Austria. There

COURTESY OF THE CAMBRIDGE GREEK PLAY COMMITTEE

Olga Tribulato (right) as Teiresias and Marta Zlatic as Oedipus in Sophocles' *Oedipus the King*, 2004

is no sign of this growth slowing, on campus or in the professional theatre. Greek tragedy seems once again to speak urgently and authoritatively to a modern audience.

A voice in modern times

Why does Greek tragedy speak to us today? As with the 5th century BC, our age is an era of great confidence in the progress of science and knowledge: Greek tragedy ruthlessly exposes the pretensions in human claims to control and certainty. As with the 5th century BC, our age is obsessed with the tension between the brutal realities of war and the rhetoric of politicians: Greek tragedy anatomises this tension with painful insight. Moreover, Greek tragedy is obsessed with conflict between the genders, between public and private duty, between self-control and a sense of helplessness in the face of the world's violence: all this too finds a powerful echo with modern audiences.

Staging Greek tragedies

It is far from clear how these great masterpieces of theatre should be translated from the page into the theatre. When the genre first flourished between 500 and 300 BC, the convention was for actors to wear specially crafted masks. All the actors were male, with a limit on how many could appear on stage at one time, and the chorus had to be composed of Athenian citizens.

How can the old conventions of the chorus work without looking like a Hollywood musical? Can masks evoke anything but bad clowns for today's theatre? Is Greek tragedy destined to be crushed by its own formality, and end up as no more than men in black yelling portentous clichés at each other?

The book *How to Stage Greek Tragedy Today* stems first from my research into ancient theatre and the history of theatre performance: I have been engaged for many years with exploring the political and social impact of theatre in ancient Athens, as well as with how these old plays became so important in the cultural life of Europe, especially around the turn of the 20th century. But my concerns in this book also come from a more direct set of experiences. I have been deeply moved by some great performances in the theatre; I have also been annoyed, bored, outraged by others. I wanted to explore why so many productions failed, and why the truly great productions were great.

I also had the hands-on experience of producing the Cambridge Greek Play over 12 years, with two outstanding directors – Dr Jane Montgomery, who was the Leventis Visiting Fellow in Greek Drama, and Annie Castledine, from the Complicite Theatre Company and who has also directed at the National Theatre and the Royal Shakespeare Company. Seeing how professional theatre is made at the 'down-and-dirty' level is not something most academics are privileged to do, and anyone who writes about theatre can learn a lot from such an experience. But the immediate stimulus to write my book was when I was asked to provide some suggestions for Vanessa Redgrave to read about tragedy – she was rehearsing a production of *Hecuba* at the time. I found to my chagrin (and to the detriment of my dignity as a Cambridge professor) that there was nothing I could really recommend to an intelligent modern actor or director to help them when daunted by the task of performing Greek tragedy. So I sat down and wrote what I hope will answer that need.

I examine the six most pressing questions any company faces with the task of staging a Greek tragedy: the theatre space, the chorus, the actor's role, the relationship between tragedy and politics, the translation, and the representation of the gods and heroes. I look at what we can learn from the ancient world about these issues, how the most successful modern productions have dealt with them, and how a company can negotiate a way through some of the most difficult problems these texts provide.

My hope is that actors and directors embarking on the journey of staging a Greek play might have some guidance. I hope too that, for the reader wishing to know more about these truly remarkable plays and their extraordinary re-emergence on modern stages, this might inspire them to consider what makes Greek tragedy so exciting and so relevant a genre today.

For more information, please contact the author Professor Simon Goldhill (sdg1001@cam.ac.uk) at the Faculty of Classics. Please go to www.the-medea.co.uk for more information on the recent play, Euripides' *Medea*. *How to Stage Greek Tragedy Today* is published by University of Chicago Press.

PERRY HASTINGS

Professor Simon Goldhill

'Simon Goldhill's new book is enthralling. A 'can't put down' and a 'forever re-read'. His detailed analyses of so many past productions are rare and exciting. His unfolding of the Greek texts and the many different translations is both instructive and exhilarating.'

Vanessa Redgrave CBE, actress

PHOTOGRAPHS BY DR GILLY CARR; ARTEFACTS COURTESY OF CHRISTINE BAILEY (TOP LEFT) AND PETER AND PAUL BALSHAW, VALLETTE MILITARY MUSEUM, ST PETER PORT, GUERNSEY (OTHERS)

A campaign of silent resistance

A fascinating study of wartime artefacts is uncovering a story of symbolic resistance and creative necessity in the Channel Islands 60 years ago.

Often considered to be wartime kitsch, frequently ending up in junk shops or in rubbish skips, the artefacts made by people of the Channel Islands during World War II (WWII) have only recently been recognised as being worthy of academic enquiry. Like the 'trench art' created in the trenches of WWI, these artefacts were made from whatever supplies were at hand – coins, tin cans, spent shells, even barbed wire – in a time of military conflict and its legacy of deprivation and defiance. Thanks to funding from the British Academy, the artefacts held in Island museums and private collections are being catalogued and photographed by Dr Gilly Carr from the Department of Archaeology. They tell a story of the quiet yet determined resistance to occupation, as well as the patriotic underpinning of a society under threat.

Occupied Islands

The Channel Islands, the only part of Britain that was occupied during WWII, endured a period of history that left such an impact on the collective psyche of its peoples that it forms an integral part of Channel Island identity and heritage today. Island newspapers still feature articles about the occupation; many Islanders still talk about it daily.

The Islands were considered indefensible by the British forces but were deemed by Hitler to be of strategic value – their occupation would effectively stick a thorn in Britain's side and wound morale. Seeing the smoke rising from the coast of nearby France and hearing the approaching shell-fire, around a third of the population of the Islands evacuated to the UK in the days before the Germans arrived. By the end of June 1940, the Germans had landed in the Islands following a bombardment of

COURTESY OF PETER SIRETT

Examples of the wartime artefacts held in museums and private collections in the Channel Islands. Above: Monty Manning shaved his beard into a 'V for victory'; drawn by fellow internee Eric Sirett. Top left: 'V for victory' mug engraved by Byll Balcombe in the internment camp of Biberach. Top right: Barbed wire brooch made in Biberach. Bottom left: 'V for victory' badge made from a coin by Alf Williams. Bottom right: George V coin on the side of a cigarette lighter.

Dr Gilly Carr

St Helier and St Peter Port, the capitals of Jersey and Guernsey. The occupation was gruelling. In September 1942 and February 1943, a total of 2200 Islanders were deported to internment camps on the continent and those who remained were trapped.

In the last year of the occupation, supply lines to the Islands were cut off after the Allied invasion of France, and the Islanders and occupying army alike began to starve. In the last six months of the war, during the bitter winter of 1944, gas, electricity, wood-fuel and soap ran out. Had the Red Cross ship the *S.S. Vega* not arrived in December 1944 bearing parcels of food, the population might have starved to death.

'V' for victory

Although the occupied Islanders were unable to mount a proper resistance, the artefactual record provides compelling evidence for a campaign of 'silent resistance' using the 'V for victory' sign, which has previously been undocumented in such detail. Following a BBC broadcast at the time, the people of occupied Europe were encouraged to use this as a symbol of resistance, and a range of artefacts that were made in 1941 and 1942 depict Vs. The most intriguing of these are badges made from coins, where the maker filed around the King's profile and scored the letter V underneath before attaching a safety pin to the reverse. These were worn underneath jacket lapels and were flashed to trusted friends in the street.

The V-sign campaign was also used as a form of resistance by the English-born Islanders from Guernsey, Jersey and Sark who were deported to civilian internee camps in Germany and Austria. Monty Manning shaved his beard into a V-shape; Byll Balcombe engraved a mug made from a Red Cross tin with a V so that he could drink a toast to victory; one woman wove a V into the plaited string sole of her shoe; and Nellie May Faulder embroidered a tablecloth with Vs around the edge, with a dedication to George V in the centre – even though George VI was on the throne!

Internees were largely kept alive by Red Cross parcels, the contents of which they recycled – including cardboard, string, tins, cellophane packing material and wooden parcel crates – to make a range of artefacts to distract themselves from the circumstances of their internment. Passing the time was a key objective, as shown by many of the items such as chess and cribbage boards and sewing baskets. Other items, including women's fashion accessories such as shoes, handbags, hats and belts, and items made from Red Cross tins, such as plates, trays, a communion chalice and a football trophy, are among surviving artefacts from the camps.

A symbolic war

One particularly fascinating element of the unfolding story has been the evidence of a 'symbolic war' waged silently between the Germans and the locals over the use of Guernsey's crest. The Crest – three lions passant guardant – was stamped or carved by the Germans on nearly every item they made as a symbol of their control of the Islands. However, the Islanders reclaimed this symbol of their identity, making rings and badges out of Island coins that displayed the crest. They quietly and unobtrusively wore these on their body and clothes, fighting back against the appropriation of their islands and symbols.

