fst journal

The Journal of the Foundation for Science and Technology
(formerly Technology Innovation and Society)

Volume 17, Number 10, July 2003

Chemical and biological threats

Sir William Stewart: Nature, our worst enemy

Dr Pat Troop: Public health and protection

David Veness: Anticipating threats

Internet in business

Andrew Pinder: The Government record

John Leggate: Business strategies

Frances Cairncross: Driving social change

Foot and mouth

Sir Brian Follett: Formulating the future

Sir Ben Gill: Empowering farmers

Elliot Morley: Updating contingencies

Innovative engineering

Professor John Burland

THE FOUNDATION FOR SCIENCE AND TECHNOLOGY

THE FOUNDATION FOR SCIENCE AND TECHNOLOGY

The Foundation for Science and Technology
10 Carlton House Terrace
London
SW1Y 5AH

Telephone
020 7321 2220

Fax
020 7321 2221

e-mail
fstjournal@foundation.org.uk

Editor
Sir John Maddox FRS

Sub-editors
Charles Wenz, Trish Dent

Production & Layout
James McQuat

www.foundation.org.uk

fst journal
Volume 17, Number 10, July 2003

contents

Wind energy to fill the gaps?

The way that the UK government plans to meet its ambitious target of supplying 10 per cent of the nation's energy needs from renewable energy sources was revealed with the announcement (on 14 July) of proposals for licensing three of the world's biggest wind farms. The wind farms will consist of 3,000 towers between five and 75 miles off the coast in the Thames Estuary, the Wash and in an area between Morecambe Bay and north Wales. The 10 per cent target (or "aspiration") was included the white paper, *Our Energy Future — Creating a Low Carbon Economy*, published in February this year (*FST Journal* Vol. 17 (9), p. 2).

Blyth Offshore, the first offshore wind farm in the UK, with two 2-MW Vestas V66 turbines. Picture:AMEC Wind.

The new proposals follow on from an initial 17 fields, limited to 30 turbines each. One is under construction and the remainder are in various stages of development. The first round of licensing has been deemed a success and, unveiling the second round, trade and industry secretary Patricia Hewitt spoke in terms of hundreds of turbines powering one in six households by 2010. This would amount to an impressive 6 gigawatts of power — provided all the licences are taken up and fully developed. For comparison, one nuclear power plant will produce upwards of 2 gigawatts of power.

Environmental groups — Greenpeace and Friends of the Earth included — have welcomed the wind power plans, as have industry groups including The British Wind Energy Association. But industry sources are also concerned that the still small wind energy sector may be hard pushed to meet the government's schedule for the first phase of the plan. Companies will have just three months to submit tenders for leases in the three ocean areas, and the government is hoping that construction of the farms can begin in the next few years. ❐

British Wind Energy Association: http://www.offshorewindfarms.co.uk/
British government plans: http://www.dti.gov.uk/energy/renewables

Big money for nanotechnology

On 2 July the UK Science and Innovation Minister Lord Sainsbury announced an investment of £90 million over the next six years to help industry to exploit the commercial opportunities offered by nanotechnology.

The money is to be spent on collaborative research and a new network of micro- and nanotechnology facilities. The new investment is also expected to ensure additional industry and regional spending of the order of £200 million and will provide a boost to future advanced manufacturing in the UK.

Of the £90 million in extra funding, £50million is to go, on an Applied Research Programme that will support collaborative research and development projects between industry and the science base. And £40million is for new and existing facilities that will make up a UKMicroNanoTechnology (MNT) Network. The network will provide access to academic and industrial facilities throughout the United Kingdom.

A Strategic Advisory Group has been established to help guide the DTI's support of nanotechnology. It includes representatives from industry, universities, research councils and UK development agencies. In addition the government has commissioned a study by the Royal Society and the Royal Academy of Engineering to look at developments in nanotechnology to understand whether it raises any ethical, health and safety, environmental or social issues which are not covered by current regulations. ❐

Royal Society/ Royal Academy of Engineering study: www.royalsoc.ac.uk and www.raeng.co.uk.
US National Nanotechnology Initiative: http://www.nano.gov/
Japan and nanotechnology: http://www.nanoworld.jp/
European Union nanotechnology programmes: http://www.cordis.lu/nanotechnology/

Foot and mouth disease

The Department of Environment, Food and Rural Affairs (DEFRA) announced its Foot and Mouth Disease Contingency Plan in March of this year. The plan was laid in accordance with Section 18 of the Animal Health Act 2002, which came into force at the same time.

The plan sets out the operational arrangements Defra intends to put in place to deal with any occurrence of foot and mouth disease, and records the policy on which the operational arrangements are based. As a 'living document', it is expected that it will be subject to ongoing revision taking on the latest scientific advice, developments in policy and comments from stakeholders and operational partners. The plan will be reviewed at least annually to meet the provisions of the Animal Health Act. ❐

www.defra.gov.uk/animalh/diseases/fmd/contingency/contingency.htm

Rough ride for Scottish fishermen

A new fisheries policy for Europe came into force on 1 January 2003. The Common Fisheries Policy (CFP) replaced the previous regime which, in the words of The Earl of Selborne, speaking in November 2001 at the FST's discussion on fisheries policy, had "failed miserably" in its 20-year term (*FST Journal* Vol 17 (5), p. 3).

The new policy marks an end to the principle of maintaining a rough balance between fish stocks and catch. Instead a series of "recovery plans" is intended to allow depleted fish stocks to build up, necessitating drastic cuts in quotas and complete bans on fishing certain areas. It is hoped that the first such plan, which aims to restore cod stocks in 5 to 10 years, can come into force in January 2004.

During 2003, interim measures are in operation. Funds to subsidise modernisation of vessels have been severely cut. Instead there is a €32 million "scrapping fund", part of a series of emergency measures for scrapping fishing vessels.

Scottish fishermen have been particularly hit by the "15 days per month" scheme, brought in because their fisheries are, say the scientists, amongst those most risk. With such cuts being imposed, more attention is being paid to ensure compliance, backed by "name and shame" league tables in a new "Compliance scoreboard" (see weblink below). ❐

DEFRA: http://www.defra.gov.uk/fish/
European policy: http://europa.eu.int/comm/fisheries/policy_en.htm
Compliance scoreboard: http://europa.eu.int/comm/fisheries/scoreboard/index_en.htm

The Lord Butterworth

The Lord Butterworth, the President and past Chairman of the Foundation, died on 19th June. Lord Butterworth, despite his frailty in the past year, always tried to attend Foundation meetings and will be sadly missed. He was well known for his development of Warwick University, during his time as Vice Chancellor to become one of the highest ranked universities in the country. At the Foundation he was known as a robust chairman and put his stamp on the way in which the Foundation should conduct its meetings. An obituary will appear in the next issue. ❐

Nature: still our worst enemy

Sir William Stewart FRS FRSE

The threat to the UK from biological and chemical terrorism: what can be done and what is the risk?

Since 11 September 2001, the protection of the public against terrorist attacks has been at the centre of government concerns. On 8 April 2003, FST arranged a dinner/discussion at the Royal Society about the British Government's response. The speakers were Sir William Stewart and Dr Pat Troop from the newly formed Health Protection Agency, and David Veness from specialist operations at Scotland Yard. The discussion is summarised by Sir Geoffrey Chipperfield.

Sir William Stewart FRS FRSE is Chairman of the Health Protection Agency. He was Chief Scientific Adviser to the Government from 1990 to 1995 and the architect of the Technology Foresight programme. Before that he was Chief Executive of the Agriculture and Food Research Council from 1988 to 1990. He recently chaired the independent expert group that reviewed the possible health risks of mobile phones.

I begin with this reflection: the biggest bio-terrorist threat remains that from Mother Nature.

Global travel brings global diseases to unsuspecting populations, as in the current SARS outbreak. Remember that Spanish 'flu killed more people between 1918 and 1920 than were killed in the First World War, that AIDS continues to increase in Britain and is rampant in southern Africa. We also now have bacteria resistant to antibiotics and viruses resistant to antiviral drugs.

Last year there were 750,000 flights into Britain carrying 72 million passengers. In a sense, the 55 million people living here now risk exposure to the bugs of 6.3 billion people worldwide. We are certainly no longer isolated on an island, and in any case we already have a rich stock of infectious agents: ''flu, *E.coli* O157, *Chlamydia*, TB, hepatitis and dozens more. And now, on top of that, we have bio-terrorism. That puts the new threat in perspective.

I shall touch on three questions. First, what is the perceived threat? Second, how prepared are we? Third, what of the future?

Bio-terrorism is low-tech terrorism. Sophisticated equipment is not required to generate the organisms. Indeed, bio-terrorism is not new: Hannibal used it, Alexander the Great used it, so did the Mongols.

My personal experience of anthrax is relevant. In the early 1940s, an island off the West Coast of Scotland was used in tests of the effect of anthrax on animals. The exercise was provoked by evidence that Germany and Japan were considering its use, so a plane dropped a bomb laden with anthrax spores on an island off the coast inhabited only by sheep. Unfortunately, they forgot that the peat along the West Coast of Scotland was several metres deep, so that the sheep were spared and the anthrax spores lived mostly at depth below the surface. So they carried out further tests using spores released from a gantry and carried downwind.

More than 40 years later, it was decided to decontaminate the site. I chaired the advisory committee overseeing the job. The technology then was simple: there was a stretcher to carry materials up from the boat to the site and to transfer anybody who died back down again. The vegetation was burnt off and the contaminated area treated with 1 per cent formaldehyde in seawater. Then 40 sheep were put back on the island to graze for several months. I used to give a talk entitle, "We counted them on and we counted them off", but a few weeks later one of them died of something that it had picked up on the mainland.

Even for that operation, we needed a robust multidisciplinary team. There were a bacteriologist, a clinician, a soil scientist, a microbiologist, an epidemiologist and a vet. The team calculated the risk of inhalation anthrax from an analysis of the deaths of wool sorters exposed to much greater concentrations of airborne spores, as well as the risks of ingestion anthrax and of cutaneous anthrax through cuts or abrasions. Then we were left with the problem of what to do with potentially infected animals, with dead animals, as well as that of how you communicate with the public.

I have described this experience because it is probably the only experience of the kind that we have. It's one we ought to think about; nothing much has changed except that we are now concerned with people, not sheep.

Chemical terrorism is not difficult either: it is low-tech. The nerve gas sarin and the toxin ricin are easily made and transported. Then there is radiation terrorism, which does not require a large nuclear arsenal, a dirty bomb will do.

But all of us should think about the ease with which illicit substances are smuggled into Britain. In 2000, drugs with a street value of £789 million were seized, which shows what might be done with the materials of bio-terrorism. In the 1940s, the use of anthrax in bombs was being touted; today it has been appreciated that overt use is actually unlikely: the source can be immediately tracked down and retaliation effected.

Covert use is another matter. Covert delivery, in foodstuffs for example, may be easily arranged. Concealment might be assisted by the use of antibiotic-resistant bugs, slow viruses (which take months or years to cause disease), possibly oncogenic viruses (which can cause cancer), zoonotic diseases that may transmit to people. There are plant diseases as well.

So how well prepared are we? I believe we are probably the best prepared country in the world. Certainly, we are one of the four best prepared countries. We have, for example, excellent facilities at the HPA Centre for Applied Microbiology and Research (CAMR) at Porton Down in

Wiltshire. That has a hugely experienced group of people that, among other things, runs the UK anthrax reference centres, specialist pathogen diagnosis facilities and the best containment facilities in the world for dealing with viruses like *Ebola*.

