TECHNOLOGY INNOVATION AND SOCIETY

Published Quarterly for the Information of Subscribers Autumn 1995

FOUNDATION FOR SCIENCE AND TECHNOLOGY

FOUNDATION FOR SCIENCE AND TECHNOLOGY

TECHNOLOGY, INNOVATION AND SOCIETY

THE JOURNAL OF THE FOUNDATION FOR SCIENCE AND TECHNOLOGY

CONTENTS

Volume 11, No.3 Autumn 1995

The Foundation For Science And Technology

Buckingham Court,
78 Buckingham Gate
London SWIE 6PE

Tel. 0171-222 1222
Fax. 0171-222 1225

Director:
D.N. HALL, FCIS

Editor:
D. EDDOWES, BSc

Editorial Advisory Committee:
Dr Richard J. HAAS
Professor Chris ELLIOTT

Technology, Innovation and Society is published quarterly by the Foundation at an annual subscription of £35.00, including postage. Single copies £11 each.

It is also circulated to all Learned Societies and Institutions accredited to the Foundation as part of the services provided to them.

We should welcome items of news, letters and articles which should be submitted to the Editor for publication in future issues.

Neither the Foundation nor the Editor is responsible for the opinions or statements of contributors to "Technology, Innovation and Society".

Typesetting and electronic page assembly by *Light Touch Typesetting.*

Printed by *Five Arts (Printers) Ltd.*

ISSN 0951-2918

FOUNDATION NEWS

Survey of Foundation Members

Questionnaires were sent to all associate members, to individual members and to a number of the guests sometimes invited to events. There was an excellent response with many interesting comments and ideas. There were inevitably opposing ideas over some matters such as timings for events and the timings within them. There were many useful suggestions for developing certain aspects of the Foundation, and a number of resulting recommendations will be put to the Foundation's Council in the coming months.

New Associate Members

Ford Motor Company Ltd
Contacts: Professor Ken Mortimer & George Davies

Public Record Office
Contact: Dr Sarah Tyacke, Keeper

Segal Quince Wicksteed Ltd
Contact: Dr Bill Wicksteed

Scottish Higher Education Funding Council
Contact: Professor John Sizer CBE, Chief Executive

Sunderland University
Contact: Professor M P Thorne, Pro Vice Chancellor

Sponsors of Events

The Foundation has been fortunate in the assistance given by the following sponsors of events during the first half of 1995:

Amersham International plc
AEA Technology
Biotechnology & Biological Sciences Research Council
British Telecommunications plc
Brown & Root Ltd
Cookson Group plc
Coopers & Lybrand
Cray Research (UK) Ltd
Department of Trade and Industry
Department of Transport
Economic and Social Research Council
Engineering Council
Generale des Eaux UK
Glaxo Wellcome plc
Health & Safety Executive
KPMG
Mercury Communications Ltd
Metropolitan Police Forensic Science Laboratory
Ministry of Agriculture, Fisheries and Food
Office of Science and Technology
Oracle Corporation
Ordnance Survey
Oxford Instruments plc
Railtrack plc
Rhone-Poulenc Limited
South Bank University
Unilever plc
University of Hertfordshire
Zeneca Group plc
Foundation's Shared Sponsorship Scheme

More news on page 21

Foundation's visit to the Science Museum to see the Information Superhighway Exhibition. From left: Mr D C Hargreaves, Firefly Communications; Mr Michael Spring and Miss M E Manson from Oracle UK (the evening's sponsor); and Ms Kieran Moore from Firefly Communications.

Visit to the Oracle Sponsored Exhibition at the Science Museum

On 17 July 1995, as a final event of the summer, some 120 members of the Foundation visited the Science Museum to see the superhighway exhibition there, hear talks and then have a dinner discussion, all sponsored by the Oracle Corporation.

The exhibition allowed members to try their hands at surfing the Internet and to learn first hand some of the facts about information highways. The talks were by Philip Crawford, Managing Director of Oracle, John Browning, Executive Director of *Wired* magazine, and David Roffey, a Partner of PA Consulting Group. Drinks and a final visit to the exhibition preceded the dinner and discussion, when the subject of information highways and the impact of them on life now and in the future was the topic. The evening sponsored by Oracle made a splendid finale to the first half year's programme.

The Baroness David (left) with Baroness Hilton and Baroness Nicol at the exhibition.

Shared Sponsorship Scheme

The Comino Foundation has recently donated £1,000 towards the Shared Sponsorship Scheme.

The following have now contributed:

3i Group plc
Biwater Limited
Comino Foundation
Esso UK plc
Glaxo Wellcome plc
Zeneca Group plc

BIOETHICS AND PUBLIC OPINION: DO THEY MEET?

On 23 November 1994 the Foundation held a lecture and dinner discussion on the subject "Bioethics and Public Opinion: Do They Meet?" The Lord Butterworth CBE DL was in the Chair and the evening was sponsored by The Russell Trust, Zeneca Group plc and the Foundation's Shared Sponsorship Scheme, with donations from Biwater Ltd, Cookson Group plc, Esso UK plc, Glaxo plc, UK Nirex Ltd and Zeneca Ltd. The speakers were: Professor P N Wilson CBE FRSE, Scientific Director, Edinburgh Centre for Rural Research, Professor the Reverend Michael Banner, Professor of Moral and Social Theology, King's College London, and Chairman, MAFF Working Party on Ethical Issues on Advanced Breeding Techniques, etc, and Dr David Fisk, Chief Scientist, Department of the Environment.

Professor P N Wilson CBE FRSE*

Summary
Professor Wilson discussed the practical aspects, animal welfare considerations and human health concerns arising from the use of rBST. Professor The Rev Michael Banner discussed the broad issues relating to public concern about new technologies and the scientific response to those concerns. He suggested the formation of a bioethics forum in which the questions which the application of emerging technologies would increasingly pose could be rigorously and fully addressed. Dr Fisk discussed the concerns felt about biotechnology safety, how the regulatory system could be improved and the problems encountered by industry. He said the stage was now set for serious international debate about the control of releases of genetically modified organisms.

INTRODUCTION

BST is the abbreviation for Bovine Somatotrophin, which is a naturally occurring growth hormone of the cow, secreted by the pituitary gland. Similar Somatotrophins occur in most other mammals. It regulates, as its name implies, the growth of the animal, including the growth of the secretory tissue of the mammary gland. So the administration of a larger amount of BST than normal, in the mature cow, leads to an output of significantly greater quantities of milk. This extra milk has been demonstrated in numerous trials, in most countries of the world, but most of the work has been done in the USA, financed by the Monsanto chemical company. The extra milk is very significant, varying between 5 and 25 per cent, with about a 15 per cent rise being the average between trials.

BST originally had to be extracted from the pituitary glands of dead cattle. Not only is this procedure difficult, but about 1000 pituitary glands from 1000 cattle are necessary in order to provide enough BST to inject a single cow at frequent intervals throughout its lactation. Originally daily injections were necessary, but now slow-acting forms of BST are available, so cows need only to be injected at intervals, such as weekly.

BST can now be synthesised by using recombinant DNA technology – in other words by genetic engineering. In practice this means using the organism *E.coli*, which is a common bacterium of the gut. The gene for manufacturing BST is taken from cows and introduced into the bacteria so that they make BST in their cells. This BST can then be harvested and extracted from the bacteria. This is done on a 'batch process' somewhat akin to the production process by which beer or spirits are made on a big scale in large fermentation vessels. The resultant product, when purified, is chemically identical to natural BST. But as it is produced by recombinant DNA technology, and not naturally, the end product should strictly be called 'rBST' where the letter 'r' stands for 'recombinant DNA'.

Let us be clear from the start about two important facts. Firstly, rBST is, as far as we can tell, identical in chemical terms to normal BST. But it obviously is of different parentage. Secondly, rBST is very effective in raising milk yields, by an average amount of about 15%.

So far so good. Now for the various scientific, legal, economic and ethical issues raised by its use.

ANIMAL WELFARE CONSIDERATIONS

We have seen that rBST raises milk yields, but does it do so in ways which are harmful to the cow? Are there, in other words, any undesirable side effects? The manufacturers claim there are none. The critics claim that rBST-treated cows are more prone to mastitis, a painful bacterial infection of the udder. The US Food and Drugs Administration, after a through examination of the available evidence, concluded that "the risk of clinical mastitis was slightly higher in treated cows", but it ruled that the increase was of no concern and the presumption was that mastitis is linked to higher milk yields anyway, so anything that raises milk yields, such as normal breeding selection, is bound to raise average mastitis incidence somewhat. A detailed examination of the data shows that there is less mastitis in herds with good management compared to herds with poor management. So rBST treated cows in well managed herds might be expected to have less mastitis than non-BST treated cows in poorly managed herds. Put another way, if the aim is to decrease mastitis, the first action should be to improve management, not drop milk yield. But the critics of rBST would argue that rBST when freely available will be used in all herds, both well and poorly managed, so

* *Scientific Director, Edinburgh Centre for Rural Research*

that overall the use of rBST will raise national levels of mastitis. Such increased mastitis incidence is detrimental to animal welfare considerations and so some would say that rBST should be banned on animal welfare grounds alone.

At present the only mode of administration of rBST is by injection – it cannot be given orally as the hormone would be digested in the gut and not reach the target tissues. In the early experiments daily injections were used, but the manufacturers are working on longer-lasting preparations. The hope is that eventually only monthly injections will be needed, or about 10 injections per lactation.

The injection mode of administration also raises ethical issues. Many veterinarians argue that any injection is somewhat painful and not without risk. Occasionally the injection site can turn septic and sometimes the needle will hit a nerve and cause damage. All veterinarians are prepared to accept these drawbacks where the injection is used to prevent or cure disease, but are far less happy to use injections solely to boost milk yield for economic, and not for health, purposes. If repeated injections are deemed to have negative animal welfare considerations some would argue that this is reason for banning the use of rBST.

COW NUMBERS

As rBST raises milk yields by about 15 per cent, it is theoretically possible to produce the same amount of milk from 15 per cent fewer cows. Fewer cows means less pollution (in the form of methane, ammonia and nitrogen run-off from fields) and less work for the farmer, with fewer cows to milk each day. At the margins it would also mean fewer farmers, as small farms become uneconomic and are bought by larger farms. On balance it could be argued that these changes could be beneficial in overpopulated countries like Holland which suffer from major agricultural pollution of potable water supplies. There are clearly economic and socio-economic arguments of importance to the major milk-producing areas.

CONSUMER CHOICE

In the past the Milk Boards were obliged by law to buy all milk produced on farms provided the milk came up to satisfactory standards of hygiene and was free of impurities deemed harmful to man. rBST milk comes up to these standards. The rBST it contains cannot be distinguished from the natural BST secreted by the cow, and therefore there are no legal reasons or laboratory methods for discriminating against rBST milk. However, the Milk Boards have now been abolished and there is a freer market for milk. Buyers can stipulate methods of production and enforce them, refusing to purchase if the required methods are ignored. So it is now possible, in theory, to buy organic milk, free from artificial chemical additives, drug residues and so on. Where the public are free to choose between rBST milk and non-rBST milk it is fairly certain that the 'chemical free' milk would be chosen, even though the choice may be deemed irrational. In the USA about 20 per cent of milk comes from rBST cows, and dairies wished to discriminate against this milk and buy milk from the 80 per cent of non-rBST herds. But the manufacturers of BST have taken court action to prevent such discrimination on the grounds that it is unlawful. Since US law differs between states it will be a long time before the US has an overall policy in this area, if indeed it ever will.

Although it is not yet licensed, rBST has already entered the UK food chain. Some four or five farms have been conducting tests on rBST at the request of, and payment by, the pharmaceutical companies. The Milk Marketing Boards, which were still operating until last month, had by law to accept this milk and did so. The tests were conducted under an Animal Test Certificate, awarded by the licensing authorities to enable data to be collected on the efficacy, safety and quality of products prior to licensing. The fact that this work was being legally carried out, and the milk legally entering the food chain, before a full Product Licence was granted, angered the consumer lobby, and there was a major campaign mounted in the areas around the test farms to stop the milk leaving the farm. It is a little strange that an Animal Test Certificate allows the milk to be used in this way long before the product in question is legally licensed. One might have thought that the law would have required the milk to have been poured away rather than being sold to the Milk Board. The cost of such wastage would have been minuscule compared to the total cost of researching and licensing the new product.

POLITICAL CONSIDERATIONS AND PRODUCT LICENSING

According to present law, a pharmaceutical product, however made, may only be licensed if it satisfies three criteria: Efficacy, Safety and Quality. The licensing authorities have agreed for several years that all these standard have been met in the case of rBST. In theory, therefore, the product should be licensed as indeed it already is in the USA. However, the EU, and thus the UK government, have refused to award a licence for purely political reasons. These political reasons have already been touched upon, and are three in number. The animal welfare lobby has been active in lobbying against rBST for animal welfare reasons. The

'There are no experiments that can be done to prove that anything is 100 per cent safe'

Milk Boards have been lobbying against rBST because of their fear of a downturn in milk sales. The economists have been lobbying against rBST on the grounds that it would increase the size of the milk lake, which is already too large. The present state of play is interesting – last year the EU turned down the Product Licence on the grounds that more evidence was required, but it promised to make a decision on the matter by December 1994. So in the next month the EU politicians will have to come off the fence, and either award or refuse a Product Licence, bearing in mind that in theory the only grounds available for turning the Licence application down are Efficacy, Safety and Quality. Or they could procrastinate and ask for yet more evidence and delay the decision by a further year. We must wait and see.