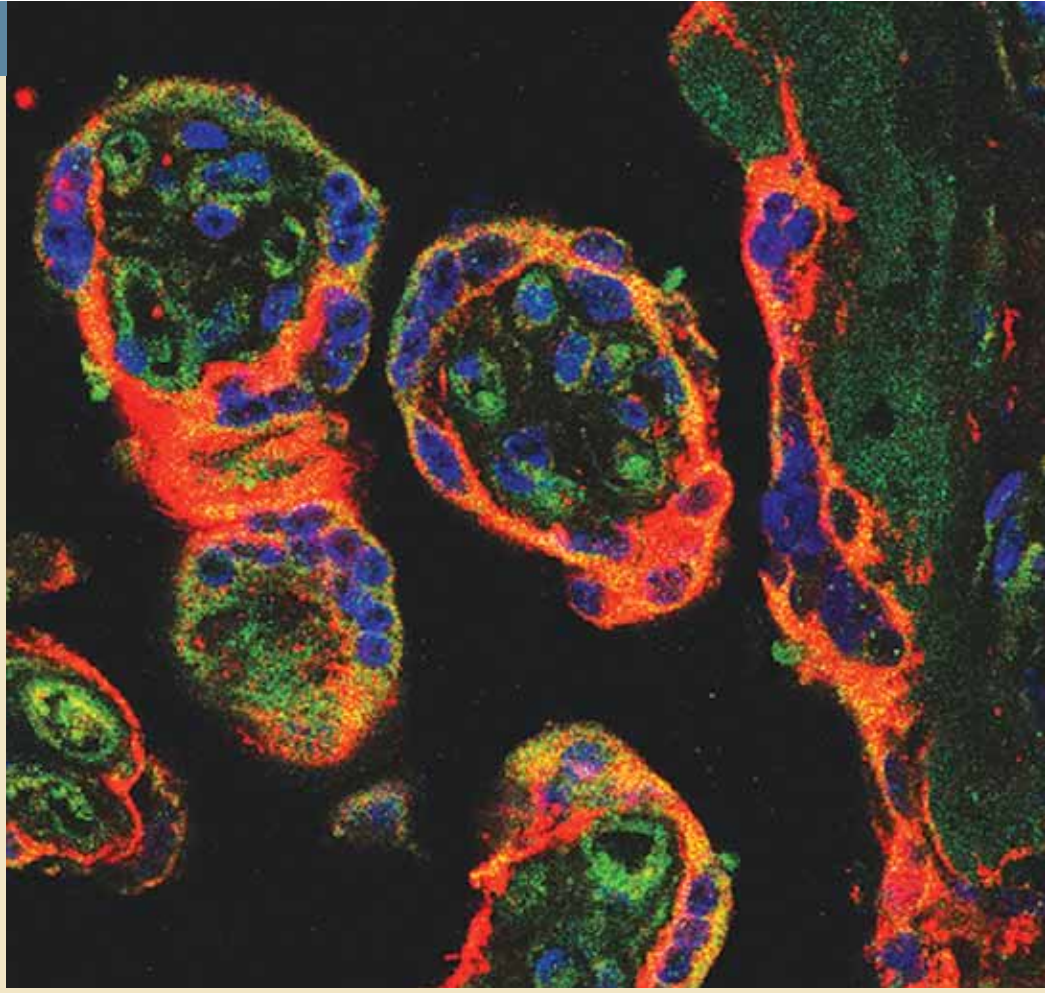
Rewriting history

This research has overturned some long-held beliefs about the occupying army. For example, it is widely believed that German soldiers, like the Islanders, had also run out of gas, electricity and wood-fuel months before the end of the war. However, many German-made artefacts were carved out of solid lumps of wood as late as 1945. One soldier had carved an electric lamp stand with the date 7th May 1945 – two days before liberation – which raises the question of whether the soldiers suffered as much as the locals in terms of a lack of supplies.

Resonance of troubled times

The physical artefacts speak volumes of a people living under occupation. Not knowing when the war would end, or how they would survive until that time, some of the artefacts show how Islanders used their creative talents to make life more bearable. An 'Occupation Monopoly' board was produced, to be played during the hours of curfew, with instructions such as 'exceeded gas ration, go back 2', 'receive Red Cross letter, go forward 3' and 'identity card lost, go back 4'. Findings such as this offer a snapshot of life under the occupation and illustrate the proud, defiant and patriotic spirit for which Channel Islanders have long been known.

For more information, please contact the author Dr Gilly Carr (gcc20@cam.ac.uk) at the Department of Archaeology. Although Dr Carr was brought up in the UK, her family is from Guernsey and were variously evacuated, occupied and deported during WWII. She is currently writing a book and preparing two museum exhibitions on the subject of artefacts of the occupation.



Human placental villi showing evidence of oxidative stress

Most pregnancies develop normally but when complications arise they can have devastating effects. Two recent initiatives in Cambridge hope to deliver a new understanding of events during this critical period of human life.

Great expectations in pregnancy research

Complications in pregnancy represent a persistent and major problem in public health. The first three months after conception are known to be the most critical, with as many as 20% of pregnancies lost during this time. For pregnancies that develop beyond 24 weeks, between 0.5 and 1% result in death of the baby, either in the womb or in the first four weeks of life. Premature birth can incur major complications associated with delivery, immediate care of the infant, childhood diseases, and educational and social problems in later life. Not only is there an emotional cost to families, but an economic assessment in the USA reported that the cumulative subsequent healthcare and social costs associated with one year's worth of pre-term deliveries was $26 billion. Understanding and intervening to prevent these events is clearly crucial.

Although some advances have been made, the dismaying fact is that the rates of stillbirth have generally remained static over the past 20–30 years. This partly reflects an incomplete understanding of the biological events that lead to these complications of pregnancy. Determining what these mechanisms might be is essential for devising new strategies of intervention, and applying in-depth scientific studies to human pregnancy is now seen as vital.

Two multidisciplinary initiatives in Cambridge have recently embarked on improving our understanding of pregnancy and its outcomes: a large antenatal screening of women at the Rosie Maternity Hospital in Cambridge and the recent endowment of a Centre for Trophoblast Research within the School of Biological Sciences. Both initiatives build on the wealth of expertise in the biology of pregnancy that exists across Cambridge.

Screening for adverse outcomes

A four-year research project that aims to monitor 5000 pregnant women commenced in 2007 under the leadership of Professor Gordon Smith in the University's Department of Obstetrics and Gynaecology. A multidisciplinary team of translational researchers in both the School of Clinical Medicine and the School of Biological Sciences are participating in the project, which is funded under the Women's Health theme of the UK Department of Health's Cambridge Comprehensive Biomedical Research Centre.

Women enrolling in the study are scanned and give blood samples at 12, 20, 28 and 36 weeks of gestation, allowing detailed characterisation of the baby's growth and development. Thanks to an industrial collaboration with GE Healthcare, the long-term loan of two state-of-the-art scanners will enable real-time three-dimensional scanning of the babies *in utero*. At birth, samples of placenta and cord blood will be obtained and stored.

The study is prospective; for those women whose pregnancies sadly have complications or adverse outcomes (such as pre-eclampsia, spontaneous pre-term birth, stillbirth or low-birth-weight babies), the stored samples will be retrieved and compared with controls. These samples then become the focus of extensive clinical and biological analyses to try to establish the cause. Studies will analyse the development and function of the placenta and the effect of oxidative stress; the expression or silencing of genes in relation to whether they came from the mother or the father (known as genomic imprinting); the maternal–foetal immune interaction;

PROFESSOR GRAHAM BURTON

and the genes that are expressed in the placenta. The MRC Epidemiology Unit will conduct follow-up studies of the growth and development of the babies who have been carefully monitored during the pregnancy.

The hope is that this detailed characterisation of foetal development, on such a large scale, will lead to mechanistic studies on the causes of common clinical problems in pregnancy. As well as providing refined risk assessment, novel treatments might be identified that could improve the outcome of pregnancies in women deemed to be at higher risk.

Centre for Trophoblast Research

The recent endowment of the Centre for Trophoblast Research, due to be launched on 9 July 2008, is a highly innovative initiative aimed at promoting research into trophoblast biology both within Cambridge and on the wider national and international stages. The trophoblast is the cell type that forms the interface between the foetus and its mother, supplying nutrients to support the growth of the foetus. It is fundamental to successful pregnancy and must interact intimately with the maternal cells lining the uterus, leading to the formation of the placenta.

