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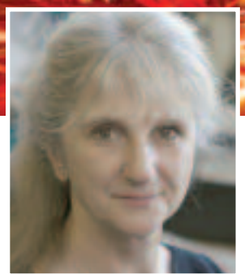
Understanding drug misuse

Flood prevention

The pattern hunters



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Reaching out

There are many ways in which the University engages with the wider community. Through our Widening Participation programme, for example, we encourage and support people who have the ability and potential to thrive at university, but who come from groups that are currently under-represented in higher education. In addition, our Higher Education Summer Schools offer year 11 pupils an opportunity to experience what studying at university is like. The programme's impact on young peoples' aspirations and confidence levels is remarkable.

We also run a Community Engagement programme that includes events such as lunchtime talks by academics in the local shopping centre where people can just walk in off the street to hear about the latest developments in research. Researchers also engage in dialogue with community groups and participate in schemes such as 'Citizen science' – a three-year programme in which teachers and scientists create new activities to get young people thinking and talking about biomedical issues. The biannual Science Alive festival brings staff and students into contact with thousands of members of the general public.

Less obvious is the fact that a considerable amount of our research is also aimed at improving the lives of others. While it could be argued that all research has this ultimate objective, some projects set out from the start with that specific intention. For instance, the winners of the £15,000 prize in our 2006 New Enterprise Competition were a group of postgraduate students in computer science who are developing a device that can be operated by people with minimal hand movement. SensaGest is connected to a small wearable computer that alerts a nurse or care worker via a paging system when help is needed. Using this system, victims of spinal cord injury will be able to rehabilitate with dignity and independence.

A number of the articles in this issue highlight some of the research being done around the world where academics are reaching out to help the wider community and making a difference.

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*pre:*view

University of Bristol Dorothy Hodgkin building. Courtesy Evening Post.

Dr Kim Etherington

The Southmead Project: understanding drug misuse

Almost 12 years ago the Southmead Project was set up to help residents deal with the drug problems that have hounded Southmead for many years. Dr *Kim Etherington* from the Graduate School of Education has been involved with the Project for almost ten years.

Southmead is a deprived area of Bristol. When Tony Blair visited it earlier this year he spent nearly an hour talking to residents about the impact crime had on their lives. But, were it not for the Southmead Project, things would undoubtedly be a lot worse. The Southmead Project was the initiative of Mike Pierce, a former resident of Southmead, who had lived there as a child. Mike returned to Southmead, having survived a personal drug problem, only to discover that relatively nothing had changed since his childhood. Mike understood the type of support drug users needed and he was angered by the unchanging situation. He decided to take action and created the Southmead Project at the heart of the community, currently located alongside the local shops.

Mike understood the impact of abuse and its correlation with self-harm

With charitable funding and a small amount of local funding, the Southmead Project took off. It offered methadone-substitution programmes for drug users, along with a variety of other services. As Mike explains, 'the beauty of methadone is that it is a substitute which people can use to stabilise themselves'. Later, a programme was set up to help drug users find training and employment once their drug problem had become stabilised, and a Relapse Prevention Group was established to provide people with the skills to avoid relapse. A Parents' Group was also started which gave advice and support to the families of drug users. However, this was not enough for Mike. He wanted to explore the relationship between early trauma/abuse, and how that subsequently led to drug misuse. Having worked as a volunteer at an NSPCC abuse counselling service, Mike understood the impact of abuse and its correlation with self-harm.

Over the past 18 months, Kim Etherington, her research assistant Emma Barnes, and a small team of volunteer researchers have evaluated the work of the Southmead Project, exploring the fundamental reasons for drug misuse. Users were invited to participate in the study by completing questionnaires and to take part in semi-structured, individual and group interviews. Their report, which has just been published, provides an understanding of drug misuse, treatment and aftercare, and the processes involved.

As the research progressed it showed how, in some cases, drug dependency in later life was linked to trauma or abuse during childhood. Many clients using the Southmead Project had experienced childhood trauma of some kind. As Mike Pierce described, 'about 70-80 per cent of clients would turn up to the clinic purely to talk about their abuse as a child'. In one of the interviews 39-year-old Mark told how, as a nine-year-old, he had watched his seven-year-old brother die in a road traffic accident on Christmas day and how the impact of that had subsequently killed his father. By the age of 29, Mark was spiralling out of control, following the break-up of his marriage. Heroin became his emotional painkiller: 'I didn't use heroin to get high. I used it to take away the emotional pain that I was feeling. Without heroin I think I may have committed suicide'. Mark realised he needed help and turned to the Southmead Project. It provided him with the possibility of a new beginning, and with the help of the Relapse Prevention Group Mark has been free from drugs for five years. ➜

IMAGE COURTESY BRISTOL EVENING POST

➜ Mark is just one of the many people the Southmead Project has helped. He is living proof that Mike's understanding and empathy with drug users has enabled him to take a more successful personal approach to those who seek help. However, it has not been plain sailing. The Southmead Project finds itself constantly hampered by a lack of resources and funding for core activities. Some financing has come from Government Trusts, but 70 per cent of the income is raised by its own fundraising activities. These must exceed £300,000 each year if the centre is to stay afloat. The past six months have proved particularly turbulent, resulting in threatened closure due to lack of finance. However, Mike and his team were not prepared to give up. Service users marched with banners on Bristol's Council House and, with the support of a paper written by Kim and Emma demonstrating the value of the Southmead Project to the community, they were successful in their bid for a grant from the Neighbourhood Renewal Trust.

We must help the children

For Mike, however, the fight is not over. His aim now is to address the issues that are affecting the addicts of tomorrow: 'We must help the children who do not have a chance in hell of getting a life unless the abuse from which they suffer is challenged'. The mission is not only to continue to help current drug users, but also to prevent the children of today becoming the drug users of tomorrow.