RECENT HUMAN HEALTH CONCERNS

As rBST is indistinguishable from normal BST circulating in the cow, it has been assumed that rBST poses no health risk to man. However, when rBST is used, an insulin-like growth factor, known as IGF-1, is found in higher than normal concentrations. The US FDA studied this point and concluded that there was nothing to worry about as IGF-1 gets digested and therefore does not pass through the gut wall. More recent work however indicates that a protein very similar to IGF-1 can survive digestion when swallowed with casein, and all milk contains large amounts of casein. It is therefore possible that IGF-1 may escape digestion and enter the blood stream. As Dr Mepham, Director of the Centre for Applied Bioethics at the University of Nottingham, recently put it, 'We are not saying there is a problem; we are saying we are not sure there isn't a problem'. This is a very significant turn of phrase because in science it is impossible to prove a negative. One can demonstrate that certain materials are hazardous. There are no experiments that can be done to prove that anything is 100 per cent safe. Thus there are many who would

urge caution and demand yet further work. As the Institute of Biology put it recently in its submission to Government on BST, 'This may justify a continuation of the moratorium until such time as the absence of adverse effects may be demonstrated'. The Institute of Biology had in mind when writing those words adverse effects on animal welfare, but they could equally apply to the adverse effects on people drinking rBST milk with elevated levels of IGF-1.

But the pharmaceutical companies and some farmers would ask: when do we reach the end of this seemingly unending road? If the mastitis argument is found to be without foundation, and if IGF-1 is found to be non-deleterious even if it passes through the gut wall, it would not take a genius to raise a host of new theoretical problems, each of which (if pursued with full scientific vigour) would take several years to resolve. And the pharmaceutical companies have already spent several billion dollars on developing rBST, which they see as a good way of increasing human protein supplies, in the form of 15 per cent more milk from dairy cows, in a world which, taken as a whole, is desperately short of good quality protein food. These are big questions which pose big problems, and perhaps it takes the wisdom of Solomon to make the proper decisions.

Professor The Reverend Michael Banner*

The debate surrounding the issues which are the concern of bioethics is marked by mutual suspicion which fuels itself. If on the one side we find a public who are inclined to take the view that scientists and industry cannot be trusted since they will stop at nothing in the pursuit of Nobel prizes or profit or whatever, we find on the other side, scientists and industry who are inclined (of course not universally) to be scornful of public questioning of their work, thinking that it must arise from ignorance, or from a Luddite hostility to science, or both. The public mistrust of science and industry fuels the scorn which science and industry has for the public; the scorn which science and industry has for the public increases the public's mistrust – and so it goes on in a spiral of ever increasing suspicion.

One of the factors in the perpetuation of this state of affairs – a sociologist or historian would be needed to explain the full picture – is the absorption by scientists, medics and industry of a way of thinking about bioethical issues which is typically (and unconsciously) at odds with public concerns and encourages the less than serious treatment of public concerns. It is a way of thinking which renders some objections invisible, ruling them 'out of court' when in fact they deserve a fair hearing. It is a way of thinking, in other words, which justifies the perception that the scientific response to public concern about these matters is more often than not simply question-begging.

The way of thought to which I refer is that which leads many of those who discuss the new technologies to speak exclusively the language of cost and benefits, risks and prudence. Let me give two examples of this tendency, and then explain how it is that it wrongly cuts short the debate.

According to the report from a working party set up by the BMA, *Our Genetic Future: The Science and Ethics of Genetic Engineering* (Oxford, Oxford University Press, 1992), "biotechnology and genetic modification are in themselves morally neutral. It is the uses to which they are put which create dilemmas. The challenge which faces us is to try to achieve an optimal future: one which maximises the benefits of genetic modification and minimises the harms". This conception of "the challenge which faces us" in virtue of our ever-expanding understanding of genetics is essentially the same as that which is found in a book written by J R S Fincham and J R Ravetz in collaboration with a working party of the Council for Science and Society, entitled *Genetically Engineered Organisms: Benefits and Risks* (Open University Press, Milton Keynes, 1991). They too think the challenge, as the title indicates, is that of maximising benefits and minimising risks. Given this conception, it is hardly surprising that, like the BMA working party, Fincham and Ravetz find the chief difficulty for the application of genetic _engineering to lie in our lack of a complete knowledge of the consequences of our interventions and manipulations. It follows then, that the dilemmas in this field, to which the BMA report refers, are really the familiar difficulties which arise when we must act with imperfect empirical information. As the BMA Report puts it:

> Our predicament would be a great deal simpler if we could simply ask, in respect of any proposed development, questions such as 'Is it safe?', 'Will it enable us to find cures for genetic diseases?', and 'How much will it cost?', and receive unequivocal answers. Unfortunately, life is not so straightforward. The totality of scientific knowledge which we should like to have when making judgements about the future is rarely available. Consequently, the judgements which need to be made, and the decisions which need to be taken, are complex, contestable, and often incomplete. Until we have answers to these questions it is not possible to form settled news about the acceptability of some developments.

The characterisation of the 'challenge' which faces us in coping with the new biotechnology (as that of maximising the benefits and of minimising the harms) and of our 'predicament' (as that of doing so in a situation of imperfect knowledge), shared by these two Reports, has an air of common-sense about it. Nonetheless, we should reject it as begging the important moral questions. The point is that the tendency of both reports to locate the contestability of decisions about the application of genetic knowledge in the empirical realm, and in particular in the realm of uncertain futures – for all its rather robust, commonsensical appearance – betrays an albeit unconscious commitment to a highly questionable moral framework which renders certain questions invisible.

Let me say two things by way of clarification, for I am not contending that the considerations which dominate these reports have no place in the discussion of these or similar issues. First of all, there can be no doubt that the determination of the likely outcomes of alternative courses of action represents an element, and an important element, in many or most moral decisions. It follows, of course, that any uncertainty about these outcomes may be at the root of controversy and disagreement. Thus, to take an obvious example, a dispute as to whether capital punishment really serves as a deterrent, may underlie a difference of opinion as to whether or not it should be permitted. Similarly, a dispute as to whether a genetically engineered organism will or will not affect the ecology of the environment into which it is to be released, may be the source of a disagreement between those who advocate its release and those who do not.

In the second place it may also be that in some cases a consideration of likely outcomes is the *only* issue at stake in certain decisions as to the application of biotechnology. Release of a genetically engineered plant, for example, should be permitted only if it is prudent. Now there may be disagreement over whether that release is indeed prudent – a disagreement which may in fact be complicated by a dispute as to what constitutes a risk, or a risk worth taking (these last two being quite plainly ethical, not empirical issues). But supposing that the disagreement is

* *Professor of Moral and Social Theology, King's College, London; Chairman, MAFF Working Party on Ethical Issues on Advanced Breeding Techniques, etc.*

not so complicated, the question of prudence may well be the only one which arises – as it may well be the only question which arises in connection with many instances of the introduction of a new technology.

What gives the impression, however, that the discussion in both these reports and elsewhere is question begging is the sense that for these reports these questions about risks and benefits are *always* the *only* questions, when this is not the case. The questions which are overlooked are questions as to the intrinsic acceptability of whatever is under review.

'As well as worrying about the effects of the new technology, many people feel distinct unease about its very use'

Let me explain what I mean. It is clear from the responses to the consultation exercise undertaken by the MAFF committee I have been chairing that though they may not use this language, many people have intrinsic objections to the use of genetic modification. An intrinsic objection to a particular practice is an objection which does not relate to the practice's consequences or effects (the risks and benefits), but to the practice or action itself. That is to say, in relation to genetic modification, it is an objection focusing not on the effect of genetic modification on animal welfare, genetic diversity, the environment or the pattern of farming and rural life, or whatever it might be, but on the practice as such. For as well as worrying about the effects of the new technology, many people feel a distinct unease about its very use. Take an analogy – suppose someone went into business selling children unwanted by their parents. And suppose studies showed that children bought and sold in this way suffered no ill effects – or even that such children were happier than children raised in their own families. Someone might well say that regardless of the effects, regardless of the benefits outweighing the costs, the practice of buying and selling children is, in itself, objectionable.

Behind the expression of misgivings in a number of the submissions made to the Committee lies the conviction that the use of genetic modification involves an essentially improper attitude towards animals, treating them as no more than raw material from which we can fashion new things. But to seek to manipulate what is given to us as if it were a formless lump of clay is fundamentally disrespectful and an expression of overweening human pride or hubris – it is, as it is sometimes dramatically put, an attempt 'to play God'.

An example of a use of genetic modification which would be found objectionable in these terms would be the attempt to produce by genetic modification to a line of pigs of such reduced sentience that they were disinclined to move, and so converted their food into meat more efficiently. Even if I were perfectly content that animals should be kept for a variety of uses and purposes I would still find this objectionable – and would find it objectionable even if it were shown that by any standards or tests available, the resulting animals were as content as unmodified stock. For it would not be on account of its effects that I would find the modification objectionable but in itself in virtue of the fact that it fails to respect the nature and natural worth of animals. I might take the same view of dressing animals in human clothes for public spectacle – it is fundamentally disrespectful and degrading, even if the animals are not unhappy.

It is interesting to note that very few of those who responded to our letter of consultation and who were, broadly speaking, well-disposed to the new technologies, actually addressed intrinsic concerns. It seemed to be taken for granted that if the effects of a technology are shown, on balance, to be good, there could be no reasoned opposition to it. Hence, on this view, any opposition which does not focus on the supposed ill-effects of the use of biotechnology can only be explained by the disparagingly-labelled 'yuk factor': as an emotional reaction to the introduction of technology which is quite without rational warrant, and can be expected to disappear as people become accustomed to genetic modification or whatever.

The intrinsic objection to the use of biotechnology which I have stated, from whatever perspective it is put, makes an important point, is not to be treated lightly, and ought not to be discounted. Certainly the fact that the objection is often stated in emotional terms is not sufficient reason for discounting it: revulsion or disgust at certain uses of animals may be perfectly rational and must be addressed.

Now my view is that it can be addressed to some extent – that it is only some uses of the genetic engineering which are objectionable in the sense I have mentioned. But that is not my point at the moment. My point is rather that the tendency to think only of costs and benefits obscures from view the existence of perfectly legitimate questions about the application of new technology – and the same phenomenon occurs throughout the sphere of bioethics. Very often the supposed justification of a particular practice – it might be genetic engineering of animals; it might be experimentation on embryos; it might be the use of a certain measles vaccine – just ignores objections which have to do not with the consequences of the practice, but with the practice in and of itself. So it is that the scientific response seems so often to be morally beside the point and, frankly, rather shallow.

I want to end by making a practical suggestion as to one way in which the misunderstanding which plainly exists could begin to be remedied – and this is by the creation, by Government, of a bioethics forum in which the questions which the application of emerging technologies will increasingly pose can be rigorously and fully addressed. If such a Committee were to command public respect its membership would have to reflect the plurality of moral outlooks in our society, not simply be made up of those supportive of the status quo. But such a Committee, properly constituted, would not only be of assistance to ministers but ought to be welcomed, so I believe, by all those engaged in scientific research and in its practical or commercial application. The present lack of an adequate forum for the full and careful discussion of the complex questions raised by new technologies leaves a vacuum in which public concerns, such as those I have indicated, can go unaddressed.

'The fact that the objection is often stated in emotional terms is not sufficient reason for discounting it: revulsion or disgust at certain uses of animals may be perfectly rational and must be addressed'

Public acceptance of legitimate applications of scientific research is severely threatened by a state of affairs in which ethical issues are in danger of being ignored rather than debated, and a forum for discussion of such issues has an important part to play in the creation of greater trust between scientists, industry and the public.

RELEASE OF GENETICALLY MODIFIED ORGANISMS

Dr D J Fisk*

INTRODUCTION

In 1991, when I last addressed the Foundation on the regulation of the deliberate release of genetically modified organisms, our regulatory system was in its infancy. Since February 1993 when the regulations came into force there have been 40 consented releases in the UK. This compares with only 75 in the preceding six years. Releases take place within a system of European Directives that are now implemented throughout the Community. In addition, some new product Directives take into account the possibility of using biotechnology by including risk assessments appropriate for genetically modified organisms. Our growing confidence in some classes of release of genetically modified organisms is reflected in special fast track approvals procedures developed since 1993. It is therefore very timely to revisit the topic.

The DOE postbag on genetically modified organisms is largely about the safety of a release into the environment. The correspondence divides between those who believe our regulatory system is too burdensome and those who think it too lax. Other regulators of biotechnology such as HSE and MAFF no doubt receive correspondence about more profound ethical issues. These might be concerned with the ethics of the original modification of the organism or the ethics of its use when it is harvested or otherwise used. The debate in our postroom is more conventional, but none the less important.

THE CURRENT POSITION

The Environmental Protection Act avoids some traditional ethical concerns relating to environmental legislation. It aims to ensure that a release does not cause harm to the environment. This contrasts with other environmental legislation that seeks only a tolerable level of damage. It also contains powers to recover from a releaser the cost of remedying any damage that have occurred from a release. Theoretically the Act can even offer a degree of economic efficiency. It is not fussy about the definition of the boundary within which the genetically modified organism is released. Releasers are therefore free to strike any bargain they wish with their neighbours to redefine boundaries if the original adjoining land might suffer some disamenity. For example, a neighbour might be persuaded to avoid growing certain crops next to a genetically modified organism trial site.