At HPA Colindale, we also have the Central Public Health Laboratory; that processes over 200,000 specialist reference tests every year. We also have there the Communicable Disease Surveillance Centre which, within 24 hours of the first outbreak of SARS had issued an alert to all doctors in the UK. Within 72 hours they had a strategy in place to deal with such infections.

On the radiation side, there is the National Radiological Protection Board (NRPB), due to become part of the Health Protection Agency. The NRPB is not just a think-tank, but a practical means of monitoring radioactivity in Britain and protecting us from it. They have been instrumental in helping the Department for Environment, Food and Rural Affairs to set up an incident monitoring network, with gamma-monitors mounted across the country as well as a system for dealing with emergencies; my colleagues, who follow me, will tell you what else is in place. My purpose is simply to say that Britain is as well prepared as any other country in the world.

On the future, I have some thoughts to share with you. First, good surveillance and intelligence on a global basis is the key: prevention is better than cure. Second, we need assured information electronically and quickly available in everything we do: horizon scanning, surveillance, models, diagnosis, prognosis, advice and communications.

We also need to focus on upgrading our protocols to make them clear, unambiguous and joined up. They need to work irrespective of personnel involved. We need better links with the huge untapped intellectual resource in our universities, which should be better targeted to support public health protection. And we need to be alert without overstimulating the fear factor.

On the research side, there are lots of problems to be addressed. Is there, for example, a generic short-term immune stimulant to give some breathing space until an unknown agent has been identified and treated? Are we naïve enough to believe that advances in human genome research will not spill over into the defence sector? Will it ever be possible to use biological agents to target specific groups of people? Does that have implications, for example, for the workforce-mix at key installations?

Discovery consists of seeing what everybody has seen and thinking what nobody has thought. Dilemmas such as this will not go away. The cultivation of caution and the avoidance of complacency must be our goal. ❐

discussion

Research control. A principal theme in the ensuing discussion was concern about the ability to control chemical and biological research so as to inhibit its use for terrorist activities. The boundary between civil and defence usage of materials or substances was porous; much science was capable of dual use, and we needed to think carefully about whether control was possible, or whether the best that could be done was for scientists to have some code of practice. Are there circumstances when research should not be published because of fears of misuse? Even where efforts for control, such as the Chemical Weapons Convention had been put in place, and signed by 150 countries, there was a lack of political will in enforcing it.

Melding public health and protection

Dr Pat Troop CBE

Dr Pat Troop CBE is Chief Executive of the Health Protection Agency. She was previously the Deputy Chief Medical Officer with particular responsibility for public health. She is also a Visiting Professor at the London School of Hygiene and Tropical Medicine. Most of her career has been in public health, mainly as a public health doctor, but also a chief executive and with roles in universities.

This may be the first public appearance at a conference of the Health Protection Agency (HPA), as we are only a week old. Good emergency planning must be built on what we know and are familiar with.

If we were to have an anthrax problem, the response would be similar to an outbreak of Legionnaires' disease, as they are both point-outbreaks, and treatment of patients for a deliberate release of a chemical is similar to an accidental spill. If we were unable to manage known potential incidents, we should certainly not be able to respond well to novel threats. By setting up the HPA we are creating an infrastructure the better to tackle existing problems that we can also use to deal with problems we have not yet come across.

Health protection is about human health. The role of the Health Protection Agencies is to look at the health impacts of infections, poisons and chemicals as well as radiation hazards. One of our roles is to give advice, which we expect to be enhanced in value as we weld together the great diversity of our expertise. But we also deliver services, notably to the NHS in its response to health impacts. To be credible to the public it is important we are open, impartial and authoritative.

We must also act quickly. If there are emergencies, we must be able to respond immediately. I was pleased that on our very first day, the head of the division concerned was able to respond within 12 minutes to a report of an unidentified white powder. (We get such reports frequently.) We have done well on SARS. We have also to be alert to new threats.

We need to improve our knowledge base and to make the evidence we have accessible: there is a lot of education and training ahead. We see part of our role as that of a resource for others.

The HPA, when fully integrated, will

be an amalgam of existing agencies. Sir William has listed the chief components. As well as the national divisions we have a range of local and regional staff in infectious disease control, in emergency planning and many with expertise in chemical and environmental issues. Our aim is that they work together to meet community needs.

We cover England and Wales. In Wales, the local staff and laboratories report to the National Public Health Service for Wales. In England, we have nine regions that coincide with the Government's regions, which should strengthen contingency arrangements. We have 42 local teams, each of which has a clear identity and focus. In the north-west, where the teams have been up and running for some time, team members say that when they were identified as the Health Protection Team, local people began to come to them with questions and suggestions. Now they have set up local websites. We are creating these local identities that all the other agencies can easily come to. Our goal is to build up capacity and to make sure that everywhere we have standard protocols and responses.

We are building on the current responsibilities of the national agencies. CAMR is now HPA Porton Down, but we have also placed the new Emergency Response Division there. The Communicable Disease Surveillance Centre and the Central Public Health Laboratory, which is now part of the Specialist and Regional Microbiology Division, are at HPA Colindale, the National Focus for Chemical Incidents and the Regional Support Units for Chemicals are now part of the Chemical, Hazards and Poisons Division. We now manage the contract for the National Poison Information Service. We are working closely with the National Radiological Protection Board, based mainly at Harlow. We have a small central office in London.

How does HPA fit into the government machine? We must work in partnership with many other organisations, but especially with the NHS; both of us are accountable to the Department of Health. In emergency planning, our international networks are crucial — SARS was picked up very quickly by that means. But we also work with the Food Standards Agency, the Environment Agency and the Health and Safety Executive, other emergency responders including the police, various government offices and local authorities. We must also strengthen our links with academic centres. We see ourselves as part of a coordinated response.

I should clarify the responsibilities of HPA in relation to the NHS and the Department of Health. The department is responsible for overall coordination in a major emergency as well as for liaison across government. The department would also take on liaison with governments overseas. The preparation of major incident plans, however, is the responsibility of the NHS, whose trusts are required to prepare major incident plans.

Our role is to support both the Department of Health and the NHS in preparations for an emergency with guidance and expert advice, to coordinate training and scenario planning, to provide expert support in an incident and to coordinate the overall health protection response. If, for example, a clinician suspected a patient had anthrax, they would contact one of our local teams who would contact us nationally and so trigger an overall response.

So, what are the potential benefits of our existence? The chief benefit is that we will be a 'one-stop shop', allowing all our resources to be deployed in response to a triggering event anywhere in the country. Because the local teams are all part of the same organisation, we should be able to use resources much more flexibly than when they were employed by 80 different organisations. We should also be able to anticipate problems better and do more pointed horizon scanning, providing early warning systems to pick up problems quickly. We should be an authoritative and impartial source of information and advice for the public.

We should be able make an integrated response to emergencies. With training, we shall have a more knowledgeable and skilled frontline staff; we shall also augment our research.

We shall not achieve all these benefits tomorrow. But we have a comprehensive programme for the next five years, during which we shall continue to strengthen our already much improved infrastructure for health protection by building on what we know. We are a large multidisciplinary organisation, but one that is fully aware of its close partnership with all the other agencies, nationally and internationally. I hope that people will begin to see who we are, understand what we are there for, and begin to have confidence that we shall deliver. ❐

Anticipating an enduring threat

David Veness CBE QPM

David Veness CBE QPM is Assistant Commissioner, Specialist Operations, at Scotland Yard. He joined the Metropolitan Police in 1964. He is presently responsible for policing serious, organised and international crime and, since 1994, for protection, terrorism and security. In the course of his service, he read law at Trinity College, Cambridge.

I will round out the story you have already heard by talking about the nature of the threats we face, which are an enduring danger. The new threshold of global terrorism is marked by three novel characteristics. First, there is the range of the explicit target nations. Second, the geographical span of attacks (as the past few months remind us). Third, the harmful terrorist methodology we confront.

There are also three levels of threat, of which the most dangerous are the attacks of high impact, marked by the intent to commit mass murder, such as those mounted by al-Qaeda itself. Although there has been welcome progress, particularly in Afghanistan, there remain 4,000 kilometres of porous border through which this threat continues to manifest.

The second tier of activity is that of groups associated with or modelled on al-Qaeda. The linkages between these groups are closer than used to be the case. It is relevant that terrorist groups may have a common experience of combat in the Balkans, Chechnya, Georgia or elsewhere that marks the style with which they operate. So there are emerging regional models of terrorist activity. In Britain, to date we mostly see the impact of terrorist groups associated with North Africa that have been active in France and Western Europe over the years.

The third tier of terrorist activity is that of small groups and individuals, which are no doubt inspired by — and even linked with — the groups I have described, but which have their own motivation. I fear that this will be a growing category.

Among target nations, three are in a league of their own. The United States is the centrepiece of all of the statements by al-Qaeda, but Israel and the United Kingdom are also mentioned in the same documentation. At the end of last year, published statements and the broadcasts of al-Jazeera, anticipating the conflict in Iraq, also mentioned Canada, Australia, France, Germany and Italy, either because of their previous involvement in Balkan conflicts, in counter-terrorist operations or because of specific issues — the Algerian question and its linkage to France, for example.

The geographical spread of terrorist activity is unprecedented. Look at what has happened recently. In October 2002 there were attacks on a French oil tanker at sea off Yemen, on US military in Kuwait, on innocent tourists, predominantly Australian, in Bali and then dual attacks on Israeli targets – a tourist hotel and an airliner in Mombassa.

In all cases, the objective was high public impact. Simultaneous attacks, as on 9/11 itself, ensure that. So do suicide bombing and man-portable air defence (MANPAD) missiles. So would chemical, biological and radiological weapons, as would improvised but serious explosive devices. A MANPAD attack was feared in West London only a few weeks ago. There were clear examples of plots across Western Europe during the Christmas and New Year period to use chemical and biological agents. And there has been a series of bombs without warning in South-East Asia during last year and this.

The challenge that confronts counter-terrorism is complex. The objective is to damage terrorists' plans before they can damage the public. What we know is that the mounting of an attack must be a deliberate process. Having chosen a target, the perpetrators must position the people required and their equipment, make detailed plans locally, reconnoitre the target, make final preparations and then deliver the attack. The authorities' counter measures include border control, monitoring movement near putative targets, hardening targets and the use of logistical means to deny terrorists the ground, their people and equipment, accommodation, transport, storage and finance.

The lesson of the past 19 months is that we presently operate closer to the point of attack than in the past. During 30 years of Irish Republican extremism, we were often able to recognise terrorist activity in the early stages, largely because we had the advantage of geographical proximity — in South Armagh or Dundalk, for example. But if the foe is spread across the geographical range, lawless and inaccessible zones included, it is likely that we shall be dealing with counter-terrorist activity much closer to the point of attack. All of us engaged in counter-terrorism must strive to interdict, on the basis of intelligence, at an earlier stage than is possible at present.

The counter-terrorist challenge also requires that we seek to understand and anticipate the enemy in more detail. He (or she) will make ever more imaginative use of technology; so must we in our horizon scanning. That is how to enhance the defences of all target countries.

To be specific, chemical/biological attacks would entail a mix of crisis incident management and of dealing with the consequences. Our ability to assess and to analyse such events accurately and quickly would have an important influence on the public perception of how greatly it had been harmed.

