TECHNOLOGY INNOVATION AND SOCIETY

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TECHNOLOGY, INNOVATION AND SOCIETY

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ANGLO/BELGIAN LUNCH

As reported in the News section, the Foundation was invited to join the Royal Belgo-British Union for a lunch meeting in Brussels on 28 October 1997 in the presence of His Royal Highness Prince Lorenz of Belgium. The Rt Hon The Lord Jenkin of Roding PC gave a speech at the event, the text of which is reproduced below.

The Rt. Hon. The Lord Jenkin of Roding, P.C

Your Royal Highness, Your Excellency, my Lords, ladies and gentlemen. It is a very great pleasure for members of the Foundation for Science and Technology to be with you here today in Brussels for what is, I believe, a unique event in the long history of UK-Belgian collaboration in the fields of science and technology.

We are very grateful for your generous hospitality, which not only facilitates an ever closer rapport between the scientific and industrial communities in both our countries but is also a most enjoyable social gathering.

I would like to express my gratitude to one of our Vice Presidents of the Foundation for Science and Technology, Dr Richard Haas, for his part in establishing the links and helping to make possible today's gathering.

It may come as something of a surprise to the British participants to learn that, while it is well-known that Britain was the cradle of the industrial revolution in the 18th and early 19th centuries, Belgium was the first continental country to which British expertise and technology was exported and where it took root.

Visitors to the fine city of Liège are sometimes intrigued to discover that the address of the famous University of Liège is in the "Place Cockerill". The Place was so named as a tribute to the two English Cockerills - the father, William, who brought wool-spinning and weaving to Verviers and subsequently to Liège, and his son, John, who established at Seraing Sur Le Meuse what was to prove the most extensive iron foundry and machine manufactory on the Continent or indeed perhaps in the world.

The father, William, had a chequered history before settling in Verviers. He tried to interest the Russians in his machinery but was thrown into jail by the mad Czar, Paul, because he failed to finish a model on time. Cockerill escaped to Sweden, but, again, his efforts to introduce machinery were not appreciated! In 1799 he arrived in Verviers where he entered into a contract with the firm of Messieurs Simonis and Biolley for the supply of his machines. When this contract expired in 1807 Cockerill came to Liège with his sons and built factories for the construction of textile machinery. He thus secured to Verviers supremacy in the woollen trade and introduced to Liège an industry of which England had hitherto possessed the sole monopoly. His contribution was acknowledged by the Industrial Commission of 1810 and he received letters of naturalisation.

John Cockerill's achievements were even greater. The great foundry and machine factory at Seraing was built two years after the Battle of Waterloo and the town became totally dominated by the Cockerill plants. Interestingly, William I, King of The Netherlands, was a strong supporter and until 1835 was himself a partner in the business, having invested in it the sum of £100,000. Sadly, John Cockerill died of typhoid in Warsaw, but much later a statue of him was unveiled at Seraing on 29th October 1871.

Textiles were not the only industry to come from England. In 1835 the first Continental railway line was opened between Mechelen and Brussels. British engineering was necessarily employed; unfortunately, the British engineers didn't think that Continentals might like to drive on the right so that, to this day, when trains cross the border between Belgium and Germany (and, even more fascinatingly, when French trains move from Lorraine into Alsace) they have to switch from driving on the left to driving on the right. Four locomotive engines were imported from England. Thereafter, they were manufactured in Belgium - by the Cockerills of course.

Today, Eurostar runs between Brussels and London, and on 14th December of this year the journey will reduce from 3 hours 15 minutes to 2 hours 40 minutes with the opening of the high-speed track through Belgium. Thus are the tables turned; for the train will still go slowly through Kent because the British high-speed link will only follow some years later.

I have dwelt on this interesting history because in it lies, I believe, the seeds of today's successful and multi-faceted collaboration that exists, Your Royal Highness, between your country and ours. Indeed, when I asked the Director of the British Council in Brussels, Dr Ken Churchill, whether there were any problems in this collaboration to which I should make reference, he told me there were none. On the contrary, the Joint Research Programmes which the British Council operates with the Flemish and French communities (the Belgian responsibility for these are devolved) run thoroughly smoothly and successfully and can be held up as an example of the way in which scientific and technological co-operation contributes to the spectrum of good cultural relations.

But of course it does not stop there. Britain and Belgium collaborate in a long list of other projects, many of them under the Eureka umbrella. I have been provided with a list of these and it covers an astonishing range of scientific collaboration. I discovered one which intrigued me: a European strategic cigar automation project entitled (I know not why!) "ESCAPE"! This is completed.

Projects still to be completed include a wide range of near market research such as "MEDEA", the micro-electronics development for European applications (the execution phase), "HEROIC", helios-embedded real-time operating system for Internet activity, and one which I find very intriguing called "SAM", the development and construction of a sweating articulated mannequin for clothing comfort research and testing! There is also one called "CHOCLAB", which at first sight seemed to be a project connected with the chocolate war! On closer examination, it turns out to be quite different; it covers instruments and standard test procedures for laser beam and optics characterisation!

There are also bilateral projects. Some researchers from Edinburgh University have a successful collaboration with Belgian researchers based around a facility at Louvain la Neuvre, where there is good basic science being done concerning the origins of the elements and the stars. On a more immediate scale, there is collaboration between the Institute for Animal Health and the University of Liège on T-cell mediated immune response and, of huge relevance today, on the molecular pathenogenesis of BSE.

Further, the Institutes of the British Natural Environment Research Council and its Belgian counterparts are major players in pioneering interdisciplinary, international work being carried out

in the North Sea under EU funding. For instance, the Centre for Coastal and Marine Sciences in Britain is involved in projects funded under MAST (the EU programme on Marine Sciences and Technology) including "OMEX".

"OMEX" is a project aimed at getting a better understanding of the physical, chemical and biological processes occurring at the ocean margins. This is one of the largest ever projects funded by the Commission in which the Centre for Coastal and Marine Sciences has a major role. The project is co-ordinated by the Université Libre de Bruxelles.

As I have said, all the evidence which has reached me suggests that these bilateral collaborations are proceeding smoothly. For us, in the Foundation for Science and Technology, this is indeed excellent news. It has been our practice in recent years to engage our members and, where appropriate, members of other bodies in joint discussions with our opposite numbers in other countries. For instance, only last week we helped to organise a joint symposium between Britain and France on the training and certification of engineers in our two countries; next April we take a party to Japan to examine our two countries' approaches to industry/university research collaboration.

My message to this gathering today is that I hope our partners will come to recognise both the force and the authority of this critique of the Fifth Framework Programme, as it is at present constructed, and that together we will hold the Commission to its expressed aim to deliver a programme that is both more focused and more relevant than its predecessors. However, when one looks at future EU collaboration on R&D - and, in particular, at the European Commission's proposals for the Fifth Framework Programme, I must confess to some misgivings. This was examined by the very distinguished House of Lords Select Committee on Science & Technology earlier this year, which concluded as follows:-

"The single most important reform which is needed for the Fifth Framework Programme by comparison with previous Framework Programmes is for it to be focused on a smaller range of subjects, and within each subject on a smaller range of better-defined programmes. We urge the government to make every effort in the Council of Ministers to force the Commission to honour its commitment to a more focused Programme; to this end some of the activities of Framework Programme 4 must be explicitly terminated.

We are grateful to Professor Routti and his colleagues for their co-operation in this inquiry. However, we are dismayed by the approach to Framework Programme 5 set out in 'Towards Framework Programme 5 2'. Where the Commission promised focus and selectivity, they offer instead a programme of vast scope and unlimited geographical extent; they promised a reduced role for the Joint Research Council, but it now appears that its role is to be maintained or enhanced. The United Kingdom and the European Union have much to gain from Framework Programme 5. All those involved in the negotiations over the coming months need to work together to ensure that the Programme is focused, adequately resourced, properly managed on the basis of uniformly open competition and capable of meeting the needs and opportunities of the future."

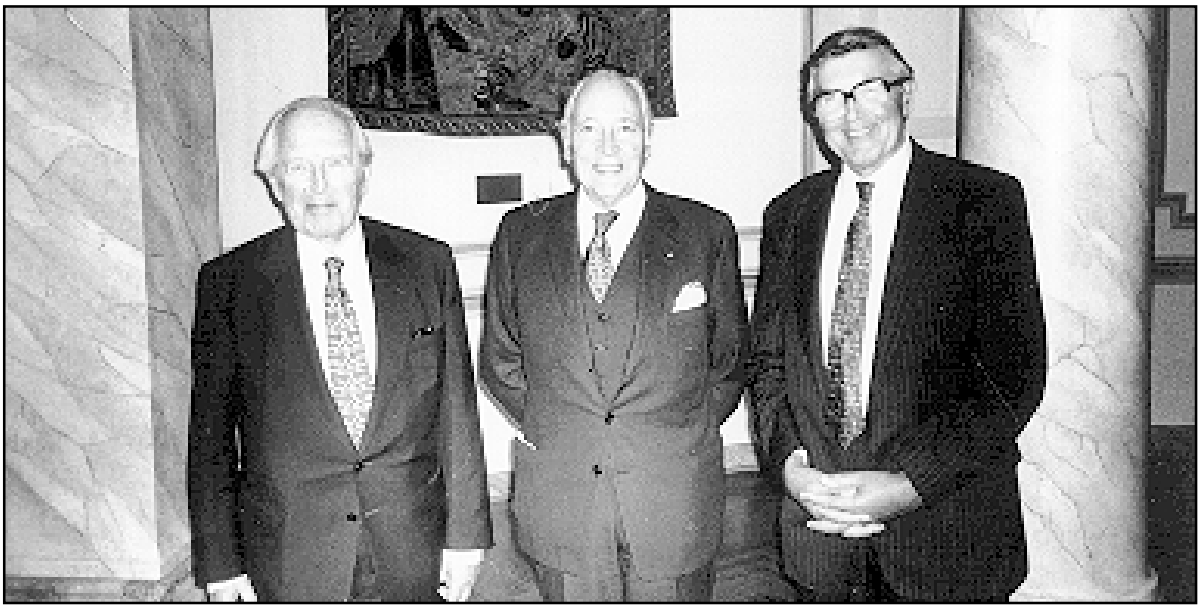
The United Kingdom Government fully endorses these views. In a White Paper, published only last week, they said:-

"It is an explicit theme of the UK negotiating position that we expect the Programme to be focused, through the key action concept and other mechanisms, on a limited number of objectives of clear European importance, including the research necessary to support the delivery of other chapters of the Treaty as provided in Article 130f. The Government is therefore disappointed that the Commission's formal proposal merely reaffirms the framework set out in the working document to which the Committee's comments refer. The Government will continue to work closely with other Member States, a number of whom share the Committee's and the Government's view, to try to influence the further development of the proposal towards a more clearly defined, more purposeful focus on significant European challenges."

Today's bilateral event, therefore, although somewhat briefer than our other bilateral events, nevertheless fulfils one of our objectives, which is to keep our members informed about relevant activities in other countries. It is immensely encouraging to come to Brussels and to learn just how satisfactory are the relationships on the science and technology front between our two countries. Our respective governments may find themselves at odds on the Single European Currency and on the proper constitution of chocolate. So far as I can discover, there is no comparable dissension in the field of science and technology.

Of course, the newspapers will find this intensely boring and their readers may have to search hard to find anything about it at all. But for those of us who take a close interest in such subjects, the news is reassuring and positive.

Once again, may I thank you, Your Royal Highness, and your colleagues for enabling us to meet you here today and to enjoy your hospitality. Perhaps there may come an opportunity when we can reciprocate by inviting you to Britain. However, perhaps we should wait until our high-speed link is up and running, for then we could hold our heads high. I'm sure, Your Royal Highness, that the spirits of William and John Cockerill would approve!



◀*The Foundation's meeting in Brussels. Count Yves du Monceau, President of the Belgo-British Union, hosts to the Foundation at a lunch meeting at the Cercle Royal Gaulois. Lord Jenkin of Roding on his left, and on his right is Dr Richard J Haas who initiated the event with HRH Prince Lorenz of Belgium.*

IT - THE POLICE & SOCIETY

The Foundation held a lecture and dinner discussion on 22 May 1996 on the subject "Information Technology, the Police and Society". The Lord Butterworth CBE DL was in the chair and the evening was sponsored by EDS & A T Kearney. The speakers were Dr Craig Baker, Vice President, A T Kearney, Mr John Newing QPM, Chief Constable, Derbyshire Constabulary, and Chairman, Technical & Research Committee, Mr Andrew Foster, Controller, The Audit Commission, and Mr Jonathan Bamford, Assistant Data Protection Registrar.

Summary: **All the speakers welcomed the developments that had been made in information technology as applied to the prevention and detection of crime. These were detailed by Mr Baker and Mr Newing. It was, however, pointed out that care had to be taken, especially in regard to data protection, to ensure the privacy of the innocent individual.**

Dr Craig Baker*

Introduction

My task this evening is to set the scene and to try to identify some of the key issues to be considered this evening in this fascinating and multi-faceted area.

There are important changes under way in society which demand changes in policing.

• Rising consumer expectations of the quality of service to be received from all service providers are being led by the standards set by the best commercial organisations which have great capacity to invest in new ways of working supported by new technology – this is making it increasingly difficult for cash-limited public services to "compete" with these companies in the eyes of members of the public – but, if they are to maintain public satisfaction, compete they surely must.

• There are new crimes and new ways of committing old crimes – fraud, money laundering, computer hacking, industrial espionage, etc – all of which create demands for new services from the Police.

• The breaking down of national borders, globalisation of industries and markets, use of technology and communications, mean that everything happens faster and less predictably. For many industries this trend represents both a challenge and an opportunity; for the police service, I suggest, it is an unmitigated challenge! A challenge to be faster, more responsive and in even more places at once than ever before.

These changes contribute to increasing pressures on police resources:

• Firstly, more sophisticated approaches are required to match this increasingly complex environment and demand for high quality customer service

• But, secondly, there is still a continued public desire for a uniformed presence for reassurance patrol, even though this has been shown to have a limited impact on crime unless it is carefully focused and directed. I am sure Andrew Foster will return to this issue in a moment.

• Even though efforts are under way to streamline paper and information flows within the police and between the police and other agencies in the criminal justice system, the paperwork burden continues to mount.