In humans, this interaction is particularly invasive and, during the first few weeks of pregnancy, the foetus becomes completely embedded within the wall of the uterus. This form of placentation, seen only among the great apes, poses unique immunological and haemodynamic challenges. The invading trophoblast cells, which are genetically related to, but distinct from, those of the mother, must negotiate passage with her immune system to allow them to reach their target – the specialised blood vessels in the wall of the uterus. As a result of this invasion, the vessels undergo major structural changes that ensure the placenta has a plentiful and continuous supply of blood in later pregnancy.

There is now abundant evidence that the major complications of pregnancy are associated with deficient trophoblast invasion, resulting in aberrant maternal blood flow to the placenta. Research performed in Cambridge has demonstrated that, paradoxically, too much flow in early pregnancy results in miscarriage, whereas too little in later pregnancy is associated with low birth weight and pre-eclampsia. These new insights have radically changed our understanding of human pregnancy and have helped to explain why miscarriage and pre-eclampsia are virtually unique to humans. Studying trophoblast biology is therefore not only of basic scientific interest but is also key to understanding the root causes of these pregnancy disorders.

Raising hopes for future pregnancies

The aim of these multidisciplinary initiatives across Cambridge is to arrive at a better understanding of the biology of normal and complicated human pregnancy. Only by doing so can scientists hope to develop new diagnostic tests to identify women at increased risk of complications and, potentially, new interventions that might prevent the life-long effects of these complications on mothers and their children.

Professor Gordon Smith (left) and Professor Graham Burton

For more information, please contact the authors Professor Gordon Smith at the Department of Obstetrics and Gynaecology (gcss2@cam.ac.uk) or Professor Graham Burton at the Department of Physiology, Development and Neuroscience (gjb2@cam.ac.uk). Please go to www.trophoblast.cam.ac.uk for more information about the Centre for Trophoblast Research.

GE HEALTHCARE

Three-dimensional scan of a baby *in utero*

Participating researchers

Antenatal screening initiative (Principal Investigator: Prof Gordon Smith)
Dr Steve Charnock-Jones and Dr Miguel Constância (Dept of Obstetrics and Gynaecology); Prof Graham Burton, Prof Abby Fowden, Dr Dino Giussani and Dr Anne Ferguson-Smith (Dept of Physiology, Development and Neuroscience); Dr Ashley Moffett (Dept of Pathology); Prof David Dunger (Dept of Paediatrics); Dr Ian White (MRC Biostatistics Unit); Dr Ken Ong (MRC Epidemiology Unit).

The project is within the Women's Health theme of the Cambridge Comprehensive Biomedical Research Centre – a partnership between Cambridge University Hospitals NHS Foundation Trust and the University of Cambridge, and created by the National Institute for Health Research (NIHR). These themes focus on translating advances in basic medical research from the laboratory to the hospital clinic.

Centre for Trophoblast Research (Director: Prof Graham Burton)
Participating researchers will be announced in 2008. The Centre will facilitate research by providing flexible and responsive funding for seminars, workshops and visiting scholars, as well as laboratory space in the Department of Physiology, Development and Neuroscience. The Centre also aims to encourage the next generation through graduate studentships and postdoctoral fellowships.

Putting metabolism on the eco-map

One of the latest 'omic' technologies to emerge – metabolomics – is being used to create a snapshot of how environmental chemicals affect living organisms.

To what extent do living organisms absorb pollutants in our environment? Are particular 'chemical cocktails' more risky than others? Do current ecotoxicological risk assessment techniques adequately protect the environment? These are the sorts of questions that interest Drs Oliver Jones and Julian Griffin in the Department of Biochemistry, who are working as part of a Europe-wide integrated research project to develop better tools to evaluate the chemical risks we face in everyday life.

Ecotoxicology

It is generally acknowledged that many organisms in the environment are exposed to a large variety of pollutants during their lifetime; a fact borne out by advances in analytical technology. For example, many people will have heard of the effects on fish populations caused by endocrine-disrupting compounds in sewage, whereby some male fish living downstream of sewage treatment plants were found to have developed female characteristics, leading to a reduction in their ability to reproduce. In recent years, a plethora of other anthropogenic contaminants such as pharmaceuticals, personal care products, pesticides and flame retardants, and the potential for these man-made products to work their way into the food chain, have also begun to be of concern to environmental chemists.

However, the majority of these pollutants are present at extremely low concentrations and so it is difficult to ascertain whether or not they have an overall effect on ecosystem health, especially if outward effects are minimal. An added complication is the fact that the interaction between the environment and organism health is extremely complex, with chemical, biological, physical and geographical stressors each contributing to toxicological effects over time.

It's important therefore to develop methods for assessing the cumulative risks for a range of species that are being exposed to mixtures of pollutants at non-lethal levels. In this way, steps can be taken both to improve safety in the environment and to safeguard ecological health.

Metabolomics

One technique that shows a great deal of promise in the area of ecotoxicology is metabolomics. This rapidly emerging discipline measures the thousands of naturally occurring small molecules (metabolites) such as sugars, organic acids, amino acids and lipids that are the products of cellular metabolism. An organism's 'metabolome' is its full complement of metabolites, in the same way that its genome is its complete genetic content.

Why study metabolic changes? Well, these changes often happen much earlier

MISS KAROLINA ŁADA AND DR OLIVER JONES

The tricarboxylic acid (TCA) cycle, a metabolic pathway involved in energy generation, is often perturbed following exposure to pollution

in an organism than either tissue accumulation of pollutants or induced histopathological changes. The technique can be used to give a biochemical snapshot of a cell, tissue or indeed whole organism at a moment in time. When an organism is stressed or diseased, its metabolic pathways are perturbed. Advanced computer-assisted pattern recognition techniques can then be used to assess the differences in metabolic profiles between sample groups. Metabolomics therefore offers a particularly sensitive method to monitor changes in a biological system and is proving to be an outstanding tool for studying ecotoxicology.

NoMiracle

The environmental research in Dr Griffin's group in the Department of Biochemistry is part of a European Union (EU) research project involving 38 laboratories spread across 16 countries and is known as NoMiracle (for 'Novel Methods for Integrated Risk Assessment of Cumulative Stressors in Europe'). The project seeks to improve ecological and environmental risk assessment in the EU, and to help scientists gauge the impact of chemicals on the environment and human health.

The Cambridge team are developing analytical techniques based on high-throughput analysis of metabolites from organisms at different positions in the food chain, such as earthworms, nematodes, slime moulds, marine mussels and water fleas. Being able to study such a broad set of experimental species has been possible because of long-term collaborations with the Centre for Ecology and Hydrology (part of the UK Natural Environment Research Council), King's College London, the University of Piemonte Orientale in Italy and the University of Antwerp in Belgium, all developed as part of the NoMiracle project.

Using state-of-the-art nuclear magnetic resonance spectroscopy and gas chromatography mass spectrometry, long-term studies are being run to establish a basal metabolic profile for each of these species, as well as how these profiles change in response to toxic insult. By looking at the different patterns of metabolic profiles between organisms, a comprehensive description is being built up of how each of them responds to stress and toxicity. One important finding has been that biochemical effects are often observed at lower chemical concentrations than were previously thought to cause any effect when assessed using traditional toxicology testing techniques.

Assessing the risks

Why is there a need for improved risk assessment in ecotoxicology? In current toxicity tests, an organism is typically exposed to a single chemical in a strictly controlled laboratory setting, over a relatively short period of time (typically days or weeks). Yet, in the environment, organisms will clearly be exposed to many different pollutants possibly throughout their entire life. An accurate risk assessment must take into account cumulative effects rather than just direct effects and single factors. Organisms are also often likely to be stressed by other factors not present in a laboratory setting. For instance, work within the NoMiracle project has demonstrated that organisms can be affected by pollutants at much lower levels than those predicted from traditional toxicity tests if they are also stressed by other factors such as co-exposure to pollutants, temperature extremes or food restriction.

The work in the Cambridge section of the NoMiracle project is moving into its third and final year. The research is showing that the accurate assessment of chemical mixtures is more complex than current testing regimes allow for and the aim now is to use these results to develop a new framework for assessing the effects of complex mixtures of pollutants. The ultimate goal of the NoMiracle partners is to change ecotoxicology policy in the whole of the EU, so that long-term, multi-stressor exposure testing is considered as standard. This will offer great improvements in understanding and mitigating the effects of cumulative pollution exposure on the health of our ecosystem.

CHRIS GREEN

Dr Oliver Jones (left) and Dr Julian Griffin

For more information, please contact the authors Dr Oliver Jones (oahj2@mole.bio.cam.ac.uk) or Dr Julian Griffin (jlg40@mole.bio.cam.ac.uk) at the Department of Biochemistry. Further details of the NoMiracle project can be found online (http://nomiracle.jrc.it/).

