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Whose heatwave?

The heatwave that hit mainland Europe in summer 2003 resulted in many deaths. It was probably the hottest summer since at least 1500. Extreme events of that type can occur by chance in any climate, whether or not there has been warming due to external influences. But a recent study by climatologists from the Hadley Centre at the University of Reading, and the physics and zoology departments at the University of Oxford, suggests that we can put a figure on the likelihood that the effects of human activity create such a heatwave (ref. 1). Using a threshold for mean summer temperature that was exceeded in 2003 but in no other year since the start of the instrumental record in 1851, they estimate that it is very likely that human influence has at least doubled the risk of a severe heatwave.

One of the co-authors on this study, Myles Allen, takes the logic a stage further. Allen and environmental lawyer Richard Lord argue (ref. 2) that refinement of the methodolgy used to detect global climate change might soon be able to identify causes so accurately that "blame" can be laid at the door of a specific country, company or human activity. A short step, then, to liability claims for costs incurred by climatic shifts. Could we one day see Californian farmers suing EU member states for authorising emissions that threatened the security of their water supplies? That is far-fetched, but "attribution studies" of this type may well become a factor in international negotiations on ways to mitigate, adapt to and ultimately pay for the consequences of climate change. ❐

1. Stott, P. A., Stone, D. A. & Allen, M. R. "Human contribution to the European heatwave of 2003" *Nature* **432**, 610–614 (2004).
2. Allen, M. R. & Lord, R. "The blame game" *Nature* **432**, 551–552 (2004).

Balancing the risks

Several of the risks referred to in the FST discussion meeting *Risk Perception and Public Policy* held on 20 October (see www.foundation.org.uk for summary and the next issue of *FST Journal* for full report) are back in the news. The "over 30 months rule" that prevents older cattle from entering the food chain is to go at last. Instead, as in many other countries, meat will be tested for the presence of the prion proteins that cause bovine spongiform encephalopathy (BSE).

And the Government's white paper on public health, published on 16 November, included a plan to introduce "traffic light" coding on foods, intended to give the public the information they need to assess for themselves the health risks associated with diet.

The ban on meat from cattle aged 30 months was introduced in 1996, as older cattle were thought to be most likely to infect people with the human BSE equivalent, variant Creutzfeldt–Jakob disease. About 18 months ago, the Spongiform Encephalopathy Advisory Committee (SEAC) concluded that the risk to the public from eating meat from animals aged over 30 months was negligible.

On 1 December it was announced that, starting next year, the 30-month ban is to be replaced with a system of testing. The ban on offal and meat extracted from the spine and skull entering the food supply is to stay in place.

The new system requires Meat Hygiene Service officials working in slaughterhouses to send a brain stem sample from all cattle aged over 30 months for analysis. The meat will be allowed onto the market once the results are known to be negative.

The costs of the 30 months rule have been high, with many tonnes of meat having to be destroyed. Farming interests have accused government of being too slow to adopt testing instead. However, the Government's calculation has not been simply one of risk, but has also taken into account the perceived risk and public attitudes towards it.

On BSE-related matters government intervention and exaggerated caution is expected, even demanded.

In contrast. as Food Standards Agency (FSA) chairman Sir John Krebs says in the FST discussion, the public expects a more hands-off approach to advice on healthy eating. A week after the government white paper advocated a "traffic light" system of food labelling, the FSA published new research suggesting that there was considerable public support for the idea, although the food industry is less keen.

The FSA will now work with the food industry, consumer groups and public health groups to evaluate a number of different signposting options that will be tested in shops.

Three of the five options being considered combine the main nutrients into a single measure:

- The "simple traffic light" which might be depicted as red, amber or green;
- The "extended traffic light" which might be red, red/amber, amber, amber/green or green;
- A symbol appearing only on healthier options.

The other two options show separate key nutrient information for the total fat, saturated fat, sugar and salt. These are:

- The "multiple traffic light" which might be depicted as separate traffic lights for high, medium or low levels for each of the key nutrients;
- Guideline daily amounts for men and women and the amounts of fat, saturated fat, salt and sugar per portion.

This evaluation work is due to be completed in summer 2005.

The FSA has also commissioned research to develop a scheme to categorise foods on the basis of the nutrients they contain, for possible use together with signposting. ❐

www.food.gov.uk/news/newsarchive/2004/nov/signposting

Swiss voters back stem-cell research

In a recent national referendum, a majority of Swiss voters approved a measure that would allow embryonic stem-cell research using leftover human embryos from fertility clinics.

The Swiss government, universities and the pharmaceutical industry had all campaigned in support of embryonic stem-cell research as vital for a country with a strong tradition in medical research and drug development. But the result — 66.4 per cent voted their approval — was more clear-cut than many expected.

The new Swiss law imposes strict limits: research is permitted only on cells from embryos less than seven days old which are left over from fertilisation treatment and would otherwise have been destroyed. Britain and Sweden have less stringent restrictions in force. ❐

GM crops "harmless"

The findings of the government-backed "Bright project", a study of the environmental effects of genetically modified (GM) crops, were released in November and conclude that there was no evidence of harm to the environment.

The Botanical and Rotational Implications of Genetically Modified Herbicide Tolerance (Bright) Link project looked at two GM crops — sugar beet and winter oilseed rape — that are modified to be tolerant to certain herbicides. These were grown in rotation with non-GM cereals in a four-year study. The GM crops, used in this rotation, did not deplete the soil of weed seeds beneficial to birds and other wildlife.

The results of this quite limited trial add to the continuing debate on GM crops; the trial had limited objectives and is unlikely to convince sceptics of a case for the commercialisation of GM crops. ❐

Following the Chancellor's announcement of the new ten-year framework for science and innovation, on 13 July the Foundation hosted a meeting at the Royal Society to consider proposals for a European Research Council.

European research partnership

Lord Sainsbury

The Lord Sainsbury of Turville was appointed minister for Science and Innovation at the Department of Trade and Industry in 1998. He spent his career before becoming a minister in the family firm, J Sainsbury, where he was finance director, deputy chairman and finally chairman. He read history and psychology at King's College, Cambridge and has an MBA from the Columbia Graduate School of Business in New York.

The dimension of research has been one of the less heralded aspects of European development. Nevertheless, it has been a success story, deserving more of a highlight than it has had.

During the past two decades, through a series of framework programmes, the European Union (EU) has increased its expenditure on promoting and supporting research activity. As a result, researchers across Europe have come together to pursue joint projects in various disciplines and increasing collaboration between centres of excellence. Through successive framework programmes, Europe has progressed towards the establishment of a genuine internal market for science and technology. Today the European Research Area (ERA) is more than just a high-sounding slogan.

The UK Government has made a clear commitment to funding research through its increases to the science budget and the publication of the Science and Innovation Framework 2004–14. The European dimension is a key element in our strategy for science and innovation.

We are currently in the middle of a consultation for the seventh Framework Programme. We should be clear about what we are seeking to achieve here. In the case of the European research area there are three major challenges that most European countries face:

- First, to match the Americans in the quantity and excellence of our basic research;
- Second, to improve the translation of that research into new, high-value products and services, thereby creating more jobs;
- Third, to increase the amount of R&D done by industry.

If we want to match the innovation performance of American industry and reach the Barcelona agreed target of 3 per cent we must encourage and provide incentives for more companies to make innovation central to their corporate strategies and spend more on R&D.

Whatever the outcome of the current EU budgetary negotiations and however well research expenditure may come out of this process, EU funding will still account for a modest percentage of total European research expenditure. We need to ensure that it is effective.

The proposal to set up a European Research Council (ERC) is important as a way of achieving our first goal, that of matching the quality and excellence of American basic research. The need for action is clear. Research undertaken by the UK Government's chief scientific adviser shows that two thirds of the world's most cited scientists are US-based. *Time* magazine recently noted that many European scientists pursue their careers in the US because of the quality of basic research being undertaken there. We must attract these people back to Europe and attract the best researchers from around the world to Europe. An ERC would be an important means to achieving this goal.

The March Council Conclusions on Basic Research pointed the way. If an ERC is to help Europe match the US's quality of basic research, it must focus on research excellence.

