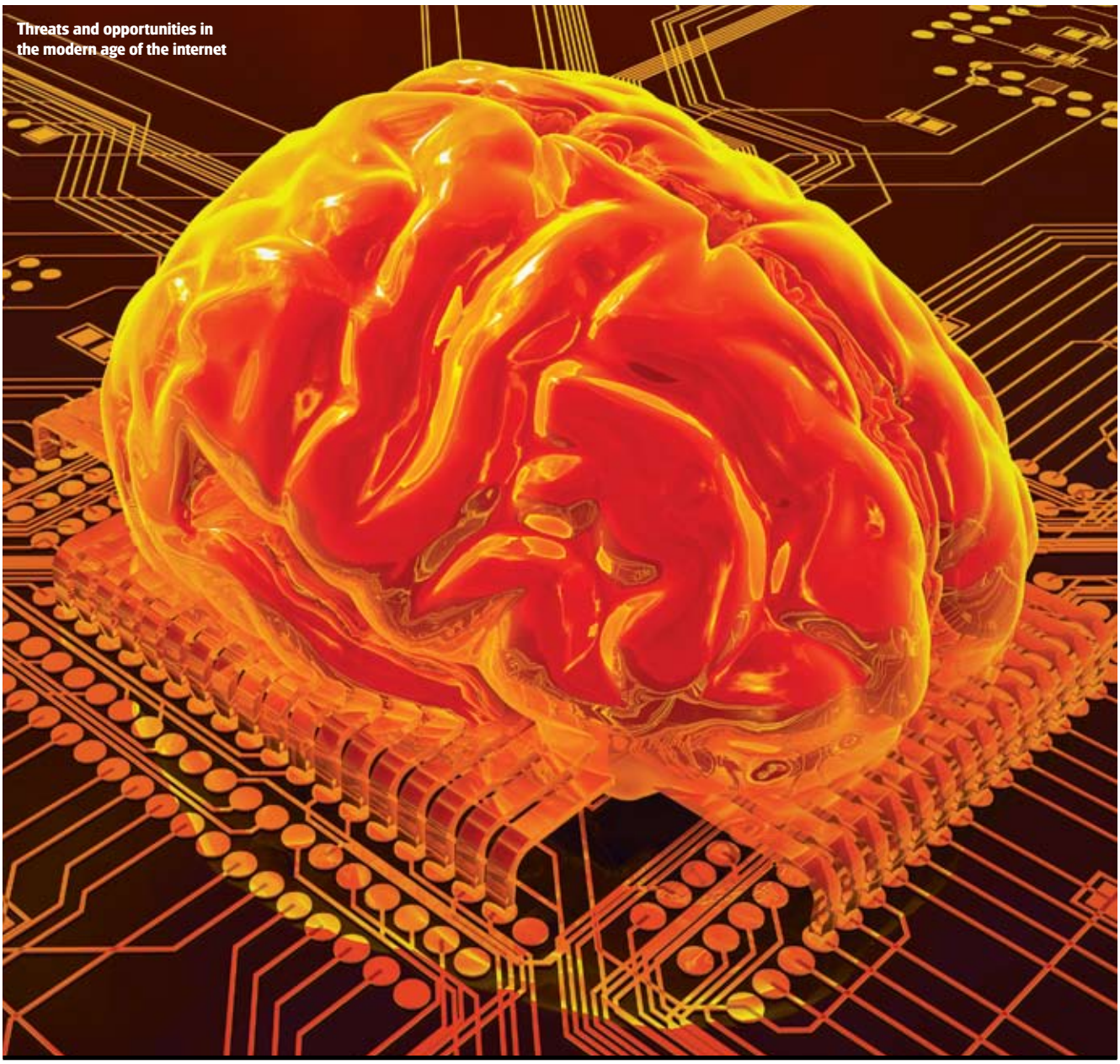
SCIENCE



Threats and opportunities in the modern age of the internet

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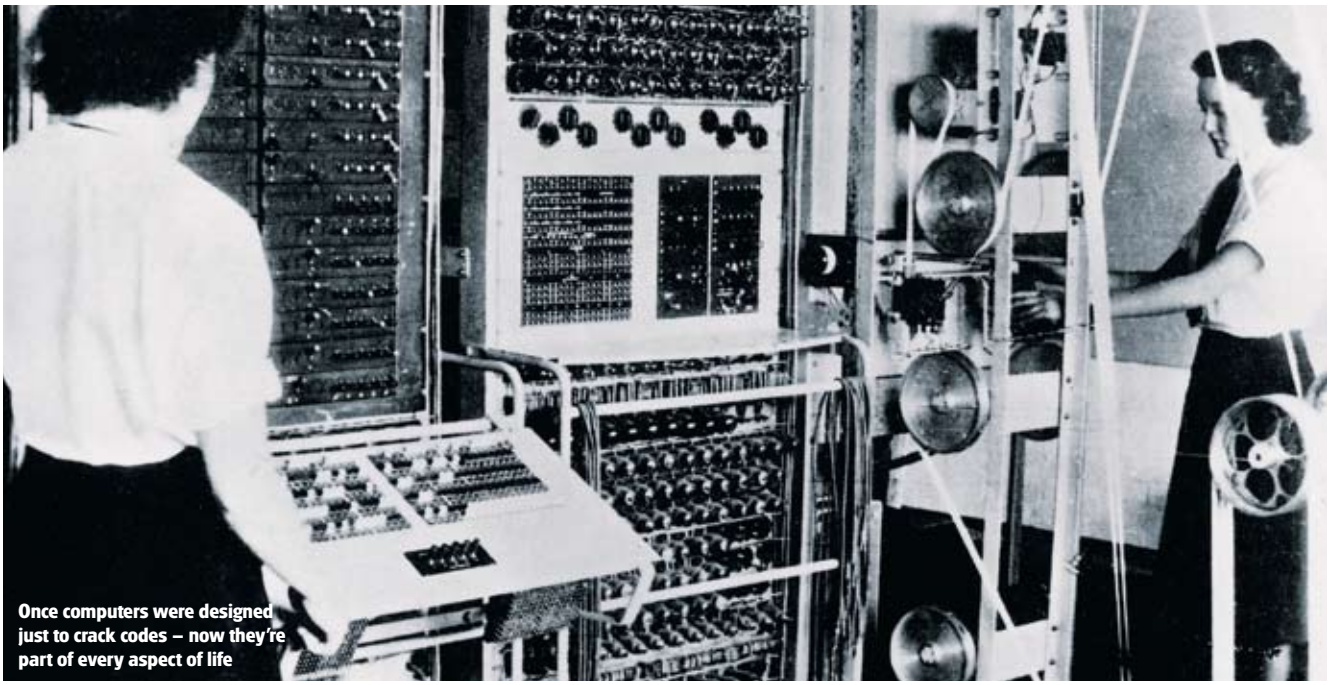
88 › Brave new world



Alamy

Once computers were designed just to crack codes – now they're part of every aspect of life

Brave new world

Martin Ince talks to Professor Bill Dutton about the legacy of Alan Turing and the internet's ability to empower

2012 MARKS THE 100th anniversary of the birth of Alan Turing. Now regarded as one of the creators of the computer age, Turing died by his own hand just before his 42nd birthday. He was receiving drug treatment imposed by the court after a conviction for homosexual behaviour, then a crime in Britain. Since then, the enigmatic Turing has become a hero. He is remembered for his theoretical insight that a computer can be a 'general-purpose machine' that can solve any type of problem. And he is idolised for his role in World War Two, using some of the first modern computers to break German codes, a breakthrough thought to have turned the tide in the Battle of the Atlantic.

But what does Turing mean today? Professor Bill Dutton, director of the Oxford Internet Institute (OII) and one of the world's leading social science experts on the IT revolution, is in no doubt about his importance. "I think of him as one of the early inventors of computing, alongside Charles Babbage, and I am struck by how visionary he was. In his era, people thought computers were machines for doing calculations. Now we use computers in every aspect of life from work to entertainment, so they are true general-purpose machines." Professor Dutton points out that despite the universality of PCs, laptops, smartphones, tablets and the rest, there are still "far more stages" to go in the development of the general-purpose machine. "The leading edge now is in the recognition of facial expressions, voice and gesture," he says. "This is one key to better human-computer interaction that goes beyond the keyboard, keypad and mouse."

The leading edge is in the recognition of facial expressions, voice and gesture

This is not merely a technical issue. OII's survey data shows that about 27 per cent of people aged 14 and over in Britain are offline. They tend to be less well-to-do or older people in need of government services. "These people would benefit from access to the internet, but it is hard for them to use the current interfaces. Our research shows that the internet is an experience technology. If you explain it to people, they don't get it. When they use it and realise it can do everything from showing them a film to filing their tax return, they do. Because many people who use government services are still not online, and governments need to reach all, e-government has been slower to develop than e-commerce." This divide is especially marked for older people. OII data shows that over 63 per cent of people beyond retirement age are not online. At the moment, says Professor Dutton, most recent thinking about information technology for the old is based on the "internet of things". This concept would involve people being tracked and monitored by devices, often while being left mainly on their own, and he finds this a frightening vision.