KEITH HEPPELL

A FINDING FAULT

A multicentre project led by the Faculty of Law has reached its conclusion, having studied over a century's worth of European legal changes relating to liability.

Examining how western legal systems have developed, and understanding the factors that have shaped the dynamics of legal change, has been at the heart of a three-year study that reached its conclusion in December 2007. The European Legal Development project, funded by the Arts and Humanities Research Council (AHRC), was led by Professors John Bell and David Ibbetson at the Faculty of Law. It brought together some 70 academics, including eminent scholars and early career researchers, from 10 different jurisdictions across Europe.

Although concerned with legal development and involving the research input of many lawyers, the project also benefited from the insights of historians, philosophers and scholars in other disciplines. It stands as a model for how national scholars can be supported and developed in an international context in the humanities and social sciences. Regular meetings and website interactions have built a network of researchers that will continue long after the project itself.

Illustrations of legal development

Of course, the topic 'How do western legal systems develop?' is very broad. Does the law change principally in step with the state of the economy and of society at large, or does it respond to its own internal dynamics of change? Even where there are strong similarities between the social and economic factors that fuel changes in the law, how do legal systems in different European countries respond? To make these areas of enquiry more manageable, they were tackled through the lens of a particular branch of law that illustrates legal change over a specific period of European history: the liability for harm caused to others by fault in the years 1850–2000.

In England, the core principles for deciding when one individual has to compensate another for the harm they have caused date back to the 14th century; in continental Europe, they date back to the 3rd century BC. This research has sought to chart how these old principles have needed to change and to seek explanations for what happened.

The law relating to fault began to alter around 1850. Enormous technological and economic changes took place as industrialisation and urbanisation occurred in different countries, influencing many aspects of society, including the law. With the rapid rise in the use of steam boilers to power factories, boats and trains, accidents became more frequent. Machinery was both more complex and less predictable than before, causing injuries to employees and passengers. Although in 1850 there were many similarities in approaches to liability for fault across the legal systems of western Europe, significant divergence began to occur in the years that followed.

Constructing the case

To understand the forces behind legal change, we have to look beyond the experience of one country and investigate many. To this end, six case studies were investigated by academics from jurisdictions across Europe: England, Scotland, The Netherlands, Austria, Germany, Sweden, France, Italy and Spain.

The six case studies, each convened by a different project member, focused on the problems that the law has faced in the 150-year period under study: liability in relation to technological change; liability between neighbours; liability for traffic accidents on rail and road; liability for products; liability for medical negligence; and legal doctrine, or the writings of legal academics trying to set out the principles of this developing law.

Factors for change

In a second stage, the project examined the factors that actually shaped legal development in the fields studied. Certain legal institutions, such as law reform bodies, have been important in fostering change in the law. But these bodies have depended on key individuals who have promoted change, typically by persistence over many years. Governments often promote legislation in response to recent prominent crises or disasters, and at such moments proposals that are already formulated are often seized upon.

To what extent does the law reflect developments in social and political ideas? Sometimes there is a clear connection. For

Members of the European Legal Development project met in December 2007 to discuss findings of the three-year study

example, the French social theorist Émile Durkheim influenced key French legal writers of the late 19th century to argue that the law should provide compensation out of social solidarity with those who were injured, rather than focusing simply on whether a responsible individual was at fault. But, in other areas, it is the opinions of specialist technical experts that shape the law. For example, the law governing asbestos was strongly influenced by relatively small numbers of people in inspectorates, rather than by a broad movement of opinion or ideas.

Changes in the economy clearly have an impact on law – new problems arise that the law has to solve. But it is less clear whether the pattern of solutions directly responds to economic interests. For example, the easy availability of insurance is frequently invoked in arguments for legislation or in court. But it does not dictate a solution. Although Germany and France introduced insurance-based compensation for road accidents, England did not, even though the economic conditions and the availability of insurance were similar. And so, similar economies do not necessarily adopt similar legal solutions.

This study has illustrated that private law can operate with a kind of relative autonomy from contemporary social and political ideas or economic interests. History and legal ideas can be powerful determinants of how far private law contributes to the solution of contemporary problems.

Coming to a conclusion

Three main trends in the law relating to liability have become apparent from this study:

- Victims of accidents have gradually found it easier to obtain compensation, either because the burden of proof has shifted towards the person causing the injury or because liability no longer depended on proof of fault.
- Simpler and less expensive compensation systems have gradually been created outside private law (the law of relations between individuals). For example, although the victims of boiler and railway accidents tended to be employees, they rarely gained compensation through private law but instead through state-created insurance-based workmen's compensation systems. In Germany, Sweden and France, such schemes have also replaced private law for most road accidents, and Sweden and France have now adopted similar schemes for medical injuries.
- Although private law has played a minimal role in incentivising accident prevention, other forms of regulation could have an impact. For instance, state regulation on the siting of boilers, or of buildings or crops alongside railway lines, as well as regulation related to determining who can practise as a doctor, has played a very important role in reducing the incidence of harm.

KEITH HEPPELL

Professor John Bell

For more information, please contact the author Professor John Bell (jsb48@cam.ac.uk) at the Faculty of Law or visit http://eld.law.cam.ac.uk and http://www.findingfault.co.uk

John Morrill explores one of the most extraordinary and least understood aspects of Anglo-Irish history – the rebellion of 1641.

Rebellion, reb

The true course of events of the Irish rebellion of 1641 has never been fully known. Initiated by disaffected Irish Catholics rebelling against Protestant settlers, the rebellion quickly escalated in violence, resulting in widespread killing. But was the rebellion intended to be a bloodless coup that spiralled out of control, or were the thousands of Protestants deliberately driven out and massacred? What's clear is that the years that followed were a time of savage revenge for the events of 1641 – Oliver Cromwell arrived with 30,000 English troops to conquer Ireland in the name of the English Republic and to exact 'a just judgement of God upon those barbarous wretches, who have imbrued their hands in so much innocent blood' – and the groundwork was laid for Ireland's Catholic–Protestant divide.

A curious aspect of the rebellion is that although it is the least understood of all the great massacres of European history, it is amongst the best recorded. Historical narratives in the form of eyewitness accounts of those who lived through the rebellion are still in existence in the library of Trinity College Dublin, where they have remained largely unstudied. This is chiefly because there is *too much* of a record of what happened and it has taken until now, with improvements in technology and the political climate, to conspire finally to make it possible for the secrets of the '1641 depositions' to be unlocked. A team of scholars in Cambridge, Dublin and Aberdeen are poised to do just this. Professor John Morrill from Cambridge's Faculty of History is chairing the three-year project, working alongside Professor Jane Ohlmeyer and Dr Micheál Ó Siochrú (Trinity College Dublin), and Professor Tom Bartlett (University of Aberdeen).

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Propaganda image of the type circulated in contemporary Europe depicting atrocities allegedly committed in the rebellion

Roots of an uprising

The 1641 rebellion had roots stretching back to the mid-16th century, when the Irish provinces were heavily colonised by English settlers. Throughout the reign of Queen Elizabeth I, the English government, fearful that continental Catholic kings would use Ireland as a springboard for invading England to exploit the dynastic weaknesses (Elizabeth was, in Catholic eyes, a heretic bastard tyrant, unmarried and the last of her line), sought to impose strong Protestant control of Ireland. This led to a dreadful cycle: Catholic rebellion, repression of the uprising, replacement of Irish landowners by English as part of a 'Plantation' policy, then more rebellion, more repression and further Plantation.

In and after 1610, the largest of the Plantation policies, in which not only the Irish landowners but also the tenant farmers and urban elites were displaced, affected large parts of Ulster in the far north of Ireland. Previous Catholic owners and occupiers were driven into exile, where thousands either became mercenary soldiers ('Wild Geese') in the armies of the Habsburg kings or fell into destitution.