To promote excellence any delivery agency must be independent of member states and any other pressures that might dilute the focus on scientific excellence. It should operate on the basis of international peer review undertaken on the widest possible basis. It should provide a level of funding which acknowledges the need to sustain the research base and pay the true economic cost of research to the institutions where researchers are based. It should be, as far as legally possible, a lightweight structure, providing funding with the minimum of formalities consistent with accountability for the use of European taxpayers' money. In short, it should be run by scientists for scientists.

Once we have agreed our approach to basic research, the rest of the Framework Programme should be more clearly focused on the second and third of our goals, the translation of that basic research into new, high value-added products and services and increasing business R&D.

Professor Sir David King, the UK Government's chief scientific adviser, has undertaken an analysis of the effectiveness of research in ten European countries compared with that in the US. The US population in 2001 was 278 million and that of the EU-10 346 million. Public expenditure on research (government

R&D expenditure plus expenditure on higher education) was very close — $53.5 billion in the US in 2001 and $52 billion in the EU-10 for the same year.

However, in 2001 the US private sector invested $180 billion in R&D. The equivalent figure for the EU (all 15 current member states) was $106 billion. The shortfall underlies my view that the real, continuing, problem lies in the private sector and in a failure to translate the excellent basic research done in publicly funded European universities and institutes into products and processes.

It is critical for our economic success that we improve our performance. We must work closely with industry to ensure that research is focused on achieving competitive advantage. Worryingly, we are seeing a decreasing input into framework programmes by industry across Europe. We must scrutinise how the commission's work on technology platforms can help us achieve our goals and, rather than designing new instruments, we must consider how the instruments of Framework 6 can be streamlined and focused more clearly on industrial objectives.

Looking critically at the framework programmes, a major problem has been that basic research and applied research have been linked, making management and evaluation difficult. We should consider having an ERC focused on basic research, a second set of programmes focused on competitive advantage, as well as giving support to the Eureka programme. Thus we will be able to align the seventh Framework Programme more closely with the challenges which we all have in Europe and get better value for money as well. ❐

Cooperation fosters innovation

Reinhard Grunwald

Dr Reinhard Grunwald is the secretary general of the *Deutsche Forschungsgemeinschaft* DFG (German Research Foundation) and chairman of KoWi, the European Liaison Office of the German Research Organisations. He was a member of the management board of the German Cancer Research Centre in Heidelberg. He trained as a lawyer and used to work in international intellectual property rights, including the question of patenting human genes and living organisms.

Europe's governments expressed their firm belief that, by 2010, Europe should be the most competitive and innovative region in the world. There is consensus that we must take action, especially in the light of rapid developments in the US and Asia. The important question for us Europeans is whether our actions are already sufficient or whether we have to take further steps. Cooperation among national funding agencies within Europe already exists. What could be improved? The answer is, we must do more in Europe by intensifying our efforts and joining forces even more.

We face increasing complexity and must improve the overall performance of R&D, both in academia and in industry. We need a European Research Council (ERC) if we are to compete successfully on an international scale. There is consensus that an ERC should deal with basic research, covering all areas of science and the humanities. This combination is not contradictory: Germany's DFG, which covers all fields of research, is a good example in this respect. The standard for an ERC should be scientific excellence, defined by peer review, with evaluation and feedback given by the scientific community. The key element has to be scientific autonomy.

An ERC should progress in a stepwise fashion. Initially, funding should go to individual teams. Eventually, additional funding instruments should be introduced; for cooperation, for larger teams, for individual scientists or for smaller individual projects. The administration should be lean and science oriented. Finally, all these mechanisms should be accompanied by improved cooperation between national research communities and their institutions.

How should an ERC be structured? Recently, we have seen much progress in the interaction between agencies. The multilateral interaction of national agencies is fostered by the European Science Foundation. They have established common programmes such as EUROCORES and a funding mechanism for young scientists, the European Young Investigators Award. The next step could lead to an ERC, which would act as an interface between the national funding system and the funding system of the Commission.

We should aim for the ERC to be both universal and politically independent.

In the current debate, we have a couple of well-defined suggestions for the structure of an ERC: an early one was to run the ERC as an executive agency that is part of the Commission; another one was to have a European agency modelled on existing European agencies. The common denominator is that any legal form of the ERC has to ensure that no other criterion but scientific excellence has an impact on its decision making.

An executive agency with clear chains of command could be installed rapidly; for the Commission, this is very attractive. A European agency would be complex and time-consuming to set up, but more independent; there is a built-in system of checks and balances. A joint undertaking on the other hand would be more complicated and also take longer to set up; could one successfully found a joint undertaking and start right away?

The other important question to ask is whether autonomy is a question of structure. To create a structure that guarantees autonomy, the decisions must come from the scientific community. Other players — universities, laboratories, national research councils, European research organisations

— must also be involved. These groups should all come together, either in an advisory board or, better still, they should advise the senate, which should be comprised of eminent scientists who appoint the board of directors and the chief executive.

What are the challenges and prospects of creating an ERC? In the best-case scenario, there will be more intensive competition: the ERC will draw more money into a better system than the national ones. However, in the worst case, funding "bad" European scientists or "bad" European science will result in a loss of funding for "good" national science and scientists. We must therefore create a system of international peer review to minimise the risks. The prospects and the challenges for the future will be how best to balance the interests of national research agencies and those of an ERC and how to integrate international research outside Europe. ❐

Changing European science

Ian Halliday

Professor Ian Halliday FRSE is chief executive of the Particle Physics and Astronomy Research Council, a member of the European Research Advisory Board (EURAB) and the UK representative on the CERN Council and on the Governing Council of the European Research Foundation. He is a theoretical particle physicist and was head of physics and dean of the Graduate School at the University of Wales and a professor at Imperial College.

For more than 40 years the work of the Particle Physics and Astronomy Research Council (PPARC) and its predecessors has been quintessentially European. I spend roughly half my budget in CERN (the European Organization for Nuclear Research) in the European Space Agency (ESA) and in the European Southern Observatory (ESO).

This year sees the 50th anniversary of the foundation of CERN. What made CERN happen in 1954? The politics and the barriers were very different then. The United Kingdom realised that, if you wanted to build accelerators to do nuclear physics or particle physics you needed not just the ideas, but a budget comparable to that available in the United States. That pressure made it possible to overcome the not inconsiderable political barriers to putting UK taxpayers' money in Geneva as part of a collective project. A huge act of faith and trust was required to make that happen, just as it would be to create a European Research Council (ERC).

My position on the European Research Advisory Board of the Commission (EURAB) gives me a view from the other side of the fence, in Brussels. I have been engaged, through EURAB, in many discussions about European universities and the challenges facing them as a crucial part of the European research enterprise.

The intersection of science budgets, the restructuring of universities and the position of universities in the European research area is important. It has taken the US National Science Foundation (NSF) 50 years to construct the competitive American university system, including peer review.

I believe that the exercise we are discussing here has a similar timescale: not a two- or three-year fix for some funding problems for science; this is a serious effort to restructure how European science is done. Recently, we discussed the serious effort of the UK Government to implement some of the UK science and innovation policy (*FST Journal* **18** (5) 3–8 (2004)). This is an exciting time for science.

There is a down side to CERN and ESA and ESO: budget overruns and other problems. European collaboration is not a trivial exercise. It is important that there is a debate about how the wish lists are turned into a structure. How will it fit in with the UK system, the German and other systems?

Science is changing; it is not just the big facilities that PPARC is involved with. The whole spectrum of science requires better support for scientists, better equipment, labs and technical support. A result of that is, undoubtedly, concentration of resources. We see this in the United Kingdom where money is being concentrated in a comparatively small number of universities and research laboratories. The Commission recently opened some doors in Washington to reveal how America designed its systems. The fitness for purpose of so many things they do and the constant refinement of their procedures is extremely impressive, resilient and adaptive. Can we write the terms of reference for a European research council, given the global argument, in a way that allows this flexibility to do good science?

CERN is successful because it has created a scientific playing field where people compete because of their scientific excellence. The physicists lose all trace of nationality: they are experts in electronics or detectors and it becomes a truly European object. Through CERN, European particle physics has become globally competitive. Overt competition will improve European science.

