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TECHNOLOGY, INNOVATION AND SOCIETY

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NORTHERN IRELAND'S SCIENCE BASE FOR FUTURE ECONOMIC REGENERATION

The Foundation held a lecture and dinner discussion at the University of Ulster, Coleraine Campus, on 24 February 1999. It was sponsored by the Industrial Research & Technology Unit, Perfeceal Inc. The Rt Hon The Lord Jenkin of Roding was in the chair and the speakers were Mr William J Todd, President, Georgia Research Alliance, USA, Sir Roy McNulty CBE, Former Chairman, Northern Ireland Growth Challenge, and Chairman, Short Brothers plc, and Sir Kenneth Bloomfield KCB, Chairman, Northern Ireland Higher Education Funding Council.

Mr William J Todd*

Summary: Mr Todd described how Georgia had created a robust technology-based economy from an area devastated by violence. He strongly believed Northern Ireland could do the same. He offered an opportunity in semiconductor design. Sir Kenneth Bloomfeld described the contributions made by Northern Ireland's, institutions of higher education and the opportunities they had, and could, offer to industry

Introduction

If a place in the American South called Georgia can create a robust technology-based economy as a matter of civic will, then surely this proud land can do likewise. My message to you this evening is this: Northern Ireland can realistically aspire to create a technology-driven economy and should do so with enthusiasm and all deliberate speed. You can and you should.

There are three reasons why I believe that you can and you should:

- Northern Ireland has the strongest of motivations to be successful – peace.
- Northern Ireland has the assets to develop and leverage its universities and its people. If we can do it you can do it!
- Northern Ireland has the model for success – for I plan to present it to you as my gift to this special place, the homeland of my forefathers.

Comparison with Georgia

Let's look at each of these points in relation to how we did it in Georgia.

First, Northern Ireland has the strongest of motivations to be successful – peace.

Georgia, like Ireland, was devastated by violence. The capital city was burned to the ground, and the state languished behind the rest of the nation economically and educationally for generations.

In the 1950s and 1960s great upheavals of social change and integration truly opened the door for improvement. Only with social peace did the Georgia economy begin to perform at national standards and only last year did per capita income pass the national average after languishing near the bottom for generations. It was only with peace that we could grow and so can you.

Second, Northern Ireland has the assets to develop and leverage its universities and its people. You have two great universities ... You have business that is interested in growth and you have a government that wants to succeed. And that's what it takes to succeed – a marriage of business, academia and government working together.

Background to Georgia Research Alliance

The Georgia Research Alliance was created in 1990 by the business leadership. The goal has always been to develop and manage a twenty-year strategy to take Georgia from the middle of the pack of the fifty states to the top tier economically. The goal was for our universities to be developed into powerful engines of economic growth. The goal was to create a consortium in which public and private investment could be directed to projects showing a high probability of commercialization. A vast research enterprise could be created to lead Georgia's economy.

Since 1990 the state of Georgia has invested $200 million in the Georgia Research Alliance, matched with $50 million in private funds. Together, this investment has generated another $500 million of federal funds competitively awarded on a peer reviewed, merit basis. This overall portfolio of three-quarters of a billion dollars has fuelled much of the technology growth we are experiencing in Georgia. There is clearly a cause-and-effect phenomenon at work.

During the 1990s our research universities have doubled their sponsored research funding to nearly $1 billion per year. Correspondingly, patent awards have doubled, venture capital has tripled and industry-university relationships have quadrupled.

These favourable growth rates in the technology sector have been the result of general economic growth in Atlanta and Georgia, plus a clear and deliberate strategy conceived and implemented by the leadership in business, academia and state government.

Today Georgia ranks in tenth position of states with a technology-based economy. We are at the halfway point of the 20-year vision. We aspire to be among the top five by 2010. This is an audacious but realistic goal. There is absolutely no way that we could have made this much progress, or to realistically strive for top five position, without a clear strategy and the collective will of the three key sectors.

An example and the lessons for N I

Let me share a story that brings this strategy to life, a story that is a case study of how the process works and how we are achieving success.

In 1992 the Georgia Research Alliance funded an endowed chair at the Georgia Institute of Technology in electrical engineering to focus on the issue of high-performance/low-cost electronic packaging. We saw great promise in this area, and sought for Georgia to be a player in the field of designing the next generation of semiconductors, ten times faster and ten times cheaper. This is an order of magnitude of improvement.

We were able to attract great interest in this recruitment, based on the offer of a distinguished university chair and the commitment of a state-of-the-art laboratory and the best equipment and

** President, Georgia Research Alliance, USA.*

instrumentation. The winning candidate was an IBM fellow at corporate headquarters in New York. He came to Atlanta, along with his 57 patents and his team, and within nine months had successfully competed for a $37 million grant from the National Science Foundation and a consortium of electronics firms. Today Atlanta is a leading international centre for electronic packaging research and development, and on the verge of becoming a major employment centre for semiconductor design.

There are two lessons from this story about a victory: (1) it was the result of achieving pre-eminence in university research, focused on the needs of industry and led by a world-class scholar, and (2) it is part of a larger economic growth strategy.

Northern Ireland has the model for success. I believe that this same strategy will work here in Northern Ireland the way it works in Georgia. It requires a rock-solid belief by all parties in the consortium that research universities can be powerful engines of economic growth.

There would be no Silicon Valley without Stanford University, nor any Route 128 in Boston without MIT. Georgia is certainly not Silicon Valley, nor Route 128 in Boston, but its technology sector has seen a frenetic growth curve since 1990. High-tech jobs have doubled from 80,000 to 160,000 during the period, the number one rate of growth among the fifty states.

Atlanta is certainly not San Francisco, where the Internet fires are raging and fantastic wealth is being created. In fact, prior to the 1996 Centennial Olympic Games many European businessmen had no clear impression of Atlanta, even confusing it with Atlantic City as a Mecca for gambling. Today, however, Atlanta is consistently ranked number one by *FORTUNE* magazine as the best city for doing business in the United States.

It is not automatic, however, nor particularly easy to harness this energy and direct it towards solid economic growth. It requires strategy and commitment.

The strategy

The strategy can be distilled down to its most elemental form as follows: public and private funds can be invested in research universities to cause jobs to be created *de novo*, jobs to be attracted from somewhere else, and jobs to be saved through an introduction of technology into traditional industries. Other issues must certainly be addressed, such as the presence of venture capital and the proper regulatory environment. But the most critical ingredient in the formula, the independent variable, is the presence of world-class, leading-edge, industry-oriented research.

The Georgia Research Alliance is focused on three areas of technology – advanced telecommunications, environmental technologies and biotechnology.

Eminent research scholars have been recruited in each of these areas, some thirty in all so far, and centres of excellence have been developed. One such initiative holds particular promise for collaboration with colleagues here in Northern Ireland and I have had fruitful discussions with new friends here over the last several days. I am most encouraged by what I see and hear.

A new initiative

This new initiative is in the area of semiconductor design, for microchips used in broadband communications, content manipulation and optical networks. Throughout most of 1998 we worked with a prominent California technology company in a highly confidential planning effort to create a new industry cluster in Georgia. It was code-named "Project Yamacraw" and since it has been announced publicly is called The Yamacraw Mission. Yamacraw is a wholly appropriate name for it is the American Indian word which identified the place where General James Oglethorpe first landed to found the new colony of Georgia. This is a new industry and a new beginning for our economy.

Our ability to succeed is dependent on our ability to find enough talented design engineers to create a new cluster. We have significantly re-engineered the curriculum in our universities to meet this need and see many opportunities to partner with local affiliates here in Northern Ireland. It is indeed promising.

Northern Ireland can realistically aspire to create a technology-driven economy and should do so with enthusiasm and all deliberate speed.

You have the assets to be developed and leveraged – your universities and your people. Like Georgia, you have strongest of motivations to be successful – peace. You have the model for success.

Sir Kenneth Bloomfield KCB*

Introduction

As Chairman of NIHEC my theme will be the contribution which our institutions of higher education have made and can make towards the economic regeneration of Northern Ireland, in addition to their already noteworthy contribution to world class research as measured by successive Research Assessment Exercises.

I have, as it happens, sat on both sides of that fence which divides academia and the business world. From 1960 to 1963 I headed the Ministry of Commerce's search for inward investment from North America, gaining in the process some insight into the factors which influence major companies in the investment decisions they take. Thereafter for a number of years I was diverted into other areas of government, before returning to the Department of Commerce in 1981, in time to be involved in the creation of the new Department of Economic Development and the formation of the Industrial Development Board. And, of course, as Head of the Northern Ireland Civil Service from 1984 to 1991, I was conscious that "strengthening the local economy" occupies at all times a very high place amongst our public expenditure priorities; and those priorities, as a (hopefully) incoming Northern Ireland administration will find, are one of the principal instruments of public policy.

Issues of economic development

I drew a number of conclusions from these separate periods of exposure to the issues of economic development.

One was to be deeply suspicious of any arbitrary division of departments of government into the "economic" or "social" or "environmental" categories. In particular, I came to the firm conclusion that the Department of Education must be regarded as an economic player of primary importance.

▲ *The Rt Hon Lord Jenkin of Roding (right) who chaired the Foundation's event with the University of Ulster is seen here with the three speakers. From the left, Mr William J Todd, President of the Georgia Research Alliance, USA, Sir Roy McNulty CBE, Chairman of Short Brothers plc, and Sir Kenneth Bloomfield KCB, Chairman of the Northern Ireland Higher Education Council.*

* *Chairman, Northern Ireland Higher Education Funding Council*

Second, I came to the view that the grant and loan assistance offered by government for new projects was the icing on the cake and not the cake itself; that if any area, and specifically Northern Ireland, could not match some basic requirements of a forward-looking industry, those deficiencies could not be counterbalanced indefinitely by barrow-loads of pound notes.

Third, I could see the danger of exposing Northern Ireland to the risk of developing too many industrial projects with relatively shallow roots, where the driving force of an enterprise was located elsewhere.

As Chairman of NIHEC I have, of course, moved much closer to some of these issues. It is striking, I think, that when Stephen Byers spoke at the Mansion House on 2 February of this year, three of his principal themes as Secretary of State for Trade and Industry were

- preparing for the knowledge-driven economy:
- the importance of preserving world-class science in the United Kingdom; and
- the challenge of overcoming the shortage of people with up-to-date engineering, electronic and leading-edge technology skills.

How do we in Northern Ireland shape up in terms of such an agenda?

How does N I fit the agenda?

First of all, we must appreciate that our two local universities constitute a very large part of the science base of the Northern Ireland economy. Northern Ireland lags far behind the United Kingdom norm in terms of investment of its GDP in research and development (0.6% as against 1.7%). Furthermore, it relies much more than the nation at large upon its universities for that relatively modest R&D effort. Yet modern industries such as Seagate, which has made a major investment here, lay a great emphasis upon employing graduates who are familiar with research and development activity. Thus, the role of our universities in providing graduates in science, engineering, business and management is crucial to inward investment and to our future growth.

The pursuit of excellence

It is, of course, vital that the quest for excellence should be at the forefront in our research efforts as well as providing the capability to meet our regional needs. Research of true excellence reaps a multiple award. It earns enhanced core funding driven by quality, based on the periodic Research Assessment Exercise; it greatly enhances the prospect of external income from other sources, such as project funding from the Research Councils and contract research; it attracts the highest quality academic practitioners; it enhances the status of the discipline and retains the best local talent; and it often spins off into improvements in the quality of life of importance to the local community.

I am sure you will all recall that the Dearing Report laid great emphasis upon the impact of higher education on regional development within the United Kingdom. If you look at a map of Great Britain you will see how many of the great conurbations are in close proximity to a whole range of higher education institutions. The Northern Ireland economy can, and should, look for R&D support to institutions in Great Britain, the Republic of Ireland or elsewhere. Nevertheless, I am convinced that local access to R&D through the intimacy of close co-operation and mutual understanding leads to a synergy between the academic and the business players which is best suited to the needs of a largely SME-based economy.

Let's have a look now at how a number of areas of science and technology have been assessed for excellence.