For 30 years, the strong authoritarian government, softened by a blind-eye to private Catholic worship, kept the dispossessed of Ulster and elsewhere in check. But in 1641, England was paralysed by the disputes that were to lead, a year later, to civil war. King Charles I's puritan opponents had plans to introduce much more effective religious persecution of the Catholic Irish and to make Ireland increasingly part of an enlarged English state. This provoked,

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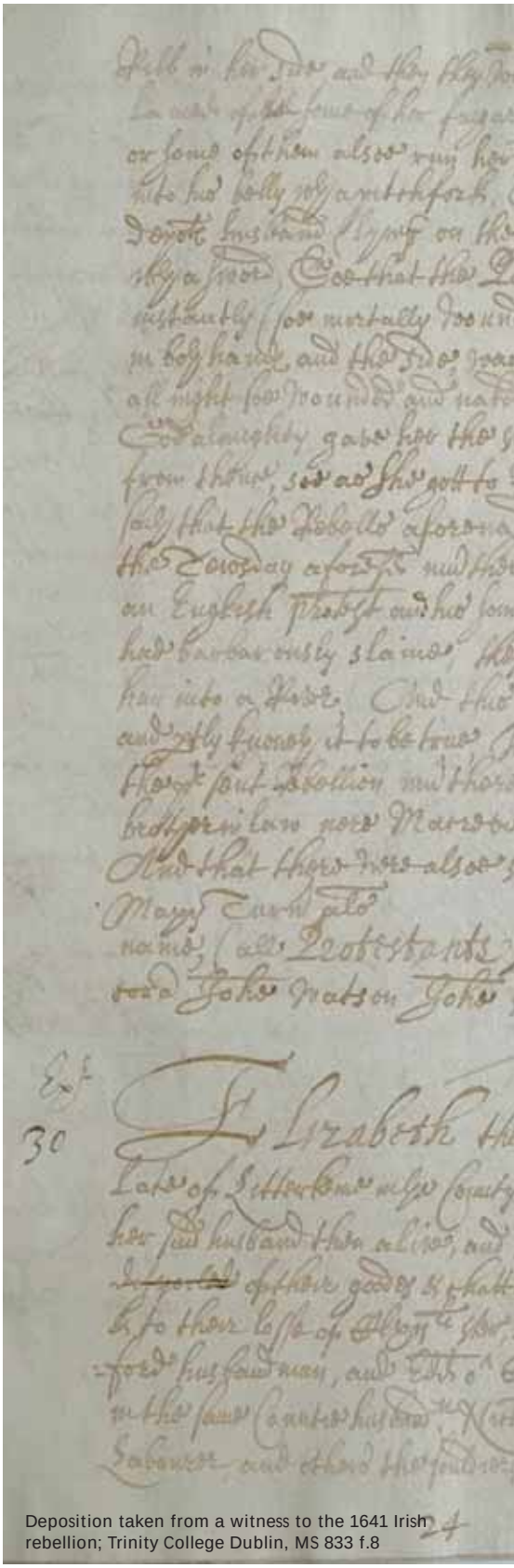
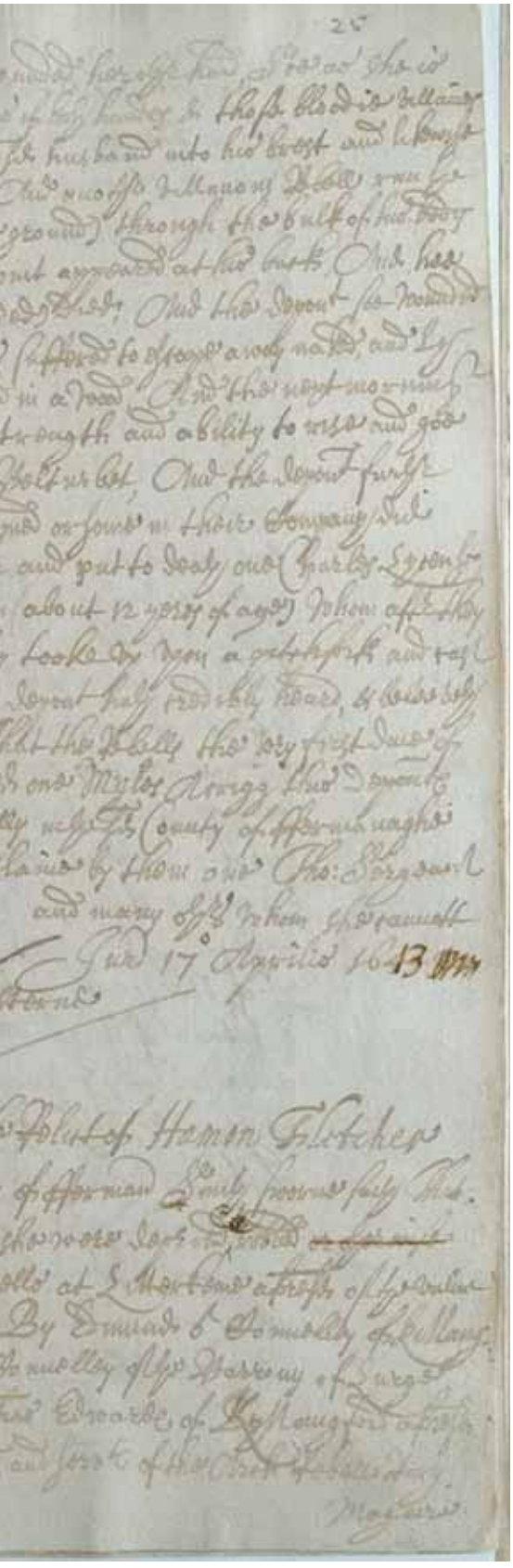


Deposition taken from a witness to the 1641 Irish rebellion; Trinity College Dublin, MS 833 f.8

ression, retribution



from late October 1641, a series of pre-emptive strikes by members of the Catholic nobility and, in the ensuing chaos, a series of what (unless this research project tells otherwise) appear to be spontaneous revenge attacks on Protestant settlers that quickly got out of control.

An imperfect account

Although we have no idea how many people were killed during the events of 1641, the most prudent estimates are that 4000 died through acts of violence and that 6000 more died of the consequences of being driven out naked into the winter cold, while many more fled from their homes and made their way eventually back to England. So much is clear. But the precise chronology and geography of the rebellion have remained hazy at best.

The English government had to do something to protect the English Protestant settlers, but their own country was in chaos. They could not raise taxes to fund the army. So they borrowed money from 2000 venture capitalists (the 'Adventurers') against the promise that they would receive two million acres of Irish land once Ireland was conquered. To establish which land was to be confiscated, all (mainly Protestant) witnesses to the rebellion were questioned by government-appointed commissioners and their accounts recorded as 'depositions' that could be used in court.

Today, 3400 depositions are in existence, providing the fullest and most dramatic evidence we have for any event of this kind before the 20th century. They add to up 19,000 pages of testimony in crabbed 17th-century hands. Trinity College Library acquired the documents in 1741 and for centuries there they have remained, far too extensive for any one scholar to explore them all and in too poor a condition for widespread access. Even with a team of researchers, it will take a total of more than eight person years to transcribe the accounts.

A new kind of history

The spirit of co-operation between the UK and Irish governments following the Good Friday agreement has made it possible to fund a project of this size – the most ambitious British-Irish collaboration in the humanities ever undertaken. Separate but linked funding streams in the UK and Ireland have raised more than 1 million euros from the Arts and Humanities Research Council (AHRC) in the UK, the Irish Research Council for the Humanities and Social Sciences (IRCHSS) and Trinity College Dublin.

Once the depositions are captured and online, they will constitute a database that can be arranged and re-arranged in any way a scholar would like: by date, by map reference, even by act of violence. Many of the depositions give detailed inventories of goods taken and destroyed, affording unique insights into the material culture of a colonial society. Members of the general public might even use depositions to trace family trees. There are endless possibilities for further study, both looking backwards to the pattern of exploitation that provoked the explosion of Catholic violence, and forwards to the way in which these massacres resulted in the confiscation of 40% of the land of Ireland and its transfer from Catholics born in Ireland to Protestants born in England. These are events that transformed Irish history and therefore British and world history. This collaborative project represents a new kind of history: one where the medium and the message can change how we understand ourselves in time.

Professor John Morrill

For more information, please contact the author Professor John Morrill (jsm1000@cam.ac.uk) at the Faculty of History.

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The Arts and Humanities Research Council (AHRC) supports research within a wide subject domain, from traditional subjects such as history, modern languages and English literature, through to the creative and performing arts.

Arts & Humanities Research Council

Established in April 2005 from the Arts and Humanities Research Board (AHRB), the AHRC has an annual budget of around £90 million to fund research and postgraduate study, as well as museums and galleries associated with higher education establishments. In 2006–2007, the value of awarded grants to the University of Cambridge was £4 million.

The AHRC recognises not only the importance of sustaining the arts and humanities research base, but also of ensuring that the knowledge and understanding it generates is widely disseminated. The two Cambridge projects highlighted here – the Shahnama Project and Accessing Virtual Egypt – address this strategic priority in different ways. Indeed, the Council has established itself as a leading authority on research-based knowledge transfer (KT), with several new initiatives (including the KT Fellowship) launched specifically for the AHRC research community. Because the AHRC's definition of KT is broad and flexible in implementation, its impact has extended to key societal and economic challenges.