So, the Southmead Project continues its invaluable work. Nevertheless, it is still haunted by the threat of insufficient funding, which looms large as current resources slowly seep away. ■

If you would like to help, either by becoming a volunteer or making a donation, please contact:
The Southmead Project
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Telephone: 0117 950 6022
Email: southmead_project@yahoo.co.uk

This research was funded by the European Social Fund and the Higher Education Funding Council for England.

www.bristol.ac.uk/education

Key recommendations from the research report:

- **Young people should be educated about potential dangers of drug use by local ex-drug users, rather than outsiders with little understanding of local residents' lives and the area.**
- **Users should have the opportunity to contribute to the running of the Southmead Project, as this provides routine and responsibility.**
- **Education about the impact of negative life events on subsequent drug misuse could increase public understanding and reduce stigma.**
- **Workers and counsellors should be educated to focus on the users' understanding of their identity development.**
- **Parenting classes should be offered to enable clients to learn about the needs of their children.**
- **Relationship-skills training helps users build on the need to improve relationships with others.**

Dr Steve Thomas

Chewing the quid in Papua New Guinea

Dr *Steve Thomas* first visited Papua New Guinea in 1983 where he stayed for four years looking into the cause and prevention of oral cancer. This association with Papua New Guinea has continued throughout his time at the University in the Department of Oral and Dental Science.

Components of the betel quid: leaves of the betel pepper plant, ground areca (betel) nuts and slaked lime.

Papua New Guinea is an island nation in the South Pacific, described as a nation in transition. The population is predominantly Melanesian with smaller Polynesian and Micronesian groups. It is a heterogeneous, culturally diverse society where over 700 Austronesian and Papuan languages are spoken. Oral cancer is the most common malignant tumour in Papua New Guinea. Melanesia has the highest incidence of oral cancer in the world with 267,000 cases reported globally in 2000, two-thirds of them in men. Rates are also high in South Asia where it is the most common cancer in India, but worldwide there are marked variations in reported incidence of the disease.

Smoking has been consistently associated with an increased risk of oral cancer but smoking patterns do not explain the geographical variation of this cancer. A possible explanation is the chewing of betel quid. Betel quid generally consists of areca nut, part of the *Piper betle* plant (flower stalk, leaf or stem) and slaked lime (either as a powder or paste). In India and Pakistan, tobacco and other spices are often included as well. The quid is used to produce a sense of euphoria and alertness in the user, but several lines of evidence support the suggestion that the chewing of betel quid increases the risk of oral cancer. Betel quid contains various carcinogens – it is carcinogenic in animal models and there are higher rates of oral cancer in areas where the chewing of betel quid is common. In many countries, but not Papua New Guinea, people put tobacco in the betel quid, as well as smoking it. Few studies have been able to reliably estimate the role of betel chewing (as distinct from the role of tobacco) as an independent risk in oral cancer.

The quid is used to produce a sense of euphoria and alertness

A series of studies undertaken by Thomas in the 1990s and published in *The Lancet*, led to a possible explanation of the cause of the disease and how it could be prevented. These studies showed that although oral cancer geographically reflected the distribution of betel quid chewing, smoking was a vital co-factor. While the risk of getting oral cancer was doubled for those people who either chewed betel quid or smoked tobacco, those who did both were five times more likely to get oral cancer. In addition, slaked lime when added to the chew appears to have a crucial role in the development of mouth cancer.

In Papua New Guinea oral cancer is predominantly a disease of lowland and coastal regions and is most common in New Ireland Province. ➜

➜ In the highland region – where the *Areca catechu* palm does not fruit – low rates of oral cancer persist in spite of smoking being common. Thomas and his Papua New Guinean colleagues therefore undertook a large study in the lowlands of Papua New Guinea where betel quid use is common but, importantly, does not contain tobacco.

This study was conducted among a mostly pre-literate population (that is, a culture without a written language), which posed some particular challenges. People were interviewed in Melanesian Pidgin. Their age and the length of time they had smoked or chewed was estimated relative to key events such as the Second World War. However, assessing the frequency of smoking and betel quid chewing was more problematic as different groups of people did not necessarily use the same base for their counting system. To combat this, each person was first asked about their daily activities from waking until going to sleep. A typical day was divided into activities such as from sunrise to going fishing or hunting; coming back to work in the garden; eating and sitting around a fire in the evening. The interviewee was asked whether they chewed betel quid or smoked during each period. The specific components of the quid (eg the chewing of commercial building lime) or the type of tobacco smoked (eg most people smoked home grown, high-tar tobacco rolled in newspaper or leaves) was recorded in the local language.

The risk of cancer increased in chewers who also smoked

Although the risk of cancer was increased with the frequency of chewing the quid, the effect of chewers smoking was greatly increased. But Thomas also looked at the role of slaked lime added to the quid and found that oral cancer in Papua New Guinea is concentrated at the corner of the mouth and cheek, which corresponds precisely with the site of application of slaked lime in most cases. Powdered slaked lime – a corrosive chemical – is applied to the chewed nut with *Piper betle* flower stalk at the corner of the mouth. This causes the betel quid ingredients to generate free radicals which, together with carcinogens from the tobacco smoke, cause DNA damage that cannot be repaired because of the rapid cell turnover caused by the caustic lime.

Over and above the research investigating the cause of oral cancer and its prevention, the team also collaborates as surgeons. As Thomas (a head and neck surgeon) has practised in Papua New Guinea, he is very aware of the problems associated with such surgery in this remote setting. The operations required are technically difficult, both in the removal of the cancer from the mouth and the neck, and the reconstruction of the defect so that the person can swallow and speak. The team is currently establishing links with head and neck surgeons in Papua New Guinea to undertake a visit to transfer practical skills of micro-surgery applicable to local conditions.

In addition, a discussion is now taking place as to how oral cancer can best be prevented. Obviously cutting down on both chewing and smoking is likely to reduce the risk of getting oral cancer, as well as other smoking-related diseases, and Thomas believes that the chewing of commercial building lime as part of the quid should also be discouraged. However, betel quid chewing is deeply engrained in traditional practices and thus there would be wide cultural implications if its use were modified. Furthermore, a recent article in *The Lancet* has highlighted the problems of a deteriorating health system due to the constraints of a troubled economy. The management of this disease is not easily solved at any level. ■

Dr Thomas's work in Papua New Guinea was funded by the World Health Organization and the Royal College of Surgeons of England.

www.dentalschool.bris.ac.uk

In the news:

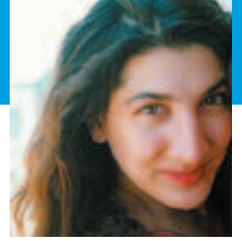
Are two medicines better than one?