But we must also be transparent. During the white powder episode, immediately after 9/11, we were bedevilled by the media coverage and asked leaders of the media to be more socially responsible: the pictures of people in decontamination gear were adding to the problem. But the media people said, "If you are going to give us these wonderful pictures of people in moon suits, they are what we are going to print." We have to live with that reality.

We also have a great deal going for us. There is a grand alliance of activity that has developed in the 19 months since 9/11. Political will is critical, diplomatic initiatives are self-evident, international law enforcement is being rapidly strengthened and the combined effects of finance ministries and UN directives has lent a new edge to the financial attack on terrorism. The role of international aid in addressing the root causes of terrorism is being discussed. International intelligence moves at a much quicker pace, military action has been effective, notably in Afghanistan: that combination of multi-agency, multinational and multidisciplinary activity is currently the greatest asset of enhanced counter-terrorism.

I was invited to conclude with a wish list. Here it is. Three things, please: First, better detection and identification methods, especially in the chemical/biological field, that work in the urban environment and are as nearly as possible immediate. Second, personal protection for those who work in the emergency services to enable their continued function. Lastly, on decontamination, we need a move into the 'post-bucket era'. Sir William Stewart has told you how, as recently as 1986, they decontaminated workers from that anthrax island off the Scottish coast by means of a bucket with holes elevated above ground. The emergency services are looking for 'post-bucket modernism'.

I regret not having been able to give a more optimistic analysis of the future threat of international terrorism. Realistically, it will change little in the next five years. Our challenge is an enduring threat, but an alliance of skills and talents can reduce the risk to the public. Much has been done in the 19 months since 9/11, but much more remains to be done. ❐

discussion

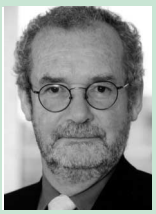
Resources. There was also concern about whether adequate resources were being made available for the struggle against terrorism and whether they were being appropriately targeted. At present the HPA would be cost-neutral, with a budget of £178m (£100m government funding). It was very doubtful if local authorities were adequately staffed and resourced to carry out their functions and respond to emergencies: the London arrangements needed urgently to be rolled out to the rest of the country. Surge problems also concerned speakers: could the NHS possibly cope with, say, 10,000 casualties from a catastrophe; how could information be disseminated if systems were blocked by panic calls? The answers lay in integrated systems – networks of hospitals, pre-emptive information delivery, and speed of response.

Finally, there had been great play about communication and information, but who knew about the HPA? Why had there been no ministerial campaign to make its establishment known, at a time when the public would have welcomed reassurance about safety? An opportunity for helpful publicity had been lost.

The Internet in business and government

Andrew Pinder

How is the internet changing business and government?
Representatives from government, business and the media met at the Royal Society on 27 November 2002 for a dinner/discussion meeting on the above topic. The discussion is summarised by Jeff Gill.



Andrew Pinder is e-Envoy to the Government, in the Cabinet Office and works alongside the e-Minister, Patricia Hewitt who has overall responsibility for the Government's e-agenda. After 18 years in the Inland Revenue, where he became Director of IT, Pinder moved to the private sector; first the Prudential Corporation, before joining Citibank Investment as head of European Operations and Technology.

How is government handling the challenge of the internet? The internet is a truly transforming technology, opening up real opportunities. Stelios Haji-Ioannou of easyGroup, the creator of easyJet, told *The Independent* recently that he felt the internet had contributed more to mass air travel than the jet engine. Hyperbole perhaps, but the internet and what it makes possible is truly a transforming democratising piece of technology. As for the Government's use of this technology, the bottom line is that government is not taking full advantage of the internet and its associated technologies. I would like to discuss why this is and how we can improve matters.

In a recent benchmarking exercise we compared our use of the internet to that of other G7 countries, and to Sweden and Australia, two notable users of the knowledge economy technology[1].

In terms of creating an environment for the e-economy, the knowledge economy, the UK ranked second behind the USA in that group of nine nations. In a number of areas, including the willingness of our citizens to take up this technology, we are about third or fourth in the list, behind Canada, Australia and Sweden. In the use that people make of government services across the internet, we are way down, about sixth out of that group of nine countries.

When you start looking at the use that citizens or businesses make of other benefits of the technology— access to banking, for example, or access to other information online, the performance of our businesses in accessing and using the internet—more businesses in the UK trade online, per number of businesses, than do businesses in the United States. So businesses are up for it, citizens are up for it in relation to other parts of the e-commerce agenda, in banking online and so on, but in government, they are not.

If you look at the number of people who are online in the USA and the percentage of those people who are using government services online, about 75 per cent of the 65 per cent of people in the USA who access the internet regularly also access government services. In the UK, about 11 per cent of the total population access government services online, which translates to just over 20 per cent of those people who regularly use the internet. If you compare that with the number of people who bank regularly using the internet, that 11 per cent compares to about 40 per cent, so people will do their banking on the internet, but they won't access government services on the internet. That tells me that government has got it wrong.

Delivering government

Why are we are failing to deliver government services properly online? First of all, we are not always failing. There are some areas that deliver services very well via their websites — the Ordnance Survey and the Public Records Office, apart from some glitches, do a great job. The Foreign Office runs an award-winning website which is heavily used, particularly in times of world crisis; at the moment, people are getting lots of travel information from that website. There are services such as Worktrain, an employment service website, where people can look for jobs which is very, very heavily used. NHSDirect, a great service, could be better but it is a great service just as it is.

A dozen or so out of the fifteen hundred government websites that are active and of the two and a half thousand registered government URLs are doing a good job. What of the rest? Part of the problem with government, of course, is that it is a monopolistic supplier and it is not subject to competition. The cold wind of competition has not blown. But that doesn't explain the success of other countries in delivering their services online. Canadian citizens have access to some of the best web technology and they use it very heavily – 90 per cent of Canadians regularly access government information online. Similarly, 80 per cent of Swedes who are online regularly use government information online. In some countries, particularly Sweden, more people are accessing government information online than are banking online but the reverse is true in this country.

Something is happening in the UK that is not related to the lack of competition because other governments have the same issue. What are we doing

wrong? Part of it is unresponsiveness — it is difficult to change governments the world over, but it is worse in the UK. Part of the problem, I think, is the capture of many government departments by their distribution channel. Many government departments are big high street departments: the Department of Work and Pensions, the Inland Revenue, Customs & Excise. All are dominated by their distribution channel, the local offices with large numbers of staff who deliver services to the public, often working very hard in very difficult circumstances, but they and their management regard that as the only way of delivering these services. Therefore the way products are made, the way the services are designed, is for delivery through this distribution channel.

Government has set me a daunting target: the delivery of all government services online by 2005. We need to get these services not just online, but online in a format that is useful to people. We need to empower our citizens so that they feel they have some sort of control over the information they obtain from government. In the past, we have put many barriers in the way of sharing information around departments and those same barriers get in the way of us giving a decent, joined-up service to customers. There are sensitive privacy and data protection issues that need to be dealt with, but the Government's information system should be able to deliver to its citizens a coherent customer-focused service: the information they need, when they want it.

A further issue is the one of the digital divide. There is a feeling that it is all very well putting all this money and effort into delivering these services, but what about all the poor people who are, on the whole, the greatest users of government services and, on the whole, are not connected to the internet? What about older people – only about 18 per cent of people over 60 are connected to the internet compared to about 85 per cent of people under 25?

The very act of delivering a service across the internet is an enabling technology that allows other people to deliver your services for you. The role of intermediaries and how government might use intermediaries in the future starts to become important. Those intermediaries might range from people like the Citizens' Advice Bureaux, who deliver a very good range of services to about 5 million people a year, through to companies such as Tesco's financial services, and anyone else who might want to do it. Now, when you start bringing those intermediaries into play, you raise a whole range of other issues. What are the rules of engagement around an intermediary? What access do they have into government and how might that access be limited, how might it be controlled?

The Government as a monopolistic supplier is illustrated by the famous story of the fishing licences. A company came along and said that it would like to offer, as an alternative to the Department of the Environment, to issue a fishing licence. In the past you went to the Environment Agency or even to the Post Office and bought an Environment Agency fishing licence. This company came along and said that they would like to offer fishing licences across the internet but, to do that, they would need to have access to the Environment Agency's database. We didn't allow that to happen but the company offered the service nevertheless but with some limitations around it. Then the Environment Agency got into the act, put its own service online and the other company had to stop operating. If Microsoft did that, they would be up in front of the Department of Justice or the Competition Commissioners immediately because that is predatory competitiveness. We need to deal with these sorts of issues and set some rules about how we engage intermediaries so that they are not disposed of through anticompetitive behaviour by government departments.

Regulation and democratisation

What role can government play as a regulator in all this? Part of my job is to try to coordinate government so that it doesn't trip over itself in relation to this area. There are a lot of issues around this. Governments, as you often see, tend to shoot from the hip, reacting very quickly to something that has happened. It does this by trying to do things in the old-fashioned ways as if it could still influence things. An example would be the famous case of the twins who were adopted over the internet from the USA. The Department of Health's understandable initial reaction was to try to put some regulations in place or propose some regulations to ban the advertising of children across the internet, but this is not a deliverable piece of policy. It might be a policy that we all heartily support but it is physically impossible to do; dropped because it was just undeliverable.

Government has to start learning some new rules about what it can regulate and what it can't regulate. It has to get over the fact that it can no longer have complete control and that is a very big lesson that government has yet to learn.

Finally, in the area of dis-intermediation of politicians, some might regard it as a good thing but this is not necessarily so. We have recently produced a consultation document on e-democracy. Everyone thinks about this in terms of voting but it is much more about the whole process of how the internet is changing the way that society communicates and discusses issues, the dangers it poses to a representative democracy such as our own and the opportunity it raises for a representative democracy if we seize it properly and use it but the dangers if we fail to seize and use it.

I was struck, at the beginning of last year, just after I came into this job, by a Sky poll of what people thought of the Chancellor's pre-budget report and the proposals for the Budget. This poll was

discussion

Freedom and control. It was observed that much of modern technology enabled the state to control its citizens, but the internet was seen as providing a last bastion of intellectual freedom through the anonymous transmission of information. Was this really so? The sheer scale of the internet and the availability of encryption made it hard for any government to control.

There was an emerging issue of identity theft via the internet (and, indeed, through other means of communication such as telephone and fax) and regulatory regimes had not yet worked out how to deal with it. A role for the UK would be to set appropriate standards.

There were other issues about the identification of individuals on the internet. If the system recognised not the individual but the machine, an academic who could reach journals via the official computer might have a problem when working from home. In response it was said that there were a number of solutions: one speaker produced a keyring that generated ever-changing internet addresses through which he would be recognised on any machine. The problem was not one of technology but of people's willingness to adapt to change and political will.

carried out using a completely unrepresentative group of people and then was presented on Sky as being an opinion poll of what people thought. There was no cushioning of the facts, no debate around it, no opportunity for politicians to act as the shock absorber to put things into context, as they so often do. This is a real issue for our democracy and something in which we have to engage.

Some politicians are starting to understand the issues here, but many of them continue to bury their heads in the sand; they are saying they are not going to disclose their e-mail addresses because they would get lots of e-mails from their constituents, which they probably would. We have to find ways of using this technology to engage people much more fully in the democratic process and use it usefully rather than allowing it to be hijacked by people, such as the Sky instant poll, something we are starting to call 'mandate theft' as a concept.