Several new strategic initiatives have been planned for 2007–2008. In 2007, the AHRC launched a joint £5m programme on Religion and Society with the Economic and Social Research Council (ESRC) and a £5.5 million programme entitled Beyond Text: Performances, Sounds, Images, Objects. In 2008, work will begin with the Engineering and Physical Sciences Research Council (EPSRC) on a Science and Heritage programme.

Alongside research grant activities, strategic programmes and KT, the AHRC is keen to highlight another priority: the support of postgraduate and early career researchers to protect the long-term sustainability and health of the UK's arts and humanities research. A recent survey showed that 74% of AHRC award holders go on to pursue academic and research careers, with the majority of others pursuing careers in creative and cultural sectors, non-profit organisations and public services.

For more information on the AHRC, please go to www.ahrc.ac.uk

Egyptology in prisons

The project Accessing Virtual Egypt is breaking new ground in knowledge transfer between museums and prisons, with empowering results.

A pioneering programme is enabling prisoners to unlock the secrets of the past as part of an initiative to improve their prospects for the future. For the past five years, Dr Sally-Ann Ashton, Curator of the Egyptian Collection at The Fitzwilliam Museum, has taken her knowledge of ancient Egypt into prisons, working closely with prisoners and prison education departments. The study of ancient Egypt is being used as a means of inspiring learning through literacy, numeracy and art at several prisons including HMP Edmunds Hill. These new skills have also supported many prisoners of North African descent in exploring their own cultural heritage.

'Many of the prisoners were serving long sentences and asked whether there was a way I could bring the museum to them more directly,' said Dr Ashton. 'The idea they came up with was a Virtual Gallery – something they could access on computers in the prison and then carry on using when they are released.'

As the idea grew, Dr Ashton realised she needed to spend more time in prison. Winning an AHRC Knowledge Transfer (KT) Fellowship in 2007, one of the first 12 to be awarded, has allowed Dr Ashton to do just this: 'I needed to find out at first hand what the important issues are for educating people serving different lengths of sentences and I needed to work with prison education departments to see how new resources could complement building basic reading and writing skills.'

The KT Fellowship scheme is designed to support academics who would like to embark on a programme of knowledge transfer that will 'make a significant difference beyond the world of academia.' As Dr Ashton explained, it was important that any new resources should have as wide a benefit as possible: 'I wanted to do something that was sustainable and could reach potentially all of the prison population, as well as the wider public.'

Among other resources, one outcome of the KT Fellowship will be the Virtual Gallery, which was funded by the Heritage Lottery Fund (HLF) and is due to be launched later in 2008. The look and feel of this facility – a virtual walk through the real museum, allowing the user to stop at any of the cabinets and examine the artefacts – has been driven entirely by the prisoners. 'They wanted a resource that looked both like a computer game and the outside world. The result is the nearest thing we thought you could get to being in the gallery yourself.'

Dr Ashton views the exchange of knowledge as very much two-way: 'They are a very inspiring audience. Their questions often make me go back and re-think, and I'm looking at my own subject quite differently as a consequence.' By evaluating the impact of her work during the Fellowship, Dr Ashton hopes to arrive at a clearer idea of the best way museums can contribute to society through prison education.

Dr Sally-Ann Ashton

For more information, please contact Dr Sally-Ann Ashton (sa337@cam.ac.uk).

Full-scale battle between the armies of Iran and Turan, from a version of the *Shahnama* created circa 1580 held at the University Library, Cambridge; Add. 269, f.178v

Bringing together the Book of Kings

Almost 1000 years ago, the Persian poet Firdausi created an epic poem of such unparalleled sweep and power that, after his death in 1020, it continued to live on as a seminal expression of Iranian art, literature and history. The *Shahnama* (Book of Kings) is the longest poem ever written by a single author and narrates the history of Iran from the first King until the Arab invasions in the early 7th century AD.

The story goes that the sum of money Firdausi was paid by the Sultan for his work of 35 years was so pitiful that he gave it to an attendant at the baths and left the country. Little did he know that, for the next 800 years, his epic tale would be fêted by successive Persian rulers and aristocracy, whose scribes would fashion precious copies and illustrate them using the finest materials – lapis lazuli, gold, ultramarine. Many of these manuscripts survived, became scattered throughout the world and have now been brought together in an online environment by the Shahnama Project at the University of Cambridge.

The Shahnama Project is building a powerful online resource that will stimulate research and interest in Persian cultural history.

Dr Charles Melville

Dr Charles Melville, from the Faculty of Asian and Middle Eastern Studies, was awarded a five-year grant from the AHRB in 1999 to photograph, catalogue and produce an electronic corpus of the thousands of paintings in the versions of the *Shahnama* still existing worldwide. A second stage commenced in 2006, with the award of a three-year grant from the AHRC's Resource Enhancement Scheme to Dr Melville and John Norman of the Cambridge Centre for Applied Research in Educational Technologies (CARET) to develop the Shahnama Project website.

Thanks to the technological expertise and digital know-how provided by CARET, international researchers are able to use this uniquely interactive online resource to gather together a global record of extant *Shahnama* manuscripts. Visitors are already building their own workspaces for teaching and research, and will be able to use the site to engage in research dialogue with other users. With the addition of a sophisticated behind-the-scenes approvals process, the website will ultimately even allow visitors to correct the database directly. 'Although it has been vitally important to collate and preserve these images digitally, the result is much more than a catalogue,' said John Norman, Director of CARET. 'It is a new type of research tool.'

One of the many fascinating aspects of the research is tracing the 'transmission history' of the texts and their illustrations. The oldest surviving copy of the poem dates from 200 years after Firdausi's death. 'Thereafter, seeing sections of the manuscripts side by side and comparing them over time, one can explore the context in which they were made and why they were commissioned,' said Dr Melville.

By the end of the project, it is hoped that the corpus will include 10,000 images, representing about 70% of the surviving manuscripts. 'My main aim was to stimulate and promote research in Persian history and culture. With this funding, we have had a fantastic opportunity to encapsulate a key element of this and to make it accessible for all to use,' said Dr Melville.

For more information, please contact Dr Charles Melville (cpm1000@cam.ac.uk) or John Norman (john@caret.cam.ac.uk) or visit the Shahnama Project website (www.oriental.cam.ac.uk/shah).

Dr Spike Bucklow

From organic chemist, through maker of rubber monsters, to conservator of fine art, Spike Bucklow describes his career path as 'something of a drunkard's walk'. But you could say that it has always been leading to the same end: the application of science for the benefit of art.

Coming across an article in *New Scientist* 15 years ago that described the contribution science can make to art proved to be the catalyst for a career change that Spike Bucklow had unknowingly been waiting for. Until then, his career had taken him from the organic chemist's bench, where he synthesised cockroach sex pheromones, to the film industry, where he designed and built prosthetic puppets, to artificial intelligence and technology transfer at Cambridge Consultants.

The *New Scientist* article led him to the Hamilton Kerr Institute – a place where science and art come together through the conservation of easel paintings and the analysis of artists' materials and methods. In the 15 years since joining the Institute, a department of The Fitzwilliam Museum and linked to the University's Faculty of Architecture and History of Art, his research has allowed him to combine his background as an organic chemist with his passion for how paintings have been created and how they can be preserved. Now a renowned expert on craquelure – the cracks that naturally form in oil paintings over time – he has also developed a solid grounding in the conservation of medieval art through working on the two oldest altarpieces in the UK: the Thornham Parva Retable and the Westminster Retable. His methods require an intriguing mix of state-of-the-art scanning electron microscopy, 3D imaging and analytical chemistry, together with an understanding of fine paintings, the creation of pigments and Aristotelian physics.

What would others be surprised to learn about you?
Working for Spitting Image *and the film industry in the 1980s, my role was to take a combination of prosthetics and animatronics and create rubber monsters that flexed and moved – Jabba the Hut in* Return of the Jedi*, and Margaret Thatcher and Ronald Reagan in* Spitting Image *were all my models. People might also be surprised to know that my name really is Spike.*

Who or what inspires you?
People who know what they're doing and the evidence they leave. When I was a kid I went to Wookey Hole in Somerset and I saw someone making paper – he just scooped up this slurry and suddenly he'd made a sheet of paper. It was such an elegant, relaxed gesture and resulted in this perfect product. It's the same with art: when I look at fine paintings, I see someone who knew what they were doing.

Have you ever had a Eureka moment?
About two decades before the film Pirates of the Caribbean *appeared, I had an idea of how to connect computer-generated imagery with live action imagery and I envisaged it all in terms of a computer-generated parrot sitting on an actor's shoulder. I was half-way through the patenting process when I discovered the conservation of paintings and I made the decision to become a conservator. So you could say that discovering the Hamilton Kerr Institute was my second Eureka moment.*

CHRIS TITMUS

Dr Bucklow's research uses state-of-the-art technology to study medieval works of art

What's the best piece of advice you've ever been given?
When I joined the Institute I was a trained chemist who knew no art history. I went along to an art history lecture as part of re-training and the lecturer said to me: 'Just because it's written in a book doesn't mean it's true. Always go back to the source.' Maybe I was a late developer with this, but it opened my eyes about how to think critically.