First, the good news. The general movement between the last two Research Assessment Exercises has been upwards. Both the quality and the volume of total research has been moving in the right direction. (See Table 1) It is particularly noteworthy that two disciplines of great importance for the future development of the local and national economies achieved ratings indicating the highest standard of international excellence:- Biomedical Sciences at the University of Ulster and Mechanical, Aeronautical and Manufacturing Engineering at The Queen's University of Belfast. Behind these general improvements and specific successes lay, amongst other factors, the recruitment of some very high calibre scholars and researchers from Great Britain and the United States of America.

Reservations and qualifications

Next, though, the reservations and qualifications. While the Northern Ireland universities have moved ahead, so has the whole flotilla of UK institutions. Our two universities have made some modest but useful ground in qualifying for core funding based on quality, but not enough to make up in full a "funding gap" previously filled by the local developmental funding mechanism NIDevR which was substantially reduced in the 1996 Public Expenditure Survey. My Council has argued strongly with government, and will continue to argue with those who may have responsibility for these matters in the future, for the restoration of a more realistic level of institutional research funding. For without adequate recurrent funding of the research infrastructure the local institutions could be grievously handicapped in competing for new "pots" of money becoming available nationally for specific purposes.

As we continue to mount this argument, it is important to be able to demonstrate to whomsoever may be in authority that university research is not an arcane mystery propagated in an ivory tower but a highly relevant economic activity. So I now want to give some evidence of the extent and relevance of applied research and technology transfer. For example, I will show you a number of university-based research centres established to support the needs of industry. These developments underline the commitment of our two local universities to technology and knowledge transfer for the benefit of society.

I must point out the outstanding success of our universities in

Research Assessment Exercises

University	*Unit of Assessment*	*1992 Rating*	*1996 Rating*
QUB	Biological Sciences	3	3a
QUB	Food & Science Technology	3	4
QUB	Computer Science	3	4
QUB	Electrical and Electronic Engineering	5	5
QUB	Mechanical, Aeronautical & Manufacturing Engineering	3	5*
UU	Biomedical Sciences	4	5*
UU	Computer Science	3	3a
UU	Metallurgy & Materials	3	3a
UU	Built Environment	4	4

▲ *Table 1.*

supporting the Teaching Company Scheme which places graduates in industry to help solve company-specific problems. Both QUB and UU are ranked in the first three in the United Kingdom as measured by income of currently-operating Teaching Company Scheme programmes. It is also worth noting that last year the Schools of Chemical Engineering and Mechanical and Manufacturing Engineering at Queen's – together with Wilsanco Plastics Ltd, Dungannon – won the first National Award for the Best TCS Programme in Engineering with an SME.

Aid for industry

Of course, as we all know, most of the firms in the Northern Ireland economy are small- to medium-sized enterprises (SMEs). It is therefore very relevant that our two universities are partners with the Industrial Research and Technology Unit (IRTU) of the Department of Economic Development and Loughrey College, Cookstown, in the Manufacturing Technology Partnership, which is specifically designed to give SMEs access to university research facilities and expertise.

Then there is the very substantial number of applied research centres designed specifically to meet the needs of Northern Ireland industry.

There are centres operated jointly by the two universities including:-

- Northern Ireland Centre for Advanced Materials (NICAM)
- Centre for Innovation in Biotechnology (CIB)
- Biomedical and Biosensor (BEST) Centre
- Northern Ireland Centre for Health Care Informatics (NICHI)

In addition, there are many ce ntres ope rated by UU alone (see Table 2) and centres operated by QUB alone (see Table 3).

Technology Transfer

Both universities have also been actively involved in technology transfer through patenting/licensing agreements and the formation of spin-out companies. QUB established its Technology Transfer Company, QUBIS, in 1984, while the University of Ulster established UUTECH in 1997 for similar purposes.

Examples of the successes of QUBIS, which has so far invested in 19 spin-out companies, include Andor Technology Ltd, Kainos Software Ltd and Audio Processing Technology Ltd. Other companies with origins in that university include Randox Laboratories and Besco Technologies plc.

University of Ulster applied research centres include:

Northern Ireland Centre for Diet & Health (NICHE)
Northern Ireland Centre for Energy Research Technology (NICERT)
Northern Ireland Knowledge Engineering Laboratory (NIKEL)
Northern Ireland Bioengineering Centre (NIBEC)
Engineering Composites Research Centre
Northern Ireland Centre for Sustainable Technologies (NIST)
Fire Safety Engineering Centre (FireSERT)

▲ *Table 2.*

Queen's University applied research centres include:

The Centre for Supercomputing in Ireland
Industrial Process Control Laboratory
Digital Signal Processing Laboratories
Microwave and Millimetre Wave Centre
Queen's University Environmental Science and Technology Research (QUESTOR) Centre
Polymer Processing Research Centre
Northern Ireland Economic Research Centre
Pharmaceutical Formulation Research Centre
Custom Chemical Synthesis and Process Development Research Centre

▲ *Table 3.*

Within a relatively short period, UUTECH is already responsible for over 20 patents and licensing/joint venture agreements. Four new companies have spun out in the past year, and over 10 proposed company business plans are currently under consideration. UUTECH is establishing high technology incubator facilities at each of its major campuses, based on campus-specific research strength, with Coleraine majoring on the life and health technologies, Magee on software and Jordanstown on engineering and other aspects of informatics.

The two Northern Ireland universities are to be key players and stakeholders in the implementation of the Northern Ireland Science Park Initiative, building on internationally recognised research strengths in areas which are illustrated in Table 4. The maintenance of the strong research base in the universities will be crucial to the success of the Science Park Initiative.

Northern Ireland Universities' Research Strengths include:

Electrical and Electronic Engineering
Biotechnology and Biomedical Sciences
Physics
Computing Science
Metallurgy and Materials
Built Environment
Aeronautical Engineering

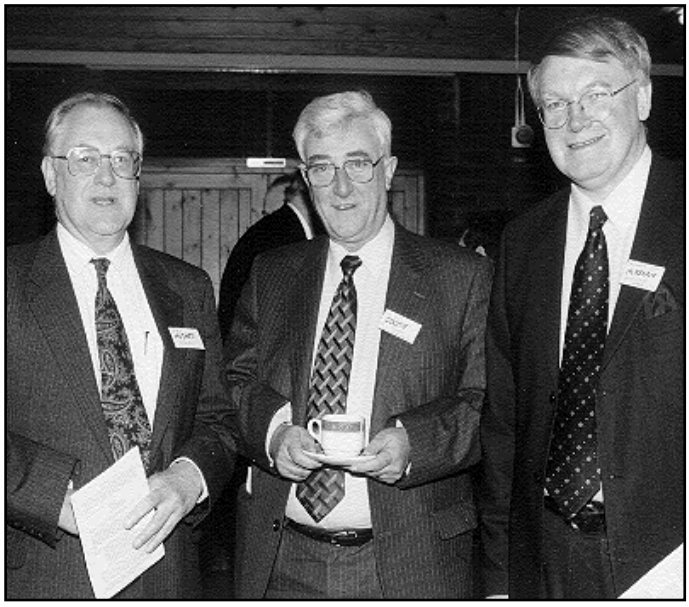
▲ *Table 4.*

Conclusions

Let us remember that research-led teaching is essential to provide the high-quality graduates required by Northern Ireland industry, and to support inward investment by high-technology companies.

It also provides the flow of motivated postgraduates and researchers, which is a pre-requisite for successful university research.

I believe I have said enough to indicate that this whole community has a deep interest in ensuring that our two universities, not least in the areas of science and technology, match the best national and, within reasonable limits, the best international standards. We are heading inexorably into a knowledge-based world where geographical peripherality is no longer a disadvantage. In Northern Ireland, we must ensure that our science and technology base is well equipped to meet the challenges, and take advantage of the opportunities, of the next millennium.



▲ *Professor Gerry McKenna (right) who invited the Foundation to hold the event at the University of Ulster, is Pro-Vice-Chancellor at the University. He is seen here with Mr John Coote and, on the left, with Dr Tony Hughes, both of the Northern Ireland Higher Education Council.*

THE FUTURE OF DISTANCE LEARNING

The Foundation held a lecture and dinner discussion at the Royal Society on 27 January 1999 on the subject "Distance Learning – can it effectively deliver to industry and business". The Rt Hon The Lord Jenkin of Roding was in the chair and the evening was sponsored by The Engineering and Marine Training Authority. The speakers were Dr Geraldine Kenney-Wallace FRSC, Managing Director & Vice-Chancellor, and Mr Simon Howison, FRAeS, FIEE, Director and Dean Faculty of Engineering & Manufacturing Technology, British Aerospace Virtual University, Professor Brian Spender CMG, Chief Executive, Higher Education Funding Council for England, Mr John Gray, Principal, Newark & Sherwood College, and Dr Anne Wright CBE, Chief Executive, The University for Industry.

Dr Geraldine Kenney-Wallace, FRSC* and Mr Simon Howison FRAeS, FIEE†

Summary: Dr Kenney-Wallace outlined the strategy on distance learning taken by British Aerospace and, from examples, suggested that a more effective learning strategy was one that combined distance and proximity approaches. Mr Gray discussed the role of colleges which, he said, should see the University for Industry initiative as their opportunity to develop new approaches to their lifelong learning support role. Dr Wright believed that distance learning for business, especially small companies, could provide a new solution to old problems such as lack of good information, courses at the wrong times, in the wrong place, too costly or not relevant.

Introduction

In the past twenty years, the evolution of "distance education" into "distance learning" in many countries has been visibly accelerated by technological breakthroughs, by demands for broader access to education driven by public policy, and by an increasing awareness of both the richness and complexity of modes of learning in a cognitive sense. More recently, a sense of urgency and concern about the preparedness of the workforce for 21st century reality, employability and workplace demands has emerged, as globalisation and technology have enhanced the competitive stakes and shifted the critical focus onto the effectiveness and efficiency of operations, be they in the public or private sector.

Thus distance learning has become a solution to meet particular needs for the education, training and professional development of the workforce within the workplace, unconstrained by geography or the time of day, but not by costs. Is distance learning the only solution? Can it effectively deliver to industry and business?

We will briefly outline the strategy taken by British Aerospace and then illustrate, through particular examples in systems and design engineering, that a more effective learning strategy is one that combines distance and proximity, blending the discipline of self-based learning with the knowledge and experience gained, shared and applied from group interactions. The latter are most valuable when focused on complex, interdisciplinary and business-based problems, with insight and ideas drawn from people with different business and academic experience.

Why distance learning?

Aerospace and Defence is a technology-intensive and knowledge-driven global business sector, increasingly shaped by information and communication technologies, and by customer demands for systems and systems-of-systems to be the integrated, cost-effective solution. Furthermore, the product lifecycle of a typical aeroplane is now approaching 40 years, placing major demands on smart maintenance and the periodic upgrading of technology. The importance of systems integration is not only as an engineering discipline but also as a global mind-set, an attitudinal shift, which links design to service throughout the product's development and its operations, and after sales service.

British Aerospace is an aerospace and systems company and with 89% overseas sales is UK's largest exporter to 70 customer countries. Sales exceeded $8.6 billion in 1998 with an order book of over £27 billion and some 20 major international partnerships: we are involved in over 50 major high technology aerospace and defence programmes world-wide. The company is the largest aerospace company in Europe, the fourth largest in the world (at time of writing), with over 46,000 employees. Distance learning offered an access route for our employees towards building their new individual competencies, and thus the overall company capabilities, to meet formidable challenges in the delivering of the design, engineers, manufacturing and business processes.

At the time of writing, British Aerospace and GEC Marconi Electronics Systems (MES) have signed the £7.4 billion MES merger, announced in January 1999, which will lead to a truly global company of about 100,000 people across several continents.

In the new electronic world, over 100 million people are currently using the Internet as a global library, research database and for marketing and commerce. However, just joining the Information Super Highway is not enough. A learning and technology strategy is needed to ensure that the investment in learning and research are aligned with the company's business strategy. Only in this way will we produce value-added and cost-effective results for the individuals, for the company and for the shareholders. Distance Learning is an important component of the strategy.

It is also important to note that the Higher Education Funding Council for England (HEFCF) is now promoting Learning and Teaching Strategies in response to government policies, and new infrastructure funding initiatives in the higher education University sector, for the introduction by the next millennium.