With these ethical pitfalls out of the way, the remaining question, and the one that fills our mailbag, is whether the consent issued by the Secretary of State might miss something, and whether, if something were missed, the damage would be irreparable. To answer this question, I ought to describe the process that issues a consent.

CURRENT PRACTICE

The law places the onus on the releaser to investigate any risks that the organism might present when in the environment. However, it is not unreasonable to suppose that, for some classes of release such as that of a novel organism, some aspect of the release might be overlooked. In that case it would be wise for the risk analysis to be checked over by a third party. In the UK system the Advisory Committee on Releases to the Environment – ACRE – provides this check.

In applying for a consent the proposer is faced with some 80 questions. Some say that this is too many, some say that this is too few! The purpose is to inform the Committee so that they can advise the Secretary of State on the form of the consent to be issued.

THE ISSUES

Broadly speaking, there are three classes of issues to be addressed. First, what type of genetic modification is proposed, and what was it supposed to accomplish? Second, what is the effect on the external expression of the genetic modification – the phenotype – and how will it affect the organism's ability to survive in the environment? Third, is the modification a property inheritable by other organisms?

'The law places the onus on the releaser to investigate any risks that the organism might present'

In the worldwide debate about the regulation of biotechnology some generalisations have been proposed about the safety or otherwise of releasing genetically modified organisms. They are generally unhelpful. In the UK system, ACRE looks at each release proposal on its own merits. Of course, in any sequence of similar releases, observations from earlier releases inform subsequent risk assessments. It may also be possible to learn from the environmental releases of closely related species. This process has enabled ACRE to develop streamlined procedures for some classes of release. Having considered the risk assessment, ACRE can also recommend to the Secretary of State conditions that should be attached to the consent to release.

There has been some recent criticism that ACRE cannot be effective because it has yet to recommend refusal of a consent. I find this an odd criticism. The Department makes it as clear as it can the likely requirements for a consent to be issued. We would hope that prospective releasers understood the risks and would not put forward a proposal that was likely to be refused a consent. In any case, as I have said, ACRE can also recommend that the consent contain additional safeguards and monitoring requirements. The failure to refuse a consent is not a sign of inadequacy in the system. I would have thought it an encouraging sign that we were developing a workable process.

RISKS IN THE SYSTEM

How likely is it that both the proposer and the consent system could miss something? This possibility must depend in part on how difficult an assessment is posed by the release. For example, a well-characterised crop, which has been modified without significant change to its phenotype, may be easy to assess because so much is known about the phenotype's population biology. Or a modified organism may have limited viability in the environment or be sterile, thus avoiding major pathways to cause harm. In contrast, assessing the release of bacteria into contaminated soil may expose that we know little about the detailed ecology of the soil system. Such a release might be consented

** Chief Scientist, Department of the Environment*

but with rigorous control and monitoring conditions. The appropriate regulatory response to releases that are difficult to assess and might involve some element of uncertainty is therefore to set conditions on control and monitoring.

This suggests that a product would be easy to assess, and should incur little risk premium, if it has already benefited from research and development releases and closely resembles an existing species. Of course, we should not be completely complacent. A product that becomes widely used in the marketplace will have a more intense exposure of the new phenotype in the environment than a simple one-off release.

However, in contrast, a research release, particularly those associated with curiosity-driven basic science, may prove much more difficult to assess. The release might be quite novel in character with no parallel experience with other phenotypes. It may be difficult, under these circumstances, to be sure what changes in the phenotype will occur. Consequently, control conditions will need to be much more severe, and I fear, expensive.

IMPROVING THE SYSTEM

Could we improve our safeguards by making the process more open to public scrutiny? As it happens, the UK system is already more open than most European approval systems. We have to recognise that some releases will have a commercial confidentially which needs to be respected. In any case it is invidious to explore general principles on the safety of releases through individual cases. It is much better to seek a public consensus ahead of a new class of release.

For example, as biotechnology develops, regulators will be faced with imports of genetically modified products. Ahead of this issue arising, ACRE has recently conducted a number of workshops concerned with the type of international regulatory system necessary for international trade. These workshops included international experts on biotechnology safety with some distinguished contributions from developing countries. These workshops have led to the drafting of possible international guidelines by the UK and the Netherlands. This approach of exploring issues early on may well be the trend for the future regulation of biotechnology, as it expands its horizons and involves new issues in releases. Another useful initiative in the same direction was a recent national consensus conference held by the BBRC at the Science Museum. I am glad to say that the conference very much supported the UK approach to regulation.

INDUSTRY'S PROBLEMS

I hope I have shown that the present system tries to meet many of the concerns about biotechnology safety. However, these responses themselves raise problems for industry. The concerns might be said to fall into three categories – that the regulatory system is giving the wrong message, that the system is too burdensome for the degree of protection that is necessary, and that it is affecting international competitiveness of European industry.

I cannot concede that the regulatory system is in the business of giving messages, right or wrong. Certainly it would hardly be justified to impose a level of precaution that exceeded that demanded by those at risk. But equally it would make no sense to suppose that a warm glow of reassurance would follow from rejecting calls for protection from those who saw themselves or their property in danger. It would be far better to forget 'messages' and seek instead to assemble evidence of biotechnology safety through a step by step approach to regulation. This would imply a precautionary approach relaxing controls as experience and confidence grows. This step-by-step approach follows the recommendations of several distinguished bodies, not least the Royal Commission on Environmental Protection.

A more substantial criticism on 'messages' can be directed at the comparison in Europe between the regulatory system for the release of genetically modified organisms and systems for approving the import of alien species. Both actions present related problems. Indeed, the unwanted spread of deliberate or accidental releases of alien species has been one of the basic models of assessing the population biology of releasing genetically modified organisms. Yet the two regulatory systems are not comparable as if the risks between natural and manmade alien species were different. While the details of these differences are beyond my scope this evening, I can only remark that it does not necessarily follow that it is the risk assessment of genetically modified organisms that is out of step.

Industry's second concern, that the procedures are too burdensome, needs to be considered carefully. It is always too easy to invent burdensome bureaucratic procedures for unpopular activities rather than addressing the real risks. I hope that the development of the UK's regulatory system since I last spoke to the Foundation shows that we are listening to industry's concerns. We have now three classes of application to reflect the respective confidence about the class of release. For example, we now have fast track procedures for modifications of certain crop species that have no indigenous wild variety. We believe we are now handling applications with a turn-round time comparable with that of any other developed world regulatory system.

Even if the level of regulation is well directed, there remains the third concern on international competitiveness. In contrast with other high technologies, much of biotechnology is a small-scale 'bucket science'. Consequently, it is a technology available to not only the developed world, but also developing countries where land and labour may be cheaper. The US magazine *Science* recently estimated that there might be several thousand scientists in China alone engaged in biotechnology research. Many thousands of hectares of land are said to be under cultivation with genetically modified crops.

While in some parts of the developed world there is concern about the implications of the technology for indigenous agriculture, in other developing countries the attitude is very positive. In a recent international survey, it was Thailand's population who expressed the most positive attitudes to biotechnology. In fact, some 80% of Thai correspondents favoured using the technology to correct genetic defects in their children. It is true that countries like China and India have safety committees overlooking releases of genetically modified organisms, but they seldom have the supporting legal or enforcement framework. Other developing countries, while not conducting their own biotechnology research, have been the site of overwintering experiments with no legal structure at all.

The UK was one of the first countries to identify the need to look at the international aspects of this technology. We were at the forefront of the work within Agenda 21 in preparation for the Rio Conference on Sustainable development that explored the positive and negative aspects of biotechnology. With the Netherlands the UK has been developing a set international guidelines for the trade in genetically engineered products. As an interim step this approach has been widely welcomed.

The stage is now set for serious international debate about the control of releases of genetically modified organisms. The European Union has welcomed the parallel track approach of developing guidelines and exploring within the framework of the biodiversity convention the possibility of a protocol. I doubt the negotiations will be easy. I have already outlined the concerns from both points of view about releases of modified organisms. However, in a world whose population is expected to grow from five billion to at least eight billion by the middle of the next century, it is difficult to believe that the potential of biotechnology can be ignored. That is the view in many newly industrialised countries. The trick will be to direct it for good rather than ill. The UK, with a strong base in biotechnology, aims to play its full role.

The views expressed are those of the author alone and do not necessarily reflect those of the Department of the Environment

INNOVATIVE MANUFACTURING

On 28 November 1994, the Foundation held a lecture and dinner discussion at the Royal Society on the subject "Industry and the Research Base: Partnership for Innovative Manufacturing". The Lord Butterworth CBE DL was in the Chair and the evening was sponsored by Loughborough University of Technology. The speakers were Professor Sir Brian Follett FRS, Vice Chancellor, University of Warwick, Professor Richard Brook OBE, Chief Executive, EPSRC, and Mr Stewart Miller CBE, FEng, Director, Engineering & Technology, Rolls-Royce plc.

Professor Sir Brian Follett FRS*

Summary
Sir Brian Follett said the challenge was to couple the excellent research in the universities and public sector to manufacturing. He described the scale and quality of research in the universities, especially that at Warwick. Professor Brook discussed the role of the Research Councils in encouraging collaboration between industry and the research base, and Mr Miller detailed the Innovative Manufacturing Initiative, its aims, development and funding.

INTRODUCTION

The UK has powerful science and technology with world-class research in its universities, in defence R & D and in some sectors of industry. The challenge is to couple this excellent public-sector research to manufacturing, or in White-Paper phraseology "how to realise our potential, thereby improving our wealth creation and competitiveness by using the technology foresight exercise as a star to steer by?"

One aspect of this coupling is "Innovative Manufacturing" and the IMI initiative aims to expend £100M annually on the enterprise, half drawn from the Research Councils, half from industry. The title of this evening's meeting emphasises that to succeed we need partnerships – essentially between industry and the universities – and my role is to speak about the research base. We are all aware, of course, that innovative manufacturing involves much more than discovering a new product: it is about the total manufacturing process and involves discovery, design with manufacturing in mind, manufacturing the product optimally and then selling it at a profit.

RESEARCH IN UNIVERSITIES

My own viewpoint is three-pronged. Firstly as the leader of a university committed more than most to research in innovation. This is epitomised most obviously in Kumar Bhattacharrya's Manufacturing Engineering Group which at the last count had over 200 staff, and in the Warwick Business School which also has over 200 researchers. Secondly, as a member of the Funding Council and one who spends hours trying to improve university research through the quadrennial selectivity exercises, and thirdly as Chairman of the Science and Engineering Board of the new Biotechnology Research Council.

As an opening salvo let me emphasise the scale and the quality of research in our universities.

Table 1 shows data for a sub-group of nine universities. The reason for focusing upon these nine is that they are amongst the most research-intensive and I happen to have quantitative data upon them. They are exemplars of what is happening in at least another 20 universities and in a more selective fashion in the other 70. Even these nine universities provide a massive research

* *Vice-Chancellor, University of Warwick*

Table 1. Volume data for research in nine major research universities.

1. Universities included:	**2. Overall size (Teaching plus Research)**	**3. Research**		
Cambridge	Turnover – £1.5 billion	(a) *Money*		
Oxford	15,000 employees	Funding Council grants	£220 million	(part salary of academic staff plus buildings and central services)
University College London	100,000 students			
LSE				
Warwick		Competitive Grants & Contracts	£410 million	(for specific short-term research)
Imperial College London		Research training	£90 million	(fees & support for postgraduate research training)
Edinburgh				
Manchester		**Total:**	**£720 million**	
Birmingham		(b) *People*		
		Professors/Readers/Lecturers	8,500	(a proportion of each person's time)
		Full-time Research staff	6,500	(research grant supported)
		Research students	22,500	
		Total:	**37,500**	

resource – larger than all the public sector research institutes looked at in the recent scrutiny report – and form a base with which partnerships must be established. Note also the gearing. The infrastructure support of £200 million – drawn from the funding councils – provides two things. It pays part of the salary bill for each academic (remember that each one also teaches – an equally important university function) and provides them with research buildings, services, libraries and computing. Using this platform the university staff raise another £500 million of short-term contracts from a host of sources for the actual research and training. The change from a decade ago is enormous. [Had I drawn the table to show all UK universities the income *for research only* would be £1.9 Billion, would involve 20,000 academic staff and there would be another 64,000 research staff on the payroll.]

Of more importance still is quality since our industrial partners must be interested in those individuals and teams at the cutting edge of international research. We now have information from three research assessment exercises which allows us to measure the quality of UK basic research across the entire disciplinary field from medicine through the sciences and engineering to the social sciences and the humanities. The key benchmark of interest is Grade 5 which can only be attained if the department is of international excellence: by that we mean the department shapes what others do, does not merely follow what has been discovered.

Table 2 again summarises data for the nine universities. Note that over 50% of all staff are in grade 5 departments.

A third point to emphasise is that the organisation and management of research in universities has undergone a quiet revolution in the last decade. We have not trumpeted the changes for various reasons, one of which is that creative research of world-class still largely springs from the mind of the individual and university structures properly reflect the primacy of the individual and the research team, even if behind the scenes we are managing them to a not inconsiderable degree! That individuality is not a weakness but a strength and we should all play to it in our partnerships.