In conclusion, there are many challenges. The expectations of an ERC have been raised to such a high degree that for the first two or three years the chief executive of that organisation is going to face a formidable challenge. But, in the long term, it will be a process that will alter the perspectives of European science. That it is a truly exciting prospect. ❐

The case for a new research council

Julia Higgins

Professor Dame Julia Higgins is the foreign secretary and vice president of the Royal Society and was president of the British Association for the Advancement of Science from 2003 to 2004. She is professor of polymer science in the Department of Chemical Engineering and Chemical Technology at Imperial College where she runs a research programme. She is also director of the Graduate School of Engineering and Physical Sciences. She is chairman of the Engineering and Physical Sciences Research Council.

Fundamental research in Europe is important, particularly in light of the Barcelona agreement. In Barcelona in October 2003, Europe took a step towards developing a European Research Area (ERA). The EU committed to increasing total R&D in Europe from under 2 per cent to 3 per cent of GDP by 2010. When the idea of a European Research Council (ERC) was first mooted the Royal Society wanted to understand the landscape of Europe, the ERA and what fundamental research activities there were.

We asked the question: "Is there a problem, the answer to which might be an ERC?" There were some macro indicators allowing a comparison between some of the member states collectively and also on a pan-European basis and with the United States. There are many misconceptions about Europe's performance compared to the Unites States. I draw here on a Royal Society background paper addressing research in Europe that can be found on our website (www.royalsoc.ac.uk/document.asp?tip=0&id=1340).

Europe produces more research papers than the US. European universities and public laboratories have more researchers than the US, although the GDPs of Europe and the USA are similar. As a percentage of GDP, Europe's funding of university research and total public funding of research is similar to that of the US. The key difference on funding is that the amount of research funded by European business is considerably less than that funded by US business.

Furthermore, although the EU publishes more than the US, the research is less visible. If you look at the highly cited publications, there is a dramatic difference: taking the top 1 per cent of publications in the citations index, Europe is well behind the US. If we were to take the top 0.1 per cent I suspect there would be an even more dramatic difference. There is also considerable variability in citations throughout Europe.

Another problem it that Europe has too little research mobility, both between member states and between the various sectors — academia, government laboratories and industry. Addressing this will be important for the future of R&D in Europe and will require collective action by the Commission, the European Parliament and member state governments.

So where does an ERC fit in? The main aim of a properly constituted ERC should be to increase the visibility of European research by increasing the number of research stars in Europe, funding them, attracting them to Europe and keeping them here. There are arguments that other tasks, including coordination of research and the mobility of researchers around Europe, might be taken on by the ERC, but that is too much to ask a nascent ERC to undertake at the beginning: it is going to be difficult enough to set up a mechanism that will deliver even on the high-quality research.

The Royal Society believes that, at least initially, an ERC should have no more than three tasks, the prime one being a grants system that will deliver the best high-quality research. We would also suggest the instigation of a highly competitive European research fellowship scheme, funding the potential star young researchers for a reasonable length of time, to sustain the growth of the next generation when their research careers are developing. An example of such a scheme is our University Research Fellowship scheme. Finally, an ERC must obtain consistent high-quality data on fundamental research activities across Europe, both to inform its work and to enable it to make authoritative contributions to the development of wider European policies in this area.

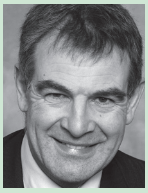
We do not underestimate the difficulty of delivering this. Governance is crucial, as are the arrangements for high quality peer review. An ERC must have independence from both the Commission and the member states. On the other hand, the Commission and the European Parliament, responsible to their member states, must set the overall guidelines and aims relating to the research. An ERC must also be answerable to the European scientific research community on its delivery of excellent research. Further details on the Society's views on the ERC can be found in its response to the Mayor report at http://www.royalsoc.ac.uk/document.asp?tip=0&id=1348.

To conclude, fundamental research is crucial to the future development of both the United Kingdom and Europe and, in particular, the visibility of European research at the highest level must be increased. The Royal Society believes that an autonomous ERC, with quality as its prime criterion for decision making, would help Europe compete for the best researchers and provide them with the funding and facilities to be leaders in their field. ❒

The Home Office is responsible for detecting and reducing crime, including cybercrime, counter-terrorism, countering chemical and biological attack, and managing the prison and immigration services. How science and technology can (and might) make these functions more effective was discussed at a Foundation meeting on 26 May 2004 at the Royal Society.

The causes of crime

John Gieve



John Gieve CB is permanent secretary at the Home Office. He worked in the Department of Employment in 1974 before moving to the directorate responsible for the planning and control of public spending and for improving productivity in the public services in January 2001. He managed the Comprehensive Spending Reviews in 1998 and 2000 and chaired the review of crime reduction and of children and young people at risk in the 2000 Spending Review.

When I joined the Home Office three years ago I found there an array of distinguished criminologists, economists, sociologists, social psychologists and social scientists, as I had expected. What I had not expected to find was that I had become the employer of almost 2,000 professional scientists, most of them in the physical sciences. I later met experts in explosives, electronic surveillance, forgery, the health impact of mobile phones, fingerprints, DNA and animal health and welfare. This is the broad range of expertise needed to answer practical questions we face, such as: "how much heroin sticks to your clothes when you carve a big block into smaller blocks?"

A Forensic Science Service is part of the Home Office group. Also, we are responsible for the licensing of animal experiments and, therefore, require vets and other experts in this field.

Physical sciences, particularly the use of technologies, are at the heart of policing, immigration control and protecting a society from terrorism. My main concern over the past few years, working with Paul Wiles our chief scientific adviser, has been to harness the science and evidence base and to strengthen that expertise inhouse.

The aims of the Home Office are to reduce crime and fear of crime, tackle organised crime and terrorism, ensure the effective delivery of justice, reduce re-offending and protect the public from known offenders, reduce the harm caused by dangerous drugs, enable the migration we need and prevent illegal migration. At the heart of these objectives lie changing social behaviour and attitudes: they are not about how many operations we carry out or how many exams we get people to pass; they are about what people do in their own lives when they are not being supervised by the state.

To succeed in this we need not only effective enforcement services but we also have to work on the causes of crime, the underlying cohesion in communities. We speak of "reducing crime" and also "reducing the fear of crime": our targets include building confidence in the criminal justice system, so attitudes are at the heart of what we are trying to change. Changing beliefs and attitudes will change behaviour. People need to believe that they are dealing with effective services, otherwise they will not engage with them. Attitudes and perceptions are part of our business.

Where does that leave science? Social science is central to the understanding of behaviour and attitudes — why do people become criminals, how can we prevent them, how do we reduce re-offending? We also work on crime mapping (ways of predicting where crime will take place), we work on the psychology of restorative justice (what works, how to engage victims and offenders and get a positive output for both). In the field of immigration there is a major research programme on the economics of immigration and the effects of migration on communities.

Recently our defence systems against terrorism have been overhauled. Chemical, biological, radiological or nuclear (CBRN) attacks or potential CBRN attacks have been in the news: we need to develop capabilities in those areas.

We also need hard science capabilities, including the DNA database, explosives and weapons detection, medical studies on the effects of CS spray. In a typical month we use DNA to identify suspects for 15 murders, 30 rapes and nearly 1,000 car crimes. This is very practical technology at work and it is developing all the time. We have recently used familial DNA links to solve a murder from the early 1970s. We are now working on identifying DNA from fingerprint residues.

Other capabilities, including automatic number-plate recognition, are transforming parts of policing in many cities. Evidence relating to CCTV, burglary schemes and other practical measures has helped cut burglary by nearly 40 per cent in the past seven years. Electronic tagging, saliva testing for drugs; these are all capabilities which have been developed with the aid of, or within, the Home Office and which we use daily.

Much of what we do comes under product development rather than the promotion of pure research but we must keep abreast of developments in science.

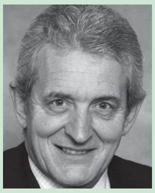
How are we doing this? First, we are developing our own centres of expertise in the hard and social sciences, in our research and development and statistics branch, in the Forensic Science Service and in the Police Scientific Development Board.