How can we stop that happening? How do you engage politicians proactively to stop them being dis-intermediated from the whole process just as the Prudential door-to-door insurance salesmen were 'dis-intermediated' in 1990 by people buying directly? There is a danger that politicians themselves will be dis-intermediated! It presents a clear danger to democracy. ❐

1. This work and other background material for this debate is available at www.e-envoy.gov.uk

Business and the internet

John Leggate

John Leggate is Chief Information Officer and Group Vice President, Digital Business at BP. He joined BP Exploration in 1979 having worked in the early years of his career in the marine consultancy and nuclear industries. He is a chartered engineer and a graduate of Glasgow University where he read Engineering.

Internet technology had something of a false start in terms of the business community. Exaggerated expectations culminated in the dotcom boom and bust in the 1990s, which undermined confidence in the technology. But since then the growth of the US economy has shown the true impact of the technology. Between 1973 and 1995 the average productivity rise in the United States was 1.77 per cent per year, but from 1995 through 1999 it was 2.64 per cent on average. Independent studies predict that the growth of economies nowadays will mainly come through investment in IT and the internet.

Our experience of digital technology at BP in the past four years has come at a time of rapid growth. In that time the company has pretty well doubled in size but, more than that, its reach has become truly global. More than half the company is in the United States and about a quarter in the UK. To make BP capable of performing efficiently worldwide and to continue adding value through the various mergers and acquisitions, we need full transparency of our business performance end across the globe. To that end it is now possible at any moment in time for a BP employee to be in contact with any other BP employee anywhere in the world. Not only that, we can use the system to interrogate the physical assets, our finances and costs and evaluate risks in a very short time.

To cope with all this, BP is committed to becoming a deeply digital company, where people have the privilege and the obligation to know what there is to know at any point in time, to learn of any transaction you need to do on the web. That actually is the company ethos. As we do it, we are driving more and more value and finding more reserves of oil and gas by using new technology, cutting production costs year-on-year, often attributed to the impact of the internet. More fundamentally, our workforce is much more mobile nowadays than it was before and they can also operate where they will, around the world, as and when they wish.

Dependence on the web

The benefits of this technology, then, are plain to see. But the web is no longer simply a tool simply for productivity, it is a vital piece of business infrastructure, crucial to architecture, crucial to efficacy and crucial to security of the company. In addition, companies have become very dependent on their IT infrastructure and increasingly it is the public infrastructure rather than a company-owned system that holds multinational companies together.

This raises the issue of security. There is no single authority in charge of the

discussion

Security. It was suggested that companies faced a different security issue as internal networks were increasingly being superseded by the use of the public internet for communications within organisations. Companies now had to decide what information should be made public and what safeguarded as intellectual property. One approach recommended was to make everything public apart from a few carefully selected issues. Trying to keep everything secret would not work.

internet, no-one is accountable for it, it has a life of its own, it is growing day-by-day day, week-by-week. But one thing that we know about the internet is that it is a very complex network and it was designed from the first for resilience. Our experience tells us that it is still very vulnerable at key nodes and hubs, like most complex networks. If you disable the key nodes and hubs, the whole system can be undermined.

We now see that society as a whole has become very dependent on the internet. A few examples have highlighted the potential for digital failure to cause havoc. Sometimes it has been a technical failure that has caused problems, but more commonly it has been corporate failure, as was the case with Worldcom. This dependency seems to have crept up ever so quietly on us, and raises an important question: should we, in the UK, be conducting a more fundamental review of the robustness of our national infrastructure both nationally and internationally?

UK e-business

Are we doing enough to ensure that the UK is a world leader in e-business? Andrew Pinder has summarised the results of the recent report on UK performance in the field. On the face of it the findings of this 'health check' are encouraging but there are many areas where we 'must try harder', including the deployment of broadband, where we have lagged behind Germany, France and Italy. Comparisons, however, were with the G7 countries. Although we are getting fitter, I am not sure that we know which race we wish to be in, or who is the competition. As I travel around South Korea, India and China, I do wonder whether we are missing the point.

On my trips to India, some things become very apparent: the government and private sector are working well together to establish India as a burgeoning and booming IT area and they are attracting a growing tide of investment from Europe and the United States. India is the world's top IT outsourcing haven today. In the whole world, one-third of software engineers are Indian. In Silicon Valley, there are 200,000 Indian engineers working and similar models are now showing up as we look at Ireland, Canada and Eastern Europe.

As a nation we could certainly do more to compete with such competition. Take broadband for instance. It isn't just a simple issue of technology. My assertion is that, for each technology revolution, there is an enabling infrastructure. For the steam engine, the infrastructure was rail and for the car, the highway and, for a modern digital economy, it is broadband connection to the internet backbone. Broadband is much more than being about a high-speed activity, the big issue that it brings us is being always on, allowing us to access existing systems and processes and have them all working and talking together seamlessly.

The report also refers to other areas where we could improve — appropriate incentives from government, tax regimes, regulatory frameworks, public and private partnerships. And there is something else missing that I spotted in my journeys to India, the issue of having internationally recognised accreditation for our people and our processes that sell in the global marketplace. There are many systems out there that are acknowledged to have given India pride of place. Ultimately, this issue is about us being recognised as a national digital capability for our people, both in number and quality compared with the competition and I would say that the real competition is from India, China and South Korea.

To sum up, there are four areas we should concentrate on. First, we must ensure that the national and international digital infrastructure is accorded the same priority, security and resources as other key elements of public infrastructure. Second, in terms of national risk management, we need to map our deep dependency on digital technology, know its full extent, identify the critical nodes and points of vulnerability and understand the critical national risks associated with these failures so that we can better harden our environment and develop contingency plans. Third, we must recognise that the corporate intranet is a thing of the past. For many years, companies like BP have invested in their own private networks but this will not continue. Global companies are increasingly looking to national infrastructure in the public domain as the place in which to do business. Finally, we need to get the message over that all businesses, and government, can benefit from embracing the internet.

If we want to make the UK the number one place in the world to do e-business, if we are really serious about this issue, we will need to see further acts of leadership from government, from industry and from academia to make it happen. ❐

discussion

Government services. The Government had set itself the target of making its services to the public available online by 2005 and was more than half way there. Projections for the remaining services tended, however, to be hockey-stick curves, with a lot to be achieved in the last few months before the deadline. It was not necessarily sensible to make all government services available online. For some it would not be appropriate, for others it would cost too much. There would be no point, for example, in making licences for burials at sea available on line, as very few were issued. This view was challenged, however: if the issue of such licences were offered to the private sector, someone would be sure to rise to the challenge and create an unforeseen boom in burials at sea.

Other speakers called for a wider change of attitudes. The technology was improving so fast that the real constraints on the use of the internet were social, and what mattered was how organisations related to the public and to their own staff. Civil servants were used to doing things to people, not receiving things from them, and played safe. The Government was keen to use the internet to convey its messages but was not so interested in what people thought. Individuals would use the internet when it was to their advantage to do so and would use Government services when they wanted something.

It was suggested that the government ought to give computers and broadband internet access to people with low incomes who were the major users of some government services. This would pay for itself in efficiency savings for the Government and, if online voting were introduced, would strengthen democracy. In reply it was said that little research had been done on the benefits of free access to the internet for citizens, and that such assessments as had been made in the UK had not produced a convincing case. Instead the government had gone for promoting public access to shared computers in UK Online centres and public libraries.

The internet as a driver of social change

Frances Cairncross

Frances Cairncross is chair of the Economic and Social Research Council, Management Editor of *The Economist*, and a regular presenter of BBC Radio Four's Analysis programme. Her latest book, *The Company of the Future*, has just been published. She has written two books about the environment and is also the author of *The Death of Distance*, a study of the economic and social effects of the global communications revolution.

The growth of the internet has been an engine of social change, as have other new technologies, in particular communications technologies. Communications technology has driven a great deal of change over the past three centuries. We are now experiencing the third in a succession of huge changes that have transformed our lives.

The first of these was a change in the cost of transporting goods. In the 19th century, Europe's population grew faster than ever before because technology reduced the cost of transporting goods — steamships and the railways and their contribution to bringing grain from North America.

In the 20th century, the big change was in the cost of transporting people. The motor car gave ordinary people the degree of choice about what they could do that had previously only been available to the wealthy. The rapid fall in the cost of long-haul air travel made possible the running of multinational companies, the development of tourism into the world's largest industry and now, of course, migration from the poor world to the rich on an absolutely unprecedented scale.

Now we see the internet and related technologies delivering a fall in the cost of transporting ideas, information and knowledge. These changes will dominate the years ahead of us.

When the internet came on the scene in the mid 1990s, many people assumed that its main effect would be on the way in which companies related to individuals. We heard a lot about business-to-consumer retailing and about how we were going to buy everything, from books to groceries, with a click of the mouse on the internet. That has only partly happened; we buy some books from amazon.com but Waterstones and Hatchards in the high street are still doing nicely. Rather, the main effects have been within companies, affecting the structure of companies and, in future, within government, affecting the structure of government.

Let me give you a couple of examples of how change has taken place within companies. A growing number of companies buy at least some of their supplies through an online catalogue which tells their employees what they can buy and where and how and delivers the orders electronically. This allows the company to make considerable savings through bulk purchasing, but it also creates a uniformity within companies and, by doing that, it also makes such markets much harder for small producers to get into.

Another effect is the way in which companies are increasingly able to see what is happening across the whole of their supply and distribution chain at one time. The pioneer has been Dell Computers in the United States. Someone wanting to buy a PC from Dell can click on an online order form and that order is then accessible to Dell's own suppliers. They can see, as it were, through Dell directly to the customer and can begin to produce what is wanted as quickly as possible. So Dell has a much lower amount of supplies in its stock than do other companies in the computer business. When you are selling something that is falling in price all the time, cutting your stocks is very important.

Changing the way we operate

It is important to take on board just why the internet and its related technologies are so important. First, as mentioned

discussion

Tax revenue. The internet was not just a tool for governments to use but also threatened their tax revenues. There was a need for rules for doing business on the internet, but politicians also needed to learn to live with the fact that it had created its own international economy. Another participant observed that the internet had already damaged the sales tax revenue on which many US states were dependent, and suggested that in the longer term governments would be less able to collect indirect taxes and would therefore be less able to provide services. The period of high taxation and high government provision in the UK after the Second World War would turn out to be a historical oddity.

above, it is a technology that is changing the way individuals and societies act and it is all-pervasive in a way that few innovations can be. The effects of the use of electricity offer the nearest parallel.

Second, we are seeing an extraordinary fall in the cost of a service, the cost of the internet, the cost of communications capacity and the cost of computer storage and processing power. This fall exceeds, by orders of magnitude, the extent to which the cost of electricity declined in the 30 years from 1890 to 1920 when it came down in real terms on average by 6 per cent a year.

Third, we are seeing the growth of a technology that has chameleon properties, which can do all sorts of different things. It is a technology that makes you think globally right from the start. You buy the book from the bookshop in Seattle without ever realising that that is what you are doing. You book tickets from an Irish airline, again, without ever thinking that that is what you are doing. From the beginning, you think globally and this makes markets work better, it delivers more information and more choice to buyers.

Finally, this is a technology that speeds and disseminates innovation like nothing that has gone before it. You come up with a new idea for your company, you come up with some idea, something new that you want to do, some new product and almost immediately the whole world knows about it. It makes it possible for everybody to look in your shop window and see what is there, for lots of other companies to see how you are doing things. Therefore the pace of innovation becomes speedier and, if you can understand what is happening, available to many, many more people.