The Virtual University: a coherent and competitive strategy

British Aerospace, in a radical move, has positioned education, training, research, technology and development of its people at the core of its growth strategy towards international competitiveness. Announced in May 1997, the British Aerospace Virtual University is a business strategy built upon strategic partnerships with academe and enterprise. This results in a dynamic co-mingling of two

** Managing Director & Vice-Chancellor, British Aerospace Virtual University*

† Director & Dean, Faculty of Engineering & Manufacturing Technology, British Aerospace Virtual University

normally separate cultures, and links business needs to learning and research in a timely and responsive way, through which both the company and universities gain benefit. The strongest motivational factor lies in preparing our people for the challenges and business issues in a globalising and consolidating aerospace sector, which still employs well over a million people in the post cold-war era and plays a vital role in the knowledge-driven economy, whose hallmarks are innovation and engineering excellence.

In April 1998, Baroness Blackstone laid the "foundation stone" of our virtual campus. Separate business units within British Aerospace had had training activities and R&D projects with universities already in place, representing a total of £34 million investment in training in 1997, but there was only a limited integration across BAe. For all education, training and research the company projects a total commitment of £2 billion over the next decade.

The Virtual University has adopted an academic framework and established a company-wide infrastructure and policies to support learning, in a Lifelong Learning context, for all the 46,000 employees. In the longer term, we will offer services to the all-important supplier chain, the customers, and the company's international partners. Thus our strategy is the twinning of academic and business excellence through carefully designed and strategically led partnerships with universities and other organisations, across the UK and internationally, and it has been set up with these long-term goals in mind. In seeking to deliver its Mission, the Virtual University has deliberately pioneered a route of partnership and collaboration, not competition, with traditional universities. Complementarity, not substitution, is the guiding philosophy.

It is also of interest to note that by 1998 there were over 1600 institutions in USA that claim to be corporate universities and share certain generic workplace features, such as distance learning. The majority of these initiatives were top down strategies. But there is no single blueprint, because each corporate university must be set within that company's particular business strategy, structure and needs. Similarly, the Virtual University, a top down strategy towards coherence and cohesiveness, nevert heless had to embrace the over 30 locations across the UK alone for 15 business divisions, all in different markets. In working together to define the business needs for education, training, research and development, new internal partnerships had to be created too. From this work a set of policies and co-ordinating procedures were developed to form the overall pan-BAe Framework, with which the *global learning strategy* could move forward while respecting and responding to *local learning needs and deliverables* in different business locations. Ultimately the outcomes must be based upon the enhanced capabilities of the individual learners and of the enhanced performance of the company as a whole.

Virtual Partnerships for Real Results

We had set out to twin business and academic excellence on a group of well identified business needs. After a year of considerable discussion and interaction with present and future partner institutions, we are pleased to report not only a significant shift towards open dialogue and collaboration by the universities, but also several new initiatives. These are outlined below as examples of this unique and pioneering approach in the UK. Several new initiatives have already begun. Distance learning was certainly a very important part of the approach because it offered an opportunity to foster a culture of lifelong learning as well as access and an opportunity to develop as individuals for the 46,000. Furthermore, education and training could be aligned for the company's time-dependent needs in terms of resource planning. The linkages we could build would embrace geography and technology and be more multidisciplinary.

The Virtual University's present organisational framework comprises the Faculty of Learning, the International Business School, the Faculty of Engineering and Manufacturing Technology, the Benchmarking and Best Practice Centre and the Sowerby Research Centre (which was first established in 1981). Our goal is to offer full educational and research services to the company's businesses and in the longer term the supplier chain, international partners and customers. To achieve this goal new consensus processes had to be established between business and academe, sometimes against the prevailing culture, to give credibility and robustness to the results. But first we had to establish the infrastructure in BAe. Where are we today?

The network of Learning Resource Centres across the company is now in place and offers access to the company-wide Learning and Development Guide on Intranet, which as the first University prospectus also guides employees through the programmes available, offers an assessment of learning styles and guidance on job profiles and career progression. With the new company-wide view, all of the programmes are supported by new HR policies and procedures, such as using personal development plans (PDP), to link "learning" to the progression of careers or reward and recognition. These practices within the different workplaces are being standardised. The next step is to determine measures of how effective such learning might be. This coherent strategy is also designed to be a cost-effective investment to empower and liberate the talent of all its people to enhance the company's future capabilities as a global company.

Virtual Partnerships must lead to real results. Through the creation of strategically selected academic partnerships, we have also sought to gain accreditation, maintain academic standards, seek recognition of prior workplace experiences towards qualifications and facilitate credit transfer. These latter two topics still merit careful attention, and some concrete results, if the fruits of "lifelong learning" are to be available to more than a few. Without significant progress in these areas, the distance learning market in the UK may be dominated by USA providers, where modular courses, credit transfers and recognition of experience and prior learning have long been academically acceptable under a more entrepreneurial banner. The seminal role of the Open University of the UK in pioneering distance education for degrees has now expanded into international realms.

In January 1999, the first cohort enroled in the new British Aerospace Management Certificate with the Open University and Lancaster University. Employees will study management for the 21st century in a co-designed programme that also includes some of the executive behavioural skills and team work that are the foundation of a learning global organisation today. Some 5000 employees will undertake this programme over the coming years, and other companies and international partners have already shown interest in this innovative educational product. The next steps will be Diploma and MBA, or Masters in professional disciplines, as development programmes.

Ultimately, the cost-effectiveness of a learning strategy has to include the affordability of such a major investment. Within British Aerospace, we seek economies of scope and scale, of optimal use

▲ *The line-up of speakers and chairman at the meeting on distance learning. From left, Professor Brian Fender (hand to face), Chief Executive, Higher Education Funding Council for England; Dr Anne Wright, Chief Executive, The University for Industry; Mr John Gray, Principal, Newark & Sherwood College; The Lord Jenkin of Roding, Chairman; Simon Howison, Director & Dean of Faculty of Engineering & Manufacturing Technology; and Dr Geraldine Kenney-Wallace, Managing Director & Vice-Chancellor, both of British Aerospace Virtual University.*

of employee's time and of the flexibility that episodic learning can offer to different groups of employees whose day jobs present them with different degrees of freedom. The return on the investment must be seen not only by the individual, whose enhanced capabilities and self-worth will allow him or her to play a new or greater role in the business, but by the customers and the shareholders and the business results too. The benchmark products and services should gain measurably in quality, innovation and performance as the company moves towards a learning organisation.

The Engineering Challenge for Distance Learning

The drive to distance learning is particularly important for the engineering and manufacturing community within British Aerospace, located in a large number of sites in UK and overseas and comprising some 33,500 people.

The pressures and logistics of delivery are manifold. First, there is a shortage of skilled engineers that is well recognised in the UK, and particular areas such as systems engineering or software designers are critical to the design and delivery capability of a growing systems company. Secondly, a professional career development structure has to be expanded across the company and in accordance with professional engineering standards and curriculum expectations. But are these all accurately positioned against future business engineering demands as opposed to extrapolation of the specifications of yesteryear? As all academic, scientific and engineering disciplines recognise, adding topics to the curriculum is much easier than removing areas which have been subsumed by more recent core developments, or are not as relevant today. The Virtual University seeks to balance this conundrum with a future view that includes core curriculum panBAe with elective modules to meet local or specialist needs. A third pressure to address for this population is the business time away from the work place. This is lost time to be made up if production times and design-to-delivery times are not to falter.

Nevertheless, if education is seen as an investment for the future then these pressures and logistical issues have to be approached in an innovative yet balanced way. There is no question that, in education *intellectual and social interaction with others is important* and this should be a feature of the overall learning experience. Part of the balance is in finding the right mix of academic with business and practical experience in the curriculum. Another is in designing the mix of computer-based, self-paced and self-managed distance learning with tutorials and seminar activities. A third is the mix of residence opportunities and team-based projects to be offered in universities, different companies and countries. The evolution of the MSc is such an example.

Traditional MSc courses required full-time attendance at a university throughout the course. Then came programmes such as the IGDS (Integrated Graduate Development Scheme) which offered a variable length course, modular based, and included with a work-based project. There are also individual industrial-based programmes (such as the BAe Airframe Engineering course at Cranfield University) which are designed around a particular company's needs and have a mixture of university-based modules and work-based exploration of the Learning. We are looking for the MSc to develop until the modules become fully flexible, allowing company employees to study the appropriate topics for their current roles at selected universities, chosen for their excellence in the topic. Thus, as an employee's career develops he or she would study different topics at different universities, the key being that the culmination of the study would allow the accumulated and accredited modules from different universities to lead to the MSc. Each module needs to have related work-based learning. This distance learning is essential in order that the MSc programme achieves the company's target for postgraduate education: an employee with increased capability.

The focus on engineering design and manufacturing is still strong in a company with an impressive order book. An integrated approach has value here too. In 1998 British Aerospace, in collaboration with Rolls Royce and the Universities of Cambridge, Southampton and Sheffield, launched a novel and interdisciplinary University Technology Partnership. The rolling 5 year research project on Design Technology reflects the importance of design on every aspect from concept to the ultimate delivery of an ultra high performance and cost effective process, system or aeroplane, and will undoubtedly produce results which will feed into the company to ensure projects benefit immediately.

The 1998 class team project of the 13 MSc students in Aircraft Engineering at Cranfield University was the redesign and conversion of a one-seater high performance acrobatic plane, into a two-seater, which was proudly flown on its test flight. Of the 30 graduates in 1997 and 40 graduates in 1998 sponsored by British Aerospace in the MEng course at Loughborough University in Systems Engineering, which was jointly designed and developed by the University and senior systems engineers in British Aerospace at the Warton site, the majority returned to the company (including 7 former aircraft apprentices). This MEng course is open to other students and other companies (even though British Aerospace sponsored all the original developments costs and produced sophisticated equipment and some lecturers to support the University's own professorial expertise), since the interaction with others is seen as an important part of the education process.

These are just some recent examples. From post-doctoral fellowships in research to undergraduate projects, the unique facilities at British Aerospace also offer unusual opportunities for bringing theory and experiment together. Business and culture programmes involving international exchange are also actively in our planning for both engineering and business career development. Distance Learning brings a borderless experience to our Learning Strategy as a necessary but not sufficient condition, to ensure we develop our people as innovative, critical and creative thinkers and doers, and to embrace change and challenge on our quest to be a 21st century benchmark global company.

Mr John Gray*

Introduction

It seemed to take a long time for the Further Education (FE) sector to begin to recognise the importance of Information & Learning Technology (ILT). For years the FE world seemed to treat its importance as marginal. It's been clear to me for at least 15 years that IT facilities were capable of revolutionising both the business & learning environments of our colleges.

The Further Education Funding Council (FEFC) set up its Learning & Technology Committee (chaired by Sir Gordon Higginson) which published its report early in 1996. The report presented an agenda which was still, even then, too radical for many – and it took a long time for any of its recommendations to get support. Now, suddenly, national and European agendas seem to understand ILT's importance and the UK Government's University for Industry (Ufl) and National Grid for Learning (NGfL) initiatives have stamped the seal of approval.

The college of 2010

The way we work, live and learn is already being substantially changed by the arrival of the Information Society and it's unimaginable that the way our colleges do business will remain unaffected. I believe that the College of 2010 will probably:

- have strengthened its capacity to deliver added value services to the local customer
- provide for an extended community via distance communica-

* *Principal, Newark & Sherwood College*

tions, links and joint projects
- deliver its mission by being the point of contact through which professional tutorial and brokerage services provide the 'added value' college customers need
- work with a whole range of business partners in order to deliver the individual learner what (s)he needs, where and when (s)he needs it
- have a curriculum through which learners are supported individually by tutors who negotiate learning programmes with the individual, guide the learning, track and assess the individual's progress and verify the teaming outcomes in order for the College to 'claim' its income
- provide workshops of one description or another, used 7 days a week, delivering the 'knowledge component' of the whole College's service through a transformation of what we know these days as the library.