Second, we are developing partnerships with outside bodies through Foresight, through the research councils and through the recently established advisory group of eminent scientists who advise us and help us identify whom we should be talking to about what. Within that advisory group there is a sub-group that deals specifically with the CBRN type of threat; this follows the Royal Society's recent report (Huppert, H., Policy Doc 06/04, April 2004).

We are building up our own expertise, while creating a bigger and more effective network, to ensure that this knowledge is embedded in policy-making and delivery. We also plan to inject more of our social science capability into our delivery teams. Over the next year, an integrated science strategy will be developed for the whole Home Office group building on that we have already published for the police. ❐

Anticipating offenders' behaviour

Paul Wiles



Professor Paul Wiles, chief scientific adviser to the Home Office and director of Research, Development and Statistics, joined the Home Office five years ago. He worked as an academic at the University of Cambridge, Institute of Criminology and also at the London School of Economics and Political Science before becoming professor of criminology at the University of Sheffield.

The Home Office has a huge spread of responsibilities and to cope with that we need access to scientific resources both within and outside the Home Office.

Since the 1990s, a long period of stability and relative prosperity have contributed to a downward trend in the incidence of crime in England and Wales, a trend that is matched in other developed counties. Better use of science and technology is also helping in reducing crime.

To illustrate how science and technology can help to reduce crime, let us pose the question, "what do you need for a crime to occur"? Three elements need to come together spatially and temporally for a crime to happen:

- a motivated offender
- an available victim or target
- a lack of effective guardianship

Crime can be prevented if any of these elements can either be prevented or disrupted. Understanding which groups are committing the most crimes allows us to direct resources to those areas where they will be most effective.

Offending is not uncommon, especially among males: between 10 and 15 per cent of males and about half that number of females will offend in the current year. Offending is most common among teenagers and young adults. Longer term, persistent and serious offending is less common than those figures suggest. We have significant international evidence that has identified three offender groups: early onset offenders, lifestyle offenders and circumstantial offenders.

Early onset offenders generally come from families where parenting is erratic or poor, often families which themselves have criminal members. These individuals tend to be hyperactive, have low self control and often low intelligence. In this group criminal behaviour often begins before the official age of criminal responsibility, namely 10 years. Their criminal careers are persistent. Most offenders are generalists, although there is specialisation at particular points in the age profile — for example, joy riding attracts the under 21-year age group. We estimate that about 100,000 persistent offenders are responsible for about 40 per cent of all crime.

The second group are lifestyle offenders. Their offending is mainly dependent on the risk factors associated with their social circumstances, particularly those associated with their peers and neighbourhood. This is the offending of young males and particularly young male group behaviour, their offending tends to start in adolescence and they have shorter "careers" in crime.

The third group, circumstantial offenders, carry very few risk factors but may nevertheless offend in high-risk situations. They account for a only small amount of crime but those can be high-profile crimes. This is the classic "middle class youth sent to prison for violence" or "the elderly person who, under great stress, murders their spouse". Their repeat rate is low.

How do we reduce this offending and how have we do we make use of different aspects of science? Fingerprints are still the biggest single source of evidence at crime scenes. There is also the new national DNA database that soon will include nearly all active offenders in this country. Automatic number-plate recognition is a way of tracking the movement of offenders.

These techniques are all very useful but there are two things to note: first there is rapid turnover in the persistent offender group, so ensuring that you have the current active offenders on the DNA database is a constant difficulty. Second, although detection is extremely important in policing, only a minority of offenders are caught through detection, so improvements in the quality of detection will have a limited impact on crime.

Preventing people taking to crime in the first place has obvious advantages and we have a series of research programmes to find out how that can best be done.

Finally, there are the things that we can do to manage high-risk situations. Some are very simple: for example, we know that most crime-related injuries in this country relate to alcohol use in and around pubs. If you replace glasses in pubs that are particularly susceptible to rowdy behaviour with ones that do not shatter then you can significantly reduce the extent and the seriousness of injury that people suffer in those violent crimes.

Each year it falls to me to brief the press on our annual crime statistics. Last year I asked journalists what they thought that the average risk of a burglary was in this country. Their answers ranged between two and five years; but the actual risk is once every 50 years. And that is for the average family for something that has a heavily skewed distribution, so for many families it is much lower.

We know something about the characteristics of people who suffer repeat victimisation: single parents who live on a high-crime estate are at risk for example. But the biggest single risk factor for repeat victimisation is having an offender in your household. Those who offend have the highest risk of victimisation. Of course, the advantage for the rest of us is that this is one of the factors that leads to concentrated victimisation. This concentrated victimisation is largely because offenders do not travel very far.

What can we do to protect victims? One of the reasons that burglary and car crime have gone down over the past seven years is because there has been a significant increase in the use of technology to provide protection. That is not simply being done by the Home Office but nevertheless, the Home Office has played its part, for example by publishing an annual car risk index that became an important factor in persuading the car manufacturers to build better security into vehicles.

The fall in burglary rates has been helped by the increasing number of households with alarms, window locks and so on — simple technologies but very effective. We are increasingly using geographical information systems to identify where the hotspots are, where people are being repeatedly victimised and then making sure that we target policing resources at those areas.

There has been a decline in the various forms of guardianship in society, both parental and more informal. That has put increasing pressure on public policing where we use various kinds of science and technology as a substitute for some of that guardianship. We have some of the greatest use of closed circuit television in public spaces in the world: we have evidence that it provides reassurance, but whether that reduces crime is not quite so clear. Street lighting also plays a part. There are new technologies that will be very important in this area; for example, the chipping of goods and linking that to biometrics so that property is only useable by its owner and therefore not worth stealing.

What of the future? Many new challenges lie outside direct Home Office control. Much of the action that is needed to reduce crime has to be taken by others. The Home Office is creating a new intelligence hub to help us both identify emerging technology and assess how far it will be useful either for us to combat crime or for offenders to commit more crime. There are two sides to technology: what threat does it present, what opportunity does it provide?

There is also a need for the Home Office to be much more porous to science and industry outside of the Home Office: we must get more involved in talking to you to help us do our job.

Finally, we must continue to exploit the important network of chief scientific advisers across Whitehall. I would like to pay tribute to Sir David King for all the work he has done helping to open up communication. We have produced the second iteration of the Home Office Police Science and Technology Strategy, which sets out the capabilities that we think we need and then looks for new threats and opportunities that we think might provide those capabilities. That science and technology strategy will, I hope, be the basis for many of you to engage with us about how we can deliver. It will provide the basis for a much wider Home Office group science and technology strategy that will be built on that same platform. ❐

Combining different approaches

Peter Neyroud

Peter Neyroud QPM is chief constable of Thames Valley Police, a member of the Sentencing Guidelines Council, a council member of "Justice" and a member of the Institute for Public Policy Research Criminal Justice Forum. He is the co-author of a study entitled Policing, Ethics and Human Rights, published in January 2001. He was awarded the Queen's Police Medal in 2004.

In one of the Sherlock Holmes' stories, Conan Doyle summed up the scientific principles of crime investigation that remain relevant today: evidence, impartiality, observation and logic. I would like to focus on the way in which combining a number of different scientific approaches with professional judgement can produce better policing and better results.

Advances in science and technology have changed both the way we set out to solve crimes and how those crimes are committed. For example, the specialist crime unit has just completed the investigation of 480 cases of serious paedophilia across the internet, cases that would have been technologically impossible a decade ago. The technical equipment and expertise required have been immense: just one of the computers that we recovered contained a quarter of a million paedophilic images.

Two case studies will illustrate how science can contribute to the practicalities of police work. The first relates to a burglary team involved in stealing high-performance vehicles. Modern anti-theft devices on expensive cars are very effective, so virtually the only way to steal a high-performance vehicle is to break into the owner's house and steal the keys. Currently this is a growth area and we faced a rash of such incidents in the Thames Valley. To counter this we have adopted a combination of sophisticated surveillance and identification techniques.