The way forward

Both government and business will be irreversibly changed by the new online technologies. This group of technologies influences service industries and the efficiency with which they operate even more than it changes manufacturing. Government, of course, is the largest producer of services in any country. Where companies are starting to integrate the internet and its possibilities rapidly into what they do and how they do it, they very often find that the traditional boundaries are broken down.

Companies increasingly find that they need to reorganise the way they relate to their customers because of the internet, and government will face similar pressures. For example, if you want to set up a company today, you have to go to Companies House, Customs & Excise for VAT, all sorts of different government agencies, before you are actually in business. But the internet pushes government to create a one-stop shop and that may ultimately require changes between government departments that may be very difficult to achieve.

There are also implications for the way governments regulate their citizens' activities. Regulation is usually nationally or at least geographically determined. It is not something that readily crosses borders and yet this is a technology that very readily does cross borders. If you buy your book from Amazon and it doesn't turn up, to whom do you complain? The answer is probably that you complain to the credit card company which also crosses borders; you don't complain either to the British government or to the American government.

So there is a challenge to government here and the challenge of course takes many different forms. Policing, privacy, pornography, piracy… the list of problems facing government in the new environment is extensive. Some of the problems spring from the way the internet offers individuals new direct access to markets and products. So, while in the past, government might have been regulating companies or large institutions, bookshops selling lewd magazines or people in Hong Kong who were pirating compact disks, in future government may increasingly be dealing with offences committed by individuals in their own homes —a new problem for those attempting to regulate.

Then there's the digital divide. Does it really exist? Does it matter? Obviously, there are many developing countries that feel that they are being left out of this revolution. It is not always clear, though, whether they are being left out because the technology is expensive or because they have poor education policies or national telecom monopolies that get in the way of the distribution of access.

Finally, what is in all this for Britain? Are there ways in which we can benefit from this as a country? We have a number of advantages here. First we have an economy that is relatively open. We have the benefit of speaking the English language which has become the world operating system for this technology. We are more closely plugged in to what happens in the United States — world leader in this technology — than most other countries. I think that the most interesting question is whether there any ways in which our government, by moving rapidly down the e-path, can actually achieve benefits that could give a comparative advantage in economic terms that would be international and not just national. ❐

discussion

Standardisation. One speaker suggested that the internet needed standardisation, so that users could easily find their way around different websites. It had taken time for the pedals in cars to adopt a standard layout, the Model T Ford having a notably odd arrangement. One source of uniformity was monopoly. It was not clear how standards would be set for the internet. Some came of their own accord, though this had not yet produced a recognised way of signing off an e-mail. For some purposes government action was needed, but in other areas standards might emerge naturally from competition and consumer preference.

Engineering and ivory towers?

The Foundation's 2002 Lord Lloyd of Kilgerran Award Lecture was delivered on 2 October 2002 at the Royal Society by Professor John Burland DSc(Eng) FREng FRS who has been responsible for many large ground engineering projects.

"Professor Burland, can you give us a 100 per cent guarantee that the structural state of our building will not be affected detrimentally by the construction of the Jubilee Line Extension tunnels"?
I was giving evidence on behalf of London Underground Ltd to the Parliamentary Committee examining the Jubilee Line Extension Bill. The tunnels run between two 22-storey tower blocks at Canada Water. The residents were very concerned, very articulate and very well represented by one of their members.

Giving evidence on behalf of the residents, the MP for Bermondsey, Simon Hughes, stated that these tower blocks had all the ingredients of the Ronan Point tower block. Built in the 40s from pre-cast concrete slabs with poor connections, a corner of Ronan Point had suffered progressive collapse in May 1968 due to a gas explosion on the 18th floor. But the Canada Water tower blocks were of a totally different construction, a robust reinforced concrete continuous frame not prone to progressive collapse. Explaining this to the local residents involved many meetings and site visits; it was clearly very important to take their concerns seriously and to be seen to do so.

This case history has proved a valuable part of our civil engineering undergraduate teaching of the wider issues of engineering and society. First I set the scene and explain the technical issues involved. I take the students through the procedures involved in a Parliamentary hearing and give them the questions I was asked by the various petitioners …. but not my answers. The students are then given the relevant extracts from *Hansard* (House of Commons Debates) and are formed into groups representing one of the parties involved – the promoter, the design engineer, the expert witness for the promoter, the local MP, the residents and their expert witness.

This role play is an effective way of getting a strong message across to students that the technical side of engineering is only a part of their responsibilities. They learn that lay people can be intelligent, articulate, imaginative and unimpressed by technical jargon. Interestingly, the group representing the residents usually wins because they can easily relate to people whose homes are threatened!

As part of a research project into the response of buildings during the construction of the Jubilee Line Extension (JLE), we measured the movements of the tower blocks during the passage of the tunnelling machines between them. The subsidence was barely detectable, less than two millimetres.

Design and analysis

The Canada Water tower blocks form a valuable introduction for students to the concepts of design and analysis in engineering. I illustrate the difference by presenting the students with the following provocative statement:

"A design that relies for its success on a precise calculation is likely to be a BAD design".

I then give the students an illustration of a three-legged milking stool supporting a milkmaid weighing 60kg. When asked how much load is carried in each leg, the answer comes straight back – 20 kg. When shown a four-legged stool, most students (and many practising engineers) will maintain that each leg carries 15 kg. Unfortunately this is not the correct answer. It assumes that the legs are of exactly equal length and that the floor is perfectly flat. In reality neither of these is ever true. To obtain an exact answer it is necessary to know the precise lengths of each leg, the profile of the floor surface and the way the material composing the stool deforms under load. But this precise answer is of little value because the stool will be moved from one position to another where the floor profile differs. A safe solution is to design each leg for 30 kg load since the stool will generally be rocking slightly on two legs.

This example leads on to the important concepts of brittle and ductile behaviour. If the legs of the stool are made from a brittle material that snaps when loaded excessively, a kick from the cow could break one of the legs. However, if the stool is made of a ductile material that can deform without snapping, then the kick from the cow will only cause the leg to bend. Moreover there is scope for the redistribution of load between the legs when the ground is uneven or the legs are not exactly of equal length. Ductility and robustness are vital principles in the design of buildings for uncertain loading such as earthquakes and other unpredictable events.

Westminster underground station

The successful construction of the new Westminster underground station represents the outcome of about 40 years of research into the influence of deep excavations and tunnelling on adjacent buildings. In the 1960s, when I was involved with the design of the excavations for Britannic House and the Barbican Arts Centre, our ability to model complex behaviour of the ground on the computer was very limited. However, over the years we made predictions of movements for a succession of deep excavations in London prior to construction, compared them with site measurements made during construction and refined and improved our testing and modelling methods. As a result of this iterative process, coupled with the rapid growth in computational power, we were able progressively to improve our models of the ground behaviour.

At Westminster, access to the Jubilee underground line is by escalators in a 40-m deep excavation. The computer modelling showed that the foundations of the Big Ben clock tower were likely to experience significant subsidence during tunnelling and excavation. The contractor, Balfour Beatty/AMEC, devised a novel

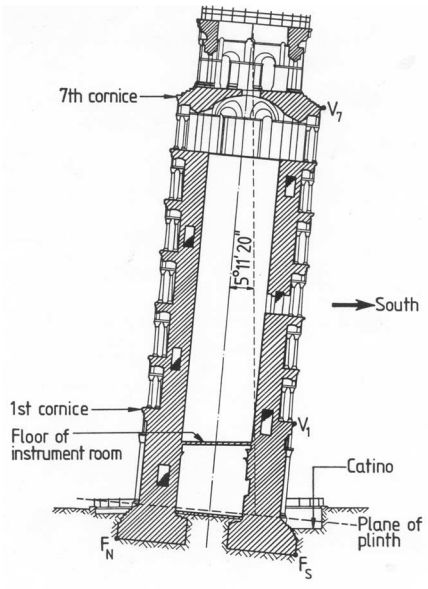


Fig. 1 The Tower of Pisa was close to falling over.

method of controlling the movements of the tower by frequent injections of grout into the ground beneath the foundations. By this means the movements of the clock tower were kept within specified limits such that no significant damage was caused to the Palace of Westminster. The project was extremely demanding, highly innovative and very successful. The construction of the Jubilee Line Extension has perhaps not been given the public recognition it deserves. Techniques of computer modelling and construction of the type used at the new Westminster Station will find wide applications worldwide.

The process is of course nothing more nor less than the scientific method. It is this iterative process that underlies the development of engineering knowledge and experience which then feeds into guidance documents, codes and standards. Real dangers exist when the basis of the guidance is not understood or has been forgotten, as this may threaten safety and inhibit innovation.

The Leaning Tower of Pisa

The rigorous application of the scientific method in engineering is well illustrated in the approach to stabilising the Leaning Tower of Pisa. Following the collapse of the civic tower of Pavia in 1989 due to failure of the masonry, the Leaning Tower of Pisa was closed to the public and a commission was established to advise on and implement stabilisation measures. The 60-m high tower leans southwards by nearly 5 m (Fig.1).

The 14-member commission consisted of academic experts in architectural conservation, architectural history, fine arts, archeology, structural engineering and geotechnics. Decisions were taken by majority vote.

Establishing the history of inclination proved crucial in assessing the mechanism of behaviour of the tower. The axis of the tower is not straight; it bows northwards. In an attempt to correct the lean during construction, tapered blocks of masonry were used at each floor level to bend the axis away from the lean. Using sophisticated computer modelling we were able to reproduce the history of the tower's tilt, and, in so doing, win the trust of most of the non-technical members of the commission. The analysis showed clearly that the tower was very close to falling over. The mechanism was one of leaning instability caused by the low stiffness of the underlying ground rather than its low strength. Children trying to build brick towers on a soft carpet will be familiar with the phenomenon!

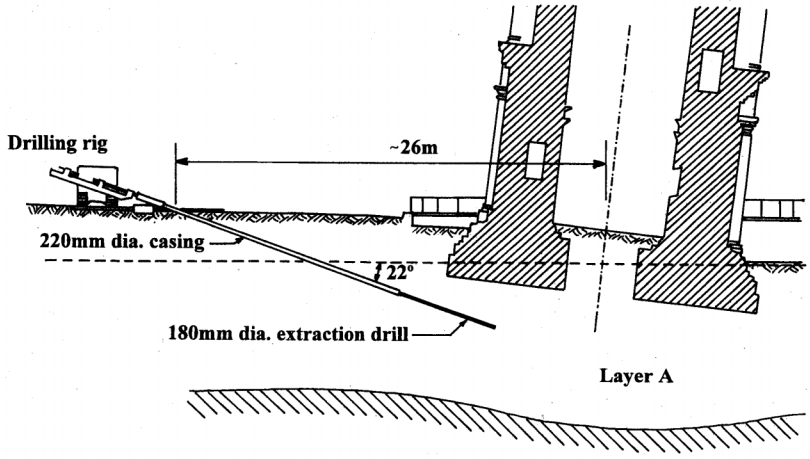


Fig. 2 Drills were installed to extract soil.

In addition, an important fact emerged – the motion of the foundations has been such that the north side has been rising. The tower was close to instability but also a possible temporary stabilisation measure was available: placing a counterweight on the north edge of the foundations would reduce the overturning moment. Accordingly, a pre-stressed concrete ring was cast around the base of the tower to support a counterweight in the form of lead ingots weighing 9 tons each. Between July 1993 and February 1994 about 600 tons of lead was placed on the concrete ring, reducing the inclination by about 12 mm and reducing the overturning moment by about 10 per cent.