Paragraph 1.2 of the UK Government's Learning Age Green Paper said in February 1998:

"In future, learners need not be tied to particular locations. They will be able to study at home, at work, or in a local library or shopping centre, as well as in colleges and universities. People will be able to study at a distance using broadcast media and on-line access. Our aim should be to help people to learn wherever they choose and support them in assessing how they are doing and where they want to go next."

In the knowledge-worker driven economy of the future the premium will be on flexibility and accessibility to learning. Colleges will need to operate more like clubs than conventional educational institutions! There is a premium upon colleges' capacity to sensitively manage learning resources in a highly flexible and effective way, extending the range of learning situations which are seen as "college business". Alan Benjamin's Community Learning Utility concept leads me to believe a college might operate primarily as a broker in between learners and the knowledge objects and tutorial services that they need to achieve their continuously developing learning needs. The Ufl could work with FE colleges very closely in this way.

One of the paradoxes of the Information Age will, I believe, be that it will actually heighten (not diminish) the importance of "locality" and "home". People will seek out ways of identifying physical communities as well as the cyberspace they occupy. As far as I can see the role of Further Education in the Learning Age will remain that of serving local & regional communities. There are still lots of people within these communities who are "distant" in ways that prevent them learning. Our job in the Information Society is to add local value to national/global resources in order to serve these communities. Our colleges, working in new ways with local partners and using their ILT expertise and facilities, should see the Ufl initiative as their opportunity to develop new approaches to their Lifelong Learning support role. Adding value locally to the Ufl's national brand is a worthy objective! In FE we are well accustomed to providing high levels of personal support and local knowledge as key ingredients for successful extension of participation.

Gleaning the harvest

The challenge and the opportunity presented by the flexible/distance learning development is of bringing the rich content and stimuli from the world's digital warehouses into situations where local value, and learning support, can be added in ways that are locally meaningful. In Newark's largely rural community, we have to work from the premise that high bandwidth will not be available in many areas for the foreseeable future. Nevertheless, there are tools that can scale to take advantage of whatever bandwidth is available. These are intrinsically more suitable to our needs across a mixed urban/rural community. To use them we aim to provide 'fat' content as close to the user as possible, with 'thin' intelligence centrally created and stored to drive users' needs. The same ICT infrastructure can be used simultaneously to support a Ufl focused support for SMEs, whilst providing the network for our work with schools, community centres and home based learners.

In our NewNET "Connected Learning Community" objects stored in the folders within our Microsoft Exchange environment can be accessed by users logged on to the network inside the College or connecting remotely (via dial in lines or the World Wide Web). This, taking advantage of Windows NT's built-in security facilities, will be the basis on which we will support flexible resource-based learning on college sites, and support learners at a distance. Wherever there is sufficient bandwidth (or arrangements are made for 'fat' content to be available close to the user) these objects can be full motion video objects in addition to all the other digital objects that can be stored in Exchange folders. This is a powerful extension to the Exchange-based learning environment's use. A key element in our strategy for supporting flexible learning has been the selection of software that lets us reduce the "total cost of ownership" of the infrastructure and reduce the learning curve for its users by providing a consistent "look and feel" throughout.

Costs and investment

Real enhancements in the learner centredness of the facilities made available to students have to be clearly connected into a coherent financial/business model so that the benefits gained through the new learning methodologies can be quantified, audited and able to deliver income to sustain the change. The costs in money, time and energy for colleges to create their own robust self-standing learning materials are substantial. I believe this is best left to publishers. Whatever publishers produce, the products of their work must be capable of manipulation and integration with other learning resources by tutors – tutors who, in the future, will develop a new role requiring quite different skills. Most of our students will continue to be funded via FEFC or TEC contracts. It is essential that the amount of time learners spend "on task", the results of their on-line assessment and similar parameters are capable of being automatically fed into the college's information systems as a backdrop to our audit and income earning relationships with these national bodies.

Creating a new culture for colleges requires significant investment – investment in time, energy and money – but above all investment in vision! Especially when resources are scarce, it is particularly important to focus investment in areas where the benefits are optimised. At Newark the three areas in which our investment focus has been applied are in the areas of people and their skills, the flexible learning facilities and in the development of partnerships. The most tangible result of this investment has been the creation of a series of college learning centres which act as catalysts for change in the way that our people see their role. They provide an opportunity for colleagues to develop new tutorial skills to cope with the changed learning environment. The learning centres can be the focus for co-working with partners in a variety of ways, resulting in an enhanced profile for the college and its image for local community members. Specifically, I am hoping that such learning centres will play an important role in the Ufl's strategy for establishing its national brand in our local communities.

A change is needed now

Access and participation in FE, taking advantage of technology where appropriate, are now high on college agendas – but often college management and governors lack the ability to bridge the educational & technical issues in a coherent way. Funding agencies and the DfEE need to be cultivating such strategic direction in governors and top management if the important FE sector is to gear up for the future. We all have an interest in facilitating such change.

Distance learning and distributed learning – the development of learning and communication technologies, and their distribution and delivery in the home and the workplace as well as traditional learning environments – present an immense and exciting opportunity for business and individuals to develop the skills they need.

The University for Industry (UfI) is at the heart of the government's commitment to promoting lifelong learning. We will promote lifelong learning, helping individuals and business to improve their skills and knowledge. This will put people in a better position to get jobs and improve their careers, and boost business competitiveness.

The UfI will help people to get knowledge and skills in a way that suits their lifestyles and the operational needs of their businesses. Information, advice and learning packages will be accessible on-line from the home, at work or in UfI learning centres nationwide. We will focus on priority sectors while meeting needs that range from basic literacy and numeracy through to advanced management techniques. By operating as a nationwide distributed distance learning network, I believe the UfI will help to transform lifelong learning through a partnership with the education and business sectors.

Barriers to Lifelong Learning

We are all familiar with the factors which mean that it is critical for us not just to improve levels of skills and training, but to create a society in which continuous lifelong learning is the norm: the rate of increase of knowledge and of change in the work environment; the drive for competitiveness in global markets; the new skills and updated knowledge which are increasingly needed.

And yet as we also know, the need to raise skills standards and re-train is not being met. Market research conducted by the UfI with individuals and small businesses told a familiar story. Eight out of ten people thought lifelong learning would be a good thing, but fewer than four out of ten participated. We found the obstacles to getting better skills were: lack of good information; courses at the wrong time, in the wrong place, too costly or not relevant. For small businesses, the financial, time and opportunity costs were seen as just too heavy. Such businesses face particular problems in ensuring that their employees have access to the skills and knowledge they need. Unlike larger companies, few SMEs have training facilities of their own, and depend on external provision.

A Solution for Business

Is distance learning for business a new learning solution to these old problems? I believe that it is, and in a way that goes far beyond simply technological solutions to a vision of a lifelong learning community: learning on demand to meet business and skills needs. And that vision includes learning products developed for specific business sectors which also meet national and regional skills strategies. These products need to be delivered at work, to the smallest businesses, as well as in large corporates with developed training facilities.

Our research demonstrates a demand for work-based learning which can lead to credits and recognised qualifications. Such products will give everyone in a business, from boardroom to factory or workshop, the opportunity to take control of what they need to learn.

The rapidly developing technologies of distributed open and distance learning – CD ROM, Internet and digital technologies – allow businesses to source the information and learning packages they need nationally or even globally. These technologies enable local delivery, which is customised for the company, the team, or the individual employee.

It is now possible to bring education and business even closer together, to achieve just in time learning, learning on demand, to match business and skill needs.

For SMEs, distance learning can allow both employee and employers easy access to learning in the workplace, with complete flexibility in timing and no time loss in travel.

Distance learning can effectively be used for all levels, from basic skills, through technical levels to degrees, and offers particular benefits for CPD.

By contrast, traditional curriculum and delivery by a college or university involves a set of activities, facilities and transactions grouped together by a single provider on a single site. These include the content of a course, the library, the classroom and teacher, the assessment and examination, and so on.

A learner has to navigate a complex system, and often a large campus, to access these products and services. The virtual integrated learning environments of today and tomorrow can distribute and deliver all these elements to your home or your workstation. And the development and delivery of the learning can involve a number of learning service providers operating in partnership.

Distance learning in the workplace can allow companies to create a complete learning system. They can source and deliver the learning relevant to their needs, and locate it firmly within the framework of business objectives, company and employee development plans.

Extending Distance Learning

To be launched in the year 2000, the University for Industry will operate as a distributed open and distance learning network through a public-private partnership. Work is now under way to put in place the systems, learning products and services which will make it a reality for businesses and individuals.

We will provide clear, comprehensive information and advice about a full range of education and training programmes. The service will be easily accessible through our help line, web site and at local learning centres.

Where appropriate, we will direct individuals and businesses to existing courses or learning materials. But where there are gaps we will act as a catalyst and stimulate the creation of high quality learning products and packages using new technologies wherever possible. These packages will meet skills needs at all levels, and the needs of particular sectors – ICT, retail and distribution, automotive and the management and business skills needs of SMEs.

UfI learning materials will be accessible through the PC at home, at work or in UfI learning centres in a variety of locations – including community and leisure environments which fit into the lifestyles of learners.

Whether getting started or working with UfI learning packages, a range of learning support will be available. Learners will receive help by contacting a tutor by e-mail or telephone, or support through contact with other learners.

A New Approach

UfI will not be a provider or educational institution in the traditional sense. We will not have our own students or lecturers. Instead, we will work through partnerships of providers, of learning products and services. The UfI organisation itself will be a broker, a creative distributor, assisting in animating and supporting the entire learning network on behalf of business, learners and education and training providers. We will create a portfolio of learning products and materials through commissioning. The learning centres will be owned and operated by local and regional partnerships of many organisations – colleges, universities, TECs, Business Links and business organisations across England, Wales and Northern Ireland.

We will also work with trade unions, employer organisations and professional bodies as we develop the University for Industry. In addition, we will involve organisations and bodies – RDAs, TECs, etc – in the collection and collation of market information and delivery of national and regional skills strategies to support economic development.

We will also aim to work with other initiatives which promote

* *Chief Executive, The University for Industry*

lifelong learning, whether ILAs, the National Grid for Learning, local lifelong learning partnerships, local advice and guidance centres and so on.

However, the UfI will always place the learner first. We will be innovative, responsive and flexible. Our approach will be market led and needs driven, not technology driven or provider led.

We will place the highest priority on quality, combing authoritative learning products with customer focus. The UfI will be a channel for credits and awards, using existing qualifications and working with awarding bodies, including universities. At the same time, we will work with others to develop best practice in distance learning, including learner-managed work-based learning. A core task is to support this activity by promoting familiarity with ICT, so that more and more users in remote areas or businesses can benefit. And to develop distributed distance learning as a cost-effective and affordable way of learning as well as flexible and accessible methods.

Responding to Demands

Around the world, there is a growth of innovative organisations which create and distribute knowledge and learning in new ways to new markets. Virtual universities, corporate universities and learning networks are developing different ways of meeting lifelong learning needs. At the same time, students and learners increasingly expect the customer focus they receive from other services. They want flexibility, ease of access, relevance, cost-effectiveness, speed and quality. Learning institutions must react to these demands. As a priority, they must embrace the transformation of learning products, their organisation and delivery, in order to meet the changing needs and expectations of business and of individuals users. The UfI will work alongside education and business to assist in this task.

How will we know when we have succeeded? In the short to medium term, the UfI will, of course, have targets and expectations in the number of people and businesses who will benefit from its services. But if we look further ahead, I hope that we can play our part in making lifelong learning totally transparent and accessible at home, at work and in the community. Lifelong learning will be taken for granted as interwoven with business development and skills needs, and a normal and expected part of everyday life. The transparency and immediacy of distance learning will help us to achieve these goals. The effect will be to turn distance learning into close learning – as close as possible to people's lives and work.

Professor Brian Duffield*

Professor Duffield attended the Foundation's lecture and dinner discussion on Distance Learning. This stimulated him to write the following article and to bring the University of the Highlands & Islands' Project (of which he is Director and Chief Executive) into Associate Membership of the Foundation.

Putting an end to the tyranny of space

The University of the Highlands and Islands project (UHI) is a radical initiative designed to create a new kind of university for this region, which occupies one-half the land mass of Scotland (one-fifth of the UK). It will be based on a network of thirteen existing further education colleges and research centres throughout the Highlands and Islands.