New applications of technology

As for many other industries, technology offers new approaches and solutions to these challenges. And much is being done, indeed in many respects the police are at the forefront of examining new applications of technology from a strategic perspective:

• The Government's recently published White Paper on the Strategy Against Crime has an annex devoted to the subject of Technology and the Fight Against Crime. It catalogues an impressive range of systems either already in use or being planned.

• These range from new applications for the Police National Computer and HOLMES, and better inter-agency co-ordination through the CCCJS, to the use of on-board computers in police cars, thermal imaging in helicopters and electronic tagging systems to help trace stolen vehicles and property.

• Recent falls in crime rates in this country have been attributed in part to more – and more effective – use of new technology such as CCTV and more analytic approaches to identifying crime patterns, persistent offenders and repeated victims.

• Overseas, the dramatic reductions in crime in New York which have been widely publicised (a 27% overall reduction in crime in two years to reduce it to levels not seen since the early 70s) have been attributed to the use of crime data to manage by objectives. In the words of Police Commissioner Bratton: "We're processing crime data faster than ever before, so we can identify patterns early and stop them after 3 crimes instead of 30. If you do that citywide, you'll knock the crime rate down". Some police tactics flowing from this new analytic capability have been heavily criticised for being over-bearing, but that should not detract from the underlying value of having better information on which to base the management and targeting of resources.

• Back in the UK again, there are even more innovative applications being developed and researched, for example:

- The national database of fingerprints and marks is under development on one of the largest magnetic disk stores ever built. This system brings with it not only much better search facilities but also such possibilities as mobile scanners which would allow a police officer to check the identification of arrested persons in the street and establish whether, for example, they have a criminal record.
- Neural computers can analyse crime pattern data, videos, criminal intelligence data, etc, in much more incisive ways than has been previously possible. This can improve detections and even predict crime patterns to enable better targeting of resource deployment and so aid crime prevention.
- Desktop virtual reality systems will enable, for example, crimes to be reconstructed so that victims can relive them and take the police through the crime scene to improve the quality and accuracy of their evidence.
- Use of the Internet offers a wide range of possibilities, including help to trace stolen goods, cars and missing persons.
- The use of multimedia booths in shopping centres and other public places will enable the public to communicate more easily with the police service.

Apart from the major national systems, the Home Office estimates that forces locally are investing some £150m a year in IT. So the service is pushing for new applications of technology which will address the challenge of more and better service with less resource.

** Vice President, A T Kearney*

New issues and concerns

But whilst technology undoubtedly offers the police service new opportunities to increase its effectiveness and performance – and this has to be good news – new opportunities inevitably give rise to new issues and concerns.

These issues fall into two broad categories – those which are matters for society as a whole and those which are for internal police management.

For society generally, there are issues about civil liberties and accountability of the police, which I'm sure Jonathan Bamford will discuss at much greater length shortly. But by way of introduction, there are at least three areas which I think merit consideration (the use of CCTV; DNA profiling and the national fingerprint system; and data exchange between organisations).

• CCTV has had some major successes in reducing crimes in various parts of the country. But there was the recent case of the man who was filmed making a failed attempt to commit suicide in a shop doorway and the local council passed on the film to the BBC who then broadcast it nationally, including shots which allowed him to be identified. That surely cannot be acceptable.

• The admissibility of DNA evidence is also beginning to raise interesting questions. Will juries convict if they do not understand the nature of evidence or process by which it was obtained? Will society feel comfortable if the activities of the police are not transparent? What role will the police or someone else need to have in educating the public so that they understand what is going on? And the maintenance of data held on the national fingerprint system will represent a significant overhead in order to ensure that civil liberties are properly safeguarded.

• On data exchange, what laws should govern how data is passed from one organisation to another? If people become unwilling to hand over personal information, what will the impact be on the size of the black economy and taxation?

The key is surely to ensure that there are sufficient safeguards in place so that these powerful technologies can be exploited to the full without people fearing that their civil liberties will be infringed. How we achieve this is an important area for consideration this evening.

For Chief Constables and the Police Service, the increased role of technology in policing gives rise to issues around the types of people they need to be recruiting in future and the training they are given; these issues have knock-on implications for pay and career structures, for relative spending priorities and for organisation structures and economies of scale.

Whereas the civil liberties aspects are specific to the police service, all organisations are having to come to terms with the constantly accelerating pace of change, rising customer expectations and the need to control resources ever more tightly.

So how are the best managed organisations approaching the issue of deriving better value from their resources, being more customer-focused and ensuring that technology is used to support the business strategy?

Broadly speaking, they are following five basic steps:

1. **Understand customer needs in detail** – including analysing trade-offs between potentially conflicting desires, examining price sensitivity and so on – so that the product or service they provide can be tailored very carefully to meet those needs, with price an integral part of the analysis. This is an area where public sector organisations generally can learn a lot from best practice commercial organisations. And the issues for the police are particularly challenging, not least because they involve educating the public to understand the true opportunity cost of general foot patrol.

2. **Focus on core business and competencies – sticking to what they do best**. This is potentially a big issue for the police service which is forever being given additional responsibilities without being relieved of existing ones. There are topical debates about an extended role for Special Constables, "parks police", the role of private security firms on housing estates and so on, which (although wider than the subject of our debate this evening) may be touched on during the course of the conversation.

3. **Make absolutely certain that they make those core processes as efficient and effective as possible**. Essentially, this involves a more analytic, targeted approach to the deployment of resources. Building on the understanding of customer requirements, then focusing effort single-mindedly on meeting those as effectively as possible. Taking this customer-focused approach means that efficiency almost takes care of itself, because achieving the right levels of customer service inevitably requires careful co-ordination of resources, well-trained and motivated staff, intelligent management and appropriate technological support.

4. **Exploit innovative uses of technology where they can enable entirely new ways of working and deliver step-change improvements in performance**. Introducing robotics or virtual reality or neural nets is clever and exciting, but these tools have to be used in ways which deliver tangible business benefits and represent good investments – the potential is undoubtedly tremendous. But realising it will require police personnel to accept large-scale changes in the way they work – and this is invariably the stumbling block for many organisations seeking to exploit new technology.

5. **And, finally, adopting these customer-focused, analytic approaches generally requires a certain amount of insight and creativity, and a lot of information, used and interpreted with intelligence**. And this is the other main way in which information technology can really make a difference to the business – by improving management decision-making.

I would suggest that this five-step approach is as applicable to the police as any other organisation. In particular, it ensures that investments in new technology are led by customer and business needs, and their implementation is fully integrated with changes in the ways of working. It is not, of course, entirely new, but it will demand significant changes in working practices and culture if the full benefits are to be achieved.

Conclusion

The focus for our discussion this evening is how technology can best be applied to help the police improve their performance and service to the public, and what controls need to be in place to ensure that the constant drive for better performance does not take us down paths which are subsequently deemed to be unacceptable from a civil liberties perspective.

Mr John Newing QPM*

The Police Service and change

I joined the Metropolitan Police in 1963. Change has been my constant companion. When I joined there were no personal radios; there was no Police National Computer; there were fewer vehicles, most police officers walked or rode bicycles; there were many more police forces. Attitudes within the service toward the public were different, professional judgement overrode customer demands and service. There was no Police Complaints Authority. The public view of police, despite the fact that we were less accountable, was more benign. The media interest in policing was

** Chief Constable, Derbyshire Constabulary, and Chairman, Technical & Research Committee*

significant but different. There were crime reporters rather than Home Affairs or Crime correspondents. Reported crime was comparatively low.

Today's police service has fewer and larger police forces, is better trained and managed, highly mobilised, is equipped with an array of protective technology and training to deal with public protest and disorder, has regional crime squads to fight organised crime and a majority of forces have air support units equipped with imaging technology. Reported crime, despite the recent downward trend, has risen nearly fivefold: from just over 1 million in 1963 to nearly 5 million in 1995. Calls for policing services have risen at a similar rate.

Each of us carries a much heavier workload than officers did thirty years ago. Yet we are a service which is both more responsive and more sensitive to the needs of its many different publics. British police management is now highly focused on the delivery of quality services both internally and externally. It is a far cry from the service I joined in 1963.

The impact of change

Changes within the police service have not been produced in a vacuum. They have been a response to trends and developments within society as a whole. The Audit Commission, who have been working closely with the police service over the last seven years, can confirm our readiness to question existing operational and management methods and conventions and our willingness to change to meet the fresh challenges that social, economic and political changes generate.

More police officers in cars has mirrored the growth in car ownership and been a response to public expectations of a swift response to calls for assistance and the increasing mobility of criminals – too often in other people's vehicles; it has lessened daily contact between citizen and police officer.

The use of computers, and in particular the Police National Computer with its various databases, heightened fears about civil liberties, but, in general, has enhanced people's freedoms and lessened inconvenience by reducing the time people are detained for questioning on the street. One unwanted spin-off was some loss by police officers in the art of questioning people. There is a strong temptation to take the information provided by computers entirely at face value.

Nothing, however, has changed the face of policing more than the personal radio, itself a product of the growth of telecommunications. In its early days one journalist referred to it as "the babbling lapel". The personal radio distracted officers' attention away from happenings around them to focus on happenings elsewhere. Before the advent of the personal radio police officers had to seek support from within the communities they policed. Discretion and caution were the police officer's survival techniques. Now police officers almost invariably seek operational support via the personal radio – not from the neighbourhoods they police, but from their colleagues.

In these ways increased mobility and technological improvements led to a worsening of communication between constables and their communities.

Changes in training and induction with an emphasis on a service ethos have since been made to redress these unforeseen changes in the culture of policing. We are now (as I have already suggested) a more responsive and sensitive service than we were thirty years ago or than we were fifteen years ago, but the increasing use of technology not only means we provide similar policing services differently, but also that we provide different policing services than hitherto.

Policing and technology: its management and use

There have been welcome increases to police strengths in the past thirty years, but the gap between resource and demand has continued to widen. Pressure on public expenditure, integral to the success of government economic policy, has accentuated the process. Police forces face a bottom line where they have to make scarce resources more productive and more efficient if public confidence is to be maintained. Technology, particularly IT, offers the potential to balance the new policing ledger.

In broad terms, police work consists of crime prevention, law enforcement and helping people. These requirements do not always sit easily one with another. Nevertheless, all are essential to our role as *keepers of the Queen's peace*. IT can help improve police performance in all three areas. IT can also provide the means for reducing the time that operational officers spend on paperwork and records – thereby increasing the time that they are available for direct operational police duty. In addition, IT can speed up or lead to changes in operational and administrative practices and processes, enabling improvements in quality of service and a reduction in costs. Above all, IT offers new opportunities, both nationally and locally.

The distinction between national and local is an important one in the British police service. In April 1987 I was seconded to the Home Office to assist in the development of a second-generation Police National Computer (PNC2) and conduct a national survey of police IT requirements.

PNC2 has been in place for six years but of the major requirements identified by the survey only the provision of a police national data network (PNN) has been realised in full.

Work on a searchable criminal record has been under way for some time, but difficulties with back record conversion are currently being experienced.

The Forensic Science Service operates a DNA database. Currently it has a sizeable backlog of records waiting to be entered. A national automatic fingerprint identification and retrieval system is in the progress of being implemented. Once the fingerprint database is in existence new and developing technology will eventually allow police officers to input and search fingerprint files from remote work stations in police offices or police vehicles.

There has been some enhancement of vehicle and driver information on the PNC database, but direct access with the Driver and Vehicle Licensing Agency (DVLA) is still under negotiation. The cost of the service to police forces will be a major consideration for chief constables.

Nationally, ways have to be found to meet the needs of the service more quickly. A Police IT Organisation separate from the Home Office is in the process of being established. The hope is that it will be more responsive to the requirements of the service.

Moving outside the national arena, the picture of police IT is different. It should be stressed that things are improving, but the overall picture is one where individual forces are at different stages of computerisation.

That is a natural consequence of policing being a local authority responsibility. Different authorities have different service priorities. Unfortunately, it is a picture, when seen from a national perspective, that is characterised by waste, omissions, incompatibility and duplication.

The situation is being addressed in two ways. First: by a national strategy for police information systems (NSPIS). Work on this strategy was started in 1993 and launched publicly by the Home Secretary on 1 November 1994. It sets out proposals for developing the IT applications that all forces need for the police service as a whole. Substantial development time and expense will be saved, both for suppliers and police. In addition, police forces will save on procurement costs. Technical standards and standard data definitions are being developed in parallel with the work on applications.

Second: by the insistence that all forces develop their own IT strategy and migration plan. The models of good practice all have the integration of information as their overriding aim. Other objectives common to the better force strategies are:

- open and distributed systems
- upgraded networks
- all-purpose terminals

• information available when and where needed
• single entry of information
• investment appraisals in respect of the overall strategy

In addition to these projects a major radio project is also being undertaken. This is being forced on the service because of a change to emergency service radio bandwidths; all police forces will have to change over before 2004. The costs are substantial. It does, however, provide an opportunity for police forces to change from analogue to digital.

A major problem the service faces at the moment is from criminals who are able to follow police activity by scanning police radio channels. The move to digital radios will prevent that. It will also offer other opportunities. Some police forces already have cars equipped with mobile data terminals, which enable them to be receive messages, access the PNC and have their movements monitored for deployment purposes.

In Derbyshire we are conducting trials with personal hand-held devices, which link Apple Newton hand-held computers and Nokia telephones. The project is attracting national and international interest. Officers can access the force Crime Recording System as well as the PNC by means of the device. Recently, the Head of my Information Services went on holiday to Australia. He took a device with him. Once logged on to the force system he was able to access the PNC in less than twelve seconds.

It is estimated that their use saves 1 hour of police time per officer per shift. Quantitatively that represents a saving of 4 weeks per officer per year. In terms of quality, as one officer involved in the trials said to me, "*It enables me to spend more time with the victim. I give them a better service and I am more likely to obtain information that may help to identify the offender*". The business case is irresistible.

Police and technology – the future

In the future I confidently expect the personal radio to be replaced by dual voice and data hand-held communications equipment. In February of this year the Audit Commission published a report about police patrol. Amongst its many conclusions it noted:

• effective patrol underpins 'policing by consent';
• 80 percent of people want to see more police on patrol;
• around the clock only 5 percent of police strength is on the streets, in car or on foot;
• forces need to target patrol effort and get closer to communities by expanding the use of IT to support patrol and improve briefings and debriefings.