Finally let me remind you that university researchers are well attuned to managed research initiatives. They do not live in ivory towers – that is a view from wonderful novels we all enjoy reading. In reality they live in a highly competitive world and raise *all* their research money in open competition where only one contract in every four is funded. Give them an opportunity and they will bite off your hand to comply with the requirements and the aims. In the most recent bid exercise I chaired at the BBSRC we had 59 applications for 10 grants! Industrialists are joining therefore a worldly-wise group of persons.

Table 2. Quality of Research in UK universities.

1. Data from 1992 Research Selectivity Exercise

2. Scale
5 (International)
4 (International/National)
3 (National)
2
1

3. For the nine universities:
Cambridge
Oxford
University College London
LSE
Warwick
Imperial College London
Edinburgh
Manchester
Birmingham

Grade 5	54% of staff	(5,200)	83% (8,000)
Grade 4	29% of staff	(2,800)	
Grade 3/2	17% of staff		

4. The national picture:
About 60,000 academic staff in about 100 universities.
Of these, 15% (9,300 staff) are in Grade 5 Departments and another 17% (10,000 staff) are in Grade 4 Departments.
About one-half of these are in 10 universities, 90% in 30 universities.

FINANCE

Let me next deal briefly with finance. In the partnerships stemming from the IMI we *must* ensure that the funding is sensible and realistic with income streams large enough and for sufficient time – preferably rolling contracts – to recruit people of sufficient calibre and deliver the answers needed in the time available. Do not let us spread the resources too thinly; let us be disciplined in how we set up the partnership contracts both in financial terms and in terms of objectives and deadlines.

There is clear evidence that when medium-term strategies have been developed they form a virtuous circle. If I dare mention Warwick again then we have relatively few difficulties in our partnerships with major industrial companies in either manufacturing engineering or in the Business School. We have a sensible career-structure in place for long-term research fellows so the best stay with us. We do have a real problem though in providing high quality infrastructure, equipment and buildings. In the case of equipment industry is wise and has placed expensive modern equipment in the university (and incidentally over 100 of their staff). Providing top-quality research space is more difficult especially as the funding councils have effectively ceased providing support for buildings. Our experience at Warwick is that even this problem can be overcome if the income stream is stable enough over time and as a result we are currently investing upwards of £15 million in new research buildings for engineering and the social sciences. A key to this is the overhead rate which remains an unholy mess and one has to observe that the industrial partners we have at Warwick are more than willing to pay sensible overheads so long as we continue to deliver.

Thus my conclusion is that the UK's basic research resources are of high quality, are substantial and the culture exists to establish proper partnerships.

TRAINING

There is one other area related to but separate from research, and that is training. It is an absolute key and I would distinguish between two types. One aims to ensure that the labour skills exist whereby "innovative manufacturing" can succeed. This is best done at the postgraduate level and probably in the part-time mode whereby the youngish person spends a proportion of their year on acquiring much higher level skills such as an MBA or a Master's degree in manufacturing processes. In parallel we need facilities for post-experience training of our managers. The scale of this can be surprising and at Warwick this year we have 3,000 students reading for degrees in manufacturing engineering and the MBA: 2,000 from the UK, 1,000 from overseas. There are another 7,000 who attend short-courses at the management training centres. The second stream of training is to produce the next generation of researchers. The main route for this is via the PhD, the DEng and soon the DBA. Universities are the only place where young people can obtain their research training and we want to be involved much more than heretofore in partnerships with industry. We can produce bright, energetic and flexible young people but quite frankly we need you to hire them into your organisations.

THE OPPORTUNITIES

I would like to touch upon two specific areas of innovative manufacturing to give a flavour of the opportunities.

The first lies at the interface between engineering, manufacturing and the social sciences. This is one of the primary areas

where the initiative should be focused and I expect the technology foresight exercise to throw this up as a key element. The ESRC are reflecting this in two parallel strands. The first relates to research on the innovation process itself. The importance of this is enormous for we hardly understand at more than an anecdotal and highly subjective level, what really leads to innovation and its transfer into wealth creation. As an example of our local concerns at Warwick we are funding a study by Andrew Pettigrew's team along with that of Paul Stoneman on how product champions arise and flourish in our university environment.

The other strand is the Business Processes Resource Centre. Basically this is a fancy name for a co-ordinated programme to promote best practice, for so much of excellence in innovation is generic not specific. The aims here are complementary to innovation research *not* competitive.

My second area is biologically based and reflects an involvement with BBSRC. Innovative manufacturing usually conjures up ideas of engineering/physical science-based industry, but manufacturing in the biologically-based industries is of enormous value.

> "…as early as the year 2000 the impact of biotechnology processes and products will increase from today's Ecu 5.1 Bn to Ecu 83.3 Bn…"
>
> *Ernst & Young "European Biotech 94"*

> "…(bio-based industries – excluding agriculture) account for over 21% of EU output, 17% of EU employment and almost 30% of EU exports…"
>
> *Ernst & Young 1994*

These comments make a few observations on the scale of the enterprises involved. Putting some hard figures to the statements then agricultural output in this country – farm-gate prices – is valued at £14 billion annually whilst food turnover is £50 billion.

Our approach at BBSRC has been to develop a bioprocess initiative, worked up by a specialised committee and using a senior consultant who has travelled between British academe and British industry and, vitally, gone overseas to see what is happening elsewhere. No-one doubts the importance of pharmaceuticals, food and agricultural processing or of the challenges involved *(see Table 3)*.

To retain our excellent competitive position we need *now* to address a host of major research/competitive issues. There are many instances and I will mention just a few:

– At a practical level we need better sensors to know what is going on in industrial processes as it happens. Are contaminants such as pesticides or natural toxins creeping through into the final product?

– How do we ensure bioprocessing does not lead to problems such as we have experienced with bovine encephalopathy or the homologous difficulty emerging in some children who were treated 15–20 years ago with pituitary-derived growth hormones?

– We now have rapid prototyping in some areas of engineering. How can we develop similar devices for testing the scaling up issues in bioprocessing?

– Separation technology was largely discovered in Britain and two of our fellow countrymen were awarded Nobel prizes for chromatography. We need new technologies here linked to bioprocessing.

– Finally biosciences is moving as fast as computing! This requires training, updating and a shift in management style, especially in the pharmaceutical industries.

We have not even begun to face up to this pace of change and on that note I will end with a recent personal observation! On Friday last Walter Bodmer came up to Warwick and we visited our molecular biologists. What struck me was the sheer pace of development (as well as the youth of the scientists!). It is only twenty months since I stopped doing bench science and yet the pace of molecular biology left me struggling. There are messages here for all of us trying to manage the science base – perhaps the first thing we ought to do is to bring on board the younger scientists for if they do not own the innovative manufacturing initiative then it will never succeed. I leave you with that thought.

Table 3. User sector: Chemicals and pharmaceuticals.

Strengths:	**Weaknesses:**
Trade surplus of £3.5 billion *per annum* Excellent UK science base Strong commitment to R & D	Escalating R & D costs Long product development time
Opportunities:	**Threats:**
Strong and expanding science base Growing market for biopharmaceuticals White Paper and BBSRC	Short effective patent life Insufficient new equity Regulation Competition from USA and Japan Lack of suitably trained manpower Public perception

THE ROLE OF THE RESEARCH COUNCILS

Professor Richard Brook OBE*

INTRODUCTION

The 1993 White Paper on Science, Engineering and Technology, "Realising our Potential" charted a new course for the government's support of science and technology in the United Kingdom. I would like to begin this short talk by reminding you of the first two paragraphs of that White Paper:

The understanding and application of science are fundamental to the fortunes of modern nations. Science, technology and engineering are intimately linked with progress across the whole range of human endeavour: educational, intellectual, medical, environmental, social, economic and cultural. They provide – through tools as diverse as mathematical modelling, biotechnology and earth observation from space – a vital part of humankind's armoury for solving long-standing world-wide problems, such as poverty and disease, and for addressing new global challenges such as those facing the environment.

The history of the United Kingdom has shown the intimate connection between free trade, the application of science to tradeable products, and national prosperity. The industrial revolution which played so large a part in creating the modern world was made possible by our great engineers of the eighteenth and nineteenth centuries. In a world where ever fiercer competition prevails, history's lessons are highly pertinent.

These two paragraphs set the tone for the White Paper which is about cultivating and harvesting the UK civil research base and indeed primarily the academic research base in order to enhance the nation's wealth and improve the quality of life for us all. Two particularly significant consequences followed the White Paper. Firstly the Government decided to reorganise the research councils and secondly the Office of Science and Technology embarked on the Foresight Exercise which I am sure is

* *Chief Executive, EPSRC*

well known to most of you here tonight. In addition it was agreed that a rolling programme of plans for research and training, the Government Forward Look, would be published and updated annually.

The new research councils were established to ensure that they were better equipped to play their part in the new partnership between the science and engineering base, industry and Government and each council was provided with a mission statement and a clear definition of their perceived user communities. The Foresight Exercise was set up to provide guidance to the research councils about future programme priorities. Underlying the whole of the Government's strategy is the acknowledged excellence of academic research and postgraduate training in this country, and it is my contention that in talking about the 'Role of the Research Councils', a key role must be that we locate, nurture and maintain that excellence.

The White Paper rightly highlights the contributions made to our former prosperity by the great engineers of the eighteenth and nineteenth centuries, but we are now approaching the twenty-first century, well into the technological and systems revolution of the last 30 years or so, and the great people who will influence our prosperity in the new millennium are quite possibly some of the young scientists, technologists, engineers and indeed management scientists who are currently funded through the research councils. However, while a necessary condition, supporting excellent individuals and teams is not a sufficient condition to meet our missions as set out in the White Paper. We must also, with the aid of colleagues from other departments of Government, and from industry, seek to generate environments where our scientists and engineers will become more aware of industrial and social challenges.

'We must seek to generate environments where our scientists and engineers will become more aware of industrial and social challenges'

DELIVERING THE AIMS OF THE RESEARCH COUNCILS

Since taking up my post as the Chief Executive of the Engineering and Physical Sciences Research Council in April this year I have concentrated on laying the foundations necessary to deliver the aims of the White Paper. This has meant starting to build stronger partnerships with my fellow Chief Executives, with other departments of government, particularly the Department of Trade and Industry and the Department of the Environment, together with industry and associated research and trade associations. I have also received advice from the Royal Society and the Royal Academy of Engineering. Furthermore, in my Chairman, Alan Rudge, I have an excellent source of information and good counsel.

We have had many examples of industry collaborating with the research base through schemes such as LINK, Teaching Company and Interdisciplinary Research Centres, and most recently the highly successful 'Realising our Potential' Awards (ROPAs) and industrially based CASE studentships. Even so, I believe there is still scope for greater coherence in our approach to users' needs and more focused collaborations, not least because the majority of universities are organised on a formal discipline basis and most companies need a multidisciplinary approach to research problems. However, I do have to spend a high proportion of my time reassuring the academic community, that the White Paper does not imply sacrificing excellence in order to carry out research for industry through a greater emphasis on strategic and applied research. One thing that is very clear is that the research councils all need to develop a better understanding of industrial requirements including a greater understanding of the business processes of industry and commerce if we are to carry out our new missions successfully.

RESEARCH & TRAINING ACTIVITIES OF EPSRC

As an illustration of what the new research councils can bring to the partnership this active role with industry and commerce, I would now like to give you a brief overview of the research and training activities of the Engineering and Physical Sciences Research Council.

Most clearly mapped on to industry are the core engineering programmes of the electrical, mechanical, civil, structural, process and marine engineering. Among some key opportunities we see for the future are the processing of structured materials, development of fuel cells and research to support offshore oil and gas production from deeper water. Structured materials are multiphase materials which are soft and which deform under small degrees of shear. The UK has already established a significant world lead in the processing of structured materials and research in this area is of vital interest to a wide range of UK industries producing products such as cosmetics, oils, fats, detergents, polymers, mastics, pharmaceuticals and food. Fuel cells offer prospects for high efficiency and low environmental emission in applications such as combined heat and power units, distributed power generation and transport. In the light of increasingly stringent environmental legislation there is a major world-wide effort to develop competitive systems and while Japan has an overall lead, the UK has strengths in specific areas and could compete in niche markets. Whilst the North Sea is now considered a mature province there are major new opportunities in overcoming the technical problems involved in producing oil and gas from deeper waters (1000m – 3000m) elsewhere in the world. Conventional techniques are not suitable at these depths and alternatives must be found such as floating or subsea production systems. All installation operation and maintenance (eg welding) will have to be undertaken remotely.

While not all mapping directly onto discrete industrial sectors, the key genetic technology research and training we support in control, design, production, IT and materials technology have the potential to make an even greater contribution to competitiveness. For example, research supported at the Cavendish Laboratory where the first light emitting devices based on organic polymers were produced has now led to the development of efficient polymer electroluminescent devices which are stable under atmospheric conditions and can be fabricated on silicon substrates. These developments could lead to computer and television screens thin enough to hang on walls and even rolled up after use. Major advances continue to be made in communications and the use of optical fibres and optical amplifiers are changing the face of long distance communications, with fibre optic cables carrying signals beneath the oceans.

Underpinning all our wealth creating potential however is the strong academic science research base, and it is no coincidence that a high proportion of our most successful engineering programmes owe much to fundamental physics, chemistry, mathematics and materials science. Mathematics underpins the entire science and engineering base. The impact of UK mathematics on the world scene, as measured by citation analysis, has increased over the past decade. The UK has established a world lead in non-linear applied mathematics and is in a strong position in

many areas of applied and computationally intensive statistics, especially image analysis, Bayesian statistics, molecular and population genetic analysis, expert systems and communications networks.