Instead, Professor Dutton's idea for the future of IT is that seniors might have what British computer scientist Yorick Wilks and his colleagues call a 'digital companion' that would support them and connect them to the rest of the world. He argues that older people are just like the rest of the population. "In general," he says, "people who use the internet socialise more in other ways than the rest of the population with their families and friends. The internet does not cut people off; it reconfigures who we know and what we know."

Professor Dutton also agrees that on occasion, the internet allows people to know too much about us. Internet developments such as location tracking allow new levels of intrusion into our lives. But he is optimistic about the long-term. He says: "Companies such as Google and Facebook are now competing to offer users more control of their personal information. People are becoming less naive about this issue and are asking for as much control online as they have in the physical world." He adds that privacy is a big concern in Asia, Latin America, South Africa and other areas where internet use is growing the fastest. "People in these nations do not have the range of open channels of communication that we are used to in Europe or North America. This might help explain why they value the internet as much or more, and are less likely than Americans or

Europeans to support government efforts to 'control' it." By contrast, he is highly sceptical about the idea, circulating after the summer 2011 rioting in Britain, that digital media can simply be turned off to avoid social unrest.

Instead, Professor Dutton believes that the internet is already empowering new forms of knowledge and awareness. Key to this is his concept of the 'Fifth Estate'. He explains: "The idea of the press as the Fourth Estate dates back to Edmund Burke in the 18th century, when the three estates of the realm were the clergy, the nobility and the commons. Now we might think of them as the intellectual, business and political classes respectively, while the fourth estate now includes broadcasting and other mass media."

THE FIFTH ESTATE AND BEYOND

The Fifth Estate goes beyond existing media to include a wide range of networked individuals and organisations that use online information – and which connect to others online – and which is not subject to central control or planning. Examples include the multiplicity of support groups for sufferers from specific medical conditions. They share information as well as support, and offer a new way to challenge established authority.

Professor Dutton agrees that journalism as practised by the Fourth Estate is still needed, although a business model to pay for it remains elusive. And he says that people who are often online also watch a lot of TV and read newspapers. But he is struck by the flexibility and scope of the internet as a news source, and as the enabler of the Fifth Estate. "A newspaper covers a small number of subjects with a single article about each," he says. "In the online world you can find more articles on a specific subject. And there is coverage of a wider range of issues, such as minority as well as mainstream election candidates." He sees the Fifth Estate as a whole new machine for holding authority to account. Its remit even reaches the Fourth Estate, with a website dedicated to exposing journalists who reprint press releases instead of getting their own stories. Another favourite is the Indian site ipaidabribe.com.

The Fifth Estate, says Professor Dutton, is under the radar of most academic research, which has an institutionally blinkered view of the effects of the internet. It tends to focus on issues such as moving present-day systems of government online. He says: "These networks exist outside government, do not have international boundaries and can support action against the powerful. Their emergence is the most dramatic current consequence of the ways we use the internet." ■

microsites.oii.ox.ac.uk/oess

Professor Bill Dutton *is Principal Investigator of the Oxford e-Social Science Project, supported by the ESRC*

Testing technologies

Non-invasive prenatal diagnosis technologies raise ethical questions about antenatal screening and testing

PREGNANT WOMEN FACE a range of examinations. But sometimes a test or examination requires consideration. Amniocentesis, for example, most often used to test for Down syndrome in the foetus, is an invasive procedure that carries some risk of miscarriage (estimated by the NHS to be between 1 in 100 and 1 in 200). Because of this, most pregnant women are offered some form of screening to identify whether their pregnancy has a sufficiently high likelihood of abnormality to justify such a test. Prospective parents in this situation must weigh the miscarriage risk against factors including the value of the diagnostic information and what steps they might take. These are difficult choices, requiring careful counselling and support.

Prospective parents will need support to understand and to deal with the results

Technological advances now allow for the clinical introduction of Non-Invasive – and therefore safe – Prenatal Diagnosis (NIPD) for a range of genetic conditions. A simple blood test removes the risk of miscarriage – making management of some clinical conditions in pregnancy easier – but also opens up a new world of information about the foetus. The development of NIPD testing coincides with a number of other developments in the broader world of genetics, including direct-to-consumer genetic testing. Currently, foetuses diagnosed prenatally with Down syndrome are frequently aborted, but the numbers of women undergoing diagnostic testing are small. With more widely available NIPD, will the number of terminations rise? How will prospective parents make decisions about whether to test, and what to do with the information, for an expanded number of conditions? Will there be limits? And who should decide?