The key factor in the realisation of UHI's distinctive approach to the creation of a new university is the widespread utilisation of 'cutting edge' information and communication technologies (ICT) and the opportunities they provide for educational innovation. ICT developments are fundamental in overcoming the barriers of distance and time. Data networking between sites will be based on the UHI Wide-Area Network (WAN) using a private ATM network delivering a multi-megabyte service at some twenty-six locations across a region bounded by Perth, Shetland, Elgin and Stornoway.

In turn, the enormous technical capacity of the UHI WAN will support a range of complementary developments:

- data networking at sites through a Local-Area Network (LAN)
- integrated telephony systems at all sites allowing self-dialled tariff-free internal voice and ISDN video conferencing calls across the network
- internal broadcasting services, including TV and radio channels

These ICT infrastructures will allow data networking, both to the Internet via the JANET network, and internally to provide various Intranet facilities, including on-line teaching materials and learning resources and, importantly, a platform for integrated management and administration systems. Some twenty-five million pounds will be spent on this ICT development programme through to the end of the century.

These ambitious ICT developments will create a new kind of university whose physical presence will be that of distributed network centres, all linked together by telephone and telematic technologies and sharing the same learning materials. The main centres of network nodes will be the campuses of the UHI partner institutions, but local centres, which are rapidly proliferating, are giving rise to 'Community Learning Networks' allowing local communities to gain access to educational services provided across a common ICT infrastructure spanning the Highlands and Islands and linked into the Internet. Such developments extend UHI educational services to many small communities outwith normal commuting time from UHI campuses and also have significant local economic and social benefits.

The philosophy underpinning the UHI Highlands and Islands Educational Network (HIEdNet) is one of empowering and enabling local communities to play a full and active role in all UHI activities, and thereby accessing educational opportunities on a lifelong basis regardless of physical location. Building on UHI's core network infrastructure, the aim is to provide access to demand-led educational opportunities, owned and managed locally, and development through local and regional partnerships.

The UHI remains distinctive in a United Kingdom context, yet provides a model for the development of educational opportunities in **all** remote areas – it uses modern technology to overcome the obstacles of distance and time whilst, at the same time, utilising the existing knowledge, skills and cultural achievements of individuals, organisations and communities in its region to ensure the quality, relevance and accessibility of education opportunities.

** Director & Chief Executive, University of the Highlands & Islands Project*

CHAIRMAN'S REPORT FOR THE YEAR ENDED 31 DECEMBER 1998

Chairman: The Rt Hon Lord Jenkin of Roding

1998 was an unusually active one for the Foundation, with a total of 30 events in the twelve months, three being overseas. It was a year with two continuing significant developments. First, the Foundation continued the production of summaries of the discussions at the lecture and dinner evenings. Each summary comprises a single, two-sided sheet of notes which scrupulously observe the Foundation's neutrality and the *Chatham House Rule*. These aide memoires for those participating in the seminars who want to take matters forward are proving extremely popular. The Foundation is very grateful to the two skilled rapporteurs, Jeff Gill and Sir Geoffrey Chipperfield.

Second, Dr Geoff Robinson's proposal to introduce younger people to the events has been developing well. The Foundation's Council agreed that during the years around the Millennium there should be a series of seven lecture and dinner discussions under the single theme of "Quality of Life for the Millennium Generation". About twenty younger engineers and scientists and potential leaders attend a day's workshop during the day; one is invited to be one of the three speakers in the evening seminar, and all attend the evening session, mixing with the hundred or so other guests.

During the day the workshops operate in two groups, each with a facilitator, and these sessions have proved to be very stimulating and encouraging. The scheme is run in association with The Royal Society, the Royal Academy of Engineering, the Economic and Social Research Council, the Natural Environment Research Council, the Health and Safety Executive and the Departments of Trade and Industry, Environment, Transport and the Regions and Health.

The Foundation has been fortunate in having some excellent facilitators: Dr Geoff Robinson, Dr David Metz, Mrs Elizabeth Mills. The topics under the general theme have been "Living and Working Space" and "The Third Age". 1999 sees the series developing well with some slight modifications for the benefit of all attending.

Some years ago, Dr Richard Haas proposed taking the Foundation to other partners of the European Union. In 1998, a seminar was held in Dublin jointly with the Royal Dublin Society under the title of "Building Closer Irish/UK Collaboration in the Fifth Framework Programme". A team of 20 came from the United Kingdom, and a total of some 96 attended the event, which was held in the magnificent rooms of the Royal Dublin Society, whose generous support and involvement was crucial to the success of the event. The visit to Dublin ended with a morning spent being briefed by Dr Danny O'Hare, President of the Dublin City University, and his senior staff, and discussing issues of common interest in education between the two countries.

The British Council in Tokyo invited the Foundation to hold a seminar jointly with the Japan Society for the Promoti on of Science, and a team of 22 members flew to Tokyo for three days of visits and seminars. The theme was "The New Partnership between Universities and Industry in the 21st Century", and we learned from visits to universities and industry that there was virtually no research collaboration between industry and universities. The visit culminated in a lecture and dinner discussion at the residence of the British Ambassador. Sir Robert May, the Chief Scientific Adviser to the UK Government, spoke after the dinner.

In the autumn, a party of 17 went to Geneva for briefings from and discussions with the World Trade Organisation; and we visited CERN at the invitation of Professor Llewellyn Smith, the Director General. The visitors could hardly but be impressed by the sheer scale of the operation and by the enthusiasm of the international team of scientists and engineers, many of whom were young.

A seminar was arranged with the French Embassy in London to encourage the movement of scientists between France and the UK and vice versa.

We remain, as always, grateful to the Royal Society for allowing us to use their rooms for our evening seminars. These have included topics such as "Investing in R&D", "Science for Sustainable Development" and "The Private Finance Initiative: its Impact on Science". The topic for the annual event with the Royal Society of Edinburgh was the timely topic of "Science and Devolution".

The Foundation visited the British Library, Cranfield University and the Millennium Dome, adding important breadth to the programme. Dr John Ashworth, the Chairman of the British Library, welcomed guests to a visit to the St Pancras building, this being the Foundation's fourth visit to the library over the years – the first was when it was in the early days of construction.

Professor Frank Hartley, the Vice-Chancellor, invited the Foundation to visit Cranfield University with its emphasis on aerospace. It was appropriate that one of our guests, Hommy Khosrowpanah, flew in to the University's airfield for the visit in his private aircraft. Finally, the Foundation visited the Millennium Dome and held an illuminating discussion with Ian Liddell, Partner, Buro Happold, followed by dinner in the Trafalgar Tavern.

The Foundation was once again invited to join the Office of Science and Technology in their prestigious Zuckerman Lecture when Madame Edith Cresson talked on "Europe needs Research, Research needs Europe". The Foundation greatly values being involved in this major event of the OST.

Our activities are only possible through the generous sponsorship of industry, commerce, educational organisations, other charities, government departments and some individuals. The Foundation's Council is always grateful for the support which is crucial to the development of the existing activities and to developing new ones.

The Lord Lloyd of Kilgerran Prize for 1998 was awarded to Professor Ian Wilmut of the Roslin Institute "for developing and using embryo manipulation techniques in farm animals, leading to many potential uses in bio-medicine and livestock breeding".

Work with learned and professional societies continued. There were seminars during the year on deformation, governance, strategic planning, VAT, trading and databases; the bi-monthly newsletters were published, each with occasional papers on topics such as standards in public life, and trustees' liability; and advice was provided on constitutional, organisational and other matters of interest to learned societies. Keith Lawrey, the Learned Societies Liaison Officer, also organised working parties on the Review of the Charity Commission Register, and also on SORP 2. Comments arising from both these groups were subsequently sent to the Charity Commission.

In the background Derek Eddowes continues to edit the Journal, and Chris Staffurth assists over the book-keeping and accounts. Meanwhile, the team of Jennifer Grassly, Keith Lawrey, Christine Broomhead, under David Hall's splendid leadership, continues to keep the Foundation operating with an interesting and valuable programme. Jennifer has been with the Foundation for ten years,

making a great contribution to its progress and smooth running. We greatly appreciate her role and work, which will be especially important during the change of Directors.

Towards the end of 1998, Council embarked on the process of choosing a new Director to succeed David Hall who, sadly, will retire in May 2000. It is hoped that the appointment will be announced this autumn. As the success of the Foundation over the years owes a huge amount to the wisdom, experience and skills of David Hall, the task of identifying his successor is seen as one of the utmost importance.

Finally, I owe a great debt of gratitude to The Honorary Officers and the Council. The Foundation is well served, and I look back on 1998 with great satisfaction, and look to further developments in the turn of the Millennium.

FOUNDATION FOR SCIENCE AND TECHNOLOGY
STATEMENT OF FINANCIAL ACTIVITIES FOR THE YEAR ENDED 31 DECEMBER 1998

Income and expenditure	Unrestricted funds £	Restricted Funds £	Total 1998 £	Total 1997 £
Incoming Resources				
Donations	14,050	-	14,050	13,642
Sponsorship income	144,120	-	144,120	142,083
Accreditation fees and subscriptions	102,122	-	102,122	114,758
Learned societies activities	6,827	-	6,827	5,010
Fixed asset grant	967	-	967	967
Listed investment income	9,390	-	9,390	9,047
Bank deposit interest	28,445	808	29,253	24,752
Total Incoming Resources	305,921	808	306,729	310,259
Resources expended				
Direct charitable expenditure	201,555	42	201,597	195,856
Management and administration	56,811	-	56,811	54,055
Total resources expended	258,366	42	258,408	249,911
Net incoming resources	47,555	766	48,321	60,348
Other recognised gains and losses				
Unrealised gains on investment assets	5,669	-	5,669	29,822
Net movement in funds	53,224	766	53,990	90,170
Retained funds brought forward	633,158	11,431	644,589	554,419
Retained funds carried forward	686,382	12,197	698,579	644,589

CONTINUING OPERATIONS
None of the Foundation's activities was acquired or discontinued during the above two financial years.

TOTAL RECOGNISED GAINS AND LOSSES
The Foundation has no recognised gains or losses other than the gains and losses for the above two financial years.

BALANCE SHEET AT 31 DECEMBER 1998

		1998		1997	
FIXED ASSETS		£	£	£	£
Tangible assets			6,346		6,127
Investments			533,022		411,765
			539,368		417,892
CURRENT ASSETS					
Debtors		17,384		22,967	
Cash at bank	– on deposit	154,229		210,417	
	– current account	500		500	
	– The Harold Silman Fund	12,495		11,687	
Cash in hand		89		122	
		184,697		245,693	
CREDITORS					
amounts falling due within one year		25,486		18,996	
NET CURRENT ASSETS			159,211		226,697
TOTAL NET ASSETS			698,579		644,589
Financed by:					
FUNDS			12,197		11,431
Restricted			686,382		633,158
Unrestricted			698,579		644,589

Approved by the Council on 23rd March 199 and signed on its behalf by Council members: THE RT. HON. THE LORD JENKIN OF RODING and R G L DAVIDSON

THE THIRD AGE

This is an edited version of a paper further to those already published in the Spring edition of the Journal (pages 13-15) reporting the meeting held 3 November 1998.

Professor Anthea Tinker*

Summary: Professor Tinker discussed questions that arose about the quality of life in the third age.

Introduction

Issues about the quality of life for people in the third age raise a number of questions. These include: What is the third age? Why should we be concerned about it? What is the quality of life and who determines it?

What is the third age?

A useful starting point is to consider Peter Laslett's four ages:
"First comes an era of dependence, socialisation, immaturity and education
Second comes an era of independence, maturity and responsibility, of earning and saving
Third comes an era of personal fulfilment
and Fourth comes an era of final dependence"

Laslett. *A Fresh Map of Life: The Emergence of the Third Age*, 1989, p. 7.

Others define ages chronologically. The Carnie Inquiry into the Third Age took 50-74 as a working definition. The starting point for this conference was that the third age began in 'a person's fifties, and continues to death' but then subdivided it into two. 'The first is where the person enjoys independence and the ability to offer much to society, enjoying life to the full. The second is when frailty sets in, independence is lost, and for one reason or another they become and feel a burden to society'.