Current strengths in physics are non-linear and laser optics, magnetism, surface spectroscopy, condensed matter theory and quantum fluids and solids. Future applications include the development of highly compact tuneable ultra-short wavelength and soliton pulse laser systems for use in medicine and communications and the development of new magnetic techniques such as giant magnetoresistance for high density magnetic recording media. Such work is closely associated with our materials science programme where important current priorities are scanning probe microscopy, nanotechnology and functional ceramic processing.

Chemistry plays a key role in a broad range of activities including health environment, agriculture, food, construction and most sectors of manufacturing. The chemical and pharmaceutical industries are among the UK's most vigorous and internationally competitive and employ more PhD students than any other industrial sector. Perhaps there is a message here.

In this brief survey I have not been able to say very much about our diverse range of postgraduate training schemes which we see not only as a means of maintaining and enhancing the excellence of the science base, but also as important mechanisms for knowledge transfer into industry. The EPSRC will continue to have a strong and dynamic education and training programme.

With such a wide range of activities and with new advances occurring all the time it is very easy to argue that increased funding for research should also follow the new dawn heralded by the White Paper, but that would be totally unrealistic. A fundamental objective of the Foresight Exercise is to provide advice to research councils to assist them in deciding on priorities and those areas of research that should be given enhanced funds at the expense of others. As we move towards the next century there is no doubt that we will need to be ever more selective and there will be little gain in trying to spread our resources too thinly.

THE FUTURE

At the beginning of this talk I reminded you of some of the main features of the White Paper on Science, Engineering and technology and of my ambition to increase further the industrial coherence of my research council's programme. A major step in this direction was taken on 21 July this year when Mr Robert Hughes, Parliamentary Secretary of the Office of Science and Technology announced the first three targets in a new tri-research council programme, the Innovative Manufacturing Initiative, where we are working together with the Biotechnology and Biological Sciences Research Council and the Economic and Social Research Council. These targets are: Customer Integrated Aircraft Manufacturing; Construction as a Manufacturing Process; and Responsive Processing.

This programme has been designed with the White Paper in mind and taking note of the developments of the Foresight programme. Indeed, some members of the various Foresight Panels see this Initiative as a natural delivery mechanism for the outputs of Technology Foresight related to manufacturing and because of its importance it has been necessary to lay sound foundations. However, it is not for me to begin the detailed presentation of the IMI; I shall leave this to Mr Stewart Miller, the Director of Engineering and Technology, Rolls Royce plc, who is Chairman of the IMI Management Committee and a Fellow of the Royal Academy of Engineering. I am confident that Innovative Manufacturing will be the "Rolls Royce" programme of the future.

THE INNOVATIVE MANUFACTURING INITIATIVE

Mr Stewart Miller, CBE FEng*

INTRODUCTION

I will be introducing you to the concept and content of the Initiative. It is only beginning, but I, and many colleagues from industry, are determined that it should succeed, because we believe its objectives are important and wholly appropriate to the present-day needs of UK manufacturing industry.

As Sir Brian and Professor Brook have described, the Government's recent white papers on Science, Engineering and Technology and on industrial competitiveness provide clear guidance to industry and the science base on the need for partnerships to unlock our potential for improvement, in both wealth creation and quality of life. I do not see any contradiction between these two objectives and, increasingly, the means of achieving one must also take into account the other.

I expect that this message will be endorsed in the first outputs from the Technology Foresight exercise. I also expect that its early conclusions will emphasise the importance of setting priorities and encouraging the right processes of implementation. Our Initiative is seeking to do both these things, at this stage of course at a comparatively small scale.

THE INITIATIVE

In setting out to describe it to you I will be talking in more detail than the two previous speakers. It is at one end of the spectrum of activity which extends from blue skies work to applied research. The concept follows very much the declared needs of manufacturing industry. We acknowledge the continuing need for the existing programmes in the traditional science and engineering disciplines, but we also require extra emphasis on multi-disciplinary work carried out within a framework which recognises the business environment in which industry works. I will have more to say about business processes later.

One logical outcome of the multi-disciplinary requirement is that more than one of the research councils should be involved and I am very pleased that the EPSRC, the BBSRC and the ESRC are joint sponsors. I hardly need to say that, in calling for applied research of this type, the councils are not about to relax any standards of quality or scientific and technical challenge.

Industrial strategy nowadays is planned against a carefully thought-through mission statement. The Research Councils have these, and are operating to them, and our Initiative has its own consistent mission – which is to support high quality strategic and applied research (and related post graduate training) in response to the need for more innovative manufacturing within UK industry – and to accelerate the process of beneficial change by adding to the base of appropriate technology in order to enhance industrial competitiveness.

We use a common definition of innovation – the successful exploitation of new ideas. This already implies a process which takes an idea all the way through to a customer, and so our requirements for innovation in manufacturing are comprehensive. We are looking at three main areas:

* *Director, Engineering and Technology, Rolls-Royce plc*

In the design and development of products

In the processes by which these products are manufactured

In the overall business process of which these products and manufacturing processes are part

You will immediately understand how this leads to a multi-disciplinary approach in the planning and execution of the research programmes. It also requires us to follow best practice in the management and operation of the Initiative itself. We have to be a model for others to follow.

One of my main objectives this evening is to be clear about what we mean by Business Processes – I don't want it to remain as jargon. Business Processes are the strands of activity which link all the operations of an organisation to the requirements of its customers. This sounds straightforward, but achieving improvements requires much fundamental thinking and radical change in ways of operating.

It represents a considerable intellectual challenge. I find in my own experience that the demands are greater than in the thinking that we have to go through in the design of a high pressure turbine blade for one of our aero engines. That represents possibly the most complex design activity that we have in our company.

It is apparent that the functional specialisms employed by companies since the time of Henry Ford, perhaps even since Adam Smith, no longer satisfy the needs of competitive business. Problems which need to be solved include products brought to market late, products of poor quality and large inventories in manufacturing and logistic operations.

A wide variety of techniques and technologies have been adopted, with variable success, for instance, cellular manufacturing, total quality management and the Japanese just-in-time approach. All that has gone before does not provide a reason to stop the search for improvements, and it is this crucial need which was central to the thinking of the industry panel which developed the concept of the Initiative. In this context the involvement of ESRC will be invaluable.

HOW THE INITIATIVE WILL WORK

Central to our plan is that the Initiative will be led by industry. We have a powerful Management Committee, including senior industrialists, academics and the chief executives of the three research councils. Of course, the day-to-day management is in the hands of the research councils. It seems to us that this arrangement, for one segment of the research council's activities, is entirely consistent with the objectives of last year's White Paper.

The sub-title of the Initiative is "A New Way of Working", and this is indeed providing a challenge to the research councils' staffs in how they manage and operate. I believe it will provide a healthy development for them and may well spread its benefit beyond the work directly involved in this Initiative.

The central feature of the arrangement is that each sector of activity will be led by an individual programme manager, appointed to develop and exploit the partnerships within each approved research target. These are key appointments and we are selecting the individuals with great care. So far we have three people to meet the need and their performance is going to be crucial to the overall success of the Initiative.

You may have guessed from my comments about a new way of working that the changes are taking some time to achieve. I would have wished for some faster progress, although when you remember that it is still less than a year since the old SERC approved the programme and that this period has contained the big changes to Council structure, then perhaps progress has been as much as could be expected. We have not been held back so far by lack of money. William Waldegrave and Sir John Cadogan made an allocation in January.

In order to make maximum impact, the Initiative will focus on the manufacturing aspects of a number of selected industrial sectors. The first three targets were announced by Robert Hughes in July, and they are:

Construction as a manufacturing process

Customer integrated aircraft manufacture

Responsive processing

There has been a great deal of dialogue already between industry and the academic community relating to these targets. Following the July announcement, individual research frameworks for each sector were published in September and formal calls for proposals have just been issued. Given the amount of discussion and consensus which has already been achieved, I would expect the proposals from the community to be prompt and responsive to our requirements. It is good industry practice to be clear about strategic objectives before doing the detailed planning.

Let me briefly illustrate the content of these three sectors.

Within the construction industry, major firms are developing partnerships with the research base to improve performance, interestingly not only through traditional associations with civil and building engineering departments, but also with other departments who have something to contribute from their experience elsewhere in manufacturing. We can see a great deal of potential from the exploitation of information technology, for instance.

The primary needs of the aerospace sector are reductions in manufacturing cost and in time to market. Advanced materials and structural design will contribute, as well as improved assembly and operational techniques.

Our responsive processing target recognises the need for the UK industries to respond to global market demand, customer preference and scientific and technology advances. We will commission work on structural materials, for example, plastics, foams and pastes and flexible modular plant design.

FUNDING

The scale of our total plan is ambitious, and I make no apology for that. It is expected to build up to £100 million per annum in steady state in about 5 years time, made up of equal contributions from industry (in cash and in kind) and from public sources.

We will commit some £5 million of public funds in the first year. This consists of £2 million of Realising our Potential Awards (or ROPAs); £1.5 million on other research grants within the sector targets; £0.5 million of Teaching Company Programmes – mainly at post-doctoral level in the biotechnology industries; £0.4 million on Masters students to be employed by industry; and £0.5 million on scoping studies and programme support. Industry contributions alongside these programmes are expected to be a further £4 million.

I am very pleased that the ESRC has agreed to establish a Business processes Resource Centre as its initial contribution and to complement its own programme on Innovation for Business and Commerce. The Resource Centre will be operational from April 1995. I am also very pleased for the support given to the Initiative by the BBSRC whose community are playing a prominent role in the Responsive Processing Sector Target.

Support for the Initiative has been strong and consistent from the industrial side, including the CBI. As you might expect, there is considerable interest and anticipation from the academic community to see a new channel of funding.

Within government, the Department of Trade and Industry and the Department of the Environment have been involved from the beginning and it is our intention that their support will be built into the financing of the programmes as plans develop. From the outside, the strong support from the Royal Academy of Engineering has been very encouraging. All these parties are ambitious to see progress in the development of the Initiative and the management are dedicated to providing this.

We are all agreed on the need for this enterprise and the objectives of our mission fully justify the effort which we are applying.

INDUSTRY IN JAPAN 1994 – WHAT CHANGE?

The Foundation held a lecture and dinner discussion on 16 November 1994 at the Royal Society on the subject "Industry in Japan 1994 – What Change?" The Lord Butterworth CBE DL was in the Chair and the evening was sponsored by Oxford Instruments plc. The speakers were Sir Geoffrey Allen FRS, Executive Adviser, Kobe Steel Ltd, Mr T Kurachi, Resident Managing Director for Europe, The Bank of Tokyo Ltd, and Mr John Chisholm, Chief Executive, Defence Research Agency.

Sir Geoffrey Allen FRS*

Summary
Sir Geoffrey Allen discussed changes in Japan over the past 20 years in terms of social attitudes, the political system and industry and trade. Despite Japan's current problems, he believed the country would emerge as a strong, resourceful, manufacturing nation. Mr Kurachi discussed the business style of Japanese banks, especially in relation to "lifetime employment". The banks were trying to harmonise the characteristics of Japanese banking with the needs of international banking, serving commercial and investment needs, coupled with the long-termism of a Japanese bank.

INTRODUCTION

My views on Japan are conditioned by four main relationships:

(i) A friendship beginning in 1953 with the late Prof Shimanouchi now continued with his students

(ii) Contacts with officers of Mombusho, Japan Society for the Promotion of Science since 1979

(iii) A working relationship with Nippon Lever during my period at Unilever 1981-90.

(iv) My present activities with Kobe Steel Ltd which blossomed in 1990 following six years of informal contact with two CEOs and their liaison officers in London.

Thus I have friends to whom I can turn for information and advice on matters academic or cultural. For example, Japan is more inclined to leave education and primary training and some basic research to academe. A white paper such as 'Realising Our Potential' would be directed almost certainly to industry.

Nippon Lever gave me an insight into the ways of smaller companies, factory attitudes, subcontractors and the special character of the distribution system for nondurable consumer goods in Japan. In particular, I learned that the famous 'life-time employment' system was enjoyed mainly by workers in larger companies – some 35% of the workforce.

Coming to Kobe Steel has allowed me to observe how a large Japanese Company functions, before and after the collapse of the 'bubble' economy.

FIRST IMPRESSIONS

My first impressions were much as expected:

a major company with a network of small affiliated companies

a close partnership with Financial Institutions

a dedicated, highly trained workforce

a long term business view

a quiet pride in the Japanese way of doing things

a diverse range of business activities compared with Western counterparts

a strong R & D function

I was given a friendly but cautious welcome due mainly to shyness; the welcome soon warmed into working partnerships. Even so, certain aspects took some getting used to! For example,

overlapping areas of responsibility between two and sometimes three managers at the same level

the time to reach decisions and to realise where the decision was being made

the ambiguous separation of work and family life – everyone seemed just as comfortable at work as at home.

We often hear that the Achilles heel of Japan is its quality of life which in part is conditioned by its dense population. I consider this view to be out of date. The houses and apartments of my colleagues are certainly different from and usually smaller than ours. But with their families they enjoy a warm culture, a high standard of education in a law-abiding homogeneous society. Their homes bristle with all modern appliances and the social infrastructure is much improved. The Japanese are arguably the best dressed nation in the world and they vie with US citizens to be the most travelled. They enjoy their prosperity.