Parents should be advised to use the minimum dose necessary when treating a child with fever, says Dr *Alastair Hay*, senior lecturer in Primary Health Care.

Non-drug treatments for reducing a fever include loosening clothing, reducing the ambient temperature and encouraging the child to take fluids. The drug options are paracetamol and ibuprofen, and parents commonly give both drugs to a child with fever. But should these drugs be used together, or alternately? And at what dose and frequency?

To try to answer these questions, scientists searched the scientific literature, but found very little evidence to support prescribing paracetamol and ibuprofen, either in combination or alternately. They also found other important gaps in the evidence, including limited safety data and no clear definition of what is a clinically important temperature difference after treatment. Until such evidence is available, the role of combined anti-fever drugs is uncertain, they warn, and parents should be advised to use the minimum treatment necessary. ■

www.bristol.ac.uk/primaryhealthcare



Dr Lorena Barba

SCATtering knowledge

There are now three ways of doing science. For centuries scientists have made discoveries by means of *experiments* and *analytical thinking*, but in the past few decades they have acquired a new partner: *computer simulation*. Dr *Lorena Barba*, from the Department of Mathematics, is leading a project to train young scientists from developing countries in this new way of working.

It is safe to say that computer simulations are playing an increasingly dominant role in the process of scientific discovery. The computer is a virtual laboratory where we can study what happens at both the smallest scales – atoms, molecules, proteins – and at the largest scales – the Earth's atmosphere, the stars, and galaxies. Every discipline now benefits from scientific computing, and computational excellence is the key not only to a research institution's success, but also to the community's.

With the installation of three supercomputers, the University will soon be at the forefront of High-Performance Computing. The largest of these computers will be the fastest university-owned computer in the UK and among the top 100 in the world. But these new facilities will not just benefit the University, they will also help the developing world.

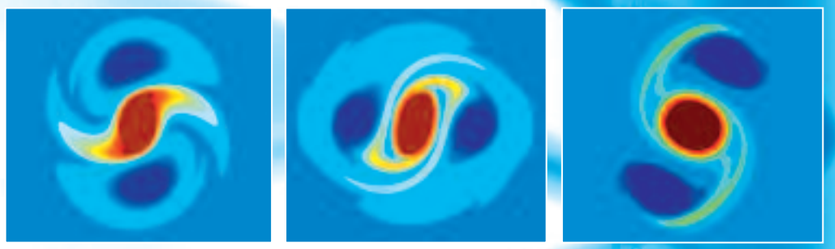
In addition to the mobility grants, the SCAT project organises international scientific workshops and it is undertaking both e-learning initiatives as well as distance collaboration assisted by technology. These actions, underpinned by the goal of improving the expertise of young scientists in scientific computing, have a beneficial effect in all partners. For the University of Bristol, leading such a project increases its international standing and influence. It will also benefit from long-term professional relationships, increased collaboration, and the enriching nature of the visitor programme.

Dr Lorena Barba is the instigator and current co-ordinator of the SCAT project. She grew up in Chile during the dictatorship and obtained her first degree in mechanical engineering. During that time she became interested in fluid mechanics and in research, but her options were limited,

> The University will soon be at the forefront of high-performance computing

SCAT, which stands for Scientific Computing Advanced Training, is founded on the idea that co-operation in higher education is a means of fostering economic and social progress and, in the end, improving lives. The specific aim is to improve the conditions of training of highly qualified individuals in a skill that will undoubtedly play a dominant role in the future of scientific discovery and engineering design. The SCAT project is funded by EuropeAid and it will provide 20 high-value mobility grants for postgraduate students to spend a period of study and research in a partner institution. The European partners are in France, Spain and the UK, while the Latin American partners are in Brazil, Chile and Mexico.

so Dr Barba is not unfamiliar with the difficulties faced by young people aspiring to be scientists in developing countries. After finishing her degree it took seven years of hard work to pay back her university loans before she could start her postgraduate studies at the California Institute of Technology, where she obtained a PhD in aeronautics in 2004. Now resident in Bristol, she maintains ties with her first mentors in Chile and through them has extended her network of contacts to Brazil, as well as to France and Spain. Her proposal became one of only six successful projects in this final round of funding. ➜



Tripole evolution.

➜ After a year of negotiations with the EC, the project finally got started and following the launch meeting in Barcelona (February 2006), the SCAT project held its first international meeting in the Daresbury Laboratory last June. There the international team considered the first batch of applicants for the mobility grants and chose to award three. Two of the successful applicants will come to Bristol to work with Dr Barba, while the third goes to Marseille.

> Clever algorithms can achieve far more than fast computers

Felipe Cruz is currently an MSc student in the field of Informatics and Computer Science, in Valparaíso, Chile. His SCAT grant will enable him to work on the implementation of fast particle methods where the calculations involved are usually too great, and the computational resources too small, to complete them in a sensible time frame. Moore's Law suggests that computer processors double their speed every 18 months, so in theory if we wait long enough the computer will eventually become fast enough to solve any problem. But in fact clever algorithms can achieve far more than fast computers, and in a much shorter time-scale. For example, if a problem has a million unknowns and there is a solution algorithm which requires N-squared operations, it would take 16 generations of Moore's law (ie 24 years) before this solution method is comparable to a 'fast' algorithm only requiring N operations. Felipe will be working on devising such intelligent algorithms that will speed up the calculation of large numbers of interactions by making small approximations. When simulating the interactions of millions of celestial bodies under gravitational forces, for example, those that are far away from a point can be bundled together to calculate their approximate influence, thereby greatly speeding up the results.

Helmut Wahanik, from the Instituto de Matemática Pura e Aplicada, Brazil, will come to Bristol to study objects that appear in fluid flows where a number of eddies form a tight constellation and rotate together. They are called vortex multipoles and they behave in fascinating ways. The tripole, for example, is an arrangement of three eddies, where the central one rotates in the opposite sense to the two outer vortices. The whole arrangement rotates around the centre and can survive for a long time. These types of vortices are studied in relation to the oceans where the main source of variability in temperature, salinity and other properties is caused by eddies, so it is important to understand their behaviour.