Definitions can be useful, but there are dangers in generalising. Are Laslett's ages as definite and is it anyway helpful to make such generalisations? How far is it sensible to categorise by chronological age? There are some differences but these are averages. For example, for self-reported health one-third of men and over one-quarter of women aged 80 and over defined their health as good (Table 1). This table shows some of the differences by gender. Not only are there differences in numbers, i.e. whereas numbers of men and women are roughly equal at the age of 60-64, by 80+ only one-third are men and two-thirds are women. Even more remarkable are differences between men and women in their living arrangements. For example, at 80+ two-thirds of women but only one-third of men live alone.

There are also other variables such as cultural ones. Only about 6% of people aged 60+ now are from black and ethnic minority groups, but there will be more in the future as those in middle age come into old age. Little is known about differences in perceptions of quality of life between people from different ethnic backgrounds.

An important question is how can the social and physical sciences, including the biomedical sciences, engineering and technology, extend the first period and compress the second phase of the third age? The answer has to take account of the differences in old age; e.g. to take the gender issue, women have some different health problems and differing housing needs. We have to note the contribution of research and also pioneering operations, but also the more mundane interventions such as cataract operations, care of the feet, etc.

Why should we be concerned about the quality of life of this group?

Whichever age we are discussing, we need to look at the demographic situation, e.g. more (but not many more in the short term in the UK) older people, i.e. an ageing population – caused by falling fertility and reduction in mortality at older ages. We also need to note the drop in numbers of young people, including those of working age.

There is also concern because of

- rising expectations/changing attitudes
- growing power (economic, political and social) of older people – the so-called 'grey power' which will influence not only decisions but also what is produced
- cost (for example public expenditure on personal social services on those aged 65-69 is £210 p.a. and on those aged 85+ is £1,930 p.a.)
- concern about long-term care for those who have physical and mental disabilities
- the impact of medical advances and technology (for good or ill).

Industry and commerce needs to respond to the market but also to design not so much for disability but for all. For example, technology which enables people to keep in contact with others or enables homes to be easier to run will help older people and everyone else.

What is quality of life and who determines it?

A big issue is how quality of life is measured. It includes:

- individual characteristics such as functional abilities, physical and mental abilities, gender
- physical environmental factors such as facilities and amenities, standard of housing, control over environment, comfort, security, etc.
- social, environmental factors such as levels of social and recreational activity, family and social networks
- socio-economic factors, e.g. income, nutrition
- personal autonomy factors such as the ability to make choices, exercise control
- subjective satisfaction: as assessed by the older person
- personality factors such as psychological well-being, morale, happiness
- what older people say about quality of life, especially the importance of social relationships, health and finance and their contribution to the workforce, to families e.g. as grandparents and to voluntary organisations
- the potential conflicts between the views of older people and families (and with professionals)
- the importance of independence

The issue of independence is probably the key one. What causes dependence may be physical, a fall is a major cause, but may be mental, which may include dementia. The lack of finance and society's attitudes are also key factors and may lead to a loss of confidence.

Conclusion

Whatever we may say or think, older people may get on with their lives without our intervention. But at least we can think about changing our attitudes to old age and consider the positive contribution of this group whether they are in their third or any other age.

* *Professor of Social Gerontology, King's College London*

SELF-REPORTED HEALTH
By age within gender; those aged 60 years and over; Great Britain

	MEN				WOMEN			
	60-64 years %	65-69 years %	70-74 years %	80 years & over %	60-64 years %	65-69 years %	70-74 years %	80 years & over %
Health reported as:								
Good	45	46	39	33	48	42	37	28
Fairly Good	32	36	41	39	36	38	40	38
Not good	23	18	21	27	15	20	24	33
TOTAL	100	100	100	100	100	100	100	100
N (Base)	637	588	420	246	667	675	577	497

Source: Askham, J. et al, Life after 60, ACIOG 1992

▲ *Table 1.*

ENERGY POLICY AND FUTURE TRENDS

The Foundation held a lecture and dinner discussion on 25 November 1998 at the Royal Society. The title was "Energy Policy and Future Trends" and the Rt Hon The Lord Jenkin of Roding was in the chair. It was sponsored by The Engineering Council and The Royal Commission on Environmental Pollution and the speakers were the Hon Anna Walker, Director General, Energy, Department of Trade and Industry, Sir John Houghton CBE FRS, Co-Chairman, Scientific Assessment Group of the Intergovernmental Panel on Climate Change, Dr Michael Grubb, Royal Institute of International Affairs, and Dr Eoin Lees, Chief Executive, The Energy Savings Trust.

The Hon Anna Walker*

Summary: The Hon Anna Walker spoke on the Government's energy policy with special reference to environmental issues. She discussed energy regulation and efficiency, the drive on renewables and the economic instruments introduced by Lord Marshall for ensuring the UK meets its environmental targets. Dr Lees examined future trends in energy policy within the context of meeting international and domestic targets on reducing carbon dioxide emissions.

Introduction

I am not a scientist, I am not a technologist, I am not even an environmental specialist. But I do have responsibility within the Department of Trade and Industry for energy policy issues and I thought that I would speak, this evening, briefly on the Government's energy policy with special reference to environmental issues.

The Government brought out the so-called Energy Review White Paper in October 1998, which was quite a statement on the part of the Government about what its future energy policy was. It contains a clear Government commitment to an energy policy ensuring secure, diverse and sustainable supplies but within a framework of competitive markets. It is a 'third way', as the press release said. It is *not* centralised Government planning or market laissez-faire, but does have a clear role for Government within a competitive market framework. What I want to show is what I think that actually means in practice, particularly in relation to the environmental issues.

What the energy review says is that we need to move forward with competitive markets but that there are some serious distortions in the electricity market and that those need to be put right. What we have got is a temporary stricter gas consents policy – we shall have to look at it on a case by case basis – which will generally not allow new natural gas fired power plants in the UK for the time being, but, and this is the important point, what the Paper said was that the Government believed that once this reform agenda was complete the market should deliver diversity. As long as there were properly operating markets, they could be relied on for diversity and that diversity should ensure some level of security.

Energy regulation

The Government is also committed to overhauling the legislative framework for energy regulation. This legislative framework will involve the merger of the two regulatory bodies, OFFER and OFGAS, because they are actually overlapping markets and need to be regulated as a single whole. It will aim to separate competitive from monopoly activities so that we can deal with regulatory issues better. But, more importantly from the point of view of this evening's discussion, it clarifies the relationship between the Government and the regulators because, for the first time, the Government is going to give statutory guidance to the regulators. These will particularly fall into two areas of energy regulation, environmental issues and fuel poverty issues. I would like to say

* *Director-General, Energy, Department of Trade & Industry*

something about fuel poverty, which is a very important issue for the Government. What they are saying is that they want competitive markets but not at the price of a bigger and bigger division between the haves and the have nots. Therefore, they are concerned that the regulatory framework pays attention to the fuel poor and what can be done for the fuel poor.

There has been some concern that the Government might use the regulatory framework to load the regulator and, therefore, the industry with hidden requirements to carry out Governmental obligations. What the Government has said to meet that concern is: "No, there may be obligations on the regulator but that these will be open and transparent. There will have to be legislative provision for them". Of course, if you have legislative provision for them, that means that you also have to debate them publicly.

Environmental issues

Moving on to environmental issues, the Government is very strongly committed to all its environmental targets. The Energy White Paper, contrary to the impressions of some, does not put those at risk. Of the EU countries, only the UK and Germany are clearly on target to meet the year 2000 CO_2 targets and the really important point is that in the UK it is largely the result of the competitive energy market policies which have brought significant developments in gas, more gas for electricity generation and increased efficiency on the part of the nuclear industry. Those competitive market developments are putting us on course for our environmental targets. However, over and above that, the Government has a strong commitment to CHP renewables and energy efficiency as playing an important role in meeting environmental targets.

Action on renewables

There is a manifesto commitment to a strong drive on renewables; currently about 2% of our electricity is generated from the renewables. The Government is potentially looking at a target of 10% by 2010. In order to achieve that, the Government recognises that, within a competitive market framework, it will need to take some extra action to achieve that level. It is seeking to do that in a number of different ways. One of the mechanisms is the so-called non-fossil fuel obligation; in other words, a levy on electricity bills which is then re-fed into a programme for renewables. We believe actually that the programme overall has been successful, both in terms of increasing the amount of renewable electricity generation in our fuel mix, but also that that the money that is available to subsidise renewables is put out to competitive tender. What that has done, over a period of time, has brought the price of renewables down in the market place so it is a subsidy for renewable. At the same time, it aims to operate as a pressure so it isn't a subsidy which has no recognition in the marketplace. The problem is that, if you don't do that, the point at which you take the subsidy away, you may lose all the renewables.

We are actively, at the moment, looking at what our future programme should be to try and see whether we can achieve, as I say, a target of 10% by 2010. That target is very much driven by the ambitious environmental targets. In this, we are somewhat helped by the European Union, which is also beginning to look at renewables on the same basis that the UK does.

Clean coal technology

Another important element that we have been trying to look at, together with industry and science, for helping environmental targets is the development of clean coal technology. This has involved a £34 million Government support so far for a collaborative UK programme and we are actively looking at what our future support should be. We believe that in the UK the clean coal technology is not going to be immediately applicable because the best solution in the UK at the moment is to fit flue gas de-sulphurisation to our current plants. However, we do recognise that clean coal technology could be enormously useful overseas and, in due course, here in the UK as well.

▲ *The Hon Anna Walker preparing to give her talk.*

Combined heat and power

Another thread of our environmental policy is work on combined heat and power. The UK's CHP capacity has doubled in 10 years and we have a Government aim of 10 gigawatts by 2010. Some of this is advice on best practice for CHP, but, over and above that, the Government's stricter gas consents policy actually gives a preferred position to good quality CHP and we have indeed been giving consents for CHP power plants since the temporary gas consents policy restrictions.

Energy Efficiency

I also want to speak briefly about energy efficiency as another very important thread of the Government's environmental policy. The comprehensive spending review, completed in the summer, has increased funds for energy efficiency through the Energy Efficiency Best Practice programme, the Energy Savings Trust and the Home Energy Efficiency Scheme – action targeted on provision of information and help for low income consumers – and the Electricity Standards of Performance Scheme, on which there is a consultation about the future, particularly under the merged regulator, and which is expected to lead to very significant savings of CO_2 emissions. This is an area where we would expect the Government to be giving guidance to the regulator about what they would like the energy industry to achieve in this area.

The Marshall Task Force

The Marshall Task Force Report, published about a fortnight ago, gave the results of consideration by Lord Marshall of the use of various economic instruments for ensuring that the UK met its environmental targets. He made a number of important points, and I have a feeling that this report is going to be extremely important to us. He made a point, which is perhaps obvious, that longer term planning is absolutely vital to meet environmental targets. It is perhaps obvious because I sometimes feel that within Government the issues are so complicated and operate between so many different departments that there is a risk, if we don't all keep our eyes on the longer term target, of it being put a bit into the 'too difficult' box. So this is encouragement for us to ensure that that doesn't happen.

Marshall actually looked at three main instruments: voluntary action by industry, taxation and tradable permits. What he said was 'measures must maximise the environmental value'. We must look at what, in the end, is going to achieve the key objective of meeting our environmental targets and it must keep British industry competitive. It would be an 'own goal' if, by looking at the environmental targets, we did something which meant that British industry was not able to compete in global markets, and, of course, energy prices are a very important element of that. He said he thought there could be a role for tax, but that needed to be subject to further consultation. That would be a role for tax on business energy users, not on the energy industry, with the revenues recycled in some way back into industry. He raised the question of whether that tax should be carbon-related, but he did not come down on one side or the other. But he certainly said he thought any tax should have benefits for CHP and renewables, they being such an important element of energy savings within the energy mix.

Finally he also said he thought there should be work on tradable emission permits – another issue which can easily get put into the 'too difficult' box. But where we are going to be faced by an international system of tradable permits by 2008 and where, I think, for all sorts of reasons, including environmental and fitting in with the international framework, there would be great value in the industry, the DTI with DETR, taking work early further forward on tradable permits and I hope very much that we will be able to do that with industry in the coming months.