Researchers Dr Susan Kelly and Dr Hannah Farrimond at the ESRC Centre for Genomics in Society (Egenis) have been exploring the ethical, legal and social implications of NIPD, including a survey of public attitudes. "Although there was a wide range of views, we did find a consensus of concern about NIPD being offered directly to consumers," explains Dr Kelly. "Participants argued for the need for health professionals to act as gatekeepers to and interpreters of these testing technologies. Prospective parents will need guidance to understand the implications of testing before it takes place, and support to understand and to deal with the results." Is our healthcare system ready to provide this?

NIPD technologies raise new questions about the public health justifications for routine antenatal screening and testing, but there is a major ethical dimension too, not least in considering attitudes towards disability. The Egenis researchers are bringing together experts from around the world engaged with NIPD to consider emerging practice. A symposium hosted by the Brocher Foundation in Geneva will consider development efforts in the light of the ethical and social implications and of intellectual property and regulatory issues. It is hoped the event will lead to the creation of an international, interdisciplinary 'network of expertise' among scientists, bio-ethicists, social scientists and health policy researchers. Such a network could be called upon to advise governments and other regulators as they develop policies on clinical implementation. ■

www.genomicsnetwork.ac.uk/egenis

Less invasive tests are now available in pre-natal care, offering women safer choices

Beyond nature versus nurture

Social and biological scientists should work together to decode human behaviour

Science Photo Library

Physical and social environments influence how our genomes are read at a biological level

BACK IN THE 1970s arguments raged over which of our attributes were biological and which derived from culture. For example, are boys, on average, naturally more aggressive than girls, or is it our society that makes them seem so? Many biologists and psychologists held the former view while sociologists and anthropologists mostly took the second. In the absence of compelling evidence either way, the argument was able to continue more or less indefinitely.

At the start of this century, the first draft of the human genome was published and it looked as though the issues would soon be sorted out. Certainly, biologists have been successful in identifying specific bits of the genome that seem to correlate with particular attributes. More important, in some cases they have been able to show in detail how some elements of the genome give rise to features in the adult. But although the human genome is hugely long and complex, a lot of it does not seem to code for anything in particular.

THE RISE OF THE GENETIC TEST

We only seem to have about 25,000 genes (not many more than a mouse) and a large number of these are genes we have in common with all sorts of other creatures – the genetic basis for breathing, seeing, digestion, and so on. So in this genomic age, genes can matter directly but there are many fewer cases of genes determining people's attributes than many scientists had anticipated.

In the last decade it has become common for people (and journalists) to talk about 'having genes' for this and that – for waking early or being thin or for living long. And this everyday assumption that our identity and nature are in some way determined by our genetic make-up is strongly reinforced by the rise of genetic tests for identity. People now routinely accept the results of genetic paternity tests and have got the idea that past crimes can often be solved by linking evidence to suspects through genetic 'fingerprints'.

It now makes no sense to argue about nature versus nurture, as one can't have one without the other

The irony about genetic fingerprinting is that the bits of the genome used in these tests are generally sections that don't seem to code for anything obviously important. Biologically important genes get refined by natural selection so that there are typically only a few variants in most of the population; consequently there are not enough differences between these aspects of people's genomes to make individuals readily stand out for purposes of identification.

Less critical bits of the genome face fewer selection pressures and so can be more diverse. So the bits of your DNA that might link you (guiltily or not) to a crime scene are not likely to be the bits that account for your good looks and daring, but a much more random section that possibly has little genetic function at all. Although it may seem paradoxical, our genetic fingerprints can allow the police to determine whether we were at the crime scene, but these fingerprints determine almost nothing about what we are like as individuals.

Sociologists and anthropologists were generally wary of genetic explanations for people's attributes for fear that significant differences between people (in intellectual ability for example) would be seen as biologically fixed. Biologists still do generally believe that many important characteristics have a firm basis in the genome – there is no blank slate. But two key aspects of modern genomics mean that the old nature/nurture divide is long out of date.

First, it is clear that, with few exceptions, the characteristics that matter to us have a very complicated genomic basis. In this Olympic year it matters a lot to some how fast a specific adult can run at their peak, and this no doubt has a genetic underpinning. But this ability is attributable to a large combination of genes, some of which matter now and some mattered earlier in the athlete's life. Two very fast runners may have different bases for their abilities; there is clearly no gene for sprinting.

Second, not all the genes we have on our genomes are actually used. It is increasingly understood that events in the womb, in childhood and growing up, and even things that happened to the eggs we grew from (but before we were conceived) can shape the way that our genome is interpreted as our bodies develop and function – this is the new field of epigenetics. These studies indicate not simply that the physical and social environment is very important to development (although of course it is), but that the environment can influence how our genomes are read at the biological level – and these effects may even be passed from one generation to the next.