If you could wake up tomorrow with a new skill, what would it be?
A bareback horseman and world-class dressage champion.

What motivates you to go to work each day?
The opportunity to get really close to first-class works of art – the evidence of people who knew what they were doing – and to discover things about them that other people might not have noticed. I'm interested in the physical aspects of the painting today but also in the how and the why of its history, which is why I'm interested in alchemy and Aristotelian physics. I look at the painting from the point of view of 21st-century science but I also think about the person who painted it hundreds of years ago.

What will the future look like in 2050?
My job as a conservation scientist is to ensure that the paintings we work on will look good in 2050. In fact, our timescales are 50–100 years from now. We have theoretical models about how things will behave – how pigments age, how varnish yellows, and how the dynamic nature of the painting's physical structure responds to light, humidity and the environment. But, although these are the timescales I aim for professionally, I know that all of the physical predictions that I make pre-suppose certain social and political structures, and my feeling is that these structures are a bit on the shaky side.

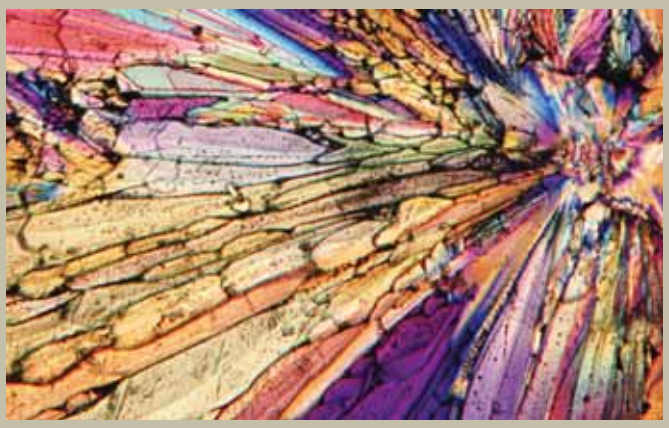
What's your favourite research tool?
The University Library: it's amazing what it contains. I've been looking for information on 17th-century alchemy in north Norfolk and they've got it!

NEWS FROM RESEARCH SERVICES DIVISION

Expanding Horizons

As we celebrate five years of showcasing Cambridge research through the Horizon Seminar series, we take a look back at its development and its value to the University today.

'The Thinking Machine?' on 18 March will be the twentieth Seminar in the series of Horizon Seminars that stretches back almost five years to the day. The events, organised by Research Services Division (RSD) with support from Cambridge Enterprise Ltd, have continued to provide participants with unique insight into the cutting-edge of interdisciplinary research at Cambridge. Each year, Horizon Seminars address four themes, attracting participants from academia, industry, research sponsors, government and the media.



'... a very stimulating and utterly absorbing day... I had no idea that so many people are active with great ideas across such a range of fields.'
Delegate, 'Green Frontiers', June 2006

Helping us to know ourselves

Many of the Seminar themes are chosen to reflect research areas of strategic importance within the University to an external audience, particularly from industry. 'Nanoscale Science and New Materials', the inaugural Horizon Seminar, coincided with the launch in 2003 of Cambridge's interdisciplinary Nanoscience Centre; 'Towards a Sustainable Earth' was timed with the launch in 2004 of the Cambridge Environmental Initiative (CEI); and 'Neuroscience and Society' in 2006 introduced the developing Cambridge Neuroscience initiative. The majority of delegates attending Seminars in the first few years were from industry, and regular coverage was given to R&D, knowledge transfer, technology and innovation. However, an unexpected but welcome realisation has developed over the years: 'We were finding more and more that academics would say how interesting it was to find out what their colleagues were doing. Something that we hadn't anticipated was that Horizon events were also helping the University to know itself,' explains Tamsin Pert, a member of RSD's Partnership Group, the team who put together the programme for Horizon events.

Although the importance of promoting the University's research to an external audience is just as relevant today, and indeed nearly 300 external companies have attended Horizon Seminars so far, the number of academics attending has also risen dramatically. This has made Horizon the perfect opportunity to network with peers and to facilitate knowledge exchange inside and outside the University.

Choosing themes

Themes are chosen not just to reflect the University's strategic initiatives but also its emergent research strengths ('Personalised Medicine' in 2005), funding calls by the research councils ('Ageing' in 2007), key issues for the government ('Foodomics' and 'Energy in Cities' in 2007), or topics of global significance ('China' in 2008).

But the choice of theme is a comparatively small step towards the end result, explains Gordana Najdanovic, Head of the Partnership Group: 'Any preconceptions of the programme change as we start talking to people about their research, and the Seminar can take quite a different direction from the original idea as a result – it's the academic input that then shapes the event.' Speakers from industry or the public sector add another perspective on the chosen theme, and often help to highlight the potential for research collaboration and applications.

'The meeting was an excellent opportunity to hear how much is going on in Cambridge, from understanding how we use energy to the development of new technologies that can reduce emissions, and – importantly – recognising the commercial and behavioural drivers behind the uptake of new ideas.'
Delegate, 'Energy in Cities', October 2007

Diversity is key

Bringing together researchers from diverse areas but with a common interest has proved to be one of the most stimulating aspects of the Horizon series. And it's not just about science and technology; the arts, humanities and social sciences have played a vital part in the Horizon mix too. In 2007 alone, biotechnologists rubbed shoulders with computer scientists at 'A Sensory World'; archaeologists with specialists in obesity and diet at 'Foodomics'; architects with chemical engineers at 'Energy in Cities'; and historical demographers with cognitive scientists at 'Ageing'. Through such serendipitous encounters, contacts are made that sow the seeds of cross-disciplinary research and applications. For the external audience, here is a valuable chance to discover both the depth and the breadth of the University's research portfolio within a chosen theme.

I found the day very useful and highly interesting. Above all, I had an opportunity to meet a lot of great people... and get to know the fascinating and challenging culture of Cambridge.
Speaker, 'A Sensory World', March 2007

Coming up on the Horizon

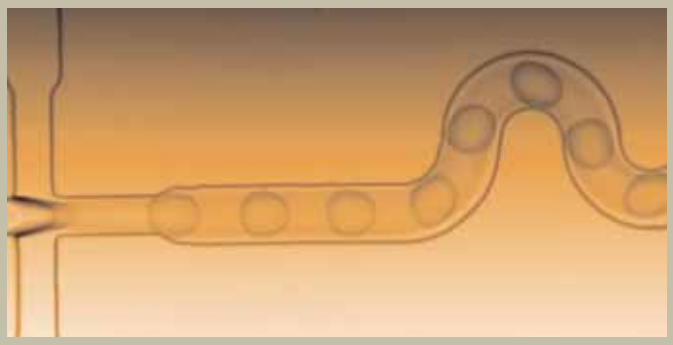
Series 6 commences on 5–6 June with 'China' and continues with 'Bioengineering', 'Materials' and 'Reproductive Health' (details of which will be announced in subsequent issues). We welcome comments, suggestions and ideas about the Seminars, and we look forward to many more opportunities for showcasing the excellence and diversity of research across the University.

For more information about the Horizon Seminar series, please go to www.rsd.cam.ac.uk/events/horizon or email horizon@rsd.cam.ac.uk

NEWS FROM CAMBRIDGE ENTERPRISE LTD

Proactive IP analysis: helping commercialisation not to (micro)drop out of sight

An innovative new project spearheaded by Cambridge Enterprise Ltd and researchers in the Department of Chemistry is taking a proactive approach to intellectual property (IP) and commercialisation.



PROFESSOR CHRIS ABELL

Too often researchers discover that prospects for patenting and commercial exploitation of their inventions are compromised before they have even begun, either because they have prematurely disclosed the information or because 'prior art' exists that invalidates their application. What if researchers could instead build into their research process a review of the patent landscape at an early stage, rather than wait until issues are forced by the desire to publish? The IP position and commercial potential could then be used to inform strategic decisions about the direction of their research.

Cambridge Enterprise is working to do just this with Professors Chris Abell and Wilhelm Huck in the Department of Chemistry. With funding from the Engineering and Physical Sciences Research Council (EPSRC), the Cambridge Microdroplets Project will be used as a test-bed for proactive IP analysis. A full analysis of the relevant patent space will be conducted, together with an exploration of the best criteria for identifying and protecting IP during the course of the project; business models for commercialisation that are synergistic with the research will then be built.