WHAT CHANGE?

The recession has revealed strains which have been developing over the past 20 years in society, politics and trade and industry and change is bound to accelerate following the current turbulence.

Social attitudes

The Japanese are hardworking, painstaking and co-operative. Their society is cohesive and there is freedom from the alienation often prevalent in other advanced countries. However, individuality tends to be discouraged and Japan is inward-looking to a degree which sometimes makes it seem the 'odd man out' amongst the major nations. The dilemma for the future is that its strengths generate the feeling internally that the Japanese way of doing things is different. This leads to misunderstandings and tensions with other countries, notably with the US. No doubt features of Japanese society will draw closer to Western practices. It will be a slow process and they will retain selected aspects of their Japaneseness.

* *Executive Adviser, Kobe Steel Ltd*

Political system

In the UK we are experiencing the strains of having one party in power for 15 years. In Japan the corruption and scandal revealed two years ago were but symptoms posed by the Liberal Democrat Party being in power for 40 years. This, compounded with a system of multi-member constituencies in which many members came from the same party, suppressed debate on policy issues. The break up has resulted in unstable coalitions and a series of weakened Prime Ministers. This is not catastrophic simply because of the power of the Civil Service. Now the political system is in the process of change and may well settle down to be government by centre group coalitions not dissimilar from that in several European Union countries.

Industry and trade

Here I shall concentrate on the change we might expect in Japanese industry as it emerges from recession. Massive problems in the financial sector followed as the bubble burst. Bankruptcies and debt are still issues. Government attempts to stimulate the economy continue but the bilateral trade disputes with the US go on and exports are handicapped by the steadily rising strength of the Yen.

'The determination to succeed is great and I believe Japan will emerge as a strong, resourceful, manufacturing nation'

Industry responded sharply just over two years ago. Faced with poor results dividends were reduced. Bonuses were suspended and salaries reduced by up to 20% for Board Members and senior staff. Some full time staff were transferred to affiliate companies usually at reduced salaries and part-time workers have been laid off. Recruitment has also been curtailed. None of these measures were new. The Steel Industry for example had restructured in similar fashion in 1986/7. Western companies might think they do not go far enough. The workforce has responded positively to these changes, but in fact they are portents of longer term, more fundamental measures now being enacted.

Most large companies are developing more flexible strategies, maintaining Japan as their base but implementing changes which include:

concentration of core businesses and divestment of peripheral activities,

increased competitiveness from fundamental cost reductions, quality improvement, differentiating design features and product efficacy,

stringent control of Capital Investment with the strong Yen forcing attention in the short term towards strategic overseas investments,

strengthening business relations with overseas companies,

R & D being focused more on short – medium term projects but still regarded as a competitive edge.

By current US and European Union standards this represents an incremental, slow approach to where the companies need to be at the beginning of the Third Millennium. However, the determination to succeed is great and I believe Japan will emerge as a strong, resourceful, manufacturing nation. The link between employer and employee may weaken and their markets open up slowly, but the long term view, financing system and company unity will remain.

Our current frustration with over-protective bureaucracy and trade practices will persist. The European Union may find persuasion in the GATT discussions more rewarding than the confrontational approach adopted by the US in their negotiations. The remedy must lie with Japan. Only when the competitive sector see that they are paying the price for the protection of the non-competitive sector will things change.

JAPANESE MANAGEMENT IN THE FINANCE AND BANKING INDUSTRY

Mr T Kurachi*

INTRODUCTION

I would like to begin my talk illustrating the characteristics of Japanese management in the finance and banking industry with a recent example of what happened when three local regional banks in Japan announced that they wished to merge.

In April this year, an announcement was made that three Japanese local banks were going to merge in January 1995. The name of the new bank was also proposed. The news was eagerly welcomed and supported by the Ministry of Finance and Bank of Japan.

The purpose of the merger was to expand the business territory of the respective banks and to avoid duplication in computer investment. This merger was considered to be an attractive business judgement.

In late June, two months after the announcement, surprisingly, the merger was cancelled because of strong opposition by clients and employees of the banks.

Is it possible in the UK that clients and employees could cast a decisive vote on a banking merger? Is there such a sense of 'common purpose' or 'belonging' in the UK, in the relationship between banks and their clients or in the relationship between 'management' and 'staff'? Is there a need for such consensus before such an action could be taken?

Mergers and acquisitions of companies, being strategic decisions, could be decided at board meetings and shareholders' meetings in Japan. But in reality top management in Japan has to consider very seriously whether clients and employees, as well as shareholders, support the merger and acquisition.

You could acknowledge that human resources and customer base are very important as are branch network, monetary assets and profitability for Japanese banks.

The business style of Japanese banks is more relationship-orientated rather than transaction-orientated.

LIFETIME EMPLOYMENT

Now let us look at so-called "lifetime employment system". I would like to explain the career development programme of the Bank of Tokyo as an example.

The Bank of Tokyo employs approximately 20,000 people world-wide. About 6,000 of these people are employed in Japan, of which about 2,500 are officers.

In Japan, the bank regularly recruits around 100 new college graduates as future officers every year and it is exceptional to employ somebody with prior job experience. More than 90% of

* *Resident Managing Director for Europe, The Bank of Tokyo Ltd*

them will stay in the Bank for over 30 years until they are over 50. The number of officers is 30 years x 100 = 3,000 people. This is an example of lifetime employment.

The number of people who leave and change jobs is increasing gradually, but it is still less than 10% and I do not think that it will increase rapidly.

Lifetime employment used to mean "pay and promotion based on seniority". This is no longer the case and there is fierce competition amongst people who joined the Bank in the same year.

'One of the merits of life-time employment is to be able to develop people with a long-term view'

After the 3-year officer training period about 50% of them are sent, all by corporate sponsorship, to universities like Oxbridge and the London School of Economics, Business Schools in the US, and overseas offices. They will eventually find their own fields of business which they are good at, having gained a wide experience and a broad overview through on-the-job training, various job assignments, consultation and internal examinations. They can choose between a specialist course or a general course.

Here, I could stress, one of the merits of life-time employment is to be able to develop people with a long-term view.

Another merit is to allow us to build up deeper relationships with our clients with a long-term policy. Because of this lifetime employment system by the banks and clients there could be long-term contact sustaining relationship at various levels from officer, through to executive level management.

Our traditional approach has been to train 'generalists' rather than 'specialists'. However, a different approach may be needed in the future as more specialists are required as business becomes more complex. More specialisation may lead to higher staff turnover as specialists may demand a premium or be attracted by other institutions. However, the long-term view is generally one shared by staff and employers who both can see the benefits of this system, the employers in taking a long-term approach in training staff, and the staff in accepting different assignments to gain a wider experience to step up to the management level.

MANAGEMENT CHARACTERISTICS

Will the characteristics of Japanese management continue? The recession in Japan has led to rethinking by many Japanese companies of traditional approaches and ways ahead for the future.

On 5 August, Nikkeiren, a Japanese counter-part of CBI, issued a survey on Japanese management approaches. This survey shows that Japanese companies are trying to restructure and reform themselves fundamentally against the background of a strong Yen and deep recession.

Changes under consideration by many Japanese companies were highlighted in the survey. Companies indicated that they will be reviewing traditional approaches. A willingness to review the following traditional management systems was indicated:

	Yes
(1) Pay based on seniority	97.0%
(2) Mentality to follow others	96.9%
(3) Mentality to be content with low profitability	93.3%
(4) Mass production and mass sales	89.7%

On the other hand companies indicated that they wished to retain the following elements of the traditional approach:

	Yes
(1) Long-termism	91.5%
(2) Main bank system	81.6%
(3) Company union	81.2%

With reference to the lifetime employment system, 62% of the companies say it has to be reviewed and 58% of them say it can be retained with some modification. 83.3% say that the best modification is combining lifetime employees with temporary employees.

In the lower level clerical work and professional areas, companies are already using temporary staff or outsourcing services but there is not much mobility in core-officer members. The labour mobility has slowed down particularly because of fear of unemployment resulting from recession.

This survey was quite interesting because it shows various concerns of top management, for example:

What to do with one of the highest personnel costs in the world as a result of the strong Yen.

How to make unique and diverse products rather than pursuing scale economies and market share, with the background of over-capacity in Japan and transfer of production to Asia.

After all, even shareholders and unions prefer long-term and stable growth rather than short-term benefit, accordingly Japanese long-termism will not change at all.

MANAGEMENT CHANGE IN BANKING

Although long-termism and the importance of human assets will not change in Japan, business relations with clients is now halfway through structural change. More and more Japanese companies above upper medium size do not need their main banks and are issuing bonds in capital markets, and traditional inter-dependence of stock shares of companies are on the decrease.

More and more foreign banks are doing business with Japanese companies. The US and UK banks are more aggressive in marketing innovative financial products which are appreciated by Japanese multi-nationals.

Overseas subsidiaries of Japanese manufacturing companies are replacing their Japanese expatriate treasurers by national staff. The Japanese practice of employing only Japanese people is no longer effective.

Banking is changing from an intermediary function between fund-provider and fund-taker to a more developed intermediary function providing information and other services. It is becoming far more important not just to be able to support clients' financial needs but also to assist in other ways to be able to compete effectively.

Today's international financial system is based on Anglo-Saxon culture. The jargon is all English and American, and British systems including finance mechanisms and accounting rules are commonly used in the world of international finance.

We are trying to harmonise the characteristics of Japanese management with the needs of the international financial system. We value customer base as a commercial bank, we do business as an investment bank, and we respect long-termism as a Japanese bank.

In this time of change, London is the most rewarding and exciting place to be in. The Lord Mayor has said that London is the financial capital of Europe and has more transaction volume than both New York and Tokyo combined according to the BIS survey.

I believe that London is becoming a worldwide financial centre rather than the European financial centre. Japanese institutions can learn lessons from their experience both in Japan and overseas. We need to change to compete but also to draw on traditional strengths to remain strong and effective.

PROGRESS IN COMPUTER-ASSISTED LEGAL SYSTEMS

The Foundation held a lecture and dinner discussion at the RAF Club on 1 November 1994 on the subject "Computers Assisting the Legal Systems – What Progress?" under the chairmanship of Lord Butterworth CBE DL. The speakers were The Rt Hon Lord Justice Neill, Mr Michael Huebner CB, Head of the Court Service, Lord Chancellor's Department, Mr Ken Olisa, Director, Interregnum Venture Marketing Ltd, and Professor Richard Susskind, Special Adviser in Law & Information Technology, Masons. The event was sponsored by Bluepoint Business Systems plc and Fairway Business Forms Ltd.

The Rt Hon Lord Justice Neill*

Summary
Many changes had taken place since the beginning of the 1950s. There had been a great increase not only in the volume of documents and of litigation. The speakers discussed the use of information technology to aid the legal process, both in the High Courts and the County Courts. Much had been achieved but even more far-reaching advances would undoubtedly be made.

INTRODUCTION

I had the privilege of addressing the Foundation in 1991 when I referred to the slow response of the legal world to the arrival of information technology. There has been considerable progress since, but I do not detect any general recognition of the fact that new methods of communication and new methods of storing information and of gaining access to it require us to look afresh at our system of justice and the ways in which the law is practised.

My approach to this evening's subject is that of someone who has had some nodding acquaintance with the courts for quite a long time and who believes firmly that information technology if properly used has much to offer us. In what I have to say I shall touch on video-links as well as computers.

RECENT CHANGES

Much has changed since the last War. When I began to practise the number of documents in a case were usually very few. Copies meant copy typing and the use of carbon paper which became increasingly inefficient as the copies multiplied; by about copy seven illegibility brought release – or more copy typing. Then the photocopier arrived. Today cases can involve thousands of documents and sometimes even millions. That is the source of one problem.

In the 1950s the Court of Appeal sat in three divisions. Today, if one includes the Criminal Division, there may be more than 10 Courts of Appeal sitting simultaneously producing judgments of authority. That is the source of another problem.

In the 1950s the number of different series of law reports was quite small. The Law Reports and the All England Reports and, from 1954, the Weekly Law Reports. In addition there were some specialist reports such as the Reports of Patent Cases and the Lloyds List Reports. I looked in the index to Current Law this morning and counted over 20 recognised series of reports. That is the source of a third problem.

In addition there has been a large increase in the volume of litigation. This too has brought its own problems.

However, in any discussion about the procedure of the courts it is necessary to bear in mind two important facts:

(a) most civil cases settle before trial; and

(b) the vast majority of both civil and criminal cases are fairly simple and do not involve much documentation; indeed many criminal cases lead to pleas of guilty and most civil cases are various species of debt collecting.

USE OF TECHNOLOGY

It follows therefore that one has to be careful to tailor the use of technology, which may be expensive, to the needs of particular classes of cases. It is in that context that I shall listen with interest to what Mr Huebner is going to say about the procedures for debt collecting in the county courts. You do not need a Rolls-Royce to haul a water cart.

On the other hand one must not overlook the needs both of the large case and of the very large case. The very long cases, which often have a number of parties, can take up a lot of judicial time and are expensive. Here in particular it should be possible to achieve substantial and perhaps dramatic reductions in the expenditure of time and money.