Having temporarily improved the stability, a permanent solution was then sought that would reduce the inclination by half a degree; not enough to be visible but enough to reduce the stresses in the masonry and stabilise the foundations.

A method known as soil extraction gradually evolved (Fig.2). This involves installing a number of soil extraction tubes adjacent to and just beneath the north side of the foundation. How could we be sure that removal of soil from beneath the high side would not create more instability? A key finding, first identified by one of my MSc students, Helen Edmunds, was the existence of a critical line located about half a radius in from the northern edge of the foundation. Provided soil extraction from beneath the foundation took place north of this line the response of the tower appeared always to be positive; however, extraction south of this line would create instability.

A carefully developed system of communication and control was established between the site and myself. This involved a system of twice daily faxes from the site containing real-time information on the inclination and settlement of the tower. I issued a daily fax summarising the observed response, commenting on it and then giving a signed instruction for the next extraction operation.

Two phases of soil extraction were planned: a preliminary phase over a limited width to test the method, followed by full soil extraction over the whole width of the tower foundation. On 9 February 1999, in an atmosphere of great tension, preliminary soil extraction commenced using 12 extraction tubes. The response of the tower was favourable and by July 1999 the top of the tower had been moved northwards by about 3 cm. The commission was convinced that it was safe to undertake soil extraction over the full width of the foundations, and between December 1999 and January 2000, 41 extraction holes were installed at 0.5m spacing. Full soil extraction commenced on 21 February 2000 and by June 2001 the inclination of the tower had been reduced by 10 per cent (50cm at the top) and all the lead weights had been removed. The tower was re-opened to the public in December 2001 and all the indications are that it is remarkably stable.

Grounded in science, engineering is essentially creative with the design and construction of each new project requiring lateral and innovative thinking, flexibility in overcoming challenges and often the shouldering of great responsibility. The ability to explain the essence of the project to non-specialists and to win their confidence is just as important as the rigorous application of scientific principles. ❐

Experience informs future strategies

Sir Brian Follett FRS

Lessons learned from the FMD outbreak. *The 2001 foot and mouth outbreak caused devastation to the farming community that is still being felt today. On 5 November 2002, the eve of the Government response to the official inquiries, the FST hosted a discussion meeting at the Royal Society. The speakers were Sir Brian Follett, Chairman of the Royal Society Inquiry, the NFU President Sir Ben Gill and Elliot Morley MP. The lively discussion that followed was summarised by Jeff Gill.*

Sir Brian Follett FRS was the Royal Society's Biological Secretary from 1987 to 1993. He has had considerable experience of undertaking public sector inquiries, from the Alder Hey affair to the electronic network linking British universities. Much of his academic work concerns farm species. He is currently non-executive Chairman of the Arts and Humanities Research Board with his academic base at the Department of Zoology, University of Oxford.

After the end of the outbreak of foot and mouth disease in 2001 there were, in effect, three official inquiries. The first, on the future of farming by Sir Don Curry, emphasised the lack of profits in livestock farming and recommended a shift of financial support away from subsidies for production towards protection of the environment. Whether that is now feasible given the current difficulties in implementing any significant changes to the Common Agricultural Policy, I don't know, but that was the primary thrust. Curry also commented on the serious nature of the animal health problems that have hit this country and damaged at least the image if not the industry quite seriously – salmonella in eggs, *E. coli*, TB, BSE, foot and mouth and so on.

The second inquiry, headed by Dr Iain Anderson, focused on a report entitled *Lessons learned from 2001 and how it was managed.*

Our inquiry, the third, was carried out under the auspices of the Royal Society and produced a forward-looking report focusing on science and management. Together, these two elements will improve our means of combating these diseases in the future.

We had a large committee that included farmers, practising veterinarians, experts in consumer affairs, a senior veterinary administrator with much EU experience and a bevy of scientists, enabling us to produce a report from a very broad range of people involved in these issues.

The report is heavy and dense; if we wish to change the way in which the future outbreaks were handled, then we had to argue our case closely. The report also covers a number of other diseases such as blue tongue. I understand that the Department of Environment, Food and Rural Affairs (DEFRA) will give their formal response to the two key official inquiries (this and the one chaired by Iain Anderson) soon after this meeting.

There have also been many other inquiries on the foot and mouth outbreak. From these I would draw your attention particularly to the European Parliament's temporary FMD Committee, as they provide the key contextual backgrounds to the outbreak. Because they were known to be international problems, exotic diseases long ago became an interest of the World Trade Organisation (WTO); hence they are also an EU responsibility.

I spent time with the Irish EU Commissioner, David Byrne, who is responsible for the upcoming 'blockbuster' directive on how to handle foot and mouth. Byrne's speech to the EU Parliamentary Committee of 12 September (2002) was most encouraging. As in our inquiry, he sees the need for many significant changes and a new strategy that combines recognising that livestock farming is an economic business with profound changes in the attitude of the public. The problem of balancing these two difficult areas caused much of the contention last year; they have to be well balanced in the future.

Whatever strategy is adopted, speed is of the essence, particularly when animals are left totally unprotected against a highly infectious disease.

Contingency plans

Our first recommendation is that the UK Government brings before Parliament a framework for the contingency plans. The reason for making that recommendation is twofold. The first is that, whatever strategies— mass culling, emergency vaccination, closing the countryside and so on— are adopted, they will be highly contentious to someone or other. For the executive to be empowered, the Government's contingency plans must be accepted by society *ahead* of an outbreak. Also, the contingency plans need to be regularly rehearsed and updated. In our view they also require a formal three-yearly assessment.

Our committee saw the handling of these outbreaks as falling into one of two boxes. One box, I will refer to later again, is how to improve the existing tools that are used to predict and fight an outbreak. We felt an obligation to look at all the alternatives to avoid mass culling. This study was led by Professor Ian McConnell's subgroup. The only realistic way of handling this microbial disease is by vaccination, ideally routine vaccination. It is only 11 years since the rest of the EU stopped routinely vaccinating cattle, so, on the Continent, there is not the cultural block to vaccination that we experience.

However, routine vaccination is inadvisable. A vaccine capable of doing the job of lifelong, sterile immunity against all strains is a challenge, but we became convinced that it could be developed. This requires an international effort but if we don't begin a process internationally to address that, then a decade from now we will have no hope of going down that particular road. So, one message was to the international community to develop better vaccines.

The existing vaccines, whilst being imperfect, are certainly good enough to be used in emergency situations to stamp out an outbreak. There have been real advances in Holland and France over the past two years such that one can distinguish between animals that are vaccinated and those rare animals that have also been infected. Some months ago the WTO made a significant shift in the rules that govern international trade after an outbreak has finished. This now makes it less difficult to vaccinate. Emergency vaccination requires extensive pre-planning and I will return, at the end, to the outstanding issues.

Central to our recommendations is 'emergency vaccination to live'. This policy allows the vaccinated animals to live out their useful lives and enter the food chain. This is one of the issues that have to be resolved. However, no-one is arguing that emergency vaccination by itself is sufficient – far from it. We believe there will remain a need to continue culling animals on infected farms and on 'dangerous contact farms'. Indeed, a suite of mainly quantitative changes are needed in our approach.

Surveillance

The other vital component is 'must move fast and decisively'. First, that requires a strengthened international surveillance system. We recommended an EU unit with well-organised linkages between the threats outside and what happens internally in the country. One idea that we toyed with, although it is not in the report, is a kind of 'green, orange, red' system in which one could, under certain circumstances, increase the internal security in the country to stop the disease entering and certainly to prevent it turning into an epidemic.

Second, improved national surveillance is essential. You cannot set up systems very easily to survey for diseases that hit only rarely. The national surveillance recommendation needs to work with the Curry recommendations for creating a step-wise improvement in the way animal health is monitored on farms. This boils down to the links between farmers and vets.

The next component is modelling. In epidemiology, modelling is a powerful tool for understanding the spread of disease and it needs applying far more widely in animal disease. The application of modelling is best done during peacetime when one can explore their potential, how they might offer a set of strategies that one could then use during an outbreak. This is an area where, in particular, much work needs to be done *now*.

The next aspect is diagnosing the disease – the virus in this case. The world trade rules have inhibited the development of modern diagnostics. We need tools that will speed up diagnosis on the farm and the aim should be a simple means of detecting animals that have caught the virus but are not yet showing the symptoms. We need to go for a simple litmus-test type of method and development of this has begun. It is difficult to persuade the Government to invest against a remote possibility. However, in defence we pay out tens of billions a year against the offchance that we shall be attacked militarily– we are not breaking new ground here.

Finally, the control of the spread, a contentious issue. The precautionary principle would argue that, at all times, we need to minimise animal movement and have standstill periods. There is a way forward here and the negotiations between the NFU and the Government are interesting and constructive. During an outbreak, we can all see what must happen: slam on movement controls *immediately*.

Jim Scudamore, the Chief Veterinary Officer, observed to me, early on, that whilst the foot and mouth scientists could tell him about the molecular biology of the virus, they were less sure about how the virus was spreading. It is remarkable that the statistics from 2001 and from 1967 indicate that 80 per cent was spread locally and by unknown means. We need to understand how this virus can transfer. That is not so straightforward because doing research on viruses like this has to be conducted in highly secure environments such as at Pirbright.

Dealing with an outbreak: increase security and enforce culling on infected farms and dangerous contacts. This will work but, no less than five times in the past 80 years in this country, an outbreak has turned into a major epidemic. On all occasions, it has caused great trouble, expense and considerable public concern. Government inquiries followed, two in the 1920s by Prettyman (when the spread of disease by manmade transport in one of the outbreaks was similar to 2001), another outbreak that Gowers looked at in the 50s and in 1968 Northumberland led the inquiry team.

Our recommendation— and I have simplified a huge report to retain the one big message— is that *we should use emergency vaccination as a weapon of first resort rather than a weapon of last resort.* We believe that this will stop an epidemic. However, it would be impossible to implement such a policy tomorrow. We have to handle an outbreak with the tools we have at our disposal but, over the next 18 months, the remaining significant issues— when to start vaccination, location, season, final validation of the test and, importantly, the exit strategy—can and surely must be resolved.

Comprehensive contingency plans have to be developed and put in place and the work necessary to implement emergency vaccination has to be completed. I have not talked about what the research needs are, that is a chapter in our report, but I have mentioned some of them: biosecurity, diagnostics, the role of modelling and routine vaccination. ❐

Inquiries, Directives and Responses

Inquiry into the lessons to be learned from the FMD outbreak of 2001, chaired by Dr Iain Anderson CBE.
www.fmd-lessonslearned.org.uk/

Royal Society Inquiry into Infectious Diseases in Livestock commissioned by the UK Government, chaired by Professor Sir Brian Follett FRS, published it's report on 16 July 2002.
www.royalsoc.ac.uk/inquiry/index.html

Policy Commission on the Future of Farming and Food, chaired by Sir Don Curry
The Commission reported on 29 January 2002.
www.cabinet-office.gov.uk/farming

DEFRA Response to the FMD Inquiries, published 6 November 2002
www.official-documents.co.uk/document/cm56/5637/5637.htm

The latest version of the Government's contingency plan for dealing with any future outbreak
www.defra.gov.uk.footandmouth/contingency/contingency.htm

EU Draft Directive on Community measures for the control of FMD.
www.defra.gov.uk/footandmouth/revisedeudirective.PDF

Empowering farmers

Sir Ben Gill CBE

Sir Ben Gill is President of the National Farmers' Union. He took over his 360-acre family farm in North Yorkshire in 1978. Ben has represented the NFU on COPA working parties and European Commission advisory committees. He is currently President of the Confederation of European Agriculture.