A COLLABORATIVE APPROACH

Our 21st-century understanding of the genome offers huge excitement to the biological and medical sciences. But social scientists should not see this as a threat or as an intellectual defeat. For one thing, it now makes no sense to argue about nature versus nurture as one can't have one without the other. Our molecular genome (nature) gets read in different ways depending on the environment (nurture). Furthermore, this means that most of the important questions about human differences and human attributes need to be studied by social and biological scientists, preferably collaboratively.

Social scientists should seize opportunities offered by the genomic and epigenetic age to build interdisciplinary understanding and devise imaginative ways to make their contribution to the new sciences of humankind. ■

www.genomicsnetwork.ac.uk

PROFESSOR STEVE YEARLEY
Director of the ESRC Genomics Policy and Research Forum

Electric excellence

Breaking down barriers to electric vehicle growth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There are now some credible electric cars

IT SEEMS THAT the tide turned for clean car technology in 2011 with the introduction of some very credible electric cars from mainstream manufacturers, among them Nissan, Mitsubishi and Peugeot-Citroën. But limited supply so far seems to be outstripping the even more limited demand. Why?

Research in electric vehicles has so far largely addressed the technologies needed. This has also been the focus of funders often more at ease with tangible, physical results than enhancing our understanding of people's motivations. Much less work has been done into the perceptions of risk along the value chain. On the one hand these range from the reluctance of suppliers of key technologies (such as batteries) to commit resources to products for which there is no known demand, to car manufacturers who know about petrol or diesel engines but who know little about batteries. On the other, potential consumers may be uncomfortable about the higher price of electric vehicles and concerned about the range of electric cars and where they can recharge batteries. Also, is the conventional car business model really the best way to bring electric cars to market? Such social, economical and psychological factors can often stop a promising new and potentially more sustainable technology in its tracks.

Limited supply so far seems to be outstripping the even more limited demand

The Electric Vehicle Centre of Excellence (EVCE) at Cardiff University was set up precisely to consider these softer barriers to electric vehicle growth. The EVCE is a joint venture between the automotive team at the ESRC Centre for Business Relationships, Accountability, Sustainability and Society (BRASS) at Cardiff University/Centre for Automotive Industry Research and the Cardiff School of Engineering, which brings expertise in vehicle engineering, safety and smart grids to the centre. The centre also enjoys input from the School of Psychology – which is experienced in research on attitudes to transport – and the School of City and Regional Planning, to understand the context of the built environment within which such vehicles need to operate.

The EVCE has secured EU funding in the shape of the British lead role in the ENEVATE programme, which is aimed at learning lessons from existing and past electric vehicle niche experiments. ENEVATE is funded through INTERREG IVB and combines several partners in northwest Europe. ■

www.brass.cf.ac.uk

Wild at heart

How EU zoos and science can give the public a greater insight into nature conservation


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Zoos are stressing their conservation role

THE PHILOSOPHY AND practices of zoological gardens and marine parks have changed. Formerly, zoos kept animals to excite the wonder of the public and to serve as living species catalogues. More recently zoos have begun to stress their role as conservation centres, breeding species in captivity that are threatened with extinction in the wild; studying species to better understand how to conserve them; and working directly or through partnerships to restore or conserve species in their natural habitats.

While zoos in general have a way to go before they fully realise their potential as conservation centres, this role has moved closer to the centre of their agenda. On this view, animals are confined for their species' good and not primarily out of scientific curiosity or for our entertainment. This gives zoos a stronger environmental role and addresses animal-rights concerns. Also in recent times, we have come to think of conservation in terms of the protection of biodiversity – the United Nations declared 2010 the International Year of Biodiversity. The 'EU zoos and science' project has involved four European partner zoos and marine parks, working with the ESRC Genomics Policy and Research Forum, in developing zoos' engagement with their visitors around biodiversity issues.

Formerly, zoos were living species catalogues

In the project, each zoo or marine park has run a public engagement exercise with visitors in which the public gets to help re-design an exhibit or zoo-based activity relating to the zoo's biodiversity-protection work. At the Durrell Wildlife Park on Jersey, for example, the exercise generated many fresh ideas, including a proposal to turn the backstage work of preparing the food for endangered amphibians into part of the exhibit itself. Endangered animals need carefully selected nutrition, which means conducting research into their diets leading to programmes to grow the bugs and insects the amphibians like to eat.

Such an exhibit would allow a deeper insight into the reality of running a modern, conservation-oriented zoo. It also aims to improve the link between what people see in captivity and the cutting-edge work going on in the wild to restore some of the world's most threatened species. Promoting public engagement around the life sciences in contemporary society is a key mission of the Genomics Policy and Research Forum, and this work with zoos and marine parks is one of the most practical manifestations of the Forum's emphasis on engagement. ■

www.genomicsnetwork.ac.uk/forum

First, do no harm

Can research collaborations between high- and low-income economies balance differing intentions and objectives?