Let me take one example. Most business documents are produced today on word processors. In principle there is no reason why the parties should not produce an agreed disk which will contain the relevant documents. In court these documents can be viewed on screen and hard copies can be run off as required. We are moving in this direction and I am glad to say that a great deal of thought is being given to ways in which technology can be used to provide litigation support.

Let me say something about oral evidence. Here the practice of exchanging witnesses' statements before the trial has curtailed the need for a witness to give what is called his evidence in chief by means of question and answer in the witness box. The written

* *Chairman, Information Technology and the Courts*

statement can be used as such evidence unless the particular circumstances of the case otherwise require.

But we are beginning to realise that in appropriate cases evidence can be given more cheaply by a video link. Moreover in cases involving children video links may enable evidence to be given which otherwise would not be obtainable. It has been found that in some cases children are unable to talk in the intimidating surroundings of a court.

'For the moment the information superhighway for the law has some of the characteristics of a cart track'

Video links deserve a chapter of their own. They have many possible applications in the law. Let me take one example. Prisons tend to close their doors to visitors ar about the time that the courts rise. Some prisons are at a distance from centres of legal practice. The Home Office is co-operating with the profession in experiments for consultations by video link between persons in custody and their legal advisers. I believe that these experiments have attracted the interest of Members of Parliament.

I must return to the court room and computers. One of the less interesting collections in the Public Record Office is, I suspect, the collection of judges' notebooks. Until quite recently the notebooks of High Court judges were sent there for storage. They contain records of innumerable hours of judicial pen-pushing setting out, usually in paraphrases, the evidence of countless witnesses. I have never calculated the speed of the average pen in miles per hour but anyone who has been in court will have observed the extent to which the tempo of the trial depends on the flow of judicial ink. Here technology is coming to our aid. At present this technology is available just in the biggest and longest cases; systems such as LiveNote make transcription possible in what is called real time – in other words a contemporaneous record appears on screens in the courtroom within seconds of the words being spoken. The LiveNote system, which was used in the Scott inquiry and will be used, I gather, in the trial of Mr O J Simpson, has the added advantage that the judge can make notes in the transcript as it scrolls past him on his screen, and these notes can be used to form the basis for a judgment or a summing-up. In addition, if a suitable link is established, the evidence can be followed by someone who is far away from the courtroom.

There are more and perhaps bigger changes to come. Yesterday, through the courtesy of Prof Susskind, I was able to see a demonstration of the new IBM Personal Dictation system which transfers the spoken word directly on to the screen. Those like myself whose keyboard skills are unimpressive can look forward to the day when we can talk in ordinary speech directly to the screen.

I should also mention the help that is being provided for judges. Under an imaginative scheme called the Judith project a number of judges, including Circuit Judges and District Judges, have been issued with laptop computers. By the end of the year the number of judges in the scheme should be about 200. Some of these judges – about 20 – are skilled enough to use their computers in court for taking notes.

As Mr Huebner will tell you, computers are now being used to help with the listing of cases and soon this use will be extended to check the progress of cases before they come to trial. In addition, electronic links are being set up so that court lists and other information can be passed directly from computer to computer.

SLOWER PROGRESS

But there are areas where progress is worryingly slow.

The law which is applied in the courts is to be found in part in statutes, in part in statutory instruments and in regulations, in part in pronouncements from Brussels and Luxembourg, but also to a very significant extent in the decisions of the superior courts. It is perhaps an oddity that the State has never, as far as I know, accepted responsibility for disseminating any reports of judge-made law. There are of course the many series of reports produced by commercial organisations to which I referred earlier, but there is no central databank of appellate decisions to which the citizen or even the lawyer can obtain access.

It is difficult to think of any other field of activity where decisions are made which may have repercussions far beyond the confines of the particular case but which, unless picked up by some journalist or a law reporter, may disappear into the sand. And even if saved from oblivion they may not appear in any report for many weeks or even months.

In time, databanks will be set up and electronic publishing will give us convenient compact disks. For the moment the information superhighway for the law has some of the characteristics of a cart track.

Perhaps we need another Henry II. It is a little over 800 years since he died, a sad and lonely figure, at Chinon. But it may be that we can learn something from him. He had, I believe, a clear vision that one of the core-activities of the State should be the administration of justice and the provision of access to justice.

Mr Michael Huebner CB*

INTRODUCTION

Three years ago, I was present when my predecessor, Raymond Potter, gave an account of what we were doing in the Court Service to introduce Information Technology. It is a pleasure to be able to tell you about developments since then and where we hope to get to in the next three years.

The Lord Chancellor's wide responsibilities in the legal world mean that his Department has an interest in a great number of actual or potential developments in and around the court system. The challenge for IT in this environment is the dispersed nature of accountability between several ministers and any number of national and local agencies. Real progress has been made in recent years, particularly in the criminal field, laying the ground for well co-ordinated systems. But there remains a feeling, not entirely unjustifiably, that the pace of change has been relatively modest.

No doubt we shall be discussing some of the constraints that lie behind this in the course of the evening. Our own efforts in my Department have been concentrated to a considerable extent on the support processes for the courts themselves.

THE COUNTY COURTS

Let me start with the County Courts, where the greatest part of our resources are deployed. We have a twin track approach with both centralised and local systems. The first involves centralising those processes where advantages of scale have made the case for Information Technology unanswerable. In 1990 we introduced the Summons Production Centre, based at Northampton, for the printing and distribution of default summonses from plaintiffs who issue in bulk. This has proved to be highly

** Head of the Court Service, Lord Chancellor's Department*

successful, with some 1.2 million summonses being issued each year on behalf of 123 plaintiffs.

In order to take the majority of the basic debt collecting process out of the hands of local courts, this process has now been extended by establishing a County Court Bulk Centre, also at Northampton. Set up in 1992, the Centre processes work for bulk plaintiffs who are willing to issue proceedings through Northampton County Court. The Centre handles debt processes from the issue of a summons through to entry of judgment and, where appropriate, the issue of Warrants of Execution. The computer support system for the Centre was introduced at the beginning of this year, which provides case tracking and the printing of judgments and Warrants. It will also provide judgment information electronically to the Register of County Court Judgments. The work at the Centre continues to build up and we are expecting to process some 700,000 default cases this year, rising to over 1 million by the end of next year.

At the local level, the strategy is for the computerisation of those processes which must remain within individual County Courts. For many years, the County Courts had systems for processing suitors' cash and controlling warrants and we have now upgraded these systems. Links are also being established between these systems and the County Court Bulk Centre for the electronic transfer of information on warrants of execution. However, much more needs to be done to eliminate the old, paper based systems that are still operating. For this purpose a new Local County Court system, known as LOCCS, is now under development. We intend to develop the system incrementally by implementing one module at a time for each major function. The first of these modules has now been developed and holds case information currently held on the manual record card. The system tracks cases and produces orders with potential links to other systems within the Court and with the Summons Production Centre so that information can be transferred automatically to each Court. The system is currently being piloted at Edmonton County Court, where it has been well received by the staff.

'While the system is expensive to run, there is evidence that the Court time savings more than offset the costs'

Future modules could include support for family cases, listing, district registries, insolvency and general accounting and the transmission of judgments to Registry Trust. A further five systems, based on the Edmonton pilot, will be installed in the new year, one in each of the other Circuits. The main roll out programme is expected to start in the 1995/96 financial year, with the aim of installing systems in the large Courts first. The whole programme is a major logistical exercise which will take two years to complete.

All this work will provide a communications network between the Courts and the two centres at Northampton, which should facilitate in the longer term the transfer of case information between Courts, and the collection and uploading of management information for the Court Service HQ. It will also enable us to proceed with work on the next stage of the centralisation programme which is to process attachment of earnings payments centrally.

THE HIGH COURT

Turning to the High Court, we have recently installed a computer system in the Bankruptcy Court and a similar system will be introduced by the end of the year in Companies Court. There is an on-going programme of IT development work in the Supreme Court based mainly on small PC networks.

On the Criminal side of the business, the Crown Court Computer System (CREST) is now installed in all Crown Court centres. In addition to the computerised functions in the court centres, CREST will provide us with a platform for collecting and exchanging information between the various criminal justice agencies. An inter-departmental initiative known as the Co-ordination of Computerisation of the Criminal Justice System (or triple-CJS) has been established under the aegis of the Home Office. Standard codes and interface protocols have been developed for use in the various computer systems in the CJS. The first stages of this initiative involve linking the Magistrates Courts with DVLA and the provision of Crown Court lists electronically. This will be followed by links between CREST and the Crown Prosecution Service's system, SCOPE, as well as between CREST and the Magistrates Courts systems.

Links will also be established between other agencies such as the Probation Service, Prison Service and Police Services. As far as the Court Service is concerned, the first stage of this will be the introduction of electronic list distribution and we expect to have this service available next year. An interface is also being established between CREST and the Department's new Legal Aid Management Information System, which should be fully operational at the beginning of 1996.

COMPUTERS IN THE COURTROOM

Lord Justice Neill has already referred to the considerable interest over the last two years in the use of computers in the Courtroom. Two systems, one known as LiveNote and the other as Caseview, have been evaluated and both appear to provide savings in court time, particularly in large cases. The systems use on-line computer aided transcription with terminals available to the Judge and Counsel, who are able to see a rolling transcript of the case taking place before them. The systems also provide for annotations to be made to the transcript by the Judge and by Counsel without, of course, either party seeing what those annotations are!

'The limited availability of experienced operators will be a constraint on widespread use of the technology'

The process enables court cases to proceed at the normal pace instead of being delayed whilst the Judge maintains a handwritten note. Whilst the system is expensive to run, there is evidence that the Court time savings more than offset the costs. Just how great these savings may be and whether the systems will become economic for shorter cases are questions that need to be considered. So is the far from simple issue of who pays for it. We are currently formulating our policy on the use of such equipment and I intend that this should be published in the near future.

The success of this technology relies critically on the speed and accuracy of the operator and also on the resilience of the equipment itself. The limited availability of experienced operators will be a constraint on the widespread use of the technology.

Judges, of course, need to be computer-literate in order to get the most advantage out of these systems. Coincidentally, the Department has embarked on a programme of equipping Judges with computers and providing them with electronic mail and

bulletin board systems to assist in their work. By the end of this year, over 200 Judges will have been equipped with lap top computers with word processing and E-mail facilities. This program is seen essentially as an enabling project and should provide the basis of further facilities and functions to be made available to the Judges, for example the use of CD-ROM for legal texts.

STATUTE LAW DATABASE

Finally, perhaps I can mention the Statute Law Database. Work is continuing on the project even though there have been major delays caused mainly by the technical problems of integrating disparate software. However, the system is due to undergo User Acceptance Testing in November and if all goes well, the database will be charged in January 1995 with a view to completing the full editorial links within a year. For the first time, a full electronic database of UK statutes will be available. We do not of course see ourselves as electronic publishers, and would expect that the private sector would have an important role to play in distributing the database outside the Government service.

CONCLUSIONS

I have touched on a number of developments, most of them connected with the day to day work, and management, of the Court system. There are undoubtedly more spectacular and perhaps far-reaching advances to be made. However, as Head of the Court Service, I am anxious to ensure that, at what is inevitably a somewhat mundane level, we get it right for court staff, for the judges and for all those who come into contact with the courts.

MORE NEWS FROM THE FOUNDATION

A group being told about the vast engineering project at the Foundation's technology visit to the Glaxo Wellcome Medicines Research Centre at Stevenage.

Visit to Glaxo Wellcome Medicines Research Centre

On 22 June 1995 about 30 members of the Foundation were warmly received at the Research Centre by Sir Richard Sykes, Deputy Chairman and Chief Executive of Glaxo Wellcome plc, and a team who all made for the members an outstanding visit to this massive new centre for scientific research in Stevenage.

From a distance the Centre appears as a vast new town of modern and interesting design. In detail we discovered it to be a Centre which had been designed for efficient research with enormous service areas below the laboratories. The building design was considerate for the people working in them.

For example, there were central areas for refreshments where scientists of different disciplines and carrying out different research would be encouraged to meet and mix informally.

After introductory talks by Sir Richard Sykes, Dr Allan Baxter, UK Research Director, and Mr Ray Scherzer, Stevenage Project Manager, the visitors were split into three groups to visit the biology and the chemistry laboratories and the engineering plant.

Finally, there was a dinner, providing an opportunity for all to discuss what had been seen, and also to have a question and discussion session with Sir Richard Sykes and his team more formally over coffee under the chairmanship of Lord Butterworth.

The Foundation members felt honoured to have been among the first to have visited this centre for scientific research, an establishment of global importance.

PROFILES OF COUNCIL MEMBERS

Roger Davidson

Roger George Leith Davidson, Honorary Treasurer since the Foundation's AGM on 17 May 1995, retired from Shell in 1994. After graduating with a first class economics degree from the University of Aberdeen in 1963, Roger Davidson joined Shell – where he was to remain for 31 years.

Roger Davidson began his career with Shell as an economist in the Supply and Planning Function, but within a year found his interest had shifted to the finance side of the business and in 1964 joined the Treasury division of Group Finance. Here he worked on economic evaluations for investments, working as a support researcher investigating potential (friendly) acquisitions and agreed purchases for the directors. Though now the biggest organisation in its field, this was the decade in which Shell was really taking off and expanding rapidly. In spite of two years in the Treasury, what was really needed in a finance career was day-to-day financial experience, as most of those recruited into the Group Finance were not economists but accountants. So, between 1966 and 1968, Roger Davidson was sent to Borneo to work with exploration and production companies in Brunei, and a refining company in Sarawak, on "routine finance jobs". It was far from being a penance; he used this opportunity to trek through the jungle and even find time (and places) for his passion – golf.