We set out to identify "crime routes" indicating where these crimes have been taking place and then used automatic number-plate recognition (ANPR) to gather passive intelligence on crime routes. The surveillance could not have been done without Home Office investment in the development of communication technologies and radio systems. We then made use of recently introduced Viper (video identification technology) and DNA analysis on samples found in different vehicles to gather evidence about specific crimes. Many of the techniques that we apply routinely today would have been used only in the most serious cases ten years ago.

My second example is the National Intelligence Model that mixes and matches information across the board. This develops the elements of Home Office research that Paul Wiles referred to (page 8) into an analysis technique that forms an important part of our day-to-day work. We use four specific approaches. The first, strategic assessments, we conduct every six months.

In the National Intelligence Model, a strategic tasking process that sets the priorities within our policing plans, this problem profile converges with the target profile. These profiles are then related to underlying criminological research. Whereas we used to see data on a six-monthly basis and were always looking backwards when trying to go forwards, we now have access to ongoing data. There is also practical application of a geographical information system.

In the Thames Valley there is a large crime concentration in Reading. Recently, we focused on our performance group concerned with cross-border burglaries, where we began running an operation using automatic number-plate recognition on the borders between Reading and West Berkshire that was specifically based on the geographical information. This is beginning to show a good deal of success.

In the case of stolen (largely high-performance) motor vehicles we try to illustrate where the vehicles are going and then map the sorts of cross-border operations that we should be doing with other forces. These are some of the most difficult operations because we have to have a cast iron case in order to convince another force to help. We have worked similarly with cross-border burglaries.

There is also the challenge of where best to deploy police officers.

We have changed our focus; these are all techniques developed within the past ten or even five years; the sophistication of some geographical mapping techniques has developed within the last two or three years. The process of looking at the combination of geography and science continues to develop and is at the heart of making policing more effective.

Finally, a personal example to illustrate the way in which science meets policing, meets politics. When I took over as chief constable of Thames Valley the force led the United Kingdom on police use of firearms, an area in which there was a lack of public confidence. Some high-profile incidents had gone wrong and I was presented with the need to deal with the Patten Report recommendations (www.belfast.org.uk/report.htm) relating to not using the plastic baton round in the context of public order in Northern Ireland. This was a very challenging, high-profile political issue that fed straight into high-level international summits on the Peace Process.

How, as a professional police officer trying to deal with that process, do you find a procedure that deals with varied weaponry, such as the glue gun, water cannon, the Taser (a high-voltage stun gun), the "sock round" (firing a beanbag-like projectile) and CS gas in various forms?

We started from a social science base, surveying officers who had been involved in public order and firearm situations, and developed a carefully detailed operational requirement from the gaps in the existing equipment. The Police Scientific Development Branch then examined the existing weaponry available on the market. It required careful physical research into what each weapon could do. The next stage was to look at the acceptability, in ethical terms, of each of them. Borrowing models from bio-ethics and medical ethics as well from practical ethics, I produced an acceptability matrix that we ran across each of the weapons and options. That was followed and linked with medical tests as to what the small number that had come through those tests would do in given circumstances, what impact that would have on the operational requirement and the operational guidance on how to use the weapon.

The result was a submission to a government minister about the acceptability of introducing a new weapon, the most obvious one being the Taser, which is now used in all 43 forces in the United Kingdom as an alternative to the conventional firearm. This scientific process, linked with the professional process, has unquestionably saved lives. I believe that, throughout the past year, the national police force experienced no fatal shootings.

Research into crime prevention

Alasdair Rose

Dr Alasdair Rose MBE is manager of the Crime Detection and Prevention Technologies Programme at the Engineering and Physical Sciences Research Council and of the Research Councils UK Basic Technology Programme. He is developing a programme of university-based research supporting innovative long-term technology research that will address long-term challenges in crime prevention and detection in project partnerships with a range of stakeholders that have a particular role or mission to tackle. He is a member of the Home Office Science and Technology Future Scanning Group.

The Engineering and Physical Sciences Research Council (EPSRC) is supporting a wide range of research into innovative technologies for crime prevention and detection. The research offers long term potential — over the next five to ten years — for great impact on crime prevention.

The origins of the EPSRC initiative go back to the publication, in December 2000, of *Turning the Corner*, a seminal report by the Foresight Crime Panel. The report identified opportunities for the science base to address crime and one of its recommendations was that to attract those in the hard sciences to work and research relevant to crime reduction a dedicated funding stream should be established.

The EPSRC responded in 2002 by allocating a budget to support research that would potentially have a direct impact on tackling crime. We want to encourage academic researchers to think about crime and to support research projects that will produce technologies capable of improving the safety of our urban environments, boost the security of people and property, help stamp out fraud, identity theft and enhance forensic science in crime detection.

We are investing in longer term, high-risk pre-development research in universities in collaborations with organisations that are capable of developing the research outputs. Having a good research idea is not in itself sufficient: by supporting research projects in partnership with users the potential impact of the research in reducing crime will be enhanced. The EPSRC will continue to fund innovative and high-quality research that may have an indirect crime relevance through our other modes of funding. We have deliberately not excluded any area in the crime reduction arena that can be addressed by physical scientists and engineers, reflecting again the Foresight Crime Panel's view of not wishing to stifle the creativity of researchers by constraining the topics that they might address.

Under the programme so far we have invested about £6 million in 29 research projects and feasibility studies and in four research networks. The range of the research being undertaken includes imaging and surveillance, forensic science, property and electronics, security, biometrics and detection of illegal substances. Home Office agencies, such as the Police Scientific Development Branch, the Police Information Technology Organisation and the Forensic Science Service, are closely involved in most of the projects. In addition to the research projects we are supporting networks of research scientists and technology users around four themes. The intention is to help build masses of critical excellence by developing new collaborations within and across the science base and the generation of research proposals.

I have chosen three examples of science that we are funding to demonstrate the potential contributions the physical sciences and engineering can make in the fight against crime. The first is research that is being conducted at Edinburgh University that will help to address the rising incidence of gun crime by detecting concealed weapons using millimetre-wave technology imaging. This research could have an impact on the emergence of new terrorist threats at vulnerable transport hubs. The project is being carried out in partnership with the Police Scientific Development Branch, the Department of Transport, the Metropolitan Police and QinetiQ.

discussion

Data protection. The question of the protection of the individual in relation to the development of a national database also raised issues of balance. Such data were retained only for good reason. The individual's right of access to such data was statutorily safeguarded. The importance of identity connected with such a database could not be underestimated. The surge in the technology connected with mobile phones illustrated the importance of enabling the police to catch up.

The value of identity cards was questioned. Their function was to provide a quick and reliable method of determining identity. This would be important in fields such as security, immigration and the handling of questions of entitlement.

The second example is developing lightweight materials that can be used for litterbins, post boxes and other street furniture capable of concealing bombs. The materials being developed are fibre-metal laminates that have very high impact resistance and fracture toughness. The research is being carried out at Liverpool University in partnership with materials manufacturing companies. Westminster City Council has expressed interest in incorporating the materials into its street furniture in Central London, once its potential has been fully demonstrated.

The third project is headed by an astronomer. The best long-range surveillance cameras are limited by atmospheric distortions, disturbances that cause the images to shimmer and distort. However, astronomers have developed technology that potentially can be adapted to produce multiple images capable of computational analysis to produce an enhanced resolution image. This research could achieve very high resolution imaging over long distances for a wide range of surveillance purposes, including helping the police to reduce illegal immigration and ship-to-shore smuggling. Partnering the research are imaging companies and the Police Scientific Development Branch.

In addition to the £6 million already invested, EPSRC plans to invest another £6 million over the next two years. EPSRC is also piloting a radical concept known as the "Ideas Factory". The aim is to provide opportunities that will stimulate highly innovative and risk-accepting research activities that would be difficult to conceive under normal circumstances. This will be conducted at five-day workshops, involving a small number of participants from a wide range of disciplines and backgrounds, who have the right mix of personal attitudes, such as willingness to take risks and to think outside the conventional wisdom. We want to do this in partnership with relevant stakeholders and with the guiding help of international experts. We believe this approach would lend itself to tackling particular issues surrounding crime prevention.