AS BRITAIN'S POSITION in the world changes, our objectives when engaging with low-income countries become more complex. Unfortunately the principle familiar to many medical students of 'first, do no harm' is often ignored in trying to achieve them. The British government has pledged to raise its international development budget to 0.7 per cent of GDP by 2013. This is admirable at a time when governments in some developed countries are slashing their aid budget, but it's not just about how much is spent but how it is spent.

How it is spent partly depends on the intentions, but the government – a large, complex organisation – does not have one simple intention: There are the moral reasons for providing support to other countries, particularly in times of humanitarian disasters; there is historical payback to help remedy problems created by the colonial era or to compensate for the effects of global climate change caused by high living standards in higher income economies; there are 'enlightened self-interest' reasons – for example helping states in conflict reduce migration to Britain, or confronting the threat of pandemics through global surveillance; and there are pure self-interest reasons, where today's developing countries may be tomorrow's emerging economies and important trade partners.

Research collaboration in all its forms can be extremely beneficial to those involved on many levels

For many years Britain has been supporting universities, research institutions and academics in low-income countries directly and through collaborations with British partners. This has been for a similar range of reasons: moral (low-income countries need educated people to address some of the challenges they face); historical payback (developed economies have often attracted and retained the brightest from the poorest countries); enlightened self-interest (global challenges require global research collaboration to tackle them); and simple self-interest (access to new environments to research, or attracting international students to Britain).

There will always be a range of actors involved in research collaboration, each with their own objectives and views. The issue is whether these are beneficial to all organisations and countries. Professor Anne Glover is Chief Scientific Adviser for Scotland and Chair of the UK Collaborative on Development Sciences, a collaboration aimed at improving co-ordination and collaboration, and sharing good practice in funding research relevant to international development. She says: "Research collaboration in all its forms can be very beneficial to those involved on many levels, but is not easy, particularly when partners are from diverse cultures and backgrounds. It requires dedication and time," she says. Unfortunately, time is what many lack, leading a number of funders to question whether they should fund activities aimed at strengthening research capacity in developing countries, or focus on producing high-quality research relevant to international development.

A QUESTION OF EQUALITY

There has been much debate about making partnerships between institutions in higher- and low-income countries truly equal. In the past some teams or institutions in low-income countries have collected information for institutions in the more developed economies, which then claim the recognition and reward for the research. While partnerships will rarely be truly equal, they should be as equal as possible, and give all partners some benefits.

The Swiss Commission for Research Partnerships with Developing Countries has developed *11 principles for research in partnership: a guide towards fair and effective collaboration.* These principles include guidance on how to clarify responsibilities and create transparency, covering areas relevant to research partnerships, such as sharing data and networks. The Commission's guide is thoughtful, but, as it says, 'knowing is easier than doing'.

It is not wrong to have multiple objectives when it comes to working with low-income countries. But we need to be explicit about the intentions behind the objectives, and ensure the first objective is always 'do no harm'. ■

www.ukcds.org.uk

Britain has long supported research institutions in developing countries

Science Photo Library

Alamy

Farmers could benefit from talking to intermediaries like vets who can more effectively link science with practice

Between lab and field

The experiences of farm advisers could provide an important bridge between farmers and scientific research

FARMERS ARE BUSY people with little time or inclination to read up on the latest scientific research. But scientists are continually coming up with results that could help them run their businesses more effectively. This is increasingly important in an era of climate change as pressures on our land and food supply increase. Research from the Research Councils UK Rural Economy and Land Use (RELU) Programme has shown that farm advisers, such as land agents, vets and ecologists, could be an important link in bridging the gap between science and field.

Farm advisers, from a range of professions, assist growers and land managers in improving their existing businesses, adopting new approaches and diversifying into new areas. They must constantly renew their own skills and develop the service they offer. Yet the role they play in linking science and practice has been little explored. The researchers found that advisers gleaned much of their knowledge from their professional associations, training courses, journals, information from government organisations, websites and so on.

We shouldn't underestimate the value of the field experience that farm advisers bring

But they also talked about the ways in which they develop their own expertise in the field. Observation, seeing what works and doesn't work, experimenting and learning from colleagues' experience is extremely important to them. They said that they learned a lot from working with people from other professions, and sharing expertise. For example, a vet might be working with a nutritionist on behalf of a client, or an ecologist could be consulting an historic environment adviser for an environmental stewardship application. Thus the advisers were working as part of a complex professional network and, at the same time, learning from their clients and developing their understanding of the context into which their advice must fit.