For all of these young aspiring scientists, the opportunity to join a research group in Europe, have the mentoring and guidance of established international leaders in their fields, and have the chance to do hands-on computational science in world-class facilities, will be life-changing. Apart from what they learn during their stay, they will go back to their countries to become part of the academic community, having developed international collaborations that will help their career for years to come. ■

www.maths.bris.ac.uk

In the news:

More fires, droughts and floods predicted

As temperatures rise with global warming, an increased risk of forest fires, droughts and flooding is predicted for the next 200 years by climate scientists from QUEST, in the department of Earth Sciences. The researchers used data from 52 different climate change models.

Even if we stopped emitting greenhouse gases now, Dr *Marko Scholze* and his colleagues predict a risk of up to 30% of forest loss for certain regions for a global warming increase of less than 2°C, which rises to more than 60% for a warming of more than 3°C.

Less freshwater availability, and with it more intense droughts, is likely to occur in West Africa, Central America, southern Europe and the eastern USA. Other regions will be at significant risk of excessive runoff as trees are lost, increasing the chances of flooding as temperatures rise.

The researchers also found that if the temperature increase is more than 3°C, land carbon sinks could release their stored carbon, starting a positive feedback loop that would increase atmospheric carbon dioxide. ■

QUEST (Quantifying and Understanding the Earth System) is a £21 million programme funded by the Natural Environment Research Council (NERC).

http://quest.bris.ac.uk

Professor Paul Bates

A flood of information

New ways of measuring the Earth's surface from aircraft and satellites now give the ability to predict, in incredible detail, areas at risk from flooding. Professor *Paul Bates* of the School of Geographical Sciences explains how.

Government figures estimate that in the UK two million properties worth £100 billion are at risk from flooding. Of these, 200,000 lack basic standards of protection, which the Government defines as being safe from a flood that occurs only once in 75 years. Moreover, the combination of continued building in the floodplain (such as the 120,000 new homes planned for the Thames Gateway region in London) and possible sea-level rise and climate change may all increase future flood risk. Understanding and managing this risk is a major concern for regulatory bodies such as the Environment Agency, and for the insurance industry which frequently underwrites the cost of flood damage. The human costs of flooding are also high, and anyone who has had their property flooded will know that it is a deeply unpleasant and frightening experience.

Predicting which areas are at risk from flooding is fraught with difficulty. Often we are concerned about the risk from very large floods which have not yet occurred. Even when we do experience very large events, such as the 1953 east coast floods, the priority is rightly on saving lives and not collecting scientific data. We also know that flooding of urban areas involves complex flow patterns and is strongly influenced by micro-scale features such as road layout, buildings, walls and fences.

In this situation computer models that can simulate flood flow are an obvious answer, but although the mathematical and computing knowledge to build these has been around for nearly 50 years, two factors have prevented their widespread use. First, simulating the →

Flooding of Carlisle city centre in January 2005.

→ detail of flow through and between buildings for large city areas has, until five years ago, been beyond the scope of available computers. Second, even with the computer power to build a model at the right resolution, the data to describe all the building features which control flooding have, until recently, been lacking.

This situation began to change about 10 years ago and from the beginning a team of scientists from the Departments of Geographical Sciences and Civil Engineering has been at the forefront of this research. The starting point in the transformation of our ability to model floods was the purchase by the Environment Agency of an instrument called a LiDAR.

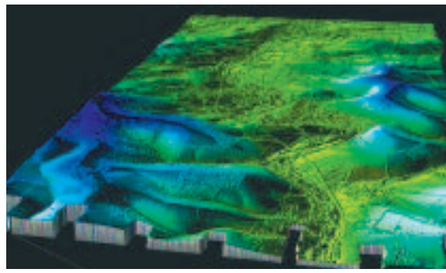
How can we be sure our models are producing realistic results?

LiDAR stands for Light Detection and Ranging and the instrument works by firing a laser pulse at a target and timing how long it takes to be returned back to the sensor. The laser beam moves at the speed of light so we can therefore calculate very precisely how far away the target is. So far, so good; however, the neat trick is that it was designed to be mounted on a light aircraft and to fire many thousands of pulses per second whilst scanning from side to side. Using the information gained this way, we can calculate the height of the ground surface for each of the thousands of laser shots. Modern LiDAR systems fire 100,000 shots per second and can measure the land height every 25 cm to a vertical accuracy of less than 8 cm. Being a light-based system, LiDAR can also penetrate many vegetation canopies to measure the ground height beneath.

However, processing LiDAR data is not straightforward and the Bristol team, along with colleagues at the University of Reading, have spent considerable effort developing algorithms to separate out vegetation and buildings from ground surface laser 'hits'. More recently, we have begun combining LiDAR and digital map data to deal with some of the more detailed features present in urban areas. This even goes as far as identifying and removing the parked cars and garden sheds from LiDAR data to create a true 'bare earth' terrain model.

Being able to map urban areas in detail is, however, only part of the story and we also need to develop computer models capable of using the vast amounts of new data now available. With approximately 50 per cent of England and Wales mapped using LiDAR and risk estimates required for individual properties, such models need to be both efficient and accurate. Here, the Bristol team has been developing a suite of computer models of varying complexity to apply in different situations. One particular code, LISFLOOD-FP, is now used by researchers at over 20 universities worldwide, including some in developing countires such as Brazil, where it is used to address local problems. Collaborators have also worked in Egypt and Ghana. In addition, the ideas behind LISFLOOD-FP have been used in a number of other research and commercial models. This includes the model used by the Environment Agency to produce maps of extreme flooding for the whole of England and Wales. When the predictions from such models are combined with other geographical property databases, the potential to calculate likely damages, identify critical risks – such as care homes or hospitals in the floodplain – and plan safe evacuation routes is obvious.

But how can we be sure that our models are actually producing realistic results? Well, here again aircraft and satellites have a role to play. In particular, highly developed radar systems can be used to map flooding to a high level of detail whilst it happens. A particular recent success was the use of a military-specification airborne radar operated by QinetiQ Ltd, during the November 2000 floods. This was used four times over nine days to map flooding along the River Severn at Upton-on-Severn at one metre resolution and has given us unprecedented insights into flood dynamics that we can compare with our model predictions.