Personal hand-held computers provide the means to make police patrol more effective, thereby strengthening public confidence in the police service and enabling our traditions of 'policing by consent'. The need to target police effort, whether it be operational or administrative, is a direct product of the increasing gap between demand and resource availability. Technology can improve the availability of police resources; it can also improve the effectiveness of those resources. Computers are invaluable aids to criminal intelligence, crime pattern analysis and command and control. All forces have them.

Computer technology also has significant vehicle crime prevention, recovery and detection possibilities. Security systems, immobilisers and tracking devices are all currently available. All it needs to reduce vehicle crime substantially is the co-operation of the vehicle manufacturers.

Imaging technology, now far too sophisticated merely to be called cameras, is a key factor in crime prevention, public reassurance, law enforcement, road safety, surveillance work and the protection of the rights of persons in custody. Television moreover is being explored specifically as a means of enhancing police training and generally as a more effective medium of communication within and between forces. The purchase of satellite time may not be too far away.

Closed Circuit TV, which has led to significant reductions in crime in town centres and shopping malls, is the forerunner to far more sophisticated imaging technology. Work is already well advanced on cameras which can read and recognise vehicle number plates – even dirty or obscured plates. But the technology offers possibilities of people recognition – or perhaps more accurately facial matching recognition. The Police Foundation is considering an initiative to explore this possibility and the prospect of linking police records to privately owned image databases. If successful, the project could herald an entirely new era for police patrol.

Technology and Police/Community Relations

Imaging developments apart, the Internet, multi-media and kiosk technology will over the next ten to fifteen years have the greatest impact on the police service and the way it interfaces with members of the public.

Police stations, police offices and telephone networks are the usual means by which the police and community interact. They are a significant cost on building, repair and maintenance and staff budgets. From community relations and quality service perspectives they are not particularly cost effective. Technology offers significant opportunities for improvement.

The Metropolitan Police, in partnership with the London Borough of Newham, has recently initiated a multi-media communications project **Attach (Advanced TransEuropean Telematics Applications for Community Help)**. The project consists of five telematic kiosk sites in different areas of Europe.

Attach aims to develop a multimedia system for the communication of all classes of public information and for interaction with public services. Kiosks will not only be based inside or immediately outside police offices, they will also be sited within supermarkets and other places which are open outside normal working hours.

The possibilities are wide ranging. Imagine the following scenario as one example of what the future holds. A crime occurs in a public place. The victim contacts local police from a kiosk. He or she not only speaks to a police officer, but sees the officer at the same time. The crime is recorded at the time and the victim is given a crime reference number. That reference will enable the victim of the crime to look at the crime report in due course in order to follow the progress of the investigation.

We are seeing the advent of a modern police box. The Internet offers similar possibilities for the delivery of services and information to individuals within the privacy of their own home.

Police offices will gradually become redundant. The staffing costs of the police interface with their communities will reduce as the police response is centralised. Despite centralisation multimedia will make the service both more personal and more specific to the individual.

The downside

Technology, however, also has a downside. New forms of crime are generated. Microchip theft and computer fraud are now big business. Hacking and viruses are also on the increase. The former is a threat to security and the latter can cost millions if it strikes successfully at a company's computer databases. Fraud on the Internet has already been detected. The threat of child pornography and incitement to under-age sex on the Internet has led to the introduction of special legislation. Police officers have had to learn new skills to combat new criminal methods.

The benefits of technological advances from the operational police officer's perspective are clear. Whether they impact on the liberties of individual citizens for good or ill will depend to a great extent on the quality of police discretion and commonsense. But that has ever been so.

Mr Andrew Foster*

I propose to give a brief introduction to the Commission's work, then look at the IT messages emerging from a couple of recent studies on the police.

The Audit Commission

The Audit Commission works with local government, police and local NHS bodies. It "promotes proper stewardship of public finances and helps those responsible for public services to achieve economy, efficiency and effectiveness", by appointment, regulation and quality control of local auditors, who do financial accounts, local vfm, probity, legality.

It also conducts national vfm studies to look at issues of economy, efficiency, effectiveness (the 3Es) and quality.

Two recent police studies

In 1993 we published *Helping with enquiries*, a report on tackling crime effectively. This year we looked at police patrol, the other side of the coin, in *Streetwise*.

Police forces are under pressure, with public expectations rising and resources tightly controlled.

Both these reports identified the vast dividends which effective and co-ordinated use of IT can pay.

"Helping with Enquiries"

The key messages were:

• clarify roles and accountabilities in management, ensuring that detectives only handle crimes of sufficient seriousness to need their attention;

• make best use of resources, and consider establishing crime desks to assess crimes;

• target criminals rather than respond to incidents.

It was in the last area particularly that enhanced role for IT – specifically crime pattern analysis – was identified.

Police officers know that many crimes – especially crimes against property – are committed by a small group of people. Analysis of the histories of a large sample of males born in a particular year showed that 7% of them accounted for 65% of all convictions in that age group.

CPA links clusters of crimes by factors such as means of entry, time of day, items stolen, thus identifying the criminal's trademark. Then forces can used combined evidence from different crime scenes to identify and catch the criminal.

CPA is not new: sticking coloured pins into maps is a basic form of analysis. But to cope with rising crime, and increasingly sophisticated and mobile criminals, an integrated computerised system is essential.

When we published the report, however, only 30% of forces had such a system. And very few forces had systems which could be linked with their neighbours'. Criminals, inconveniently, do not acknowledge administrative boundaries.

Many forces are setting up their own systems, but a properly integrated national system is still some way off.

"Streetwise"

This study, on effective police patrol, launched a couple of months ago, looked at one of the areas of police work most valued by the public, "the bobby on the beat".

The report concluded that public expectations of police patrol were not wholly realistic. And police patrol often amounted to little more than "placebo policing", valuable for the reassurance it gave to the public, but negligible in terms of detecting crime.

This is not to say that police patrol is without value. But the police could do much to work "smarter not harder". In particular, partnership with communities and other organisations could enable them to concentrate their efforts on those incidents and areas where they would be most effective, and using non-incident time more effectively.

And IT has a part to play here, too, with an extension of the methods of crime pattern analysis to patrol work.

Every patrol officer knows that there are a few high-profile problem areas – "hotspots" – on his or her beat. But the less obvious hotspots often escape notice.

Research in Minneapolis found that over 60% of calls originate from 5% of addresses.

Without proper analysis, the police are called out to the same addresses again and again, but remain unaware of the patterns which would highlight the need for a long-term solution.

Without such data the police's role will always tend to be a reactive "firefighting" approach, rather than the pro-active one needed. And officers attending incidents need as much information as they can get.

90% of domestic violence, for example, involves repeated assault. Yet few of the officers who we interviewed for this study said that they were given information (on issues such as previous assaults, whether charges had been brought or injunctions were in force, whether children at risk were present) when attending domestic violence incidents.

Such information is vital if officers are to make sound decisions at the scene. But without systematic logging and analysis of incidents, the information will not be available.

In New York, where total crime has plummeted over the past few years, precinct commanders are called to regular meetings where a computerised map shows current hotspots in their precinct. They are then asked what strategies they have for combatting the problems of these hotspots. Few come to these meetings unprepared.

Conclusions

These are just two of the areas where the Commission has examined the use of IT by the Police. And this is just one side of the picture: advances in the use of IT carry with them many civil liberties implications, which I am sure will be addressed by other speakers.

I leave you with this quotation from Lord Denning: "Information is vital to the work of the police, but there is still some way to go in exploiting that information, and setting it to work against crime and criminals".

* *Controller, The Audit Commission*

Mr Jonathan Bamford*

Introduction

I am the Assistant Data Protection Registrar within the Registrar's Office who has responsibility for a compliance group. Basically, my people are responsible for ensuring compliance with the Data Protection Act by certain sectors of the UK economy. The Police are one of those responsibilities and also I have local government to worry about, the wider criminal justice systems which includes the probation service, other bodies like trade unions, Housing Associations and, if life weren't interesting enough for me, I also have private investigators to worry about too. So those are my areas of responsibility. I have been with the Registrar's office virtually since its outset, and I have spent most of that time

* *Assistant Data Protection Registrar*

involved in Police and Local Government matters.

Maybe I can pose a few questions to alter our perspectives slightly on some of the points that have been made already. How would you react if arrested whilst driving your own car, which the police believe to be stolen, all because the information on police computers isn't kept up to date? How would you react if you were denied the opportunity to become a foster parent because the police had told the local authority that you have convictions for offences against children, all because the information on computers is inaccurate? How would you react if you were detained for the murder of a police officer on three separate occasions because they have confused you with a wanted but known criminal, all because the information on police computers were inadequate? Would you be annoyed, angry, furious?

Well, every year the Data Protection Registrar receives thousands of complaints from similarly annoyed, angry, furious individuals. Every year the Data Protection Registrar is involved in encouraging, cajoling and sometimes taking legal action against computer users who infringe individual's rights and contravene the Data Protection Act. Now, there is some good news for the Police Services: most of those thousands of complaints do not involve the police. The not so good news is that my team who have responsibility for dealing with police matters currently have an active case load of approaching 100 complaints involving possible contraventions of the Data Protection Act, and that is just the number of ongoing 'live' cases that were open this morning when I left the office.

Commitment of police service

I would wish to make clear to you that whilst the police service, like other data users, may make errors and may occasionally fall down on compliance with the Data Protection Act, they are much better than many, from my experience. I think I would wish to go further and also make clear to you that the police service has shown substantial and continued commitment to data protection, and have done this since the act first came into force, producing one of the first ever codes of practice to address the requirements of the Data Protection Act, a revised version which will be published very shortly. Whilst the Registrar has enjoyed a very co-operative relationship with the police service, I suppose any formation this evening of a mutual admiration society would not really foster the intended debate. I hope that those members of the police service present will understand if I tend to dwell on the wider civil liberties issues rather than all the positive things that we have achieved together in addressing data protection concerns.

Issues of privacy

I appear to have had a rather unexpected and highly distinguished warm-up man in the person of Sir Thomas Bingham, Master of the Rolls, who yesterday was reported as having called for a new law of privacy. Whilst I do not have access to his text, I do know that the issues of privacy are at the heart of the debate concerning the deployment of new technologies in the fight against crime. Those very new technologies which have been described this evening so far. Data protection legislation deals with an element of privacy: 'informational' privacy. It is argued that such legislation has its origins in article 12 of the Universal Declaration on Human Rights, which states that 'No-one shall be subject to arbitrary interference with his privacy, home or communications' and in this everyone has the right to the protection of the law. The European Convention on Human Rights and Fundamental Freedoms has similar provisions.

Privacy regulation in this country started to be considered in the sixties and seventies. In 1972 the Younger Committee veered away from recommending general privacy legislation, but recognised that the increasing use of computers with their power to hold, analyse and compare massive collections of personal data (and already this evening we have been given a glimpse of the future and what it might hold for us) did require addressing in specific data protection legislation.

Sir Norman Lindop in his 1978 report recommended many things which are core features of data protection legislation today. But it is fair to say, I think, that it was the 1981 Council of Europe Convention for the Protection of Individuals with Respect to the Automatic Processing of Personal Data that provided the final impetus for the Data Protection Act reaching the statute book in 1984. By October 1998 our data protection legislation will have to be amended again in this country. There is an EU Data Protection Directive that again makes clear that it applies to privacy, a term not used in the Data Protection Act. Although the term is not used, I think its privacy-related ancestry is quite well proven, and this factor has recently been re-affirmed in a judgement of the House of Lords in the case of R V Brown.

Data protection legislation

Now, a word about Data Protection Legislation itself, and how it protects individuals from the misuse of personal data; how it provides safeguards for each and every one of us in this room from the misuse of the inevitable electronic footprints that we leave behind when we lead our normal daily lives: the visits to the cash machines to check the balance in our account, the walk down the high street recorded in CCTV surveillance, the meal in the restaurant paid for by credit card, the hire car.

But, first, I would like to take a "commercial" break and give you a quick advert for the Data Protection Registrar, Elizabeth France. The Act does create an independent Official responsible to Parliament for the enforcement of the Data Protection Act. Now, for me, that rather conjures up a Dickensian image of a Bob Cratchett-like figure huddled over a dusty ledger. Yes, she does keep a register of computer users, but she does much more besides that: she considers complaints from the public and she enforces the eight data protection principles which lie at the heart of data protection legislation, and are reflected in similar data protection regimes around the world. Indeed, data users such as Mr Newing have to comply with these standards. The principles require, amongst other things, that personal data, that is information to be held on computer about individuals, is obtained and processed fairly and lawfully; that it is not excessive or irrelevant; that it is accurate and kept up to date; and that it is not held longer than necessary; that it is available to data subjects when they request it and that it is kept secure.

Many people say that, for the most part, data protection principles are good information handling practice. Who wants to hold inaccurate information? Who wants to hold irrelevant information and who wants to hold it for longer than necessary? None of us. But this term, 'good information practice', seems to imply that compliance is for the virtuous. Not so. These are legally enforceable standards that have to be complied with. Let us look at some of the issues in the policing context. In the recent House of Lords decision, which I referred to, namely R V Brown, Lord Hoffman opened his judgement with the following words: "One of the less welcome consequences of the information technology revolution has been the ease with which it has been possible to invade the privacy of individual. No longer is it necessary to peep through the keyhole or listen under eaves, instead more reliable information can be obtained in greater safety by the use of concealed surveillance cameras, the telephoto lens, the hidden microphone and the telephone bug".

The surveillance society

The very technological developments that have been described by the previous speakers raise questions as to whether we actually want to live in a surveillance society. This is becoming a pressing question now, because the technology now exists, or is very close to existing, to do this. The dilemma is the balance between preventing and detecting crime as opposed to ensuring the rights of innocent people to lead a private life. How much intrusion are we prepared to accept? Take CCTV Surveillance which has been

mentioned by previous speakers. Described as a powerful ally in the fight against crime, I, like you, have unwittingly been on television today. Many times today. Where were the cameras pointing, who is doing the recording, what is it going to be used for, who will the copy be given to? I do not know. How do we balance the right of an individual to be protected from criminal activity by the use of CCTV surveillance whilst at the same time protecting against unwarranted intrusion into their private lives? CCTV is largely unregulated. The Data Protection Act does apply in limited circumstances. It may increasing apply, as technology develops; videotapes will become a thing of the past, replaced by optical discs, and the EU Directive that I mentioned takes effect, which applies to sound and image data. The excesses of those invading our privacy and capturing images for the entertainment and titillation of others has already been referred to.