Our present strategy is not to constrain the innovative and creative potential of researchers into particular crime reduction technologies. The question of whether this "unfocused approach" is appropriate, or whether a consensus can be reached on the technology challenges that potentially will have the biggest impact in tackling crime, is one worthy of discussion, as is the idea that UK universities might develop centres of excellence with critical masses of research activity to develop crime technologies.

Finally, back to crime statistics. It is worth asking what measures should be used to determine whether the EPSRC crime technologies research programme has been successful? ❒

discussion

Modelling. Science might make a contribution through modelling and the scientific model could then be tested; was it possible to test policy models against policy outcomes? Did public reaction have to be taken into account? Hitherto the use of models had been limited and improvement was needed. Models could be used to test the balance of investment. There was scope for modelling scenarios. Before the police had Geographical Information Systems (GIS) a good model had been developed but had not been exploited.

Computer modelling could now use cognitive systems and fuzzy logic. Modern super-computing offered increasing scope. GIS predictors were taking advantage of these possibilities and collaboration with work undertaken by MOD was to be the subject of an imminent meeting.

Emphasis was given to the need for development. Laboratory-based work drawing on the input of different research councils, such as that in the field of human identification, needed to be taken forward to a point where it could be marketable. It was agreed that a development process, analogous to that in the field of weapons technology, was required.

Should peer review publication be by open-access journals that are freely available on the web or by publication in library serials for which a subscription is paid? At a Foundation meeting on 23 June 2004 at the Royal Society, two contrasting opinions were expressed, but not reconciled.

Repositories for open access

Mark Walport

Professor Mark Walport FMedSci has been director of the Wellcome Trust since 2003. He was previously professor of medicine and head of the Division of Medicine at Imperial College. He has served as registrar of the Academy of Medical Sciences and is a member of the Council for Science and Technology.

Access to the results of research has been completely transformed by computers and the worldwide web. Anyone who has access to the internet can obtain the raw data of the human genome project. They can view the annotation of the human genome and its comparison with genomes of other species. It is all available, free of charge and without restriction.

This is very different from what generally happens to the results of research. When scientists submit a scientific paper for publication, the copyright or exclusive licence is assigned to the publisher of the journal, who then charges through journal subscriptions for access to these papers. The result is that both the worldwide scientific community and the lay community has expensive and restricted access to the results of much scientific research, most of which is publicly funded.

I am unable to see the results of some work for which the Wellcome Trust was the primary funder because the Trust library does not subscribe to the particular and expensive journals in which the results are printed. About 90 per cent of the research that is funded by the NHS is potentially available online in full text. However, only about a third of that is available to the public and only about 40 per cent is available to the people who work within the NHS. Consequently, the results of NHS-funded research, although important for both patients and doctors, are not easily accessible. This is the first reason why the current situation is unacceptable.

The second reason is that scientific results only have value if they are communicated to other scientists and clinicians. The whole scientific endeavour depends on communication.

More than 90 per cent of research in UK universities is funded by public money, either from government or from charities. Of the 16,500 papers on research funded by the Wellcome Trust between 1995 and 1999, about a third were published by commercial publishers, about a quarter by university press publishers and the remaining 43 per cent by societies. Many of the learned societies subsidise their activities from profits accruing from the journals that they publish, but is that a primary mission of the research funders?

In order to understand the economics of publishing, the Wellcome Trust commissioned economist Neil Costello to produce an analysis of scientific research publishing (www.wellcome.ac.uk/assets/wtd003182.pdf). The major concerns highlighted in the report include large profit margins, dramatic increases in subscription charges that put tremendous pressures on library budgets, "bundling" of subscriptions, and the publisher's retention of copyright of papers that include key scientific data.

The situation has arisen out of a rather curious and invisible economic cycle. Research workers write their papers and submit them to a publisher. By and large, they do not have to pay for that. The journals, once purchased by their library, then either appear on their computers or in the library, but the researchers generally do not know how much they cost. Consequently the researchers who drive the system are blind to the economics of it.

The arrival of the internet offers a new model for distributing the results of research much more effectively and free of charge to the end user, the reader. This is the model of open-access publishing. In this model the copyright is retained by the scientist, who grants the public a free and perpetual right of access to the article and a licence to copy and use it for any responsible purpose, subject to proper attribution of authorship. A key feature is that the article is digitally archived in public access archives, enabling a digital copy to be retrieved easily and *in perpetuo.* The National Library of Medicine in the USA is an example of a provider of such a public access archive (www.pubmedcentral.nih.gov/). In a second report, Neil Costello calculated that using the open-access system would create total systems savings of around 30 per cent (www.wellcome.ac.uk/assets/wtd003184.pdf).

What do scientific authors like about the current model? There is a hierarchy of journal quality and the economics do not intrude significantly on the scientists themselves. It is important to publish in a good journal: you may get promoted, get grants more easily or win prizes; you will help your department get a high score in the Research Assessment Exercise. However, none of this is a good way to drive the economy of publishing the results of science.

The best journals are the most selective, they may provide added value and they market best. This quality control comes from the peer review process. Who undertakes this? First and foremost it is provided by expert referees from the scientific community, who normally provide their services free. Second, journals have salaried editorial staff who provide essential quality control. Third, there is an editorial board that provides oversight and governance, members of which usually receive a modest honorarium. The workings of this peer review process are independent of the model of scientific publishing discussed here.

Maximising the impact of research demands that its distribution is maximised. Public and charitable funders have a duty to provide public access to the results of the research paid for by the public through taxation and charitable donations. Funders of research should demonstrate that they are engaged with this issue, because they need to raise awareness. They need to fund the costs of publication because publication of the results is an intrinsic part of the research itself. Furthermore, publication is a marginal cost. A project grant from the Wellcome Trust for a piece of biological work might be about £150,000; and £1,000 on top of that for publication is significant but marginal.

We need to facilitate open-access repositories and we must recognise that it is the content of the paper that matters, not its title, the author or the journal. We must encourage the development of high quality, rigorously peer-reviewed journals that provide open access; some of these journals will be new, others will be well established journals that grasp the opportunities for transition. The world of scholarly publishing has entered a period of rapid evolution. ❒

Open access in practise

Mark Patterson

Dr Mark Patterson is a senior editor at the Public Library of Science. He moved into scientific publishing in 1994 after nine years of research in human genetics. In 1999 he was appointed as the biology reviews editor at *Nature* and was subsequently involved in the launch of the *Nature* reviews journals as the editor of *Nature Reviews Genetics.* He has also worked as the publisher for the Company of Biologists.

The Public Library of Science (PLoS) is a non-profit organisation of scientists and physicians whose aim is to make the world's scientific and medical literature a public resource.

Open access to research literature means that it is freely available immediately upon publication. There are also no restrictions on the use of open-access literature although, importantly, the author retains the right to be acknowledged and cited as the originator of the work. That is enshrined in the licence agreement. Papers published by PLoS and other open-access publishers are also deposited, upon publication, in a public digital archive. The best example of that is PubMed Central, funded by the National Library of Medicine in the USA, which begins to address concerns about long-term access to literature online separately from the publisher.

The benefits of open access are that any paper can be read and built upon by anybody with an interest in the work, thus maximising the impact of every paper. Comprehensive open access means that the literature becomes much more powerful: you will be able to mine it, to interrogate it, to use it for knowledge discovery in ways that we cannot yet imagine.

The pace of research will be increased as a result of open access, both within the academic and the commercial sectors. Beyond the well-funded scientific community, there will also be increased access for people who cannot afford subscriptions to journals, such as educators in teaching institutions, patients and patient advocacy groups, scientists in less well funded organisations and so on. Open access will also provide for a more effective journal publishing market, because the costs become transparent.

To make this system work, researchers need access to funds to cover the costs of publishing. The best way to achieve that is for funding agencies and institutions to provide those costs within grants. In other words, the same sources that support subscription-based publishing now can and should support open-access publishing. The burden of payment would therefore not be transferred from reader to author which is sometimes how this system is portrayed. The challenge is to re-route the money that currently supports publishing into a system that operates on publication charges.