Top: LiDAR data of the River Stour, Dorset.

Middle: 25 cm resolution LiDAR data of the River Mersey.

Bottom: 25 cm resolution LiDAR data of the River Mersey with vegetation removed.

As in other areas, remote sensing technology for flood science is not standing still. Truck-mounted LiDAR systems which can map buildings in 3D and cheap, networked sensors which can be deployed in large numbers to transmit water depth information in real time are just two technologies which can potentially continue the revolution which began with airborne LiDARs. The development of new High Performance Computing approaches at Bristol will also allow us to build more detailed models of bigger areas than ever before. Whatever the future holds, we know that whilst we may never eliminate all flood risks, we may at least be better informed to mitigate and manage them. ■

www.ggy.bris.ac.uk

Improving education quality

Can improving the quality of education experienced by people from poor families and communities assist in the fight against poverty and gender inequality, asks Professor *Leon Tikly* from the Graduate School of Education.

A research programme on Implementing Education Quality in Low Income Countries (EdQual) has recently been established by a consortium of institutions led by the University of Bristol. The consortium includes the Universities of the Witwatersrand, Johannesburg (South Africa), Bath (UK), Dar es Salaam (Tanzania) and Cape Coast (Ghana), and the Kigali Institute of Education (Rwanda). The aim of the programme is to generate information to improve the quality of education in ways that will benefit the poorest people in the world and promote gender equity. The programme is organised around five large-scale projects in the areas of: school effectiveness; language and literacy; science and mathematics curriculum; information and communication technology (ICT) to support basic education; and education leadership and management. The consortium also aims to create a sustainable resource through supporting African partner institutions to become regional centres of excellence in one or more areas of education quality.

Increased levels of literacy are linked to a reduction in the spread of AIDS

Good-quality education has a positive impact on enrolment and can lead to pupils staying in school longer. In addition, it helps reduce drop-out and repetition rates. Increased levels of literacy and education are also linked to greater control by women over their fertility and to a reduction in risk-taking behaviour associated with the spread of HIV/AIDS. Further, improvements to education quality lead to higher cognitive achievement, which in turn is linked to higher individual productivity and economic growth. This is increasingly important in the global era because poverty reduction relies on the ability of education systems to produce the range of skills required for successful global integration and this in turn depends on improving the quality of basic and post-basic education. The processes of learning associated with a good-quality education can also assist in achieving wider social goals such as social cohesion and conflict resolution, understanding of citizenship and human rights – including equal rights for women and girls – and respect for cultural diversity.

Scratch below the surface, however, and the issues become more complex. As Yusuf Sayed, an expert in this field, has pointed out, 'the concept "quality" is elusive and … frequently used but never defined'. It has multiple meanings that reflect 'different ideological, social and political values'. For these reasons, developing a conceptual understanding of education quality and its contribution to poverty reduction is a key objective. An initial review of the literature identified two broad approaches to education quality. One links quality to achieving higher learning outcomes with a more efficient use of resources, whilst the other views quality in terms of developing students' capabilities and fulfilling childrens' rights to survival, protection and development.

Our view of the importance of education quality has been reinforced by the views of the policy makers and others who participated in the national consultative workshops that we held in each partner country during EdQual's recently concluded inception phase. ➜ Communicating effectively with these different groups is critical not only to determine research priorities, but also to assist with identifying the mechanisms that will enable new initiatives to be mainstreamed. The outcomes of the workshops and literature reviews informed our ongoing research design. In particular, the quality of teaching and learning has emerged as a key research priority, as has the need to address the development needs of large numbers of under-qualified teachers. Three of our five large-scale projects, therefore, focus on aspects of teaching and learning – innovations in the maths and science curriculum, the use of ICTs, and language and literacy. These projects will all include research into forms of support for the teachers' professional development.

Other issues that were raised are the need to improve the quality of management and leadership at the local and school level at a time of decentralisation of state education systems, including the management of staff (reducing absenteeism and raising motivation), the mobilisation of resources, and the procurement of materials. Given the scope of the quality issues covered by our research programme, the need to identify key priorities and a very tight research focus within each project has become paramount, as has the need to develop our own capacity and capabilities as researchers. Chief amongst these has been the ability to effectively communicate across national and continental boundaries. Whilst remaining fully aware of the enormous challenges ahead, we are buoyed by our conviction as researchers of the absolute importance of education quality for tackling disadvantage. ■

This research is funded by the Department for International Development.

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The use of ICT to support basic education in Rwanda

This large-scale project aims to develop initiatives for the effective introduction and use of ICTs in disadvantaged primary schools. During the project design stage, a team of researchers visited schools in Rwanda and talked to a range of educationalists.

They found that in many cases the computers available in schools are relatively old – the majority running Windows 98. The only software available is Microsoft Office and some games. Access to the internet is often not available, sometimes because there is no electricity, and schools lack technical support for maintenance of their computers. Where computers are being used in classrooms, this is almost entirely to teach ICT skills and not to support teaching and learning across the curriculum. The same is also true for teacher training with implications for teachers' confidence and competence to use ICTs. There are often around 50 pupils in each class and all teachers observed use a traditional 'hands off', teach-from-the-front approach, even when teaching computer skills. Yet, Rwanda aims to use ICT for 'teaching purposes' by 2008.

The research team aims to develop strategies to support this policy in the core curriculum areas of science and mathematics. At the same time it hopes to promote awareness amongst parents and communities of the potential role of ICT both in children's learning and community development. A particular focus will be on designing professional development programmes for teachers.

Professor Nello Cristianini

The pattern hunters

Pattern analysis is now a central part of science and industry – from genome analysis to weather prediction, from fraud detection to the latest surveillance technology. *Nello Cristianini*, Professor of Artificial Intelligence in the Departments of Engineering Mathematics and Computer Science, has just returned to Bristol to strengthen this direction of research after five years in the United States.