We have few effective legislative safeguards to cover this, but the Registrar has participated in the development of a voluntary code of practice for CCTV surveillance by the local government information unit in which the Association of Chief Police Officers were also involved, to try to put in place 'best practice'. If that is not good enough we may need to turn to specific legislation.

Other policing issues

CCTV is just one example of technology allowing intrusion into our daily lives. Let us look at some of the other policing issues that I have to wrestle with in my professional life. To what extent should police hold information on the police national computer about individuals and should it just be about convicted offenders? Those charged with offences but who were subsequently acquitted? Those suspected of committing criminal offences? Those who might possibly, conceivably, commit criminal offences? The friends, contacts, families of any of the above?

I think John Newing referred to the various roles of the police; I think he summarised them as being the following three: crime prevention, law enforcement and helping people. Where are the boundaries in that now? If you report some lost property to the local police, be it be through one of these 'Dr Who' booths or personally to a police officer, is it right that the police should store that information other than in the context of notifying you if your lost property is found and handed in? Is it right that this may be used for criminal intelligence purposes, or for any other purpose to which the police may put it? Such integrated police force databases are already in existence and being developed further. There are data protection issues that go with that, issues to do with fairly obtaining and lawfully processing data, whether the data exceeds its purposes or is held longer than necessary.

Let us look at another issue. Say you are charged with an offence but found not guilty, acquitted by a court and vindicated. Should the police keep a nationally available record of your suspected involvement in the offence, even though you have been found not guilty? The Data Protection concerns about unfair processing, excessive dates and it being held longer than necessary are self-evident.

How many of you can vouch for the bona fides of all those you come into contact with? Say you unwittingly and inadvertently come into contact with a criminal. Should the police be able to retain those details and record that you are a known associate of that criminal? Again, there would be Data Protection concerns. The Data Protection Act does have provisions which regulate and attempt to strike a balance.

The downside and the upside

John Newing has referred to the downside of technological developments and understandably concentrated on the greater opportunities for criminality that new technology may have brought. My perception of a downside places greater emphasis on the privacy implications. But there can also be an upside in privacy terms as well. There are opportunities to design in Data Protection features when new initiatives are developed, to safeguard individuals' privacy, to comply with the Data Protection Act, to put in place features to ensure that data is not excessive and irrelevant, to flag records for removal after a set life span, procedures to ensure that data that is entered is accurate. Dr Baker mentioned the CCCJS initiative, which, very briefly, is to co-ordinate all elements of the Criminal Justice System, with the aim that you would input data once for the whole of the Criminal Justice System. So, for example, when someone is charged their name and address details are input once at this point. Well, they had better be right first time and every time if that is the case. The prospect of the PNC being accessed over commercial telecommunication networks from the other side of the world may be the technological marvel described by Mr Newing, but with what concern for security? The interception of police analogue radio transmissions could pale by comparison if there were widespread unauthorised access to the police national computer itself.

Conclusions

My message to you is that the glittering attractions of new technology should not dazzle us to the extent that we neglect to address the privacy and Data Protection concerns. To design in safeguards at the outset is notably cheaper in monetary terms that Andrew Foster would very much appreciate, but also invaluable in terms of the public confidence which I think Chief Police Officers would appreciate. Once you lose public confidence, it is very, very difficult, if not impossible, to restore. Similarly, privacy once lost is very, very difficult to recover. What is required is a balance. If regulation is too stifling of the police and their use of technology and the guilty go free, the balance is not correctly struck. If the privacy concerns of the innocent individual have been neglected, then similarly the balance is not right. The Data Protection Act goes some way to maintaining that balance, but we have to be vigilant all the time in terms of the increasing use of the new technology and the different challenges they now set us.

Perhaps, in finishing, I might leave you with the words of Lord Brown Wilkinson who, as part of his judgement in the Marcel case, gave an insight into what might be the case if the balance is tipped in a particularly alarming direction:

"If the information obtained by the police, Inland Revenue, Social Security Services, Health Services and other agencies is gathered together on one file the freedom of the individual will be gravely at risk". His chilling conclusion was: "The dossier of the private information is the badge of the totalitarian state".

FOUNDATION NEWS

In mid October there was an evening on the use of IT in teaching science in schools. Sponsored by NORTEL, the idea for the evening came from the association for Science Education. The speakers were Dr David Moore, Professor Stephen Heppel, Mr Bob Ponchaud and Mr Alastair Gittner.

Pictured at the evening devoted to "Using IT to teach Science and Technology" held on 16 October 1997 and sponsored by Nortel, are:

▲*Sir Walter Bodmer, a member of the Foundation's Council (left), makes a point with Mr Michael Grannaway, Vice-President Government Relations Europe, Nortel plc.*

▲ *Mr Ian Vance, Vice-President Technical Quality and External Relations, Nortel plc (left), talking to Professor Stephen Heppel, one of the speakers.*

WHAT AFTER GAS?

A meeting of the Foundation was held on 26 February 1997 at the Royal Society on the subject "What After Gas?" It was chaired by the Lord Butterworth CBE DL and sponsored by Shell International Ltd and the Foundation's Shared Sponsorship Scheme (BP International Ltd, Comino Foundation, Esso UK plc, Glaxo Wellcome plc and ICI). The speakers were Sir Crispin Tickell GCMG KCVO, Warden, Green College, Dr Robin Jeffrey FEng, Chairman and Chief Executive, Scottish Nuclear Ltd, and Mr Roger Rainbow, Vice President, Global Business Environment, Shell International Ltd.

Sir Crispin Tickell GCMG, KCVO*

Summary: Sir Crispin said not only was there a future after gas, but it was closer than most people realised. He discussed future strategy, involving government, business and a campaign of public education to prepare the way. Mr Rainbow outlined the evolution of the world's energy systems and drew conclusions for the future. Among these were that energy needs could be met by more diverse sources than at present and that "carbon tree" newcomers could become competitive through market mechanisms.

Introduction

In its last report published on 27 January, the British Government Panel on Sustainable Development focused on climate change and long-term energy supplies. Its recommendations are relevant to our debate tonight. The most important was that the government should develop a strategic energy policy, which promoted energy efficiency, incorporated environmental costs into energy prices and provided continuing support for non-fossil fuel sources of energy.

Energy issues run like a thread through all other issues. There are many reasons why we should ask ourselves: What After Gas? The two main ones are:

- the implications of likely climate change for energy policy, and
- future problems of energy supply.

Climate change

The problem is the enhanced greenhouse effect with its impact on climate and weather systems. Atmospheric carbon dioxide has varied widely in the past but it is closely related to surface temperatures of land and sea:

- 180 ppm in the last ice age
- 280 ppm in pre-industrial times

With burning of fossil fuel and forest cover it has since risen sharply:

- 300 ppm in 1900
- 316 ppm in 1958
- 359 ppm today

and is rising steadily. This rise has been linked to gradual global warming, with individual years from the last decade being the warmest on record. We are as yet far from any equilibrium.

The Intergovernmental Panel on Climate Change has forecast a range of possible climatic effects:

- a rise in average global mean temperature of between 1 and 3.5°C by the end of the next century. A warming rate greater than any seen in the last 10,000 years
- an average sea level rise of around half a metre in the same time frame. A rate up to six times faster than in the last 100 years. This may result in inundation of many of the world's low lying regions.

Global climate models, by their very nature, have built-in uncertainties, and yet most predict:

- wide regional variations
- more precipitation worldwide
- more extreme and irregular events

Recent work also suggests that global warming could have surprises in store for western Europe. If it affects ocean currents, in particular the Gulf Stream, Britain could find itself not like the French Riviera, but like such areas as Labrador and Newfoundland on the same line of latitude.

Energy supply

At present, our society is hooked on fossil fuels, not like a fish but like a drug addict. They supply over 75% of energy demand, and 97% of that required for transport. But on any time scale reaching beyond the present two generations, the supply is limited.

Proven world reserves at current production rates are:

- oil – roughly 43 years
- natural gas – the cleanest fossil fuel – around 65 years (but of course much less from the North Sea)
- coal – the dirtiest fossil fuel – around 235 years

Even if resources turned out to be larger (as could well be the case with development of hydrates as well as new fields) and secure (a big consideration), increased rates of production to meet rising demand could soon reduce the number of years of available supply. Projections of car use in Asia suggest multiplication of current use by over ten times.

The main alternatives are:

- nuclear power – 17% of the world's electricity; 5% of its energy: the problem of disposal of radio-active waste, safety and proliferation of weapons
- hydro-electric power – 18% of the world's electricity: geographical and ecological limitations
- solar power (photo voltaic and thermal), at present negligible in terms of current supply, but rising fast
- other renewable sources; biomass, water and tidal power, wind power, geothermal, and even chicken droppings (new power station at Eye in Suffolk run on 12.5 million chickens)

Strategy

Bringing together climate change and energy supply was an underlying theme at the Rio Conference of 1992, and is fundamental to the current debate on the reduction of carbon emissions into the atmosphere. In spite of all the talk, little has so far been achieved:

- the record of industrial countries in meeting their commitments to reduce carbon emissions to 1990 levels by 2000 is poor. Failure to meet even this modest target is shameful. Britain is one of the few countries which will meet its obligations (and that largely as a result of economic recession and the switch to gas).
- for the future we are among the virtuous. The Environment Secretary has called for all industrial countries to agree on a figure between 5% and 10% below 1990 levels by 2010. Not to be outdone, the Labour Party has called for a 20% reduction in emissions by 2020 and the introduction of a clean fuel levy (likely to be

Warden, Green College

used for the development of clean coal technology).

Any worthwhile strategy has to be international. It also has to bring in those countries, misleadingly called developing, which are likely to produce most future carbon in the atmosphere. At present most are reluctant to agree to any limitations, not only because fossil fuels are still cheaper than others, but also because the industrial countries, which have created most of the problem, are making it still worse and have yet to give any real example. Far from cutting their already excessive emissions, the United States, Canada and Australia are increasing them. The next flashpoint in the international debate will be the meeting at Kyoto at the end of this year.

All costs are highly relative. There is no such thing as a free market, and no such thing as a free market in energy. Current markets are skewed, not only by subsidies and inconsistencies of all kinds but also by failure to take account of environmental costs. It was recently well said that "markets are superb at setting prices, but incapable of recognising costs". The Chancellor of the Exchequer in his Budget speech in November made a most welcome reference to environmental costs when he said that they needed to be brought into the equation covering fuel prices. They are – here and elsewhere – far too low.

There are many ways of setting energy prices. In some sources the major costs occur in the early construction or installation phase, with relatively small running costs afterwards. But traditional calculations discount future costs and so penalise such systems. A relatively small re-jigging of the price hierarchy to take account of these and environmental costs might put such renewable, relatively non-polluting sources, as solar, biomass and wind power as the cheapest, with natural gas and nuclear power somewhere in the middle, then oil and finally coal as the most expensive of all. We must recognise that there is no magic in the present arrangements and the establishment of true cost is a major challenge of our time.

The Earth is not short of sources of energy and never will be. But there are penalties attached to the use of each, and only within a comprehensive approach can the social and economic costs be weighed against general benefits and rational priorities be established.

How can this comprehensive approach be achieved? Even if effective international action must be at a global level, individual governments have major responsibilities, not only in showing the way but also in establishing their own cost base. Governments set the frame in which markets can work, and they do so through legislation, regulation, incentives and disincentives. In so doing they have to know what they want.

Just supposing:

- that governments set themselves a deliberate policy of reducing atmospheric carbon emissions
- that governments established programmes for reducing dependence on fossil fuel
- that they were ready to adopt a long-term strategic approach

What should they do? They would want to:

- re-examine the nuclear option: prospects for a World Commission on Nuclear Energy
- examine solar prospects: it is significant that the Japanese government is currently subsidizing a major programme – the ten thousand roofs – in the present fiscal year: even in present market conditions, solar costs are falling rapidly
- promote by all means the other main renewable sources: wind power, tidal power, geothermal power and the rest.

In so doing, they would want to position their industry to occupy the technological lead, and thereby help create the energy markets of the future.

In Britain, both the government and business have already begun to respond, but in the usual pragmatic – some might say messy – British way, without clear strategic objectives and targets:

- legislation and regulation:
  Environment Protection Act 1990
  Home Energy Conservation Act 1995
  Environment Act (creating the Environment Agency) 1995
- incentives and disincentives: some progress with:
  differential taxation on leaded, unleaded and diesel fuels
  rising taxes on fuel
  the new Landfill Tax

and not to be neglected: a campaign of public education with successive White Papers, and adoption of the target of sustainable development.

Business and industry are also responding:

- ACBE
- Business in the Environment
- introduction of new technologies for buildings, cars and the rest designed to minimize energy consumption and make best use of resources

Conclusion

Not only is there a future after gas but it is closer than most people realise. The sooner that we recognise it, the easier and cheaper the transition will be. Changing minds is even more difficult than changing policies. It means looking again at current values and assumptions, and changing them as circumstances change. Such change takes place for three main reasons: leadership from above; pressure from citizens below; and, of, course new factors or externalities of which climate change is all too good an example. Unfortunately, a disaster, or the prospect of one, is sometimes necessary to jerk us out of our inertia. If there has to be a catastrophe, let it be big enough but not too big; small enough but not too small; quick enough but not too quick; slow enough but not too slow; and preferably affecting no-one present tonight.

The Evolution of the World's Energy Systems

Mr Roger Rainbow*

Introduction

Over the last hundred years, energy demand per capita has more than trebled, from 3 to 13 boe/year, spurred by economic growth. However, major parts of the world's population have still little or no access to the comfort provided by electricity nor to the wider range of choices and opportunities linked to mobility. Meeting these needs, for today and tomorrow, will require increased and sustainable energy supplies. To reflect on this challenge, a study of the evolution of the world's energy system was conducted in 1994 in Shell Group Planning by Georges Dupont-Roc, Alexon Khor and Chris Anastasi. Extracts are presented in this paper.