Advisers from all the professions were using their own field experience to interpret knowledge from many sources, both scientific and professional, and translating it into advice that was tailored to the needs of individual clients in their businesses. They were taking into account not just the business needs of farmers and land managers, but also their personal circumstances and aspirations.

Jeremy Phillipson from Newcastle University, who led the research, said: "As researchers we need to rethink our understanding of the role of field advisers as conduits of knowledge. We shouldn't underestimate the value of the field experience that these professionals bring, and which could provide a much more incisive input into our scientific research programmes." ■

research.ncl.ac.uk/scienceinthefield/index.php

Inspiring tomorrow's scientists

How can we encourage more young people to take up science and mathematics?

SCIENCE AND MATHEMATICS play a crucial role in the nation's economic success. The country needs not only an adequate supply of highly-trained individuals to work in both fields, but also a general population that understands, and is competent in using, mathematical and scientific ideas. Yet there is a widespread concern in Britain, and other industrialised societies, that not enough young people are studying these subjects (especially the physical sciences) at higher levels, and that more people need to be encouraged to pursue careers in these fields. The ESRC has funded five major research projects under its Targeted Initiative on Science and Mathematics Education (TISME) to investigate why young people don't want to study science and maths post-16, and how achievement and participation can be increased.

The research suggests that the reasons are complex. Increasing the uptake of science and mathematics post-16 is not simply a matter of increasing achievement at GCSE, as better results do not necessarily mean more students will continue with the subjects at higher levels. In some cases increased levels of attainment in a particular subject can actually lead to a decrease in the numbers of students wanting to pursue it further. One of the reasons for this may be that the pressure for schools to achieve ever better results can lead to a culture of 'teaching to the test', which can dramatically decrease students' liking for a subject and so their intentions of continuing with it post-16. Comparing students' performance on maths tests now and 30 years ago, the ICCAMS project, directed by Dr Jeremy Hodgen, King's College, London, found that despite increases in examination scores, students' actual understanding of key aspects of maths have not improved over the past 30 years, and in some cases have declined.

What can be done? The TISME projects suggest that efforts need to be directed at the early secondary years (age 11-14) – years that often appear 'neglected' in comparison to the emphasis placed on GCSE and A-level years. They recommend targeting the following areas:

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There are complex reasons why young people choose not to study science

■ **TEACHING** Secondary school pupils often view science and mathematics as 'boring' and hard to understand, so new strategies are needed to help teachers challenge and change these perceptions. The epiSTEMe project, directed by Professor Kenneth Ruthven, University of Cambridge, is working with teachers to develop new ways of teaching physical sciences and mathematics, focusing on the use of dialogue and discussion in classes.

■ **CAREERS AWARENESS** The ASPIRES study has found that although primary school children often enjoy science classes, they already tend not to see science as a career path. One reason may be that they think a science qualification leads only to jobs like scientist, science teacher or doctor, and they are unaware of the wide range of possible careers. This misconception seems to persist among older children and teenagers too, according to other TISME studies. There is a need to integrate knowledge about the wide benefits and usefulness of science and mathematics into the school curriculum.

■ **IDENTITY** Young people's subject choices and aspirations are strongly shaped by their backgrounds. The ASPIRES project finds that science and mathematics are often seen as 'hard' subjects associated with 'cleverness' and not as 'natural' choices by those from working-class backgrounds whose families are often unfamiliar with science. Even highly able individuals – especially women, and those from working-class and some ethnic minority backgrounds – find it difficult to see themselves as 'science people', particularly when their backgrounds do not fit the public profile of the wider science workforce. The UPMAP project directed by Professor Michael Reiss, Institute of Education, shows how science and mathematics suffer from an 'image problem', so that even many high achieving young people with qualifications suited to a university degree in science or mathematics continue to see the possibility of pursuing these routes as 'not for me'.

■ **INEQUALITY** Young people from less advantaged backgrounds are far less likely to pursue science and mathematics qualifications at higher levels. Research by the EISER project, directed by Dr Jim Ryder, University of Leeds, shows that there is a drastic need to increase attainment among pupils receiving free school meals and that these pupils are heavily under-represented within 'high status' separate science

courses such as Triple Science at GCSE. This under-representation was unchanged by reforms to the science curriculum in 2006.

■ **POST-16 ROUTES** The current range of post-16 routes in science and/or mathematics is too narrow and where alternatives to traditional A-levels exist, they don't have similar status. Although young people can currently pursue a wide range of different types of science course at GCSE level, there are far fewer options after the age of 16. In particular, there are very few alternatives to traditional A-levels, which may put off many young people who are interested in science and mathematics, or who may find further study useful but who do not want to study 'traditional' A-levels.