Understandable obstacles arise in trying to introduce an open-access system. Publishers will resist an open-access model where market forces operate more effectively and margins might not be so great. Some scientific societies also use the money made from subscription-based journals to support their activities. Most open-access journals currently available are new and lack an established reputation that is so important to authors. Finally, for funding agencies, there is uncertainty about the financial implications if they are being asked to provide funds to support an open-access system.

Despite the obstacles, here are catalysts among all these groups that are helping to drive this transition: new, open-access publishers, the PLoS and the London-based, commercial open-access publisher, BioMed Central. There is also increasing experimentation with open access among existing publishers: the *Proceedings of the National Academy of Science*, a prestigious US journal, is now offering an open-access option; UK publishers, such as Oxford University Press and the Company of Biologists, are doing similar experiments. And many funding agencies, such as the Wellcome Trust, are supporting open access, because they recognise that open access is in their best interests — it maximises the impact of the research that they fund.

There are, however, other objections.

First, open access reduces quality. Open-access journals are supported by publication charges, so the more papers they publish the more money they make. If they reduce the quality threshold in their journals, they can get more papers in and make more money. However, a journal is only as good as the science it publishes and, if the quality is continually reduced, authors will eventually turn away from it. Open-access journals have to maintain quality just like any other journal if they are to maintain their value to the community.

Second, authors who cannot pay will not be published. This problem can be solved by waiving the charges for authors who are unable to pay. That is what the Public Library of Science and BioMed Central do.

But that immediately raises a third problem: if authors do not have access to fees to cover publication costs, then open access cannot work. The solution goes back to the point I made earlier; there is already enough money to support subscription based journals. We need to take the money that currently supports subscription-based publishing and re-route it towards a system that supports publication fees.

One powerful way of showing that this open-access system could work is by demonstration. The PLoS was founded in October 2000, originally as an advocacy organisation to promote change within the publishing industry. Since then PLoS has become a scientific publishing organisation. Our strategy is to start at the top by launching two open-access journals to provide alternatives to the existing top-tier subscription-based journals. We want to demonstrate that open-access publishing is compatible with the highest quality of science and to send a strong signal to the scientific community, to funding agencies and to publishers that open-access publishing works. *Plus Biology* was launched last year and we are now planning the launch of *Plus Medicine*. Over the next few years, we plan to launch more open-access journals focused on specific communities and more specialist audiences.

Plus Biology has all the qualities of a top-tier journal both in print and online. It is achieving everything we set out to achieve: high-quality science, extensive media coverage and, importantly, acceptance within the scientific community as a place to publish high-quality work.

We must continue as an advocacy organisation to work to change the policy of funding agencies so that publishing fees are included in grants. We also want to collaborate in the development of tools for literature mining, for knowledge discovery, for research and also for using open-access literature as an educational resource. Ultimately we would like to see open access becoming the favoured mode of publishing. ❐

A learned society's perspective

John Enderby

Sir John Enderby FRS is the President of the Institue of Physics. He was physical secretary and vice president of the Royal Society. He is also senior research fellow and HO Wills professor of physics, Emeritus, at the University of Bristol. He chairs the editorial board of the Royal Society's learned journals and is president-elect of the Institute of Physics. He received a knighthood in 2003 and is a winner of the Guthrie Medal and Prize of the Institute of Physics.

I would like to talk about the subscription model from the perspective of the learned societies. First I must give you a health warning. I am the lead officer of publications at the Royal Society and chief science adviser to the Institute of Physics Publishing (IOPP). Both organisations derive income from the subscription model.

The advocates of open access and the defenders of the present model agree, I think, on five points. Research is not complete until it is published; quality assurance costs money and time; for the moment, peer review is the preferred option; someone has to pay for the cost of publication and any business model must meet the test of sustainability.

A crude characterisation of the two models is that open access transfers the cost to the producer of research, whereas the subscription model charges for access but considers all papers from whatever source, free of charge, and publishes those that meet the quality threshold.

I have developed a mathematical model to see how much open access would cost, using figures from a detailed study by the Association of Learned and Professional Societies Publishers; its results are not very different from others. Roughly speaking, the cost splits 50/50 between the base cost (the cost up to acceptance or rejection plus other fixed costs, such as subscription management) and the physical production, distribution and editorial work. Using this model, we discover that the charge to the authors is a strong function of the rejection rate, if the business model is to be sustainable. A significant component of the cost is expended on papers that are not published. The actual charge depends on the base cost, which of course varies hugely depending on whom one talks to.

At the IOPP, we have an open-access journal, *The New Journal of Physics*, which has been published for four years. Editorially it is very successful, but it is not very successful from a business point of view. The best estimate for the base cost, as defined above, is £750; this is consistent with estimates for other journals with a high rejection rate. I have found no estimate from any source where the base cost is lower than £500 (see Fig. 1).

As a whole, the United Kingdom is £7 million in deficit on the low base price of £500 per paper. So there is little or no financial advantage for the United Kingdom, a major research publisher, to have an open-access model. Learned societies would certainly lose income from overseas, while the popularity of US journals as vehicles for publication might lead to a transfer of resources from Europe to the USA.

There is a particular UK problem; the dual-support system would involve a transfer from funding councils to research councils and there would be variations in publishing rates, both as a function of time and the cross-research councils, that is rather unpredictable. There is also the EU complication of VAT on electronic publication.

There are other potential problems, none of which is insoluble. First, book

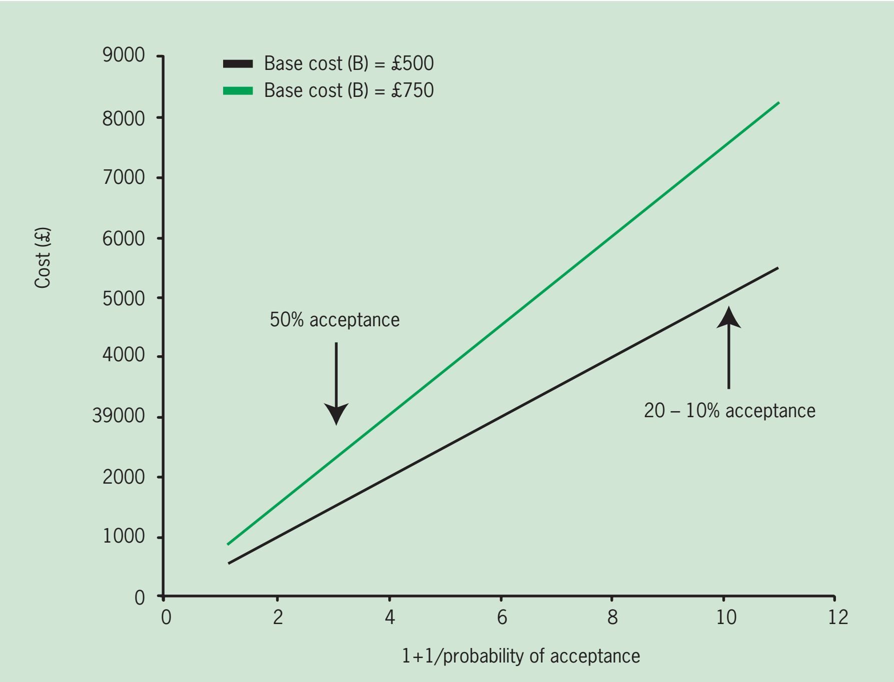


Figure 1 Charge to authors

publishing. Presumably there is no suggestion of open access here, but this is important because many publishers subsidise their book programme through journals. Second, review articles are an immensely important resource, for which authors usually receive a fee, at present. I would find it hard to imagine authors wanting to write review articles and having to pay for the privilege. Third, there are hybrid journals that contain research, reviews and news and views; and fourth, there is the possible exploitation by authors and publishers of a free review service provided by high prestige journals.

There is also the possibility of the exclusion of poor authors in the West and authors from developing countries. They might wish to submit to an expensive journal but end up publishing elsewhere.

I would like to see whether there is a middle way. My suggestion is that we retain the subscription model but that publishers should take a liberal view on copyright and allow the posting of work accepted for publication on either personal or institution websites and free availability at some stage.