The problem

Against the background of a world population growing from 5 billion people today to 8.5 billion by 2030, and stabilising at 10-12 billion by 2060, as envisaged by the World Bank, what energy system could sustainably fuel a continuing world economic growth of 3%

** Vice President, Global Business Environment, Shell International Ltd*

per annum, similar to that experienced over the last hundred years?

Building on historical patterns which have shaped economic development – inventiveness, competition, productivity, converging developments – two contrasted energy visions are explored for the future.

• In "Sustained Growth", abundant energy supply is provided at competitive prices, as productivity in supply keeps improving in an open market context. The growth pattern of the last century continues, with energy consumption per capita reaching 25 boe/year by 2060, today's Japanese level.

• In "Dematerialisation", human needs are met through technologies and systems requiring a much lower energy input. A different pattern emerges, leading to an energy use per capita of 15 boe/year by 2060.

For both scenarios, fossil fuels contribute to most of the growth over the next few decades, but renewable energy sources gradually take an incr easing market share and their contribution becomes significant by 2020-2030. The Group is currently undertaking a small number of demonstration projects, focused on testing the commercial potential of biomass – growing trees for heat and power generation – and photovoltaics systems.

Key discoveries made 100 years ago have shaped today's life.

Their history shows:

- Vigorously pursued concepts, like television;
- Surprises: it took some thirty years to understand the significance of radioactivity;
- Competitive development, like Zeppelin *versus* Aeroplane, or petrol *versus* electric cars. For instance:

"La jamais contente", an aluminium bodied and battery powered car, broke the speed record at 105 km/h in 1899 but never made it to the market.

Against this promising background, mankind was using mostly wood and coal to meet its energy needs. By 1890, oil market share was only 2%.

Oil came into the energy market through niches

Oil was first used in lamps and stoves. As industry learnt how to produce it, the average price decreased at a rate of 8% pa over 20 years and a 50-fold production increase was achieved from 1870 to 1910. Used increasingly in commercial ships, it became an established player when Sir Winston Churchill switched the British Navy from coal to oil, gaining a strategic advantage from increased power and less visible smoke emissions. By then, the oil price was, in real terms, close to today's level.

In the 1970s, sharp increases in oil prices led oil companies to develop resources at the upper end of the cost curve. When prices collapsed in the mid 1980s, competitive pressures forced engineers in the oil industry to stretch their imagination to propose competitive technologies.

For instance, Troll – an oil and gas field offshore Norway, in some 300 m water depth, declared commercial in 1983 – saw its capacity cost reduced by 7% pa in real terms over 1983-1993. This trend can also be shown for many North Sea projects after 1985 and led to the development of completely new technologies and practices which have now become routine – sub-sea satellites, unmanned platforms, long-range deviated wells.

Today, several renewable energy technologies are following a similar path down their learning curves

The cost of electricity from wind turbines fell by 10% pa in real terms over 1980-1995. Although based on an intermittent source, this technology is now commercially competitive in certain areas. This happened through improved reliability, optimising design, location and economy of scale in manufacturing and stimulated by "pump priming" policies of certain governments. There are now a dozen major manufacturers and a new industry is emerging.

Between 1976 and 1988, the cost of making photovoltaic solar panels steadily declined at rates in excess of 15% pa in real terms, following an 80% experience curve (costs are reduced by 20% when the cumulative number of installations doubles).

Productivity also improved in the use of energy

There are many examples in industry. For example, the energy used in the industrial production of ammonia has seen a steady decline over an extended period of time through the adoption of new raw materials, processes and equipment. Today, only one-fifth of the energy required in 1910 is needed.

In transport, very high speed trains, such as the French TGV, fulfil the same need as their steam ancestor but faster and using less primary energy. The weight per passenger remains an area of potential improvement.

This process of continuous improvement is reflected at macro economic level. In the USA, energy intensity – the ratio of energy consumption to gross domestic product – has declined at an average of 1% pa over the last 100 years, with up to 2% pa being achieved for a decade under extreme price pressure.

In the history of economic development, there are times when converging needs and resources can radically change life-style

For instance, individual mobility came about from the convergence of:

- A new energy source (oil with its high energy density);
- Improved and new materials (quality steel, polymers);
- New manufacturing techniques (assembly line production);
- Social needs, such as wider choices for dwelling, working and leisure.

Mass produced cars became affordable to many, growing, in the USA, from 8000 in 1900 to 17 million in 1925 – a sustained growth of 30% pa.

John Watkins speculated in *The Ladies' Home Journal* of December 1900 that "automobiles will soon become cheaper than horses and be substituted for every horse vehicle now known ... including police patrols".

As demand grew, energy supplies became more diversified

As new needs appeared and economic development progressed, energy demand grew and consumption per capita in the world kept increasing over the last century, even during troubled periods. To meet these needs, energy supplies became more diversified:

- coal, oil, gas, hydro, nuclear ... and we may now be seeing the beginning of a new transition: – new renewables.

▲ *Before the F oundation's evening under the title "What After Gas?", the Lord Taylor of Gryfe (left) makes a positive point to the Viscount Montgomery of Alamein which amuses the Baroness Blatch, then Minister of State at the Home Office.*

Waves of technological transitions will continue this process

One generation will make a discovery, perhaps explain the science and teach it to the next generation which, in turn, will develop it and bring it to our daily life. This process may take 40 to 60 years. Along this path inventions may abort or fail to become commercial. For some of the more robust, "pump priming" through limited grants may be needed to facilitate the progression along the learning curve through market niches.

Identified renewables – wind, biomass and solar photovoltaics – are clearly new technologies looking for market niches. Artificial photosynthesis and magma energy are at the stage of developing science. There are many other candidates and the unknown will no doubt bring "surprises".

"Sustained Growth"

Abundant energy supply is provided at competitive prices, as productivity in supply keeps improving, in an open market context

Companies and universities active in the deployment of renewable energy technologies would be successful, stimulated by limited "pump priming" initiatives. This would occur not only in OECD countries, but also in developing countries. As a result, the challenge of providing abundant energy at competitive prices would be met over the next decades.

New technologies would steadily progress along their learning curves, first capturing niche markets and, by 2020, become fully competitive with conventional energy sources. Cost reductions reflect an 80% experience curve for solar photovoltaics and 85% for biomass. This is not unlike the progression of oil 100 years ago (80%) and slower than that of electricity in the USA between 1926 and 1970 which followed a 75% experience curve (a 25% cost reduction for every doubling of cumulative production).

The cost of sustainably growing biomass could be reduced by advances in clonal propagation and genetic enhancement of plants, notably woody crops. Conversion, first into electricity and later into liquid fuels, could become commercial through small-scale replicable facilities. Over the last decade, Shell companies have developed experience in growing and enhancing trees (for pulp wood) and are now becoming involved in the development of biomass (trees) for heat and power generation.

The cost of photovoltaic panels would be reduced, first by advanced automation in manufacturing and improved light conversion efficiency in current crystalline silicon technology. It could be followed by the large-scale deployment of one or several types of thin film technologies. A Shell company has recently developed an improved high efficiency cell, in co-operation with public research organisations and will implement industrial production.

Renewable energy sources become significant by 2020

An attempt is made here to illustrate what energy supply could look like under "Sustained Growth". Primary energy grows at about 2%, supporting a 3% pa growth in GDP. This assumes an improvement in energy intensity of about 1% pa, as observed in the USA between 1880 and 1990, under free market conditions. Energy per capita continues its historical progression.

Use of fossil fuels increases steadily over the next 30 years, fuelling the economic development of a majority of the world population. By 2020-2030, they reach their maximum potential and no longer contribute to growth, being limited by the rate of production and commercialisation of resources economically competitive with renewal energy. At that time a number of developing countries (eg China and India) – having reached a sufficient level of industrial development – increasingly turn their attention towards renewable energy sources. Some of them may be able to leapfrog, as illustrated by rapid growth of wind power in Asia-Pacific countries and India.

Having gradually become commercial over the next two decades, renewable energy technologies increase their market share as total energy demand grows. This allows growth in energy supplies to be sustained at a time when fossil fuels reach a plateau. It is not necessary, for this argument, to determine which renewable technology has the best prospects. Technologies will compete but the market will decide.

However, by 2060 sources of supply are likely to be more diversified than today. Perhaps ten different sources will each have a market share between 5 and 15%.

In this scenario, the rate of market penetration for identified renewable technologies – wind, biomass photovoltaics – is similar to that of coal or oil and gas in the past. A second wave, possibly including magma energy and/or a surprise, might take-off by 2050.

"Dematerialisation"

Human needs are met through technologies and systems requiring a much lower energy input

For instance, data highways and virtual reality may be a harbinger of a different lifestyle, a signal perhaps similar to the emergence of the automobile and individual mobility at the beginning of this century.

Thanks to advances in materials and design capabilities, objects and equipment will fulfil their function using ever less or lighter material. Carbon fibres are four times lighter than steel and yet twice as strong.

Certainly, in road transport one could see a possible convergence of social and economic issues, new technologies – some of them developed for space application – alternative fuels and lighter materials. The result would be "New Generation Vehicles", three times more fuel efficient than today's vehicles. The challenge is to integrate these technologies, lower their cost and develop a manufacturing infrastructure, probably along an evolutionary path.

"... new technologies, such as advanced electronics, ultra light materials, CAD and a host of others could change cars more radically in the next 10 to 20 years than in the last 100..."

A. Trotman, Chairman of Ford Motor Co.

Energy consumption per capita remains virtually stable for the next 30 years

An attempt is made here to illustrate what energy supply would be consistent with "Dematerialisation". Improvement in energy intensity gradually reaches a sustained 2% pa. To support a 3% pa growth in GDP, primary energy increases at about 1.3% pa until 2030, as developing economies expand. Thereafter, energy growth slows down to 1% pa, as "Dematerialisation", started in the more advanced regions of OECD countries, gradually spreads to industrialising and developing countries, once infrastructure has been built and GDP per capita is high enough. Countries restructuring their economies would improve their energy efficiencies drastically.

Coal and oil growth is lower in "Dematerialisation" than in "Sustained Growth". However, more gas is being used to compensate for the delayed take-off of PV solar, postponed from 2020 to 2050. This technology remains a niche application until nanotechnology becomes widely applicable!

A 2% pa improvement in energy intensity has only been seen for limited periods in the past. In "Dematerialisation", relentless advances in information technology, telecommunication, materials and biotechnology would enable high energy intensity improvements to be sustained for several decades.

A different lifestyle, possibly linked to changing individuals' and customers' behaviour, could emerge. Signs may already be perceivable such as virtual reality, but consequences are difficult to anticipate fully, perhaps similar to the scale of changes brought about by the automobile and individual mobility during the 20th century.

In "Dematerialisation", the rate of market penetration for identical renewable energy – wind, biomass, PV solar – is lower than in "Sustained Growth". The second wave of renewables is not need-

ed until 2060.

Conclusions

- Hydrocarbons are needed for economic development
- Productivity improvement in supply and use will continue
- Energy needs will be met by more diverse sources
- "Carbon free" newcomers can become competitive through market mechanisms. Markets will decide which technology is best.
- CO_2 emissions from fossil fuels peak at around 10 GtC before the middle of the next century and decline to 4 GtC/year by 2100, leading to stabilisation of CO_2 content in the atmosphere at about 550-600 ppm-, according to current models, or 60% above today's level.

Among many different possible paths along which the world energy system could develop, "Sustained Growth" and "Dematerialisation" are two sustainable and plausible archetypes which could happen through market mechanisms and with minimum stimulation. These scenarios provide low economic cost options to policy makers and are genuinely "no regret".

Like 100 years ago, there are many talents in the world. Provided governments maintain a framework in which inventiveness, competition and productivity are encouraged and rewarded and where decisions are the result of a rational and open debate, business can do a lot to support sustained economic growth, supplying and using energy in an environmentally responsible manner.

UNIVERSITY RESEARCH: HOW SHOULD LIMITED FUNDS BE DEPLOYED?

The Foundation held a lecture and dinner discussion on 28 January 1997 on "University Research: How should Limited Funds be Deployed?" at the Royal Society. The Lord Butterworth CBE DL was in the chair and the evening was sponsored by ICI plc. The speakers were Sir David Harrison CBE FEng, Master, Selwyn College, Cambridge, Dr Clive Booth, Vice-Chancellor, Oxford Brookes University, Professor Sir Brian Follett FRS, Vice-Chancellor, University of Warwick, and Dr Polina Bayvel, Royal Society University Research Fellow, University College London.

Professor Clive Booth*

Summary: Professor Booth argued that the new universities had produced excellent value for money in their research performance and were entitled to due consideration in the deployment of scarce funds. He believed a new approach was needed to defining the nature and purpose of research and the criteria which should apply in research assessment. Professor Follett, giving examples from the University of Warwick, discussed the long- and short-term aspects of three key elements: outstanding research leaders, good infrastructure and adequate extra funds to the leaders for specific staff and recurrent supplies to prosecute individual research projects. Both speakers made special reference to the Research Assessment Exercise.

Introduction

I feel rather like Daniel in the lion's den tonight, the only speaker from a new university sitting among three speakers (from Cambridge, Warwick and UCL) who would certainly not want to have my university in membership of their Ivy League. But I intend to show that the new universities have produced excellent value for money in their research performance and that they are entitled to due consideration in the deployment of scarce research funds.

When the Foundation originally publicised this occasion, they raised several questions under the general question of how should limited funds be deployed and I will suggest some answers to them. I would like to look at each of these in turn.

1. *Should there be a degree of selectivity and, if so, how can that best be achieved?*
2. *Can Britain continue to spread research funds across a wide spectrum of universities and achieve world class research?*
3. *What factors should be considered?*
4. *How would the funding bodies react?*

Should there be a degree of selectivity and, if so, how can that best be achieved?

Yes, of course selectivity of some kind is desirable and indeed inevitable. Without it, how can we demonstrate to taxpayers that their money is being wisely spent? It clearly makes sense to discriminate between research groups on the basis of the quality and scale of their output. What is much less obvious is whether we have at present got the criteria quite right (but I will say more about that below).

Selectivity creates intense competitive pressures and stresses on staff - witness the academic who recently wrote to the newspaper that after his department received a grade five his excema disappeared.