Patterns are everywhere and discovering them is a quintessential part of what we call 'intelligence'. This is, after all, the basic trick used by every organism to gain some predictive power over its environment and so it should not be surprising that we – as a species – find the discovery of patterns a pleasurable experience. Endless games are based on the theme of connecting the dots and endless jokes are based on violations of apparent patterns. In fact, so strong is our instinct for patterns that often we delude ourselves they exist, even when they are not there, as in patterns seen in the night sky. Constellations are present in every culture and contain virtually no astronomical information: rather, they reveal some property of the human mind – our passion for patterns. The fact is, we are constantly on the look-out for some interesting pattern to discover.

Violations to patterns are as useful as patterns themselves

In modern society we have turned this instinct into an industry, but now it is computers – not people – looking for patterns because computers are less easily fooled by randomness and are more capable of sifting through gigabytes of information looking for faint – but significant – statistical signals. The discovery of subtle relations in data can lead to endless applications in science, business and technology. For example, it is one of these algorithms that prepares your recommendations for further reading after each visit to Amazon.com; patterns in customers' behaviour are analysed by marketing experts trying to discover a new niche or new business opportunity; election strategists follow much the same approach. Unique patterns in voices, irises and fingerprints, are exploited by biometrics professionals to develop the next generation of identification systems – the one that will replace signatures and PIN codes.

But violations to patterns are as useful as patterns themselves, flagging anomalous behaviour as suspicious to your credit card company – the entire credit card system relies on pattern recognition software for fraud detection. It would also be much harder to make sense of the eight billion web pages currently available without specialised software capable of determining relevance and similarity of those pages, based on statistical patterns in their text and link structure.

In a highly controversial development, governments have turned to pattern analysis to help monitor telecommunications, and to predict the risk level posed by individuals. In the past, attempts were made to predict our behaviour by analysing bumps on our head. Later, the measurements of bodily proportions were used. Today it could be the patterns of our everyday ➜

➜ transactions – all of which are, of course, recorded – that predict the level of risk we pose. One day, such patterns could be sought in our genes.

So it seems the entire paradigm of scientific research is undergoing a revolution from being hypothesis-driven to being data-driven. Now it is not uncommon to first gather massive amounts of data – more than any scientist could possibly look through – and then use computers to sift through it in search of interesting relations. This is how genomic projects are done, as well as surveys of the universe and some experiments in physics. Data-driven approaches are also becoming the norm in industrial applications where massive amounts of data are systematically gathered (and traded) for later analysis by computers.

The web is an awesome repository of information

But despite holding such a strategic position in the modern information-technology society, for a long time pattern analysis remained more of an art than a science. Only recently has a unified theoretical framework started emerging, based on ideas from statistics, artificial intelligence and theoretical computer science. This has led to a new generation of pattern analysis algorithms, one based on mathematical principles rather than loose analogies with biological learning systems. Gone are the neural networks and evolutionary algorithms of the 1980s (as data analysis tools, of course, not as models to understand biology) and in are the new, statistics-based methods. They can already be found in spam filters, medical diagnosis systems, machine vision devices and a hundred other applications. A leap in performance has accompanied this transition.

The new challenges and awesome potential of pattern analysis are exemplified by the two most important data analysis tasks of this century: web content and genomic datasets. These two fields also represent the main thrust of the new pattern analysis group in Bristol. The web is an awesome repository of information. Buried in it are business leads that companies can exploit, strategic intelligence about competitors, sociological information about public opinion and attitudes to products or policies, and much more. The problem is how to extract this information. Similarly, modern biology produces enormous quantities of data which are freely available over the internet. Hidden in those datasets are the answers to age-old questions of science (and philosophy), including information about the origin and evolution of modern life forms, as well as answers to pressing medical questions such as how we age. Yet the information is not readily accessible and various strategies are being devised to extract it. Relations, similarities and anomalies across these various datasets are all of interest to the biologists. A new generation of scientists, fluent in both the language of mathematics and biology is needed. For this reason the Engineering Mathematics Department has recently introduced a new course in Computational Genomic Algorithms.

At the beginning of the 21st century the opportunities offered by this new technology are difficult to comprehend. Advances in this field could translate into benefits for science and society, as yet undreamt of. ■

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In the news:

Evolution of the penis worm

Images of the developmental stages of embryos more than half a billion years old were reported by Dr *Phil Donoghue*, from the Department of Earth Sciences, in the prestigious journal *Nature*, volume 442.

Because of their tiny size and precarious preservation, embryos are the rarest and most precious of all fossils. They contain information about the evolutionary changes that have occurred in embryos over the past 500 million years. Donoghue and colleagues had to process 12 tons of rocks in order to find a few hundred embryos.

In one instance they have exposed the internal anatomy of a close relative of the living penis worm. Another case has revealed a unique pattern for making embryonic worm segments, not seen in any animals living today.

The images were revealed using a revolutionary new technique – synchrotron-radiation X-ray tomographic microscopy. ■

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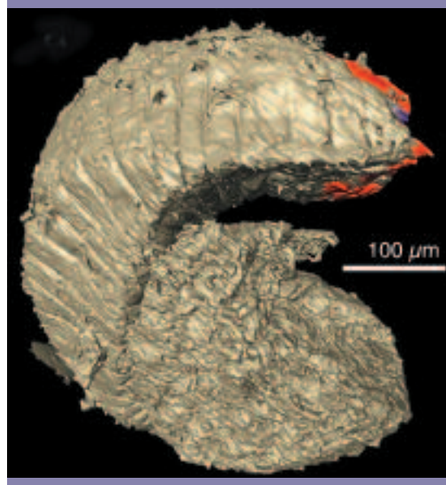


Embryo of the penis worm *(Markuelia)* from the Cambrian of China.