■ **CURRICULUM** Compared to many other countries, England has a culture of early specialisation, with young people choosing a relatively narrow range of subjects to study at GCSE and A-level. This, coupled with a popular perception of a divide between the arts and sciences, helps dissuade young people from considering a potential future career in a science- or maths-related field. Encouraging young people to follow a more 'rounded' curriculum would lead to higher rates of participation in science and mathematics.

The TISME research indicates that bringing about a real and substantial change in young people's participation in science and mathematics will require some fundamental shifts in the way these subjects are currently delivered in schools and post-16 settings. The main thrust of these efforts needs to target the early secondary years, but wider action will also be required working in partnership with students, teachers, schools, families, higher education, scientists and employers. ■

tisme-scienceandmaths.org

TISME is funded by the ESRC in partnership with the Gatsby Foundation, the Institute of Physics and the Association for Science Education

PROJECTS

ASPIRES – *Science Aspirations and Career Choice: Age 10-14*
EISER – *Enactment and Impact of Science Education Reform*
epiSTEMe – *Effecting Principled Improvement in STEM Education: Student Engagement and Learning in Early Secondary School Physical Science and Mathematics*
ICCAMS – *Increasing Competence and Confidence in Algebra and Multiplicative Structures*
UPMAP – *Understanding Participation rates in post-16 Mathematics and Physics*

The ethics of ageing science

Medical advances could help early detection of dementia, but they create many ethical issues

THE EARLY DETECTION of dementia, particularly Alzheimer's disease, has become a health policy priority for the British government. But the medical advancements that have made this policy focus possible have numerous social and ethical implications that have yet to be considered. Current research at the ESRC Centre for Social and Economic Aspects of Genomics (Cesagen) funded by the Wellcome Trust, aims to address these ethical and social issues.

Within the medical science community there is hope that early identification of people who will develop dementia may make it possible for doctors to stop or at least delay it. This belief is still to be proven, and it could then take many years before such a hope is realised. Advancements in the early detection of Alzheimer's disease have even extended to those who have no symptoms. This includes testing for the apolipoprotein E (APOE) gene – which has been shown to increase people's susceptibility of developing the disease – and the development of sophisticated brain imaging techniques.

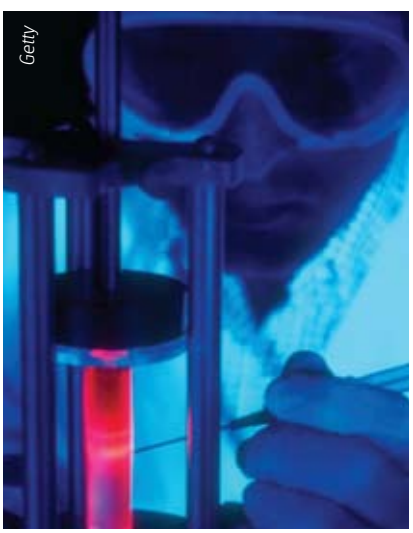
Many dementias cannot be definitively diagnosed until post-mortem

But most of these tests are yet to feature in clinical practice. The reality of current clinical practice is that many dementias cannot be definitively diagnosed until post-mortem, and therefore rely upon a diagnosis by exclusion. This uncertainty around diagnosis is compounded by the difficulty of distinguishing between particular diseases within the broader and increasingly all-encompassing condition of 'dementia'. Most significantly, there is little to offer in the way of treatments or therapies that prevent the decline that follows a 'dementia' diagnosis.

The success in dementia-related research has, to some extent, made diagnosis and diagnostic labelling of memory problems more uncertain. For example, the testing of the APOE susceptibility gene for Alzheimer's disease is used predominantly in clinical research where the results are not disclosed to research subjects. Disclosure is withheld because of the difficulty in understanding the uncertain futures that come with the revelation of an increased risk without any possible intervention.

The increasing confusion over disease and its relationship to normal ageing, particularly in regard to Alzheimer's disease, is another example of this uncertainty. For example, is a diagnosis of Mild Cognitive Impairment telling the patient that they do not have Alzheimer's disease; that they might or will get Alzheimer's disease; or that they have early Alzheimer's disease? What such labels tell family members about their current and future caring role is an equally important question that deserves attention.

Exploring the uncertainties in clinical knowledge and diagnosis about the early detection of dementias and the ethical issues that emerge from this is a key priority. Of equal significance is understanding patients' and their relatives' own beliefs about what is important for them to know or not know, how they interpret information, and what this information means in the context of their lives now and in the future. By doing so, research such as that being carried out at Cesagen will broaden the scope of ethical deliberations over the sharing of clinical information. In turn, this will help to situate such decisions in the context of the whole history of the individual's memory problems, their social relationships and their sense of self. ■



Advanced testing is now making it possible to diagnose dementia diseases earlier

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