But these competitive pressures are necessary. It is because of them that there has been a significant rise in the quantity and quality of university research, as measured by the Research Assessment Exercise over a period where funding has been stagnant or declining.

This improvement has been achieved by better university management of research, and by the galvanising effects of competition on the research active community who have both become more productive and made the results of their efforts more visible. To create a formal Ivy League of specially funded institutions would reduce the competitive pressures both inside and outside that charmed circle and I am therefore against it.

If we compare the outcomes of the 1992 and 1996 Research As-

Vice-Chancellor, Oxford Brookes University

sessment Exercises, we find that both the number of research active staff increased markedly (from 50,175 to 55,700) and that the average rating increased from 3.4 to 3.7 (normalised to a five point scale).

Interestingly, this is not as great as the increase that occurred between 1989 and 1992. You can argue whether the improvement revealed by the 1996 Exercise is virtual or real – and I am sure that some of it may be grade drift – but most commentators seem to agree that there has been some genuine improvement.

Of course the RAE is far from perfect in an imperfect world. Apart from grade drift, there are nagging questions about whether our physicists are so much better than our chemists as the RAE results (see table below) would suggest. As a former biochemist, by the way, I can only applaud the modesty of my former colleagues who have placed themselves on the top of the pile!

Subject	*Average 1996 rating**
Biochemistry	5.9
Physics	5.5
Chemistry	4.7

*Seven point scale

However, if you think that the RAE is just revealing grade inflation for no real increase in performance, you may or not be comforted to know that the funding per researcher for most grades is going to go down faster than any gain to be had from the upward drift in gradings. This may be regrettable but it is inevitable because the total money available for research is not matching the increased performance of the system. And that should be an important message both to the Government and the Government in waiting!

Those of you who wished to see world class research protected will approve of the Funding Council's decision to protect the grade five and five star departments. The consequent reduction for less highly graded departments is severe. For example, I estimate that the average funding per research active member of staff at grade four will fall from £25,000 to £22,000 in cash. At grade three the fall is even more severe, and at grade two QR funding ceases to be provided at all, a matter of great regret to the many rapidly improving researchers in new universities who have achieved good results on very slender resources.

So the upshot is that a hypothetical university which in 1996 turns in exactly the same performance in research ratings and volume of activity as it did in 1992 will suffer a significant loss of funds. This is a race in which you have to run faster and faster to stand still.

The comfort for the new universities comes from two things: first, the fact that they have improved their performance so much, and second, the sensible redistribution of money across the subject "pots" (or quanta) to reflect the relative cost of each subject and the volume of activity. These two factors favour some subjects in which the new universities have a strong presence.

All of this certainly underlines the inadequacy of the total funding for research but it does not prove that we need a radically different system of deploying funds. It will be for universities to make hard choices, as they have successfully done in the past.

Can Britain continue to spread those funds across a wide spectrum of universities and achieve world class research?

If world class research is defined as five or five star in the RAE, the results speak for themselves. Let us look at the increase in the number of units of assessment (I will call them departments for short from this point on) that are achieving international excellence as measured by a grade five or five star rating:

*Achieving grade 5 or 5**

	1992 RAE	*1996 RAE*
Number of Units of Assessment ("departments")	348	537
As a percent of all research active staff	23	31

In relation to the Ivy League debate, it seems to me highly significant that the number of institutions with at least one five or five star grade was 87, and the number achieving five star was 59. So world class research is to be found in a large number of universities. Pockets of international excellence can and do flourish in otherwise modest institutions.

Number of universities	*1996 RAE*
with at least one 5 or 5*	87
with at least one 5	59

At the same time, this increase in world class research has been achieved while the opposite end of the spectrum has been making remarkable progress. Let me take the new universities and other institutions formerly funded by the Polytechnics and Colleges Funding Council (PCFC). They are now making a much more substantial contribution to research of national significance:

Former PFCF departments achieving grade three or higher

	1992 RAE	*1996 RAE*
Number of "departments"	96	351

This four-fold increase is all the more remarkable because it has been achieved on a very small funding base as I shall explain later.

It is very much to the credit of the funding councils that the research funding regime has sustained not only such a good performance at the grade five end of the scale, but also permitted such a dramatic improvement of the newcomers. And this seems to me to be the crux of the discussion - the need to maintain world class performers and to have dynamism lower down the line.

Now this does raise a difficult question, which is this. Is the pound spent on the margin likely to produce a better return by being invested in an improving grade three A department or an already successful five star department? It is a question of value added. The answer does not seem to me to be self-evident. Intellectually, I think you can make just as good a case that the right choice is to improve the three A department as you can for the five star one.

It is important to remember that the new universities only had their research assessed for the first time in the 1992 Research Assessment Exercise. Although the RAE had been designed for assessing research in a more narrowly based range of institutions, the former polytechnics demonstrated substantial areas of national excellence in a surprisingly large numbers of subjects - surprising because the polytechnics had at that time received no national funding at all for research.

The progress made by the new universities is all the more remarkable when one considers that it was not until April 1993 that they began to receive any research funding from the funding councils. So the 1996 RAE was assessing the effect of only 30 months research funding in new universities compared to 50 months in other universities. It is therefore reasonable to suppose that the full effect of this relatively new funding stream in new universities has yet to be felt.

◀ *Sir Aron Klug and Lady Klug, closest to the camera, attended the event. Oscar Roith received the Foundation's Medal as the first business of the meeting (See Spring 1997 issue, page 4).*

It would thus be irresponsible to judge the research performance and potential of new universities solely on the basis of the 1996 RAE. This is why there is a sound case for the extremely modest continuing support that the HEFCE is proposing for grade 2 researchers in new universities.

It seems to me that the 1996 RAE outcome is extremely powerful evidence that a policy of having open competition (and I stress those words open competition) is a healthy policy and a successful policy. There seems to be not a shred of evidence that it would be in the public interest to allow a small and very privileged circle of universities to enjoy preferential funding for research in an Ivy League.

It is surely an irony that you, my Lord Chairman, as the Foundation Vice-Chancellor of Warwick would appreciate, that if a policy had been in force in the 1960s of having a few existing universities designated as preferentially funded research universities, when Warwick and its like were being set up, that generation of new university success stories which we celebrate today would have been stillborn.

What factors should be considered?

For the future we should consider some changes.

• *RAE criteria*

I believe we need a new approach to defining the nature and purpose of research and the criteria which should apply in research assessment. Present policy mistakenly assumes that narrow academic notions of excellence equate with the national interest and that only research rated important in academic terms is worth public funding. The specific criteria adopted for the Research Assessment Exercise (RAE) have a particularly narrow focus. Yet there is a strong case for dual funding to support other than basic research. The research assessed should be defined broadly, spanning a spectrum ranging from basic research, through strategic and applied to near market research. More emphasis should also be placed on rewarding Foresight-related research and relevant work with industry.

• *procedural*

Three suggestions here:

- The membership of RAE panels should be completely different for each RAE
- All proposals to award five star ratings should be validated by external peers from abroad
- Panels should have a substantial minority of members from grade 3 and 4 departments

• *collaboration*

Policy should encourage collaboration between research groups in different institutions. In many subjects, the concentration of research in particular physical locations is becoming outdated, since researchers are part of a national and increasingly international community, using information technology for regular, instantaneous communication and shared facilities through sabbatical and other arrangements. Research funding needs to support collaboration in a very positive way.

How would the funding bodies react?

It will be clear that I favour continuing with the dual funding system. It has the great advantage of devolving a modest part in decision making on the use of research resources to individual universities, rather than concentrating a dangerous amount of decision power in the hands of a small number of national research councils. Over the last ten years universities have demonstrated increasing skill at managing their research. There is also much to be said for having funding councils that can take a holistic view of universities as producers of teaching and research.

I know that there are those - some said to be close to Dearing - who say that the present system is broken beyond repair. I do not accept that at all.

Professor Sir Brian Follett FRS*

Introduction

University research is a very large business indeed, with a turnover close to £2.5 billion. I would contend that little evidence exists of university research suffering from a widespread systems failure and, indeed, the opposite can be argued. The question then reduces to how we make the dual support system work optimally, to sustain the nation's basic R&D machinery, fine tuning it if necessary.

Whether R&D is carried out in the universities or in industry it relies upon an underlying strategy linked to three key elements:

- Outstanding research leaders,
- Good infrastructure,
- Adequate extra funds to the leaders for specific staff and recurrent supplies to prosecute individual research projects.

The university system of R&D, in contrast with government research stations and industrial research laboratories, differs only in one feature: it links these three elements to a vital undergraduate teaching role and to the training of research students.

For the universities we provide these three elements through competitive mechanisms in the belief that competition generates the best R&D. We employ two rather different competitive mech-

* *Vice-Chancellor, University of Warwick*

anisms, one to supply the research leaders and facilities, the other to supply the specific funds for research projects. The reasons for having two mechanisms lie in distinguishing between the long-term and the short-term requirements of the three key elements.

Long-term aspects

The long-term aspects involve the investment in buildings and facilities to pursue a line of research and, perhaps even more importantly, investment in academic staff. Unless the financial structures provide a capacity to take long-term decisions then the whole system becomes undermined. It is the role of the R stream from the Funding Councils not only to sustain the existing staff and infrastructure (see below) but also to allow investment for the future. Let me illustrate this with some recent data from Warwick:

(i) Firstly, investment in new infrastructure. Currently we are spending £23m on new research buildings (along with £20m on teaching buildings but that is a separate story) and for additional upgrading of our research computing and library.

(ii) Secondly, investment in new academic staff. We submitted 760 staff in the recent RAE. Of these, nearly 25% (170) have joined us since 1992 and, most importantly, 130 of them are young lecturers or research fellows.

(iii) Thirdly, investments in specific research areas. Here, I think of the infrastructure commitments to molecular biology facilities, or to computer-aided design. In both cases sums in seven figures have been involved.

I would suggest that investing in such long-term aspects is precisely what the UK needs from its R&D base with the decisions being taken locally in a market situation. Put simply, it will not occur if one leg of the research funding regime is inherently unstable. To me this is the single most important argument as to why one stream of funding must come as a rolling contract, as the R money does at the moment.

Much of the R funds are spent, of course, in sustaining the present structure and universities should not be reticent to account in depth for their expenditure of R. This is not difficult and as part of a detailed Coopers and Lybrand study we estimated Warwick's expenditure to be as follows:

(i) 47% as a contribution towards the academic salary bill. [In effect, to buy out a proportion of each academic's time for research; he/she also teaches of course.]

(ii) 31% directly to the academic departments for recurrent expenses and for wages and salaries associated with research technicians and salaries.

(iii) 22% into the provision of buildings, services and libraries.

Short-term aspects

The short-term aspects of research support relate to the question of earning grants and contracts. Our academic colleagues know well how to compete against each other for these in what is now a highly sophisticated market for both purchasers and providers. In 1993/94 the UK universities obtained the following sums from a host of providers:

Research Councils £440m
Industry £170m
Charities £300m
European Union & Overseas £150m
Other UK Government £190m

This total of £1250m has more than doubled in real terms over the last decade: not much evidence here of a systems failure! Nevertheless, demand outstrips supply so that the chances of success in any one competition range from 1:5 to 1:3. One of the most vexed questions facing the research councils - and here let me wear my hat as Chairman of the Science Board at BBSRC - is how to create a research base which *at one and the same time* stimulates maximum creativity, offers a reasonable chance of success in any one competition, and is tuned to national priorities.

The particular pressure point at the moment is responsive mode grants, and OST understands the dilemma. It is encouraging the research councils to grow this stream of funding but to do so necessitates hard choices. The nature of the choices changes over time and right now an even tougher regime is being applied to longer-term funding where BBSRC is less convinced than heretofore of good value for money. We are also tough on new initiatives which emerge from short-term pressures or because one group of our colleagues is especially articulate. An example arose last year at BBSRC with respect to Structural Biology because this area is perceived as a discipline where we are strong nationally, where a leading industry (chemicals and pharmaceuticals) demands strong research and training, and where there is a need for specialised and relatively expensive infrastructure. Those working in the field were, not surprisingly, convinced of our excellence but the rest of us needed to be persuaded by hard data! Chris Higgins led a review team and I am delighted to say the evidence is indeed strong that the UK is a genuine world leader in this field and hence we are arguing for extra investment. Our strategy will be to focus funds upon infrastructure and on a *co-operative* basis around the country. Individual researchers will then seek specific funds for specific projects.

Research Assessment Exercise

Funding Council R funding. This matter is highly topical given the research assessment exercise (RAE) results in December 1996 and announcements as to the specific funding model last week. The objectives of RAEs are twofold. Firstly, to drive up the quality of British university research; secondly, to provide a means of distributing the R money selectively.

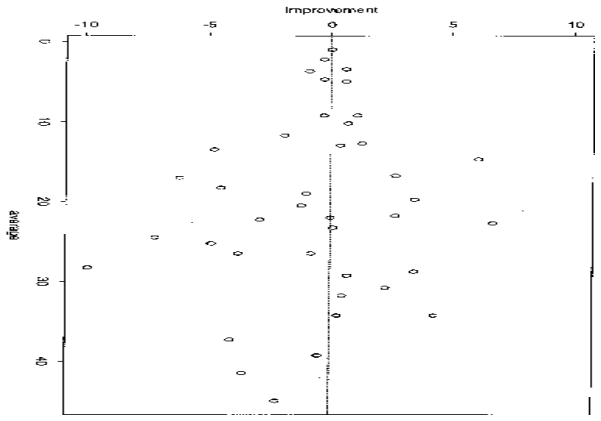
Insofar as the first objective is concerned, I would suggest it has achieved many of its aims. It focused the minds of university researchers in ways that are absent in other countries, and it has yielded evidence for both the quality and quantity of UK university research which has convinced sceptical politicians. Warwick is certainly not alone in believing that its 1996 submission was stronger than in 1992.