Professor Chris Hawkesworth (left)
Dr Tony Kemp (right)

Capturing time

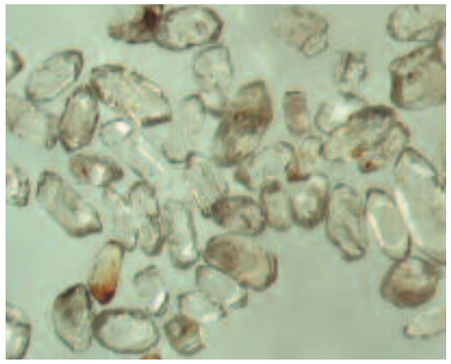
Earth and environmental studies continue to be revolutionised by the development of new analytical techniques for the analysis of isotopes and elements that are present in very tiny amounts in rocks and minerals. However, two big issues remain: can we be sure of what we are analysing, and how precisely can we tell geological time? Professor *Chris Hawkesworth* from the Department of Earth Sciences and Dr *Tony Kemp* investigate.

Rocks are made up of minerals, which in turn are made up of elements. But we now know that individual minerals found in many rocks do not always share the same history. Rather, the host rocks are an assortment of minerals, often from different sources, that have been picked up and mixed together during formation of the rock. This is most obvious in sediments, some of which are literally just grains of sand cemented together. But it is also true of many igneous rocks which are formed when a molten magma from deep within the Earth rises up through the crust, cools and crystallises. The different minerals found in such igneous rocks may have crystallised from different melts at different times. Crushing the rock up and then analysing it – the routine technique for many decades – thus obliterates any information available from individual minerals. Since precise age information is the basis for the time-scale of geological events, and hence the history of this and other planets, it is important to know exactly what is being analysed and dated.

> The oldest ages on Earth are from zircons that are 4.4 billion years old

Radiogenic isotopes are produced by radioactive decay and so they are used to determine the ages of rocks and minerals, and to investigate when major events happened in the history of the Earth. Isotopes that had relatively short half-lives, and are therefore now extinct, have been used to investigate the first few million years of the solar system. Others, with longer half-lives, are used to date the age of the Earth and to chart its evolution, such as when and how the continental crust we live on was generated.

However, a particular problem faced by geologists is that most of the Earth's crust was originally generated more than two billion years (Ga) ago and yet today 50 per cent of the rocks in the crust are less than 300 million years (Ma) old. This is because the process of plate tectonics recycles rocks in the crust over and over again. Each time →



Zircon crystals

→ this happens the geological clock becomes reset, giving younger and younger ages. It is therefore necessary to find a time archive that is robust enough to survive these events and so provide a record of the history of the early crust. That archive is the mineral zircon.

> We have a new way to see back to old events

Zircons occur in tiny amounts, but they are common in rocks of the upper continental crust. Given enough time, the magma they crystallised from will become exposed at the surface and be eroded. But because zircons are extremely difficult to destroy they have a good chance of being preserved and becoming deposited in a sediment. The oldest ages on Earth are from such zircons that date back to 4.4 billion years ago – which is within 150 million years of when the Earth first formed. These zircons are preserved as grains in sediments deposited around 3.8 billion years ago. Over time, a zircon lying around in such a sediment can become buried to depths at which the temperature is sufficient to melt the sediment, but not the zircons. Over billions of years, this cycle can happen many times and each time the original zircon acquires a new growth zone (rather like a tree ring) that reflects the changing compositions of the melt around it.

So to be sure of what we are analysing we need to be able to investigate tiny amounts of an individual mineral and be able to see the exact position of that analysis, when looking down a microscope. Using this technique, different portions of the zircon just a few tens of microns across, can be dated directly using uranium (U) and lead (Pb) isotopes, and analysed for the isotopic ratios of elements like hafnium (Hf). As we have explained, –many rocks such as granites are generated by the melting of older rocks in the crust. Hf isotopes are of interest because they allow us to 'see' back through time to when new continental crust was first generated by melting in the mantle. The ages we obtain from Hf isotopes are thus called crust formation ages. So by analysing different zircons for U and Pb we can determine when the individual zircon formed, while the Hf isotopes tell us when the original crust formed. The crystallisation ages of the zircons reflect discrete melting events within the crust. Their Hf isotopes indicate whether the magmatic events were associated with the generation of new crust from the mantle or, if not, when their crustal precursors were derived from the mantle. We have recently been involved in such a study from south-east Australia.

There we found that large numbers of zircons have ages of around 500 and 1,000 million years, which means they crystallised from magmas at those times. These dates therefore represent major thermal episodes of melting and crystallisation. In contrast, the Hf crust formation ages of the zircons define peaks at 1.9 Ga and 3.3 Ga. Thus they are much older than the ages of most of the zircons. From these data we can conclude that (a) the major periods in which new continental crust was generated from the mantle in this area was in two episodes at 1.9 Ga and 3.3 Ga, (b) the major periods of granite generation – at 500 and 1000 Ma – involved the melting of pre-existing continental crust, and (c) these granites do not represent periods when new continental crust was generated from the mantle. This highlights the point made earlier that most rocks (and zircons) are geologically young, but most continental crust was generated a long time ago. Now, however, we have a new way to see back to these old events. ■

This work was supported by the Natural Environment Research Council and reported in Nature, volume 439.

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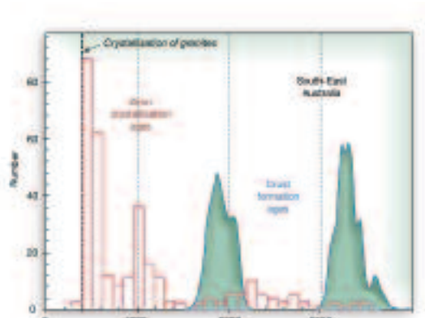
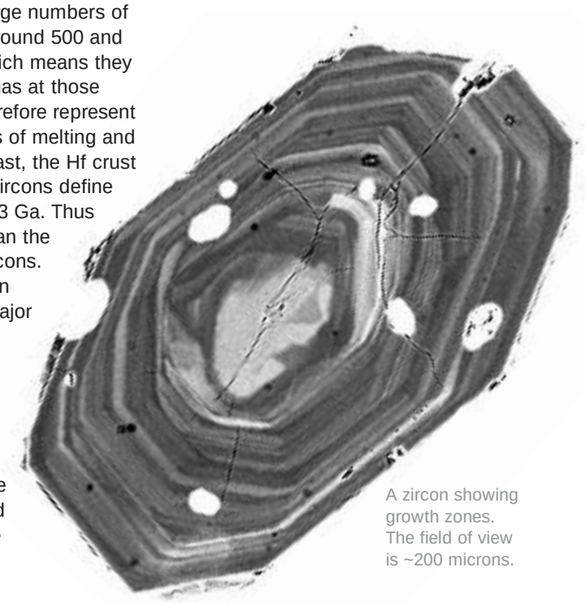


Comparison of the U-Pb crystallisation ages of zircons from south-east Australia with the distribution of Hf crust formation ages. What is striking is that periods of crustal generation can be identified, even though few zircons are preserved from those events.