The Microdroplets Project is ideal to model this approach to IP because of its numerous and diverse IP and commercial opportunities. Microdroplets – small water droplets generated in microfluidic systems – have the potential to act as individual reaction chambers in which discrete chemical or biological transformations can be conducted. 'The power of this discovery platform is that it offers the prospect of a completely new approach to experimental science by allowing quantitative analytical experiments to be carried out in a high-throughput way,' explained Professor Abell.

Microdroplet research is developing rapidly and has strong international competition from the USA, Europe and Asia. 'Understanding the patent landscape in any emerging field can inform the strategy for patenting and partnering for commercialisation,' explained Teri Willey, Chief Executive of Cambridge Enterprise. 'In this case, the intention is to optimise the value of the research results as the programme evolves. It represents a strategy by which dissemination of the results can be maximised in parallel with development of a longer term commercialisation strategy. In traditional approaches, these things have sometimes been mutually exclusive.'

This model builds on processes generally adopted in academic research and is one that may well become an exemplar as more IP-sensitive translational research is undertaken by the University.

For more information, please contact Cambridge Enterprise Ltd (email: enquiries@enterprise.cam.ac.uk; Tel: +44 (0)1223 760339; www.enterprise.cam.ac.uk).

Should my invention be patented?

Deciding whether to file a patent application depends on the invention and the opportunity.

Only some research results are patentable or worth patenting. However, assessing the patentability and commercial opportunity for your invention is worth considering because a granted patent, like any other form of property or business asset, can be licensed (leased) or assigned (sold) and doing so may improve the impact your research has on the world.

What is patentable? For a patent application to succeed, your idea must be: novel – it must not have been made public in any way ('prior art') before the patent application is filed; inventive – the invention must involve an inventive step and be non-obvious to someone with a good knowledge of the area; and industrially applicable.

How can I tell? Reviewing scientific publications, patent applications and granted patents can help to determine whether your invention fulfils the first two requirements for patentability. Published patent applications and granted patents may be searched using websites such as the UK Intellectual Property Office (www.ipo.gov.uk); please visit www.enterprise.cam.ac.uk for a list of other websites.

What isn't patentable? Scientific or mathematical discoveries, theories or methods; literary, dramatic or artistic works; ways of performing mental acts, playing games or doing business; presentation of information and some computer programs; animal or plant varieties; and methods of medically treating human or animal bodies.

What about software? Software may be patentable if it can be shown to involve some form of technical effect. Even if it can't be patented, software is protected by copyright after its creation.

Can I patent and publish? Yes, you can do both if your patent application is filed prior to publication.

We can help! In addition to the above, patenting decisions also need to take account of the University's current intellectual property policy (downloadable from www.enterprise.cam.ac.uk). If you are an employee of the University, Cambridge Enterprise Ltd is happy to assess the patentability and commercial opportunities for your invention.

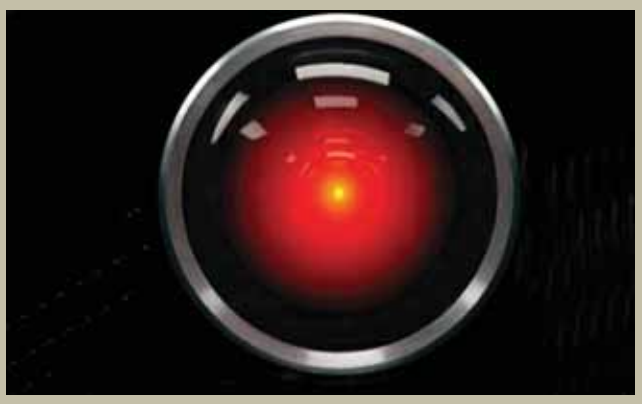
For more information, please contact Cambridge Enterprise Ltd (email: enquiries@enterprise.cam.ac.uk; Tel: +44 (0)1223 760339; www.enterprise.cam.ac.uk).

FORTHCOMING EVENTS: SAVE THE DATES!

10–20 March 2008

Cambridge Science Festival
'The World of Science'

The 15th Cambridge Science Festival will feature science from all points of the globe and beyond in 2008. There will be a series of events celebrating Chinese science and technology past, present and future, from kite-building and gunpowder demonstrations, to discussions of sustainable construction. To coincide with International Polar Year, there will also be a series of events celebrating polar science, including the opportunity for families to go 'Into the Freezer' at the Scott Polar Research Institute. Speakers appearing at the Festival include Professor Sir David King, Dr Nick Baylis and Professor Barbara Sahakian. Over 100 free events are on offer. The full programme is available at www.cambridgescience.org or please email Fred Lewsey (fred.lewsey@admin.cam.ac.uk) to request a printed programme.



18 March 2008

Horizon Seminar
'The Thinking Machine?'

Our understanding of the process of cognition in human beings – how we perceive, think and process information about our environment – is highly developed. This Horizon Seminar will explore cross-disciplinary research on machine learning and cognition, which is relevant to disciplines such as psychology, neuroscience, linguistics, philosophy and computer science. In the overlap between these disciplines, what will we learn about the extent to which man is a machine or whether a sentient machine can ever be developed? This Horizon Seminar will be held at Emmanuel College, Cambridge.

5–6 June 2008

Horizon Seminar
'China'

As the global spotlight falls firmly on China in 2008, we showcase the diversity and richness of China-related research and expertise at the University of Cambridge. This Horizon conference will highlight themes of culture, religion, education, literature and language, alongside business, technology, economy and the environment. In bringing together academic and business leaders to share their knowledge and experience, this event will be a unique opportunity to discover China from a variety of perspectives, and to meet individuals and organisations who are keen to deepen their understanding of this complex and fascinating country. The conference will take place at Buckingham House, New Hall, Cambridge. Supported by Cambridge Network (www.cambridgenetwork.co.uk).

NIGEL LUCKHURST

22 October–2 November 2008

Arts, Humanities and Social Sciences Festival
'Cambridge Festival of Ideas'

The new Cambridge Festival of Ideas celebrates arts, humanities and social sciences at the University and many partner organisations. Over 80 free events will be on offer to visitors of all ages. Activities include everything from Stone Age cooking to a day of Viking culture for families. Talks by high-profile speakers include Baroness Onora O'Neill on press freedom and Dr Paul Binski on medieval art. The full programme will be available from Summer 2008 or please email Joanna McPhee (joanna.mcphee@admin.cam.ac.uk) to be kept informed about the Festival and to join the mailing list.

Horizon Seminars are organised by Research Services Division. For more information, please go to www.rsd.cam.ac.uk/events/horizon or email horizon@rsd.cam.ac.uk

We are looking for article ideas for Issue 6 of Research Horizons and welcome suggestions from all areas of research across the University. Please send ideas to the Editor at Research.Horizons@rsd.cam.ac.uk

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Your way into Cambridge

Research Services Division (RSD) helps academics to identify, secure and manage research funding from external organisations.

We identify funding opportunities through our relationships with regional, national and international sponsors and then support academics through every step of the awards process, from applying for a research grant and checking applications are correct, through negotiating contracts to protect the interests of academics and the University, to supporting departments in managing funding throughout the life of a research project.

RSD also encourages collaboration between the University and industry, and fosters long-term research partnerships between sponsors and academics for mutual benefit.

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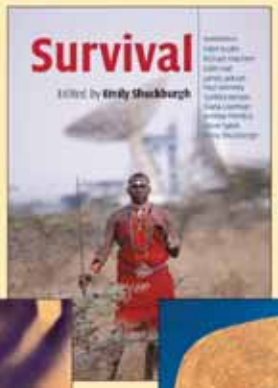
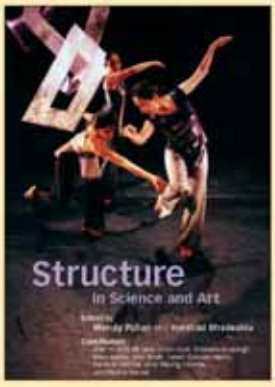
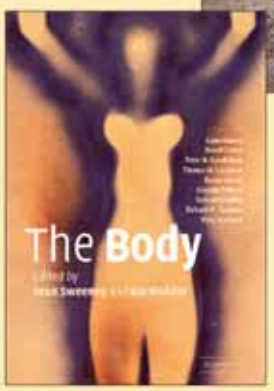
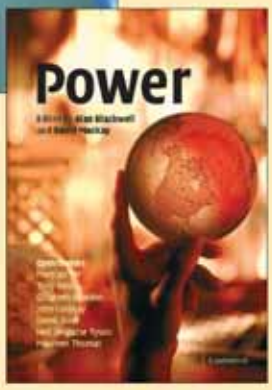
The Darwin College Lecture Series









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