It is 400 days today since the last outbreak. We have moved on a lot since then. Sir Brian referred to the European Parliament's temporary committee of inquiry and their role. When I gave evidence to that committee, I stated four points that they should make recommendations on.

First, they should coordinate an early warning system, not just for foot and mouth, but for all diseases. The EU is due to become a much larger body, creating a block of around 400 million people. It has a huge responsibility, together with the Office International des Epizooties (OIE) in Paris and other key players, to act as the coordinator of early warning systems.

Second, there is a requirement of the EU to coordinate the contingency plans between Member States. The need to coordinate plans is paramount, because the epidemiology of any disease varies with climatic conditions, with topography, with the distribution of the livestock species and with farming practices.

The third element of EU responsibilitiy should be the coordination of research work from an EU context. Foot and mouth is a world problem and the EU ought, at least, to take on the coordination effort for the European research element and should seek to coordinate that with other interested countries.

The fourth element that has an EU dimension, that Brian has referred to already, is the need to coordinate border controls. It is lamentable that we are still in the position, 20 months since the outbreak of foot and mouth, of having no adequate border protection, either in Britain or in Europe. In the same way as we make an investment in our armed forces, we need to invest in border protection, seeking at every opportunity to minimise risk. We need to make full use of the vast capabilities that technology now gives us.

The second point that Brian touched on, but with which we need to go further, concerns the level of ignorance that was pervasive last year. The old adage that "a little bit of information can do a lot of damage" could not have been more perfectly illustrated by a regular correspondent, a doctor, who wrote an article in *The Times* in early March, questioning why we were even thinking of killing animals that had foot and mouth. The logic was that the structure of the foot and mouth virus is similar to the structure of the common cold, we don't slaughter people with common colds, therefore we shouldn't need to slaughter animals with foot and mouth.

As for the debate about vaccination, I was told that I was being Luddite for bringing up the very points that Brian has brought up. I would add one point about emergency vaccination, a critical issue that we looked at intensely, twice. The question that we grappled with at the end of March was: "if you were going to do emergency vaccination at that stage, bearing in mind the outbreak of foot and mouth had been

discussion

Spread of disease. There was disagreement over the extent to which the disease was transmitted by farmers and vehicles in the 2001 outbreak. The control strategy eventually adopted, based on the slaughter on infected premises within 24 hours and on contiguous premises within 48 hours, was chosen on the strength of epidemiological modelling that predicted it would minimise the number of animals killed. The epidemic had followed the course predicted by the models quite closely.

Another speaker questioned whether the contiguous cull had brought the epidemic to a halt or rather caused infection to spread, because of the logjam on disposal of carcasses. The instructions for the contiguous cull did not reach the disease control centres until eight days after the epidemic peaked. Infected farms had prompted the slaughter of animals on large numbers of other farms, yet very few of the latter tested positive for the virus.

It was argued Dr Iain Anderson's report had agreed that the contiguous cull worked. It was not surprising if animals culled on farms other than infected premises proved not to have been infected, because the object was to slaughter them before the disease spread.

running for about two months, and bearing in mind that by 20 February there were probably already 70 or 80 outbreaks around the country (many of whose locations were unknown), then where did you start to vaccinate?" We didn't want to vaccinate a population of animals that potentially could include a significant percentage that were already infected but not showing the symptoms and there was conflict of evidence about the consequences of vaccination of infected animals yet to show the symptoms.

These are all points that should have been clear had we had proper contingency plans, proper checking through the systems and proper delivery of the rehearsals of these plans. When we are talking about the need to understand and better inform everybody, it seems almost to be assumed by many commentators that I was being barbaric to regard livestock farming as an economic business, but that it is a reality of life. We keep livestock for financial gain but that should not be confused with the fact that we keep them to proper welfare standards. It is money that oils those welfare wheels; we ignore that at our peril.

One of the most important lessons that we have learnt is the significant costs that arose from the high level of lack of trust. In the period up to about 20 March the Government's internal communication channels failed miserably. Also, just as you wouldn't expect me, as a farmer, to run the Hilton Hotel, why did we expect a vet, who is trained to look after animals and assess them for illness and cure them, to run the biggest logistical exercise the country has ever seen? What the veterinary officials needed was adequate and sufficient administrative resources.

Bio-security is clearly a key issue. It has two elements: border control that I have already mentioned and the farm. We need to have a clear protocol, per farm, of what is needed. No two farms are the same; it depends on the topography, whether there is woodland, whether it is adjacent to another livestock farm, where the public highways and footpaths are, where the buildings are with respect to the land, watercourses, if there common land or is it all fenced land. All these aspects, together with the mix of livestock and whether they are housed for part of the year or outside all year, means that there does need to be an unique protocol per farm. The logical way to address this is to empower and enable farmers to get on with it themselves, based on a common framework of principles and in an active dialogue with their private veterinary practitioners.

In absolute disease control terms, no movement whatsoever is preferable, but that is no more practical in the middle of an outbreak than it is in, as we call it, peacetime. Disease or no, animals go on procreating: they are born every day, they are growing and capabilities on farms are finite. So there has to be some movement. Again, this took time to sort out and caused a lot of pain and suffering that could have been avoided relatively easily by proper contingency planning.

As for peacetime, the considered and best way is to describe clearly what good animal health practice is. If you bring new animals on to a farm, it is good practice to keep them separate for a predetermined period. That should not affect the movement of other animals on the farm. We need to define that separateness and a reasonable period for it. At the moment, what we are facing is a series of regulations that are so complex that even those with the deepest of intent to abide by them find themselves inadvertently contravening them. Regulations need to be simple, relevant, proportionate and practically based. Only then shall we begin to regain that trust. Trust is paramount.

The key target that we must set ourselves in the lessons learnt is that we have to rebuild trust, establish best practice and adopt procedures which have to be understood and regularly rehearsed. Also, we have to have an adequate research capability that is coordinated on a world basis and a strategy that is based on testing and procedures recognised worldwide. Those are still big challenges and there is a long way to go. But do not forget this is not just about foot and mouth, nor just about animal disease, we are as much prey to the problems of plant diseases and insect pests. ❐

discussion

Vaccines. For the future it was essential to speed up the response to any new outbreak, with applied research to develop evidence-based control. The Royal Society report advised that, with a significant effort by DEFRA, it should be possible to be ready for emergency vaccination by the end of 2003. It was argued that the vaccines already available were more than adequate to control any outbreak of foot and mouth disease, but good epidemiology was needed in order to know when to use them. It would not be easy for the pharmaceutical industry to develop a vaccine good enough for use in peacetime, with lifelong sterile immunity, but it was worth the investment in view of the costs of the disease.

Updating contingency plans

Elliot Morley MP

Elliot Morley is Parliamentary Under Secretary at the Department of Environment, Food and Rural Affairs. He is also Vice-President of Wildlife and Countryside link.

When you are dealing with the world's worst epidemic of foot and mouth it is inevitable that mistakes are going to be made. That is an issue that we, as a government, freely acknowledge because, in order to learn lessons, you have to concede that things went wrong.

We had contingency plans in place for foot and mouth, although one of the many myths was that there was no contingency plan. We were prepared, but not for an outbreak on that scale. There were failures by farmers within the system of regulation, such as failing to process pig swill to the required temperature and failure to notify the authorities that animals had disease for over two weeks. In that two-week period, there were over one million, maybe more, sheep movements, spreading the disease through markets, all over Cumbria and down to Devon, so that when the disease became evident, there was a huge job to bring it under control.

Foot and mouth disease could easily have become endemic in this country.

The fact that it didn't is a tribute to all those involved who worked tirelessly to bring the epidemic under control.

Following the 2001 outbreak we saw a need to review the scientific questions relating to epidemic diseases in livestock and this was influential in our setting up the independent inquiries. We are very grateful to Sir Brian for his work and to Dr Anderson; they produced very thorough reports that will influence the way we approach such epidemics in the future. The reports have also influenced countries and organisations around the world as well as the EU and the OIE. Of course EU and the OIE regulations had an impact on the way that we responded to the disease.

One of the key aspects in fighting any disease, particularly foot and mouth, is speed. It is also important to understand the epidemiology of the disease; during 2001, some 80 per cent of the spread was local. We can never be certain what the reasons for that are, but we have a list of candidate reasons: animal to animal, movement of vehicles and machinery and movement of personnel; these were major factors.

There is a range of issues that needs addressing, such as the 'blue box' bio-security schemes that we put in place, which set out strict rules on bio-security and the movement of vehicles. Even with repeated information about the need for bio-security, there were some worrying levels of failure in parts of the country.

Other diseases

We do need to think about other exotic diseases. We have recently put up for discussion a contingency plan in relation to blue tongue, which is not a disease that we have in the UK but one that we need to be aware of and prepared for. Ben talked about early warning of diseases and there are other issues that we have to address through the EU in relation to horizon scanning, tracking the progress of diseases and risk assessment. When I was at the conference organised by Holland, UK and Brussels on FMD in December 2001, the OIE presented a rating of risk that put the UK at the lowest level. This demonstrates that, even when you have risk assessment and some kind of attempt at forecasting, it can be completely wrong.

I also agree with Ben Gill about the issue of trust. Trust is clearly very important. There were problems of trust and communication that we have to tackle as a government and as a department together with representatives from the farming industry. Among the many reasons for the breakdown of trust were the myths that surrounded the outbreak; a range of allegations were being made.

The issue of communication was not ignored, far from it. For example, there were NFU representatives in each of our regional centres as well as in London on the joint coordinating committee. They were included to ensure that we communicated as quickly as possible to the farming sector. There are always things you can do better in hindsight; we have to think about how we tackle this in future.

Most important, of course, is the contingency plan. We immediately revised our contingency arrangements as an interim measure because it will take time to respond fully to the independent inquiries. Now, of course, we are working on detailed proposals on which we want to consult widely. Officials have been focusing on a decision tree that will set out the factors to be taken into account in determining control strategies, including vaccination strategies. This will be something that we can consult on and be transparent about in relation to the kind of response that we would have in a future FMD outbreak.

We have also produced a disease control protocol that explains, publicly, when and where a decision to slaughter might be taken. This is part of the Animal Health Bill[1] that is currently going through Parliament.

Current EU rules require the slaughter of susceptible animals on infected holdings but they also allow for the emergency vaccination of animals during an FMD outbreak if the disease threatens to become extensive. We were ready in the logistical sense to use vaccination in the last outbreak but there were difficulties in relation to the food industry and mixed views among the farming community.

The real lesson from this is that you cannot determine a vaccination strategy in the middle of the world's worst outbreak of FMD; determining the approach to vaccination has to be done as part of a considered response in the contingency plan. We very much accept the recommendations from the Royal Society that vaccination should be moved up the agenda in terms of a response to be considered very early on in an outbreak.

'Vaccinate to live'

Our preference would be for a "vaccinate to live" policy. The Dutch used their vaccination policy primarily to assist with disposal; because they had very limited rendering facility they vaccinated the animals before culling them. Pro-rata the Dutch actually killed more animals in their very limited outbreak than we did in our very extensive outbreak, so there are certainly drawbacks in using a "vaccinate and kill" policy.