Dr Eoin Lees*

Introduction

The development of UK energy policy and technology have long gone hand in hand. A number of examples are discussed below, particularly in the power sector, where significant improvements in both the efficiency and the lowering of environmental emissions have been successfully achieved. However, to simplify this speculative exercise I am going to assume that the major drive for energy policy in the next decade will be environmental concerns. Furthermore, the major of these environmental concerns will be connected with climate change and the meeting of our international obligations agreed at Kyoto of reducing greenhouse emissions by 12.5% and our EU target domestic commitment to reduce CO_2 emissions by 20% by 2010.

The article will examine trends in terms of future emissions of CO_2 and point out the areas where these are technology-driven. It will also highlight some important areas for future technology development. It will finish by making some "heroic assumptions" as to the likely emissions of CO_2 in the UK in 2010.

Current situation

Fig. 1 shows the UK energy consumption by final user for 1997, the last year available. In total, the primary energy equivalent of 227Mtoe (million tonnes of oil equivalent) consumed in the UK gives rise to 148MtC (million tonnes of carbon) in the form of CO_2 emissions. The dominant sectors for energy use are transport, domestic and industry, in that order.

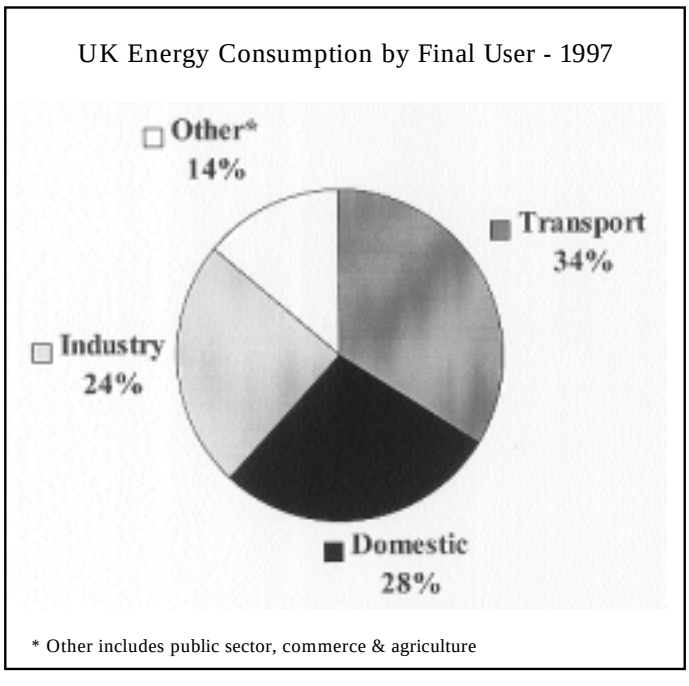
Since we are projecting twelve years into the future, it is always instructive to look at the changes that have happened over the past twelve years. In 1985, total primary consumption was 192Mtoe, implying an 18% increase since then. During this period, transport relentlessly grew from 27% of the market to 34%. whilst industry continued its steady decline from its peak in 1973, and has declined in the period from 30% of the final use to 24%.

However, it is important to look at the UK CO_2 emissions by final user, as is shown in Fig. 2. I have also taken out the electricity emissions of CO_2 from the various other sectors, and collected them under a heading of "power station emissions" (the reason for this will become obvious later on). This perspective gives a slightly different picture of the relative importance of sectors with power stations, transport and industry being dominant.

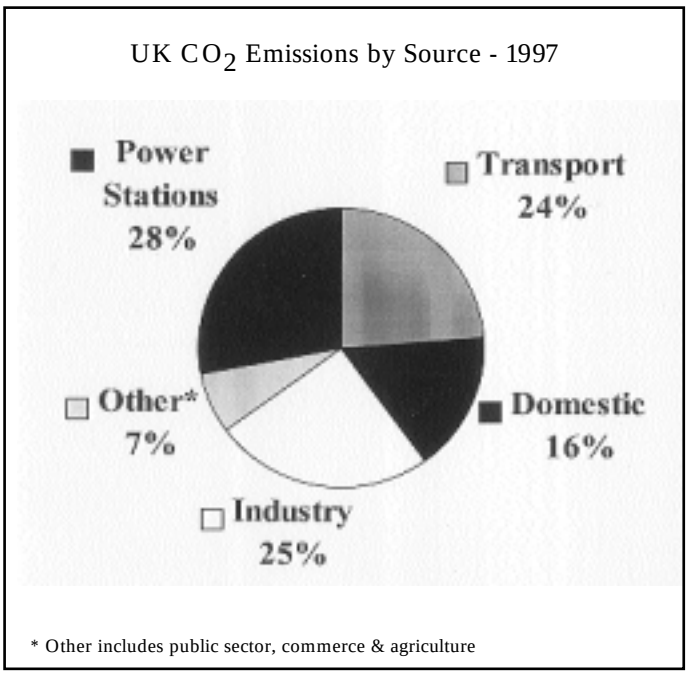
In this article I shall look at CO_2 emissions from three of the sectors in more detail, viz power stations because they are the largest contributor, transport because it is a large contributor and frequently described as a "difficult" sector to tackle, and finally domestic because it is politically important (e.g. fuel poverty issues and social equity) and also difficult to tackle.

This is not to underplay the importance of the business sectors, which together contribute nearly one-third of total CO_2 emissions. However, such emissions are easier to tackle as there are fewer players compared to either transport or individual domestic

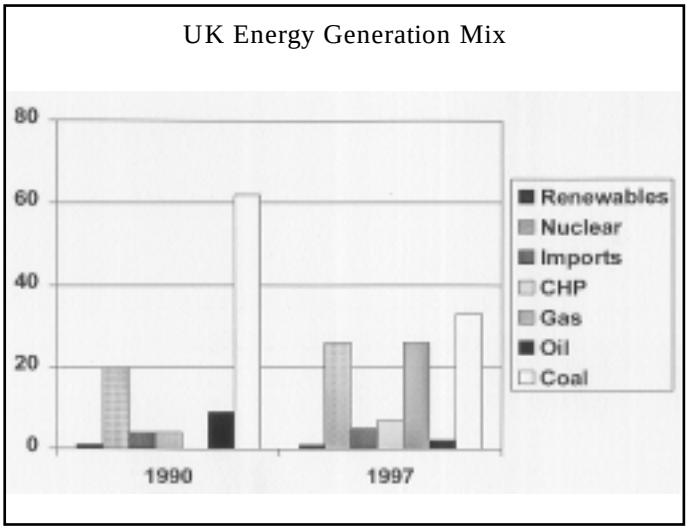
* *Chief Executive, The Energy Savings Trust*



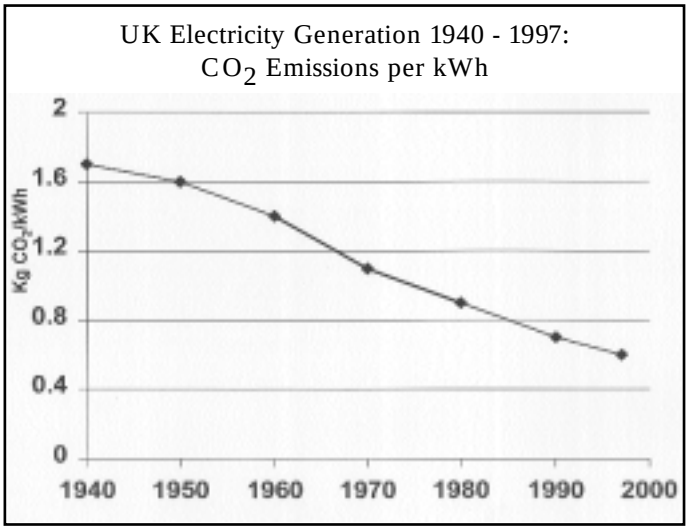
▲ *Fig 1.*



▲ *Fig 2.*



▲ *Fig 3.*



▲ *Fig 4.*

householders. Other advantages include frequent renovations of industrial plant/offices, etc. (certainly compared to the turnover of the housing stock, which has a lifetime of over one hundred years), and the fact that the business sector responds relatively rapidly to financial incentives and/or environmental legislation. I shall now examine the sectors in turn.

Power Stations

The UK electricity generation mix is shown in Fig. 3 for 1990 and 1997. In 1990 coal accounted for nearly two-thirds of the fuel needed to generate electricity, with the other main contribution (20%) coming from nuclear. However, there is much more of a balance between the fuels in 1997, with coal, gas and nuclear being more in balance. The improved performance of nuclear stations and the construction of gas-fired combined cycle gas turbines (CCGT) has, of course, resulted in considerable CO_2 benefits, and more than accounts for the reductions in UK emissions of CO_2 since 1990. However, it is not often appreciated that this is because the most recent so-called "dash for gas" is merely the latest in a long history of reducing, through technology, the CO_2 emissions produced per kilowatt hour from UK electricity generation.

Fig. 4 shows the CO_2 emissions per kilowatt hour, as a function of time from 1940 to the present. The improvements from 1950 were as a direct result of nationalisation of the electricity industry, and the move (continued in the 1960s) to bigger and more efficient plants. From the 1960s onwards, there was an increasing contribution from nuclear power, which is largely "CO_2 free" and this has continued with the recent improvements in performance of nuclear plant, through to the present time. However, this trend cannot continue indefinitely, otherwise some time after 2030 we will actually go below zero! The big question is, when will it start to flatten out? In principle, there are two 'CO_2-free' sources of electricity generation: nuclear power and renewable energies. Of course, some renewable energies are not entirely CO_2 free, e.g. waste combustion of organic material (papers, vegetable peelings, etc) merely re-cycles carbon, whereas combustion of plastics releases fossil carbon, and so is like burning conventional fossil fuels.

Let us look at these two potential sources in turn. Nuclear power has grown steadily over the last 30 years; 11% of the electricity fuel mix in 1970, 14% in 1980, 21% in 1990, and now approaching 30%. However, following the privatisation of the electricity industry, there are question marks over the investment in future plants. The economics appear to be such that in today's marketplace it is difficult to see the private sector building nuclear plant. There are also unresolved political concerns regarding the disposal of radioactive waste, and it is therefore hard to envisage the nuclear industry committing to a major expansion in the UK without a significant change in political will towards the industry.

This, of course, has implications for how we meet our CO_2 targets in the future, as the older Magnox and AGR plants will be approaching the end of their working lifetime in the first twenty years of the next century. While many of the Magnox stations are likely to be granted life extensions, which will ensure that they are still operating in 2010, sometime thereafter they will be de-commissioned, and thus there will need to be a replacement for largely CO_2-free generation plant.

Renewable energy has made great strides in tackling the cost effectiveness barriers in the last eight years. The non-fossil fuel obligation (NoFFO) has encouraged the development of renewables by 'ring-fencing' the nascent industries, and guaranteeing them a market to develop. By ensuring that there is competition between renewable generators within specific renewable technologies, the market processes have generated considerable reductions in the cost of renewable energy.

Fig. 5 shows the historic prices that have been paid for the average renewable energy supply contracted under the five rounds of NoFFO from 1992 to 1998. These have led to an average price of 2.71 pence per kilowatt hour for all the renewable energy plant offered contracts in the most recent round. This is closer to the average electricity pool price than ever (some 2.5 pence per kilowatt hour), but it also should be borne in mind that the average purchase price for the Public Electricity Suppliers is around 3.8 pence per kilowatt hour – the difference being due to the marginal price (pool) and the average price (3.8 pence per kilowatt contract). This 70% reduction in the real price of renewables over this period results from a mixture of having longer contracts (typically fifteen years now), improving technology and classic price reduction due to economies of scale. To date there is about 2 gigawatts of capacity (including the traditional large-scale hydro). Most of the new renewable capacity has been through biomass, with major contributions from landfill gas and waste as fuel. An important contribution has also come from wind power, although this remains a politically contentious renewable source.

The Government has a target for renewable energy to contribute 10% to the electricity fuel mix by 2010. This is a challenging target, and certainly will need increased public acceptability and streamlined planning permission, if it is to achieve this target.