On 1 August 1968, on the day that the new sultan was crowned, Roger Davidson and his wife left Brunei for home leave, with his next posting unknown. It was to be Thailand. Initially, he had responsibilities for Laos, which was administered from Bangkok. This involved standing in for the Resident Manager in Vientiane. In 1968 this was, in his own words, "not a relaxing time to be there"; the city was swamped with a big US presence for the Vietnam war. Later he became Finance Controller for Shell Thailand. Bangkok was, before the area became a holiday destination, "a tremendous place", Roger Davidson recollects, with all the material benefits of a European city, with the asset of a dazzling climate and, of course, golf!

In 1971, Roger Davidson spent time on a short assignment introducing graduates to the company in an initiative designed to "get on the same wavelength as the new questioning graduate intake". His role was to plan and run the courses, welcome and counsel the new recruits both Dutch and British.

Following this experience with the graduate recruits, Roger Davidson acted as a London-based support in the Middle East Regional organisation for Shell's activities in Oman and Libya, amongst others. In 1974, however, Roger Davidson muses, "not to get too comfortable", he was sent to Lagos, Nigeria, at short notice, the largest oil producing area by far. "People say 'awful place' but it is far from it," explains Roger Davidson. "The community is vibrant, I made and stayed friends with many Nigerians, and then there was the golf!"

For Roger, a posting to Borneo was far from being a penance; he used the opportunity to trek through the jungle and even find time (and places) for his passion – golf

Roger Davidson, Honorary Treasurer

In 1976 Roger Davidson moved to Shell UK, a new company being set up to integrate Shell's activities in the UK and was given the task of masterminding the setting up of the first Shell UK Treasury. This was the North Sea boom time after the first oil shock in 1973. He chose first line people, and, in four years from starting with nothing, the expansion was huge and, just as Roger Davidson was enjoying it, it was time to move on again, (and up!).

After the second "Oil Shock" in 1979, in which Western Europe took the brunt of the economic effect, Shell Chemicals UK, between 1981 and 1985, were involved in extensive rationalisation and "belt-tightening". Roger Davidson replaced both the Finance Director and the Personnel Director, combining the posts and inheriting staff from all over England; "Head Office was in London and the staff everywhere."

Between 1985 and 1988, Roger Davidson held the post of Director, Business Development (including Finance and Planning and Public Affairs) of Shell Coal International Ltd, being involved with many organisations overseas, from the Appalacian Mountains to The Hunter Valley. From the United States to Australia and South Africa.

In 1988 Roger Davidson "moved back" to the Middle East as Area Co-ordinator, for Shell International, London, with shareholder responsibility for Shell's interests in joint ventures with governments in a number of countries: principally Abu Dhabi, Qatar, Egypt and Oman. In spite of this post involving a lot of travel, at least once a month from the Head Office in London, Roger Davidson also had "a second job": Regional Finance

Adviser, responsible for 40 countries in all, in the Middle East, North Africa and South Asia. Although, he says, with "a good team of first lieutenants", Roger Davidson "let others do the travelling" for this latter portfolio.

For his final four years with Shell, Roger Davidson was Head of Finance (including IT) and Business Planning, Shell International Chemical Company Ltd, in London, at the time of yet more European restructuring.

In spite of global commuting with Shell, Roger Davidson has found time, over the years, to be a non-executive Director of a number of companies, including: Price's Patent Candle Co. Ltd, Ward Blenkinsop Ltd and Synthetic Chemicals Ltd, Birtley Engineering Ltd, Massey Coal Corporation US, Abu Dhabi Petroleum Co. Ltd, Abu Dhabi Gas Industries Ltd and last, but by no means least, Director for ten years from 1980 of the West Surrey Golf Club, of which he was latterly chairman.

Craig Henderson, who is General Manager, Commercial Coordination, Shell Centre, London, recalls: "Roger Davidson is very precise in the use of the English Language and keen to see exact and clear communication. He and a colleague had a bet on what the price of oil would be on a particular day. The loser was to provide the winner with a bottle of whisky. Roger lost. A few days later the winner received a large attractively wrapped parcel which he anticipated being his winnings. On opening the parcel he found a miniature. In making his point Roger may have been influenced by his Aberdeen ancestry in using a 'miniature' rather than a 'magnum'".

'Roger Davidson is very precise in the use of the English Language and keen to see exact and clear communication'

– CRAIG HENDERSON, Shell

Transport and the Environment

LECTURE AND DINNER DISCUSSION AT THE ROYAL SOCIETY

Sir John Houghton, Chairman of the Royal Commission on Environmental Pollution, in discussion with Mr Derek Osborn, Deputy Secretary, Department of the Environment, during the evening.

Professor Keith Bardon, Dean of the School of Natural Sciences at the University of Hertfordshire, with Baroness Platt of Writtle at the meeting.

.

SPONSORED LECTURES, LEARNED SOCIETY SEMINARS AND FOUNDATION VISITS

1 JANUARY 1995 – 31 JULY 1995

LECTURE TITLES	SPEAKERS	SPONSORED BY
"Transport and the Environment in the Light of the Royal Commission's Report"	Sir John Houghton CBE FRS Professor T M Ridley CBE FEng Professor Peter Hills OBE Mr David Rowlands CB	Brown & Root Ltd Department of Transport Railtrack plc University of Hertfordshire
Zuckerman Lecture — "Strategic Directions of French Research Policy"	Monsieur François Fillon	Amersham International plc AEA Technology Generale Des Eaux UK Rhone-Poulenc Ltd
"Women in Science, Engineering & Technology – The Opportunities"	The Rt Hon David Hunt MBE MP Mrs Lynda Sharp Mrs Marie-Noelle Barton Mrs Betty Barratt Dr Bridget Ogilvie	The Engineering Council Glaxo Wellcome plc Office of Science and Technology
"Achieving and Keeping World Class Industrial Success – the Real Challenge"	Mr Alec Daly CBE Mr Dick Seymour Mr Bernard Preston	Coopers & Lybrand Department of Trade and Industry KPMG
"Today's Challenges for National Laboratories"	Dr David Clark Dr Brian Eyre CBE FEng Sir William Stewart FRS FRSE	Department of Trade and Industry Health & Safety Executive Ministry of Agriculture, Fisheries and Food
"Realising our Potential: Can it be Done Without the Social Sciences?"	Dr Geoffrey Robinson Mr John Breckenridge	Economic and Social Research Council South Bank University
"Is There a Need For a National Digital Archive?"	Sir Anthony Kenny FBA Sir Roger Elliott FRS Dr Graham Cameron	Ordnance Survey Unilever plc Foundation's Shared Sponsorship Scheme
"The Information Age – a Global Debate"	BY SATELLITE: Deputy Secretary David Barram Dr Arthur C Clarke CBE OTHERS: Mr Martin Bangemann Mr Malcolm Laws	British Telecommunications plc Mercury Communications Ltd Foundation's Shared Sponsorship Scheme
"Science, Engineering and Technology. A Focus on the Future"	Sir William Stewart FRS FRSE Dr K W Gray	Zeneca Group plc
"One Year into the Reorganised Research Councils"	Professor J R Krebs FRS Professor Tom Blundell FRS Sir Geoffrey Allen FEng FRS	Biotechnology & Biological Sciences Research Council British Telecommunications plc Cookson Group plc Metropolitan Police Forensic Science Laboratory Oxford Instruments plc
"Beyond the Information Superhighway – Living in the Information Age"	Mr Don Taylor Mr John Browning Mr David Roffey	The Oracle Corporation

FOUNDATION TECHNOLOGY VISITS

"Hands on Medium-Range Weather Forecasting" – Visit to the European Centre for Medium-Range Weather Forecasting – Sponsored by Cray Research (UK) Ltd

"A New Research Centre for Britain" – Visit to the Glaxo Wellcome Medicines Research Centre

SEMINARS FOR LEARNED SOCIETIES

SORP 2 & Parallel Regulations – The Near Final Drafts

Information Networking and Learned Societies – Present & Future

Appraisals & Staff Development

CD-Roms & Learned Societies

Lifecycle of an Employee of a Learned Society

VAT 1995

ASSOCIATE MEMBERS & MAJOR DONORS

Whose support of, and involvement in, the affairs
of the Foundation is gratefully acknowledged

1 AUGUST 1995

3i plc
Aberdeen University
Advisory Services (Clinical & General) Ltd
AEA Technology
AIRTO
Allied London Properties plc
Allied Domecq plc
Aluminium Federation
Arab-British Chamber of Commerce
Aerial Group Limited
Aston University
Bank of England
Bechtel Limited
BIOSIS UK
Birmingham University
Biwater Limited
Blake Resource Development
Boots Company plc
British Aerospace plc
British Airways
British Antarctic Survey
British Bio-technology Group plc
British Council
British Gas plc
British Library
British Maritime Technology
British Nuclear Fuels plc
British Petroleum Company plc
British Technology Group
British Telecommunications plc
Brown & Root (UK) Limited
Brownell Limited
CAMPUS
CBI
CEST
CIRIA
Cambridge Consultants Limited
Cambridge Refrigeration Technology
Cambridge University
Campden & Chorleywood Food Research Association
Chameleon Press Limited
Channel Tunnel Group Limited
City Technology Colleges Trust
City University
Civil Aviation Authority
Comino Foundation
Conoco (UK) Limited
Cookson plc
Coopers & Lybrand
Council for Industry & Higher Education
Cranfield University of Technology
David Leon Partnership
De Montfort University
Department for Education
Department of Health
Department of the Environment
Department of Trade & Industry
Department of Transport
Director General Research Councils
Du Pont (UK) Limited
Dundee University
EA Technology
East Anglia University
Edinburgh University
elf
Esso UK plc
Ford Motor Company Ltd
Fraser & Russell
General Electric Company plc
General Utilities plc
Glaxo Wellcome plc
Graduate School of the Environment
Greenwich University
H J Heinz Company Limited
Heads of University Biological Sciences
Health & Safety Executive
Hertfordshire University
Hinckley Group
Hitachi Europe Ltd
House of Commons Library
Hull University
IBM United Kingdom Limited
Imperial Cancer Research Fund
Imperial Chemical Industries plc
Imperial College
ISIS Electronics
John Brown plc
Jones Associates
Johnson Matthey plc
Jones & Shipman plc
KPMG
Keele University
Kent University
Kesslers Manufacturing
Kings College London
Kobe Steel Ltd/Kobe Steel Europe Ltd
Kvaerner Enviropower Ltd
Laing Technology Group
Leeds University
Leicester University
Liverpool University
Lloyd's Register of Shipping
London Guildhall University
Loughborough University of Technology
Lucas Industries plc
Luton University
Machine Tool Technologies Association
Major Energy Users' Council
Management Technology Associates
Manchester Metropolitan University
Merck Sharp & Dohme
Mercury Communications Ltd
METCOM
Meteorological Office
Metropolitan Police Forensic Science Laboratory
Middlesex University
Ministry of Agriculture, Fisheries & Food
Ministry of Defence
Mitsui & Co UK plc
National Grid Company plc
National Power plc
National Westminster Bank plc
Natural History Museum
Needham & James
New Law Publishing Co plc
New Product Research & Development
Newcastle University
Northern Telecom Europe Ltd
Nottingham Trent University
Nuclear Electric plc
Office of Science & Technology
Oracle Corporation UK Ltd
Ordnance Survey
Ove Arup Partnership
Oxford University
Parliamentary Office of Science & Technology
Perkins Technology Ltd
Pfizer Central Research
Post Office
Praxis plc
Premmit Engineering Services Ltd
ProMicro Limited
Public Record Office
Queen Mary College
RHM Research & Engineering Ltd
Railtrack plc
Reading University
RINGI Ltd
Roche Products Ltd
Rolls-Royce Power Engineering plc
Rossmore Resources Ltd
Rothschild Ventures Ltd
Rover Group Ltd
Royal Botanic Gardens, Kew
Royal Commission for the Exhibition of 1851
Royal Commission on Environmental Pollution
Royal Holloway & Bedford New College
Science Connections Ltd
Science Policy Research Unit
Science Policy Support Group
Science Systems Limited
Scottish Higher Education Funding Council
Scottish Nuclear Ltd
Segal Quince Wicksteed Ltd
Serco Space Limited
Sharp Laboratories of Europe Ltd
Sheffield University
Smith System Engineering Limited
Software Production Enterprises
Southampton University
South Bank University
Staffordshire University
Strategy International Ltd
Sunderland University
Surrey University
Sussex University
T & N Technology Limited
Teesside University
Technology Transfer Ltd
Thames Water Utilities Ltd
The British Academy
The Engineering Council
The Royal Academy of Engineering
The Royal Society
The Smallpeice Trust
Thorn EMI/CRL
Trade Association Management Ltd
UK Council for Graduate Education
UK Nirex Limited
UMIST
University College London
Unisys
United Biscuits (UK) Limited
University of Buckingham
Vision Centres Consulting Group
WRc plc
Warwick University
Westport Energy Corporation
Winsafe Ltd
WIRE Ltd
Wolverhampton University
WS Atkins Consultants Ltd
Zeneca plc

Foundation for Science and Technology
Buckingham Court
78 Buckingham Gate
London SW1E 6PE
0171-222-1222