The results from RAE96 suggest an improvement nationally and in the twenty-five units Warwick submitted in, I note that 18.5% were ranked as a "5" (315 out of 1702). That is an increase from about 13% in 1992 and may now be somewhat high compared with the proportions in the National Academy of Sciences ranking of US graduate schools in 1995. One reason stems perhaps from the decision by some leading research universities to submit only 85-90% of their academic staff in RAE96. I view this as a regrettable development since no-one ever really intended that such cutting of numbers would apply widely to universities which have long received structural R funding for *all* their staff and aspire to be leading international universities. It is my suspicion that this game-playing for higher grades has undermined aspects of RAE96. If I return to the 315 grade 5s in the units where Warwick submitted then less than 50% were graded 5A or 5*A. A simple suggestion made to the Funding Council for the next exercise would stop this development: "a 5 or 5* cannot be awarded unless at least 95% of the staff in a department are submitted".

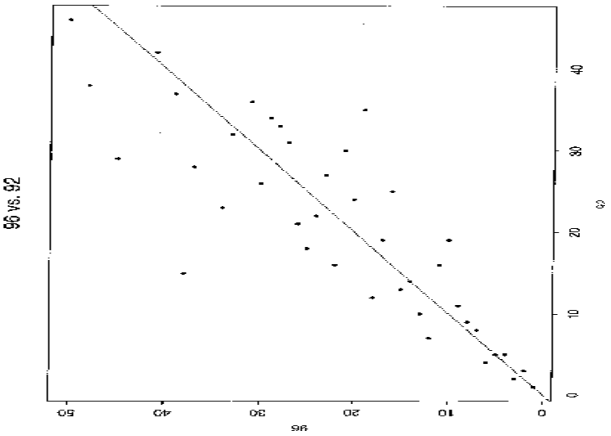
One could say so much about the exercise but I will confine myself to a few general observations. After four RAE exercises over ten years (1986, 1989, 1992, 1996) can anything be said about relative strengths at a university-wide level? I suspect so. For example, if one looks at the top twenty universities in each of the four exercises then 12 have appeared every time whilst a further 3 have appeared on three occasions. A similar type of distribution applies to the top ten universities in each of the exercises. Six have appeared in that position on all four occasions and a further three on three occasions. This does rather suggest that major research universities are strong across a wide range of academic disciplines: hardly surprising really! For the record, I strongly believe we should fund research at the level of the unit of assessment, not at a higher or lower level of aggregation. I also do not subscribe, and never have subscribed, to the view of an elite group sustained *de jure*.

A second question asks whether individual universities have

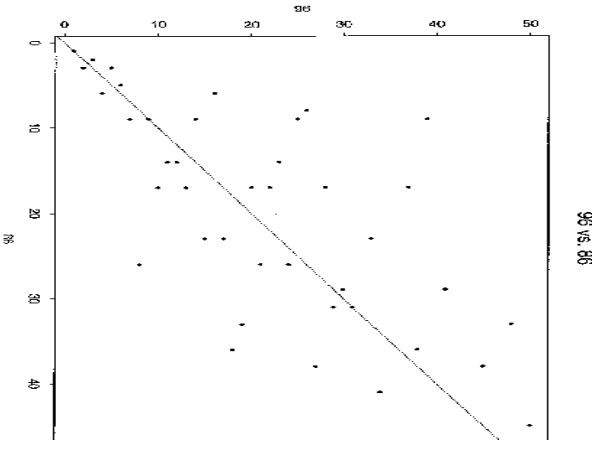
stayed in the same relative position across the ten years, or have improved, or have weakened markedly. From published data I have prepared a table which ranks each multi-faculty university in the four Research Assessment Exercises carried out since 1986. We then took the top 40 (out of now 100 institutions) and analysed this "top 40" in some detail. My colleague, Professor John Copas (Statistics, Warwick) analysed the data by measuring the rate of improvement against the average rating. Fig. 1 shows the least squares trend across the four exercises plotted against the average position from 1986 to 1996. Over half the universities (22) have not really altered their rank position across the ten years. This applies not only to the top ten but, intriguingly, to a number of others positioned anywhere from 15 to 35. Eight universities have



▲*Fig. 1. The average rank order position across the four RAEs (1986, 1989, 1992 and 1996) for the top 40 universities has been plotted against the rate of improvement (in terms of change in rank order) measured by a least squares regression. Note that over half of the universities have changed their position very little but a number have improved or weakened.*



▲*Fig. 2. A plot of the rank order in 1992 against the position in 1996.*



▲*Fig. 3. An equivalent plot showing the 1996 position against that in 1986.*

improved by more than three positions whilst 11 have weakened significantly. It would be valuable to compare the research strategies in the three types of university.

Finally, there is a clear correlation between the rank orders in 1992 and in 1996 (Figure 2), and a weaker one between 1986 and 1996 (Figure 3). Such data could form the basis for a proper scientific analysis (or perhaps a novel!). My point in emphasising these issues is to suggest that in a very real sense Britain does now know where its research strengths lie. They also show that the system is not rigid and that about one-half of universities are moving up or down, either between individual exercises or across the decade.

Given my second reason for holding an RAE (allocation of funds) then I would argue for another exercise but in a form different enough to eradicate the worst features of RAE96. One of these I mentioned above but another would be to spread the exercise (as is done for teaching assessments) so as to avoid the stress and hyperbole of the big-bang approach. How about analysing the natural sciences in (say) 2000, the social sciences in 2001 and the humanities in 2002?

Last week the Funding Council (for England) announced their formula for the distribution of the R grant for 1997/98. There will be no funding for the lowest two grades but this was inevitable given grade improvement. Between 3b to 5 are four 50% steps whilst a premium of 20% is given to a 5*. The selectivity is significantly sharper than in 1992 and this was signalled in the Secretary of State's letter to HEFCE in November. If anything it will reinforce the results of the last four exercises and will, I suspect, lead to a pervasive research culture existing only in a subset of institutions. Properly, there will be no cut-off in funding but the steepness of the allocations will probably mean that 75% of all funds may go to around 30 of the 100 universities.

We should perhaps return to asking how many research-intensive universities we want in the UK. This year there are about 88 Research Universities in the States. On a population basis this suggests we will be approaching this level of selectivity in Britain. Remember, though, that there are also 39 Research Universities II, 52 Doctoral Universities I and 61 Doctoral Universities II. It is impossible to judge when selectivity is optimal but I do suspect bright young researchers in less research-intensive universities will seek to move to what they perceive as stronger institutions, as they have done throughout history! I may worry about this slightly but it offers opportunities for collaboration. We need to make this a much clearer national strategy because in the end my *first* key element is "outstanding research leaders".

FOUNDATION NEWS

A Food Agency for Britain

Professor Philip James, Director of the Rowett Research Institute, Michael Mackenzie, Director-General of the Food and Drink Federation, and Sheila McKenchie, Director of the Consumers' Association, were speakers for an evening for which no sponsorship had been sought to ensure an open-handed approach and to show without doubt that, as always, the Foundation was providing a neutral platform.

Carbon dioxide emissions - UK targets

The autumn session started with an evening devoted to the question of whether the UK can meet its target of reducing carbon dioxide emissions. The event was sponsored by the British Nuclear Industry Forum, The Department of the Environment, Transport and the Regions, The National Environmental Technology Centre (NETCEN) - owned by AEA Technology, Johnson Matthey plc and Westlakes Research (Trading) Ltd. The speakers were Dr Mary Archer, Sir John Houghton and Mr Andrew Warren.

PRIORITIES IN MEDICAL RESEARCH

A Foundation lecture and dinner discussion on the subject "Priorities in Medical Research. A Dilemma in the Late 90s?" was held at the Royal Society on 11 March 1997. The Rt Hon the Lord Jenkin of Roding PC was in the chair and the meeting was sponsored by Glaxo Wellcome plc, The Kohn Foundation and Zeneca Group plc. The speakers were Professor John Swales MD FRCP, Director of Research and Development, The Department of Health, Professor Sir Michael Bond MD FRCP, Vice Principal & Administrative Dean of the Faculty of Medicine, University of Glasgow, and Dr James Niedel, Executive Director, Glaxo Wellcome Research & Development.

Science and Research in the NHS

Professor J D Swales MD, FRCP*

Introduction

Health care systems in developed societies are facing unprecedented pressure. Medical advances and demographic pressures are partly responsible but we should not under-estimate the role of public expectation. The capacity of science to do both good and harm is widely recognised. Professionals working in the health service share with scientists in all fields of research the obligation to justify what they are doing. The ability of modern medicine to prevent, alleviate and cure only enhances that pressure. Where treatment is perceived to be ineffective, more than ever we are asked the question: why? One simple answer may be that science has not yet identified a cure. This is, unfortunately, still true of many common disabling or life-threatening conditions such as Alzheimer's Disease or cancer of the lung. In such cases there can be no doubt about public support for more research. The strength of many medical research charities which rely upon public donation are a testimony to that, as were the results of a Mori poll carried out at the time of the last British Association meeting. A sample of the population identified medical research by a wide margin as the field of research in which they would prefer to invest savings obtained from defence expenditure.

Failure to deliver

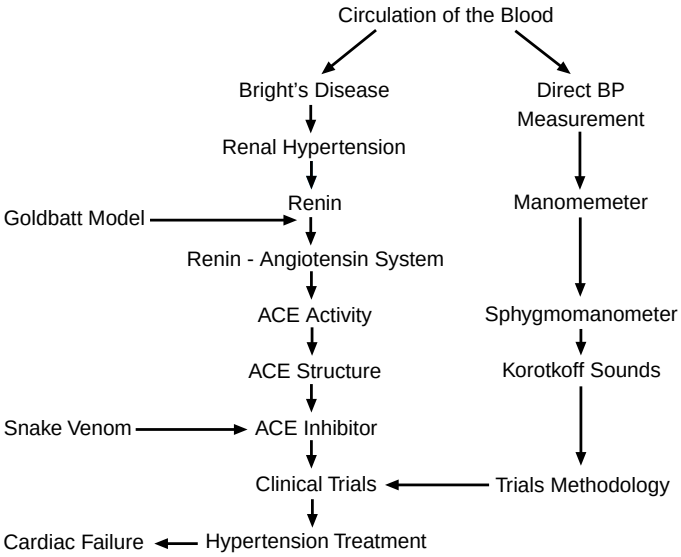
There is, however, another reason for modern medicine occasionally failing to deliver, which is much less acceptable. This is when a treatment which is ineffective or unproven is offered or when the NHS fails to make available a treatment of proven efficacy. This is most clear-cut when care can be shown to exhibit major variability between different groups of patients. The demonstration of variations in care is one of the unsung 'firsts' of British science.

Dr J Allison Glover reported with some perplexity in 1938 that tonsillectomy rates in England varied several fold between different regions. Further, when the School Medical Officer changed, the tonsillectomy rate sometimes also showed a major alteration. What did not change was the incidence of conditions, such as swelling of the neck glands which the operation was designed to prevent. The 'Glover phenomenon' of scientifically unjustifiable variations in health care has been found in all health care systems where it has been sought. To take a single modern example, thrombolytic drugs have been shown to reduce mortality after myocardial infarction (heart attacks). A recent trans-European study showed that only 35% of patients with this diagnosis actually received them. In some cases thrombolytics were contra-indicated (they can cause dangerous bleeding occasionally); in other cases the patients were admitted to hospital too late, or the diagnosis was initially uncertain. In 20% of patients, however, there was no medical justification for failing to offer thrombolytic treatment. The value of such applied research is clear: it identifies the need for studies aimed at better tolerated treatment and at improving delivery of care and diagnosis. It also targets professional education and information.

The need for research

A modern health service clearly need its own programmes of research to identify its needs and help it decide how tight funds are to be invested most effectively. The recognition of this represents a major cultural shift in the move towards 'evidence-based health care' in the last few years. This is not unique to this country. Health care systems in developed countries across the world have developed programmes of R&D to examine the effectiveness and delivery of interventions to improve health. This reflects perhaps not so much far-sightedness as a historic necessity.

There is another need if evidence is to be used in decision making. This is for systematic reviews of relevant scientific reports from the enormous mountain of scientific literature. It would be difficult to overlook the growth of scientific literature, but medicine is an extreme example. After universities, the addresses most frequently listed in scientific papers from the United Kingdom are



* *Director of Research and Development, Department of Health*

hospitals. The key component of these papers from the NHS point of view is the clinical trial. Databases such as Medline only capture about half of these, even with appropriate search strategies. There is no alternative to laborious hand-searching if all relevant data are to be found.

Identifying relevant work

The methods for identifying relevant work and integrating it into a robust systematic review has been one of the major British achievements of this growing field of applied research, pioneered by the Cochrane Centre and the NHS Centre for Reviews and Dissemination at York. The Cochrane database now contains over 120,000 randomised controlled trials, and the number is growing daily. Scientific evidence is only one component in decision making, of course, whether at the level of national policy or in care of the individual patient. Evidence has to be extrapolated to the particular circumstances of the case, and this may be no simple task in a complex and rather messy world. The need to apply social values in translating scientific evidence into decisions is also assuming greater importance as resources are more stretched; most important of all, the view of those who use the health service is a key one where choices have to be made.

The use of scientific evidence in health service decisions has been enthusiastically taken up by many groups in the NHS. Managers in general without scientific training have proved remarkably adaptable in this context. There still in my experience remains some uneasiness in the relationship between applied research and more basic science targeted less directly at health problems. The discoveries of fundamental science are responsible for the enormous growth in the power of medicine to prevent and treat disease; we should not forget that. Rightly, fundamental scientific discoveries have enjoyed a high profile and some of our brightest medical scientists aspire to contribute to these. An NHS which now recognises the value of science also recognises the value of work which carries the prospect of returns in the future as well work which addresses the problems of today.

Intellectual challenges

However, both basic and applied work involve major intellectual challenges. It would be a mistake for the basic scientist to downcry the challenge of dissecting out the causal chains which result in a particular outcome in patient treatment, just as it would be for the health service researcher to under-estimate the difficulties of developing a new method for, say, identifying the physiological role

▲*The Rt Hon the Lord Jenkin of Roding (right) talks to Dr James Niedel, Executive Director of Glaxo Wellcome Research & Development, one of the speakers at the Foundation's event on "Priorities in Medical Research. A Dilemma in the Late 90s".*

of a newly identified gene. An advance in patient care requires both basic and applied work. I am not enthusiastic about attempts to differentiate between non-targeted and applied work in the genesis of new forms of treatment, although there have been quite a few somewhat misguided attempts. Before a treatment is introduced into routine practice extensive trial data and analysis is required.