There is no doubt that price increases and margins should be monitored closely; the learned societies have a duty to be clear and transparent about what is done with the money derived from publishing. There must be free or heavily discounted subscriptions to less developed countries.

The proposal of open access has performed an invaluable service in raising the issue of the most effective way that results of scientific research can be made widely available. The existing model will undoubtedly change and learned societies have the unique opportunity to experiment. There are issues with open access, sustainability and the need for investment in new technology. Many scientists, even in the West, do not have or indeed need access to research funds. There may be downward pressure on quality if publishers opt for open access; on the other hand, the discipline for pay publication might discourage marginal papers. ❐

Free access is here

Bob Campbell

Bob Campbell has been president of Blackwell Publishing since 2001, after having been appointed managing director in 1987. He has authored and co-authored three books on publishing and a wide range of articles. He is a board member of the Publishers Licensing Society, chairman of the International Network for the Avaliability of Scientific Publications and is on the council of the Publishers Association.

Open access means free access to content, a service that most publishers offer already. The terminology has been hijacked by advocates of the pay-to-publish model because it sounds good and catches easily with journalists.

There are a number of factors that have driven this debate forward. First was the idea that the author benefits so the author should pay. Second, was a so-called journals crisis: “barrier to science”, rising prices, library cancellations, increase in titles, too many journals, too many pages. Third, was the “take back copyright” movement that was very strong in the USA and evolved into the rights of the author and then the rights of the taxpayer. Fourth, there is an argument that pay-to-publish has more impact and speeds up research.

As a publisher I find some features of the pay-to-publish model attractive: it allows flexibility to expand your journals if they prove hugely popular and it could make launching new titles easier

The most comprehensive survey of author opinion comes from the Centre for Information Behaviour and Evaluation Research at City University. Their study was called*, Scholarly communication and the digital environment — what do authors want?* and they had a response from 4,000 researchers from 97 countries, putting theirs above all the other studies recently carried out. They found that authors choose a journal because it offers targeted readership by their research colleagues; they are narrow casting. Few were aiming at the general public; they liked the imprimatur of quality and integrity of good peer review. However, the study revealed that 82 per cent knew little or nothing about alternative models or open access. Respondents showed no real interest in copyright; also revealed by surveys we have carried out at Blackwell. Unfortunately, there was also a lack of understanding, indeed a lack of appreciation, of what publishers do.

Is there a journals crisis? Fully 76 per cent felt that they have better access to journals than five years ago. The survey showed they were generally positive towards open access although they had reservations over quality, preservation and sustainability; but they had great resistance to author payment. “Can’t pay, won’t pay” was the message.

They also felt that fewer papers would be rejected and papers might become less concise as the market power shifted from reader to author.

So, is there a crisis? A report from the Association of American Universities sums up current feelings: “Librarians are suffering because of the increasing volume of publications and rapidly rising prices. The special concern is the much larger number of periodicals that are available and that members of the faculty consider essential to the successful conduct of their work.” That was published in 1927; the crisis claim is not new.

The position is probably better now than ever before. Articles downloaded from Elsevier, Oxford University Press and Blackwell double year on year. In 2002, Blackwell had 19 million articles downloaded; in 2003, 36.7 million articles and this year we are expecting about 65 to 70 million. If you price our list this year against last year, down to the number of articles available for the total subscription price, the price per article has gone up by 2.8 per cent: approximately inflation. Where is this huge price increase?

The long-term study in the US by Tenopir and King suggests that the use of articles is increasing. In 1977, the average number of articles read was 150; in 2002, it was 216.

The peak in new titles launched was in 1968; since then there have been fewer new titles each year. But the number of pages published has gone up by about 3 per cent per annum, which is about the same growth rate as that of the research and development community. All we are seeing is a steady increase in articles in pace with the growth of the author community.

Recently, publishers have improved access to their journals in the developing world, working with the International Network for the Availability of Scientific Publications (INASP) and with projects such as Health InterNetwork Access to Research Initiative (HINARI) and Access to Global Online Research in Agriculture (AGORA). The aim is to improve infrastructure through hardware and training as well as bring down the cost of content.

Does “author pays” achieve a higher citation impact? To date it does not seem to. A study from Thomson ISI compared 148 open-access journals in biomedicine with similar journals that are not author-pays and the impact factor was no higher.

What about self-archiving? One study compared papers that appeared in the *Astrophysical Journal* with papers that were self-archived in the main pre-print server in the subject as well as published in the journal. The latter achieved twice as many citations as papers that went straight into the journal without appearing in the pre-print server. Studies at Southampton University looking at other disciplines showed more dramatic findings: in physics, data suggest a 300 per cent boost in citations. So why should the funding councils or indeed the Wellcome Trust pay to publish when open access is working quite dramatically through self-archiving?

We are not going to achieve a complete “pay-to-publish” scenario. So what could we land up with? If the pay-to-publish movement is successful we could have a mixed system as it is unlikely that the subscription model will collapse entirely. This would give us far more complexity and greater expense and there would still be libraries Huge amounts of money that come into the system at present would be lost. For Blackwell around £3 million a year in subscriptions from the pharmaceutical industry alone would be lost but, more significantly, this industry spends £8 million a year on reprints from our medical journals. The overall outcome would be more complexity, adding to costs, but much less income from industry leaving us with a higher education funding problem.

There is another issue that the proponents of pay-to-publish have not addressed: who is going to administer a pay-to-publish budget? Are we going to have every university running its own internal peer review to decide that X gets £5,000 to be published in *Nature*, while Y gets £200 to be published in a low-level journal?

Finally, pay-to-publish proponents seem to have ignored self-archiving in institutional repositories, a system of free access which is already happening as outlined above. Self-archiving is getting science out to the taxpayer already, if that is what is wanted, at little cost. ❐

events

1 December 2004

Science and The City

Paul Myners, Chairman, M&S
Stephen Timms MP, Financial Secretary, HM Treasury
Dr Peter Goodfellow FRS FMedSci, Senior Vice President , Discovery Research, GlaxoSmithKline
ARM, Comino Foundation, GlaxoSmithKline (GSK) and HEFCE

23 November 2004

Strategic Subjects in Higher Education

Sir Howard Newby CBE, Chief Executive, Higher Education Funding Council for England
Pam Alexander, Chief Executive, South East England Development Agency
Tom Swan OBE, Chairman, Thomas Swan & Co Ltd
Engineering and Physical Sciences Research Council (EPSRC), Royal Society of Chemistry (RSC) and South East England Development Agency (SEEDA)

10 November 2004

Science Communication — are we making progress?

Professor Colin Blakemore FRS FMedSci, Chief Executive, Medical Research Council
Professor Kathy Sykes, Collier Chair: Public Engagement in Science and Engineering, University of Bristol
Fiona Fox, Head, Science Media Centre, Royal Institution of Great Britain
Defra, Pfizer and The Wellcome Trust

28 October 2004

Energy Policy — Security of Supply

The Lord Sutherland of Houndwood KT PRSE FBA, President, Royal Society of Edinburgh
Peter Mather, Director UK and Europe, BP
Kieron McFadyen, Technical Director (Europe), Shell Exploration and Production
Scottish Enterprise, The IEE and the Institute of Physics

26 October 2004

The Lord Lloyd of Kilgerran Award Lecture

Dr Richard Durbin FRS, Head of Informatics Department and Deputy Director, The Wellcome Trust Sanger Institute

20 October 2004

Public Health: imposing choice?

Derek Wanless, Inquiry Chairman, Securing Good Health for the Whole Population
Melanie Johnson MP, Parliamentary Under-Secretary, Department of Health
Lucy Neville-Rolfe, Company Secretary, Tesco
Professor Siân Griffiths, Senior Clinical Lecturer, Department Public Health and Primary Care, Oxford University
Gatsby Charitable Foundation and the Kohn Foundation

12 October 2004

Risk Perception and Public Policy

Sir John Krebs FRS, Chairman, Food Standards Agency
Professor Ian Diamond, Chief Executive, Economic and Social Research Council
Professor Nick Pidgeon, University of East Anglia
Defra, Fishmongers' Company and Pitchell Consulting

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