There are still issues in relation to emergency vaccination that need to be resolved. There is the need for tests that can distinguish between the antibodies from vaccination and from the virus. Such tests are available but have not yet been internationally validated.

Under EU law, the first response would be to try to stamp out any epidemic by culling and that would apply to dangerous contacts. But, within the decision tree, there will be a point where emergency vaccination needs to be considered in relation to the scientific and veterinary advice at the time.

A contingency plan has to be flexible. The 2001 epidemic very much focused in sheep, while the '67 one was very much in cattle, so there were differences in relation to the type of epidemic and also the spread of the epidemic.

We recognise the importance of independent scientific advice in terms of the input and policy decisions on animal disease control. DEFRA's Chief Scientific Adviser, Professor Howard Dalton, is establishing an independent science advisory council to advise across all areas of science of relevance to DEFRA. This council will be properly constituted on the same principles as the Phillips BSE Inquiry Report, and in light of the Office of Science and Technology's code on the conduct of scientific advisory committees.

We are also taking new powers, in the Animal Health Bill, designed to strengthen

discussion

Trust. This was an essential element and had been lacking in 2001. Better use could have been made of local knowledge in dealing with the outbreak. In France, in spite of the tradition of centralised policy-making, there had been more success in involving farmers in the local delivery of disease-control measures. In the UK there was a case for a bottom-up approach, with farmers buying into animal health systems that gave them benefits and local voices being listened to. Better interaction was needed between local veterinary surgeons and the State Veterinary Service and Veterinary Laboratories Agency, and closer links between farmers and vets.

the Government's ability to deal with any future disease outbreaks. The bill provides additional powers to apply pre-emptive culling, if circumstances would justify that. There are also clearer powers of entry for testing, culling and vaccination.

With respect to serology, we had to go to court in one instance to get permission to take blood samples and that held up the lifting of the restrictions for two weeks. We aren't prepared to face those kinds of delays again and that is why we need the power to implement measures, within the Animal Health Bill, that are not dedicated entirely to culling.

I also want to say a word about the 20-day standstill. We have to reduce the risk of spread by movement controls within the livestock sector. There is now a debate about whether 20 days is appropriate; we are having an independent scientific assessment on that and we have made changes that have reflected the needs of the livestock industry.

In conclusion, there are many lessons for us to learn from the outbreak. There are lessons to learn internationally, there are implications for Europe in terms of the rules that they apply, there are implications for the OIE in terms of international rules in relation to disease control and we must ensure that we have adequate contingency arrangements. We must ensure contingency arrangements are public so that people can debate and comment on them and they must be trialled in exercises on a regular basis; they must also adapt to changing circumstances, technologies and risk.

1. Now the Animal Health Act 2002, available from HMSO. www.hmso.gov.uk/acts/en/2002en42.htm

discussion

Bio-security. DEFRA was taking steps to alert livestock farmers to bio-security and to develop contacts between them and the Divisional Veterinary Offices. The Department had set up a stakeholder group at an early stage in the outbreak and intended to make this permanent. Farmers had to be trusted to spot the signs of disease.

It was suggested that the problem of border security was understated because it was necessary to cope with negligence as well as deliberate evasion. The temporary standstill on the movement of animals off a holding when new animals had been brought in was very controversial. The period of 20 days was criticised as being neither reasonable nor proportionate, and the rules were too complicated. Better tracking of individual animals, together with initial isolation of animals brought onto holdings, might offer a better way forward. As yet, however, only cattle were identified individually, and it was argued that a movement stop had to be a permanent feature.

events

Recent lectures and dinner/discussions organised by the Foundation are listed below. Sponsors, to whom we are very grateful for their support, are shown in italics below each event. Summaries of these and other events are available on the web at www.foundation.org.uk

16 July 2003

The Research Assessment Exercise Review: how should university research quality be measured?
Sir Gareth Roberts FRS, Chairman, Review of Research Assessment
Dr Chris Henshall, Group Director, Office of Science and Technology
Sir David Watson, Vice Chancellor, University of Brighton
Office of Science and Technology and HEFCE

18 June 2003

Congestion Management in London: Traffic and Roadworks
Mr Malcolm Murray-Clark, Director, Congestion Charging, Transport for London
Mr Mike Talbot, Head Traffic Management Division, Department for Transport
Mr Jeremy England, Director , Water Operations, Thames Water
Department for Transport

10 June 2003

Adding Value to Research & Development
Professor Gordon Edge CBE, Chairman, Generics Group
Sir Peter Williams CBE FRS FREng, Chairman, ETB
Professor John O'Reilly, Chief Executive, EPSRC
QinetiQ, EPSRC and Calderwood Han Limited

03 June 2003

Horizon Scanning
Professor Sir David King KB ScD FRS, Chief Scientific Adviser to the UK Government and Head, Office of Science and Technology
Geof Mulgan, Director, The Strategy Unit, Cabinet Office
Dr Bill Harris, Chief Executive, Science Foundation Ireland
QinetiQ and the Institution of Electrical Engineers

20 May 2003

Redesigning the science curriculum; what does society want?
Dr Ken Boston, Chief Executive, Qualifications and Curriculum Authority
Professor John Holman, University of York
Ms Sue Flanagan, Deputy Headteacher, Forest Gate Community School, Newham and Chair, ASE
Pfizer and EMTA

14 May 2003

Creativity, Science, Engineering and Technology
The Lord Puttnam of Queensgate, House of Lords
Dr Robert Hawley CBE DSc FRSE FREng, Deputy Chairman, The Foundation for Science and Technology
Mr David Hughes FREng, Director-General, Innovation, DTI
Mr Julian Anderson, Composer
City and Guilds, CCLRC and NESTA

30 April 2003

Building stronger partnerships in medical science research in the UK
Professor John Bell FMedSci, Regius Chair of Medicine, University of Oxford
Sir John Pattison FMedSci, Director of Research Analysis and Information, Department of Health
The Lord Turnberg FMedSci, Scientific Adviser, Association of Medical Research Charities
GSK and The Wellcome Trust

08 April 2003

The threat to the UK from biological and chemical terrorism: what can be done and what is the risk?
Sir William Stewart FRS FRSE, Chairman, Health Protection Agency
Dr Pat Troop, Deputy Chief Medical Officer, Department of Health
Mr David Veness QPM CBE, Assistant Commissioner, Specialist Operations, The Metropolitan Police
Centre for Applied Microbiology & Research and CodaSciSys

25 February 2003

UK in the Arctic
Mr Graham Fry, Director-General, Public Services, FCO
Dr Dougal Goodman, Director, The Foundation for Science and Technology
Professor John Lawton CBE FRS, Chief Executive, NERC
The Rt Hon Michael Meacher MP, Minister of State, DEFRA
Alstom Power, FCO and Fugro GEOS

Companies, departments, research institutes and charitable organisations providing general support to the Foundation.

3i plc
Aberdeen University
Advantage West Midlands
Aerial Group Limited
ALSTOM Power
Amersham plc
ARM
Arts and Humanities Research Board
Association for Science Education
Association of the British Pharmaceutical Industry
BAE SYSTEMS
Baker Tilly
Bank of England
BBC
BBSRC
Blake Resource Development
BP
BRIT Insurance Holdings plc
British Antarctic Survey
British Computer Society
British Council - Science Section
British Geological Survey
British Library
British Maritime Technology
British Safety Council
British Trade International
Brownell Limited
Brunel University
BTG plc
Calderwood Han Limited
Cambridge MIT Institute
Campden & Chorleywood Food Research Association
Cancer Research UK
CCLRC
Centre for Policy on Ageing
Chantrey Vellacott
CIRIA
City & Guilds
CODASciSys plc
Comino Foundation
Conoco (UK) Limited
Council for Industry & Higher Education
Cranfield University
David Leon Partnership
Department for Education and Skills
Department for Environment, Food and Rural Affairs
Department of Health
Department of Transport
Department of Trade and Industry
DSTL
East Midlands Development Agency
Economic & Social Research Council
Engineering Employees Federation
Engineering and Technology Board
Engineering Training Council
Environment Agency
ERA Technology
Esso UK plc
Ford Motor Company Limited
Foreign & Commonwealth Office
Fugro GEOS
GlaxoSmithKline
Harley Street Holdings Ltd
Heads of University Biological Sciences
Health & Safety Executive
Higher Education Funding Council for England
Houlihan Lokey Howard & Zukin
House of Commons Library
House of Lords Select Committee on Science and Technology
HSBC
IBM (UK) Ltd
ICI plc
Imperial College of Science, Technology and Medicine
Institute of Food Research
International Power
Japan Society for the Promotion of Science
International Power plc
Johnson Matthey plc
Keele University
King's College London
KMC Search and Selection
Kobe Steel Europe Ltd
Lloyd's Register
Lloyd's TSB Bank plc
London Guildhall University
London School of Hygiene and Tropical Medicine
Loughborough University
Manchester Metropolitan University
Medical Research Council
Microsoft Research Limited
Middlesex University
Ministry of Defence
Monsanto plc
National Grid Transco
Natural Environment Research Council
Natural History Museum
NESTA
New Product Research & Development
NIMTECH
Nottingham Trent University
Novartis UK Limited
Office of Science and Technology, DTI
Office of the Deputy Prime Minister
Ordnance Survey
Oxford Innovations Limited
Oxford Natural Products plc
Parliamentary Office for Science and Technology
Particle Physics and Astronomy Research Council
Peter Brett Associates
Pfizer
PowerGen
PricewaterhouseCoopers
Public Record Office
QinetiQ
Queen Mary, University of London
R & D Efficiency
Railway Safety
Research Into Ageing
Roehampton University of Surrey
Rolls-Royce plc
Royal Botanic Gardens, Kew
Royal Holloway, University of London
Rutherford Appleton Laboratory
Science Media Centre
Science Year
Scottish Higher Education Funding Council
SEMTA
Severn Trent plc
Sharp Laboratories of Europe
Software Production Enterprises
South Bank University
Taylor Woodrow
Thames Water
The British Academy
The Generics Group
The Hydrographic Society
The Institution of Electrical Engineers
The Institute of Physics
The Leverhulme Trust
The Meteorological Office
The Open University
The Royal Academy of Engineering
The Royal Commission on Environmental Pollution
The Royal Commission for the Exhibition of 1851
The Royal Society
The Smallpeice Trust
The Wellcome Trust
UK Council for Graduate Education
UK eUniversities Worldwide
UK Marine Information Council
UK Nirex Limited
UKERNA
UMIST
Union Railways North Limited
University College London
University of Birmingham
University of Bristol
University of Cambridge
University of Dundee
University of Durham
University of East Anglia
University of Edinburgh
University of Glasgow
University of Hertfordshire
University of Hull
University of Kent
University of Leeds
University of Leicester
University of Manchester
University of Newcastle upon Tyne
University of Reading
University of Surrey
University of Sussex
University of Teesside
University of Ulster
University of Warwick
University of Westminster
University of Wolverhampton
Welsh Funding Councils
Winsafe Limited

The Foundation for Science and Technology
10 Carlton House Terrace
London
SW1Y 5AH

Telephone: 020 7321 2220
Fax: 020 7321 2221
e-mail: fstjournal@foundation.org.uk

www.foundation.org.uk

THE FOUNDATION
FOR SCIENCE AND
TECHNOLOGY