This work is highly demanding and costly. But leading up to this are many years (perhaps centuries) of less targeted work. One of the seminal medical discoveries of recent years is the ACE inhibitor group of drugs which both extends life and improves the quality of life in patients with heart failure. Preceding the series of clinical trials which established this were directed programmes of research laying the basis for drug design. This, in turn, sprang from many years of study of a physiological system which had been discovered at the turn of the century as a possible factor which raised blood pressure in kidney disease. The concept of blood pressure itself can without excessive ingenuity be traced back to Harvey's demonstration of the circulation of the blood three centuries before. Basic, fundamental, research evolves with no obvious dividing line into applied programmes of research. There can be no better example of the broad church which is medical research.

Dr James Niedel*

Introduction

The pharmaceutical industry has been going through a period of rapid change and now finds itself operating in a different health care environment to that which it grew accustomed in the decades before the 1990s. It is now facing increasing demands from the providers of health care – be they governments or private agencies – for control in the pricing of medicines, for economies to be achieved through pressures applied in the form of generic substitution and prescribing limits and for better economic value in those medicines that are now coming to the market.

Added to this, demographic changes have resulted in ageing populations now require increased health care and presenting with "new" diseases – those of old age such as osteoarthritis and the senile dementias. All of this adds up to demands being placed on the industry to deliver real therapeutic advances in their products. By "real therapeutic advances" is meant the increasing of the length/quality of life, the decreased use of health care resources and increased workplace productivity.

The other major feature of the environment that the industry now works in is the rapid advance in many fields of science and technology that we have witnessed in the last decade and which impacts upon our business. These new developments present the industry with challenges but also with opportunities to discover new medicines which can meet the demands of the health care providers.

However, if we are to be successful in harnessing the new scientific and technological developments it is important that the environments in which we conduct our R&D, and other activities, provide certain essential features: First, they must ensure that there is a skilled and knowledgeable workforce available to staff our laboratories and to meet our need for good clinicians; secondly, they must provide a well resourced public sector science base with world class academic centres with which we can develop basic strategic research; thirdly, we require legislative, legal and regulatory climates which encourage innovation.

* *Executive Director, Glaxo Wellcome Research & Development*

It is also important, if pharmaceutical companies are to be successful in the future, that they are prepared to bring about changes in the way they discover new medicines. Traditionally, this has been largely based on an empirical approach determined by a knowledge of the receptors and enzymes, and their hormones, or substrates, that are involved in some way in disease processes. This has been successful in the past and led to the drugs in today's pharmacopoeias. However, with the exception of the antibiotics, these are not curative medicines and most will at best provide only palliative relief and control of symptoms.

The process was heavily dependant upon medicinal chemists using their skills to modify naturally occurring small molecules – such as nor-adrenaline, histamine, serotonin – to produce compounds that mimic or block their actions. Research was dependent on animal models which in the case of some diseases reasonably approximated to the human condition, but in other cases did not. However, there was perceived to be a clear boundary between basic and applied research and the industry was largely self-sufficient with regard to its science and technology needs.

Control of inflammatory diseases

A good example of the traditional process is seen in the discovery and development of the non-steroidal anti-inflammatory drugs which are widely used in the control of inflammatory diseases such as rheumatoid arthritis. The starting point was the discovery that the old drug aspirin acted by inhibiting a key step in the metabolic pathway that leads to the production of prostaglandins – the molecules produced at the site of inflammation which cause pain and swelling. From this information Merck Sharpe and Dohme discovered indomethacin, a compound which inhibited the enzyme cyclo-oxygenase which played the central role in the production of the prostaglandins. It was, however, very much more active in this respect than aspirin.

The success of indomethacin as an anti-inflammatory led to other companies searching for other compounds which acted to inhibit this enzyme but which produced fewer side effects.

The result is that in the pharmaceutical armamentarium today there are many non-steroidal anti-inflammatory drugs which differ very little between each other in terms of either therapeutic benefit or side effect profile. Importantly, however, none of the host of "me-too" medicines modifies the disease process *per se*, let alone effects a cure. The health care providers are now demanding new medicines that will have more profound effects than these.

New approach

The industry's new approach to the discovery of new medicines must, therefore, be clearly focused on first understanding the cellular and molecular bases of important human diseases, and then defining the cellular and molecular targets for intervention which will bring about cure, or prevention, or at least a significant arrest in the disease process. We also need to develop better and more predictive animal models for human diseases, such as, for example, the dementias, rheumatoid arthritis or osteoporosis. We must harness the new molecular sciences and, in particular genetics, to gain the insights that are needed to find new medicines. The biological sciences, engineering, informatics and computer technology and the clinical sciences must all now be engaged in the process of discovery of better medicines. This means greater and closer collaboration with those engaged in basic and clinical research in universities and external research establishments.

Genetics

Genetics, in particular, is coming to assume centre stage for the industry. It has the capacity to help us understand disease processes and their underlying mechanisms, and thus to determine more accurately the targets for drug discovery research. It will also provide new diagnostic tools that will aid an understanding of the epidemiology of diseases and detect disease-associated genes in patients and populations. For example, studies of families in which Senile Dementia of the Alzheimer's Type (SDAT) occurs have now shown that there are at least four distinctly separate genes which can be associated with the condition, and the different genes are related to the age of onset of the disease. However, there are still a large number of patients with SDAT who possess none of these four genes. This, therefore, shows that masquerading under the guise of this disease there are probably at least four distinct conditions. This will have wide implications, ranging from the discovery of new medicines to treat SDAT to the identification of those patients who will show the best response to particular medicines and those for whom a specific treatment would not be appropriate. Understanding the genes involved, or suspected of being involved, in causation of diseases will allow better animal models to be developed through the incorporation of human disease related genes into transgenic animals. These will provide both the means of studying the disease process outside the clinic and in ways that are not possible in the clinical context, and also provide better means of pre-clinical evaluation of drug candidates.

The application of genetics is already providing improved, or novel, treatment modalities. Examples of the former include the use of human proteins for the same treatment of deficiency diseases such as diabetes, haemophilia, growth defects and some anaemias. In the latter case we are now seeing the possibility of treating diseases caused by defects in a single gene, such as cystic fibrosis and some immunodeficiency diseases, by means of gene replacement therapy. It is becoming important for future progress that we are able to determine the genome of large numbers of individuals in order to identify gene associations with particular disease states. Fortunately, technology is now advancing rapidly towards the development of "GeneChips" and other methods which will allow the rapid, and relatively simple, detection of the specific genes making up the genomes of individual in large populations and thus provide indications of predisposition to future disease occurrence.

In the longer term, we believe that the knowledge we will acquire regarding the disease-causing or associated genes will lead to the identification of the underlying molecular basis of the diseases, and which will put us in a position to discover new medicines which can perhaps regulate gene expression, or allow more precise interference with the molecules responsible for the condition.

Dependence on other disciplines

We see that the discovery of new medicines will increasingly become dependent upon the bringing together of a wide range of individuals and organisations, in both industry and academia, across a wide range of scientific, technological and engineering backgrounds. The understanding of human diseases, upon which our future success will ultimately depend, will require truly interactive relationships to be developed. Thus, for Glaxo Wellcome, and the industry as a whole, the priorities for medical research are clear.

- There must be effort to develop people to serve the science base – in both the public and the industrial sectors – because we need a critical mass of well trained individuals in the new and emerging areas of science and technology. Thus the Higher Education system must be able to produce well qualified molecular and cellular scientists, informatics specialists and clinical geneticists able to create bridges between ward and laboratory.
- There must be a willingness to ensure that the resources for high quality research are available in our universities. The laboratory and clinical infrastructures, the standard of equipment and facilities, the quality of information technology support and access to databases must all be at such a level that good research at the leading edge of science and technology can be supported and flourish.
- There must be a realisation that, in order to sustain excellence in cellular and molecular sciences, genetics research and bioinfor-

matics, there must be long-term funding commitments by government, industry and the charitable foundations.

• There needs to be continuing cultural change so that barriers between academia and industry are removed and that fruitful collaborations between sectors and disciplines may be encouraged and established in order to ensure the strategic basic research which underpins the discovery and development of new medicines within industrial laboratories.

• There must be a legislative and regulatory climate which is informed by sound science and technology that avoids over-prescription which will hinder and restrict research. There must also be patenting regimes which encourage and allow the exploitation of the fruits of research.

• Finally, whether as scientists or as clinicians, we need to do more to encourage the general public to understand what we are about. We must encourage open debate of the scientific, moral, ethical and societal issues presented by the new biology in order to dispel fears; to allow the public to understand and weigh the risks and benefits within new developments and to create an awareness within the community of the potential that lies within science and technology for the improvement of health and the creation of wealth.

Conclusion

If we can get the priorities for medical research right, then we can establish a virtuous circle for health care. We can bring together all the necessary components – the human resource, knowledge, technology, the basic and clinical science, academic and industrial research – to create better medicines for the treatment of serious and common diseases, to improve health care for the world and to create wealth through increased productivity by a healthy workforce and through sales of our products in the global marketplace.

FOUNDATION NEWS

Associate Members

There has been one new member since the report in the last issue of the Journal:
Chantrey Vellacott
Contact: Mrs Helena Wilkinson: Audit Manager
(Charities Division).

There were two errors in the list in the Autumn 1997 issue, and we apologise to those two members. The D Group was omitted from the list altogether. We would be grateful if Associate Members would ensure that they are correctly described in the list on the inside back page.

Foundation Medal - Dr P T Warren

Dr Peter Warren, recently Executive Secretary of The Royal Society, received the Foundation Medal from the Foundation's President at the beginning of the lecture and dinner discussion held in the rooms of The Royal Society on 30 September 1997.

The Medal is awarded for "Outstanding Service to the Foundation for Science and Technology" and, before handing him the medal, Lord Butterworth explained that Dr Warren had been closely involved with the Foundation since the late 1970s when the Foundation was formed. He served on the Foundation's Management Committee and was also alternate to the President of the Royal Society on the Foundation's Council. During that time he attended almost all meetings of Council and participated in a number of working groups, etc. He carried out the role of Learned Societies liaison when Deputy Secretary at The Royal Society before handing over the role to the Foundation. He gave much guidance and support.

▲ *Dr Peter Warren receives the Foundation Medal from the Foundation's President, The Lord Butterworth, at the meeting on "Using IT to teach Science and Technology" on 16 October 1997. The Medal is "for outstanding service to the Foundation for Science and Technology".*

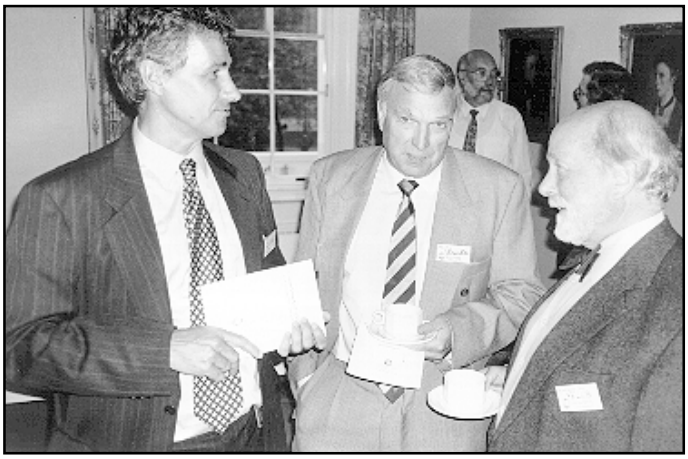
Foundation Web Site: www.foundation.org.uk

It is intended that by the time this issue of the Journal is published the Foundation's web site will be more active and worth "an occasional hit". It will be possible to find details of most learned and professional societies, and enter into their sites where they have them. This is being arranged with the British Council who have provided the resources to achieve this.

It is intended that brief details of each issue of the Journal and of the Learned Societies' Newsletter will be kept up to date.

Our resources for maintaining an interesting site are limited, but the Director would welcome ideas for making the site more useful than it is.

Recent Lecture and Dinner Discussions



▲ *A group including Mr Ken Vowles, Executive Director of Scottish Power (facing camera) and Professor Ian Fells (right).*

▲ *A group including Dr Wallace (left), a scientist with Greenpeace.*

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"After the Woolf Report - Generating Change with Information Technology"	The Rt Hon the Lord Woolf, Mr I M Burns CB, Professor Richard Susskind	EDS
"What After Gas?"	Sir Crispin Tickell GCMG KCVO, Dr Robin Jeffrey FEng, Mr Roger Rainbow	Shell International Limited, Foundation's Shared Sponsorship Scheme
"Priorities in Medical Research. A Dilemma in the Late 90s?"	Professor John Swales MD FRCP, Professor Sir Michael Bond, Dr James Niedel	Glaxo Wellcome plc, The Kohn Foundation, Zeneca Group plc
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"Carbon Dioxide Emissions. Can the UK Meet its Targets?"	Mr Andrew Warren, Sir John Houghton CBE FRS, Dr Mary Archer	British Nuclear Industry Forum, Department of the Environment, Johnson Matthey plc, The National Environmental Technology Centre (NETCEN) - owned by AEA Technology plc, Westlakes Research (Trading) Ltd
"Using IT to Teach Science and Technology. Stagnation or Success?"	Dr David Moore, Professor Stephen Heppel, Mr Bob Ponchaud, Mr Alastair Gittner	NORTEL - Northern Telecom
"A Food Agency for Britain?"	Professor W P T James CBE FRSE, Mr Michael P Mackenzie Ms Sheila McKechnie OBE	
"Information Technology: Towards an Integrated Criminal Justice System"	Mr Geoffrey Hoon MP, The Rt Hon Lord Justice Brooke, Professor Richard Susskind FRSE	EDS
"The Dearing Report and the Research Base - Industry, Academia & Charities"	Sir Richard Sykes DSc FRS, Professor David Watson, Professor Martin Harris CBE	British Council, British Petroleum Company plc, The Royal Society
"Success in Technology Ventures Through Science, Engineering and Technology"	Mr G R Wilson CB, Professor Kevin Morgan, Professor J F McClelland CBE FRSE	Scottish Power, Scottish Enterprise

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"Domesday to the 21st Century. Public Access to 9 centuries of the National Archive" - Visit to the Public Record Office, Kew

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"An International Trading Treaty" - Visit to the British Standards Institution, Chiswick

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