A zircon showing growth zones. The field of view is ~200 microns.

War without limits:

Spain 1936-39 and beyond

The 17th July 2006 marked the 70th anniversary of the military uprising against a democratically elected government. Dr *Martin Hurcombe*, from the School of Modern Languages, reveals how the Spanish Civil War had a marked impact on the politics and culture of many nations.

The Spanish Civil War started as a revolt by the ruling cast of the Spanish military, motivated by what it saw as the anarchist and communist excesses of the recently elected Popular Front – predominantly a coalition of socialists and liberals – but also by resentment at the new regime's attack on the established hierarchy and its long-held privileges. By the war's end, in May 1939, somewhere between a half and a million people had died, and the Nationalists, as the generals were to become, put an end to Spain's Second Republic by inaugurating General Franco's dictatorship, which was to last until his death in 1975.

French policies of non-intervention, sided with the Republicans and thousands of young men from all over the world slipped into Spain in order to join the Republican International Brigades. In the summer of 1936, many Europeans could be forgiven for believing that the next world war was about to begin.

Despite its scale and significance for the Europe of the 1930s, the Spanish Civil War has become something of a forgotten conflict, a conflict that has, at times, been quite deliberately forgotten. It is inevitably overshadowed by the Second World War, yet many parallels exist between the Spanish

The origins of this war were profoundly Spanish

The origins of this war were profoundly Spanish. The division of the belligerent factions into Republicans and Nationalists reflected the division of Spanish society into those liberals, socialists, anarchists and communists who defended the constitution of the Republic and who sought a more equitable distribution of both land and wealth, and those who had enjoyed such privileges: the landed aristocracy, a wealthy urban bourgeoisie and the Spanish Catholic Church. Yet the war was to become rapidly internationalised. Hitler and Mussolini lent their support to the Nationalists, while the Soviet Union, after initially supporting British and

Civil War and the Second World War, which succeeded it by only a matter of a few months. For many it is the first ideological conflict; those who fought against the Spanish Nationalists often believed they were engaged in a battle against international Fascism, while the Nationalists often claimed to be at war with the red menace of international Communism in the form of a Soviet-sponsored republic. Some of the military tactics employed by the Nationalists and their foreign backers anticipate those used by both the Allies and the Axis powers: the extensive and co-ordinated use of tanks and aircraft alongside infantry, ➜ building-to-building fighting and urban warfare, and the deliberate targeting of civilian populations, notably in the bombing of Madrid, Barcelona, and, most famously, Guernica. Indeed, Germany, Italy and the Soviet Union often treated this originally Spanish conflict as a testing ground for the military technology and hardware that was to shape the forthcoming global conflict. British and French attempts to enforce a non-intervention pact seemed futile; their inability to react effectively to its frequent violations by Italy and Germany illustrated the apparent powerlessness of the liberal democracies and anticipated the subsequent policy of appeasement.

However, the interest of the Spanish Civil War does not lie in its political or military significance alone, but also in its cultural legacy. Just as it galvanised European nations politically, leading to individuals aligning themselves with one side or the other, so many intellectuals, artists and writers also took sides and used their activities to support and justify one cause over the other. The war therefore served to accelerate certain intellectual and artistic trends already present in the 1930s, notably that of the politically committed intellectual. Indeed, the war demonstrated to many at the time that neutrality and retreat into the ivory tower were now impossible; the fate of the Spanish writer and intellectual Miguel de Unamuno seemed to exemplify this. Unamuno, who had been considered a liberal, decided to remain the rector of Salamanca University in 1936, despite it falling almost immediately under Nationalist control. Believing the intellectual could remain removed from the fray, he nevertheless found himself denouncing Nationalist claims to represent Christian and Western values in opposition 'godless' Republicans, for which he was attacked and sidelined by the Nationalist regime until his death a short while afterwards.

In contrast to Unamuno's attempted withdrawal from the conflict, many other intellectuals rushed to the defence of one side against the other. In the case of pro-Republican intellectuals, this sometimes led to fighting alongside Republican troops. George Orwell, Ralph Fox, André Malraux and many others all took up arms in what they considered to be the anti-Fascist struggle, while Ernest Hemingway, officially a war reporter and a non-combatant, was famously

Intellectuals, artists and writers used their activities to support and justify one cause over the other

photographed reloading Republican rifles for the troops he shadowed in combat. More generally, the conflict became a subject of representation for sympathisers of both sides eager to foster support for their respective causes in Spain and usually their own right or left-wing movements at home. The conflict left us several significant and internationally renowned treatments of the subject of war, its horror and its camaraderie: Orwell's *Hommage to Catalonia*, Malraux's *Man's Hope*, Hemingway's *For Whom the Bell Tolls*; the poems of Miguel Hernandez and W.H. Auden; Picasso's *Guernica*. It also coincided with the rise of the photo-journal and established the career of many war correspondents and photo-journalists, most notably that of Frank Cappa.

Despite the subsequent outbreak of a more prolonged, bloody and obviously international conflict months after Franco had marched victoriously into Madrid, the subject of the Spanish Civil War continues to return again and again in the European artistic consciousness. Ken Loach's 1995 film *Land and Freedom* and Xavier Cercas's novel of 2000, *Soldiers of Salamis*, are but two recent examples of the persistence of the memory of the Spanish Civil War that reflect, in Loach's case, a persistent European interest in the conflict and, in Cecas's case, its continued resonance for Spaniards of the post-war generation. It was in order to recuperate this cultural and political legacy that the Group for War and Culture Studies and the Bristol Institute for Research in the Humanities and Arts, with the support of the British Academy and the Alumni Foundation, held a conference in July 2006, dedicated exclusively to the Spanish Civil War. ■

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