Transport

In the transport sector, it is predicted by the DETR that the number of passenger kilometre miles travelled will increase by some 60-70% by 2025. Fortunately, technology has, and will continue, to play an important part in mitigating the environmental effects of this. Of course, it is important to realise that technology is only part of the solution, and that much will depend on the Government's intended integrated transport policy.

Looking back over the last twenty years, the average fuel consumption of cars sold in the UK has improved by 17%. This is a composite figure resulting from two conflicting trends: one trend is to considerably improve the fuel consumption of cars as a result of improved aerodynamic styling, improved efficiency of engines

and drive chains, and also lowering road resistance from tyres. However, this beneficial trend has been counteracted to some extent by a steadily upward increase in the size of engine on the roads. Nevertheless, overall fuel consumption has improved in this period. This improvement is likely to continue as, recently, the European vehicle manufacturers reached a voluntary agreement to improve the fleet average consumption by 25% by 2008.

There are also important opportunities to use cleaner fuels to reduce CO_2 and other local environmental pollutants. For example, LPG and natural gas vehicles can reduce well-to-wheel CO_2 emissions by approximately 10% and 20% compared to petrol and diesel, respectively. The other environmental improvements, noticeably in terms of particulate emissions and sulphur, mean that there is likely to be a switch in urban areas to these sorts of fuels, particularly for fleet users. The Government is trying to encourage such support by continuing to increase the differential on fuel duty between LPG/NG and petrol/diesel.

However, looking to transport technology in the future, it is fuel cells which offer the greatest potential. Using hydrogen, probably derived from natural gas, will reduce CO_2 emissions by some 30-40%, compared to the current state of the art internal combustion engines. Increasingly, fuel cells are being seen as a viable future alternative to the internal combustion engine. By way of evidence, all fourteen major car manufacturers now have fuel cell programmes and there are demonstration fuel cell buses already running in Vancouver and Chicago. Finally, both GM and Mercedes believe that production models will be available around 2005.

Thus I think technology will have an important role to play in the transport of the future, but it is important to realise that this is *not* the only policy instrument in this area, and that much will depend on the Government's integrated White Paper and the legislation that eventually results.

Domestic sector

Fig. 6 shows the energy consumption for the UK domestic sector by fuel type in 1997 – note electricity is included again in energy use. The use of electricity is largely for lighting and electrical appliances. All the other fuels are predominantly for space and water heating. Indeed, 80% of the domestic energy consumption (including electricity) is for space and water heating, and the primary fuel used for this activity is gas.

An important way of reducing the CO_2 emissions associated with space and water heating is an expanded programme of insulation measures and improving the efficiency of our central heating and hot water systems. This is politically important, because it will also tackle the long-standing problem of fuel poverty in this country, i.e. people on low incomes who live in energy inefficient homes and are not able to afford to heat their homes to the temperatures that are taken for granted by the great majority of the British public. Such energy efficiency programmes can make a very useful contribution to reducing CO_2 emissions, and the Trust expects that co-ordinated activity in this area could easily reduce domestic CO_2 emissions by 16% by 2010. However, looking longer-term, there are infrastructural problems which could limit the potential for CO_2 reductions. Foremost of these is the very slow turnover rates of the domestic housing stock in the UK. On average to the existing 25M housing stock, we add about 200,000 new houses per year and remove about 20,000 houses. While modern houses can easily be built at little or no extra cost, to produce situations where the dominant load is for hot water, rather than heat, it is difficult in terms of cost effectiveness to do this to the same extent for the existing housing stock.

Another interesting problem could be the "habit" that the UK public and the heating trade has developed for installing gas boilers to provide both domestic heat and hot water. The whole of the heating market is driven by this, and while heat pumps and even micro CHP (i.e. individual combined heat and power units, which produce sufficient hot water for the householders' needs and also generate electricity) potentially offer advantages, it will require a sea change in attitudes and skill levels amongst the installing trade if we are to make the necessary environmental breakthrough.

Putting it all together

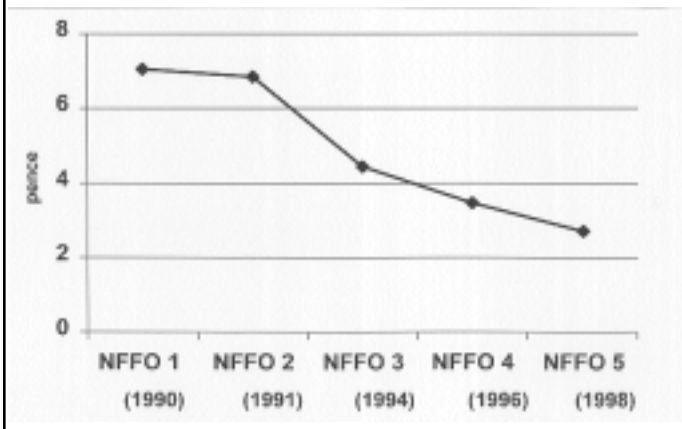
L.et me now make some heroic assumptions about what the likely UK emissions of CO_2 might be in the year 2010. I stress again that the responsibility for the estimates behind this are entirely my own.

In *power stations*, I believe these will continue to be the main source of reductions of CO_2 in the UK. I think there will be a smaller but still significant coal industry, and that the nuclear contribution to electricity generation will remain much as it is today, due to the lifetime extension of most of the MAGNOX plant. I have also assumed that there will be a 10% contribution from renewables to the electricity generation in 2010. Overall, the electricity demand will probably have risen from around 300 to 350 Twh per annum.

In the *transport* sector any increase in CO_2 associated with the high predictions of growth in travel will be offset partially by improved energy efficiency, but also due to the fuel switch to LPGI and NG and also to the increasing use of fuel cells at the back-end of the decade. However, note that the latter contribution, although important, will impact much more in the period 2010-2020 because of the average lifetime of vehicles being at least ten years, i.e. in 2010 most vehicles will still be internal combustion engines fuelled by diesel/petrol.

In the *domestic* sector, I have assumed there will be two conflict-

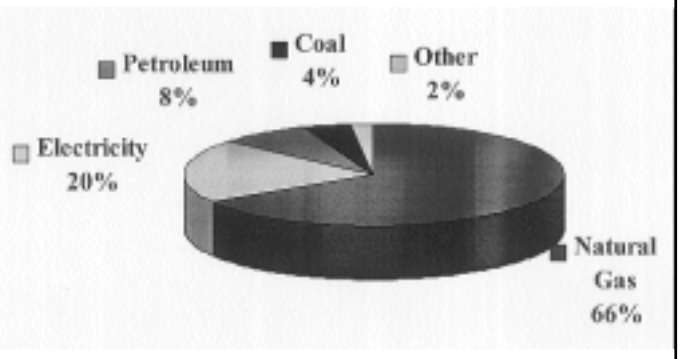
The Non-Fossil Fuel Obligation



NFFO 5:D.N.C of 1177MW. Average price of 2.71 p/kWh.
(cf average generation cost 1996/97 of 3.87 p/kWh)

▲ *Fig 5.*

Energy Consumption of the UK Domestic sector by Fuel Type - 1997



▲ *Fig 6.*

ing trends. First, a major push to alleviate fuel poverty, which will bring some environmental benefits as well. Second, the continuing decline of domestic fuel costs as a fraction of the household budget (partly due to reduced electricity and gas prices: partly due to increased affluence), will have an adverse effect in that it will result in increased consumption in the household. This will largely come from a move towards higher average temperatures in UK households over 24 hours, and thus will move more in line with our continental neighbours. However, a lot of this will be counteracted by improved energy efficiency measures, particularly in the areas of heating systems and insulation.

In the *industry* sector, there is considerable scope for energy efficiency, and coupled with a big push on industrial combined heat and power and fuel switching, I expect industry to continue to reduce its CO_2 emissions as it has done now for many years.

The results of all these trends is shown in the accompanying table, which shows that nearly all sectors are expected to decline in CO_2 emissions from their current position. However, it is noteworthy that the overall reduction in CO_2 emissions is only projected to be 15%.

In other words, meeting the Kyoto targets is achievable, particularly when one bears in mind that the target is a basket of greenhouse gases, and that considerable contributions to meeting the target can be expected from the reduction in emissions of both methane and nitrous oxide. However, the more challenging target is the Government's domestic one of achieving a 20% reduction in CO_2 emissions, and this looks unlikely to be met on the present policies. This, of course, does not mean that it is impossible to meet the 20% domestic target, merely that major policy initiatives will have to be brought forward to ensure that they are.

UK CO_2 Emissions (MtC/a)

	1990	*1997*	*2010*
Power Stations	54	40	34
Industry	37	37	33
Domestic	22	23	20
Transport	35	37	36
Other	11	12	12
	159	148	135

Change 1990-2010 = 24 mtC/a or 15%

▲ *Table 1.*

PROFILES OF COUNCIL MEMBERS

Professor Sir Colin Raymond William Spedding, CBE, PhD, DSc, Hon DSc

Sir Colin was a late academic starter: as the Methodist son of the manse, he spent no more than three years at any one school because of the itinerant nature of his father's profession and his schooldays were terminated by the evacuation of his last school on the outbreak of the Second World War. He remained in London to become a junior technician with Ilford Ltd, the manufacturers of photographic materials, which was the only job he was offered. He then began to read for a London external in science, but these studies were interrupted by his call to arms in 1943 when he joined the Royal Navy, in which he was commissioned and took part in the Normandy landings.

1946 saw his demobilisation and his joining his parents, then running a guest house in North Wales, where he was able to continue his part-time degree studies. In 1948, he entered employment as a junior chemistry laboratory technician with Allen and Hanbury. He had chosen zoology as one of his degree subjects – not because he had studied it before but because the alternative was French! Thus began his lifelong interest in zoology which was reinforced by his move, in 1949, to a post as Assistant Experimental Officer at the Grassland Improvement Station (as it then was). He remained with the Grassland Research Institute, progressing through the employment hierarchy until he became its Deputy Director, and through the London academic hierarchy of BSc, MSc and PhD in parasitology, with the awards of DSc in 1967 and the Reading Honorary DSc in 1995.

It was his interest in parasitology that led to his pioneering work in agricultural systems;for example, he discovered that twin lambs have a higher parasitic load than single lambs because twins are not able to suck as much milk as singles and therefore eat grass sooner, thus picking up more parasites from the ground. This led him to establish a Systems Synthesis Department within his Ecology Division (of which he was head) at Hurley which was concerned with the development of new agriculture systems and included the development of approaches to the synthesis of new systems. Such developments required an ability to understand complex systems and ask simple key questions, to think creatively about new and more effective systems. Sir Colin excelled at this skill which was to underpin a professional lifetime of writing simply about complex issues as his twelve textbooks and some two hundred papers readily show.

In 1970, he became Visiting Professor and then part-time Professor of Agricultural Systems at the University of Reading in tandem with the Deputy Directorship of the Grassland Research Institute and, in 1975, he left the Institute to join the University full-time. He must be one of the few teachers whose first post was that of an university chair, which is even stranger given that he had thoughts of teaching while at a school but was not selected. Reading made good use of his talents, culminating in his service, from 1986 to 1990, as Pro-Vice-Chancellor, and he had considerable influence in its Department of Agriculture of which he was Head from 1975 to 1983, as Director of its Centre for Agricultural Strategy from 1981 to 1990, and as Dean of its Faculty of Agriculture and Food from 1983 to 1986.

For many, these positions and their associated scholarship would be more than enough, but Sir Colin continued also to contribute widely outside of his employment fields both at home and abroad. This service let to his appointment to CBE in 1988 and to a knighthood in 1994; he was an active and successful President of the Institute of Biology and is a member or fellow of numerous other professional and learned societies; he holds a considerable number of fellowships, medals and memorial lectureships from a variety of organisations which have sought to recognise his contributions, and he holds the chairmanship, or similar, of a number of agriculture or animal related bodies. He is much in demand as a broker because he has the political talent to bring together those who cannot come together by themselves and he has the creative ability to encourage them to avoid confrontation in settling their affairs. He sees himself as an outsider to these societies which then benefit from his outsider's view and his natural intellect.

He wanted to be an artist when young, but his creativity has

been channelled into research, into communicating his ideas and into his political broking activities. He is highly organised and efficient, as one would imagine for someone who has consistently done so much, although he does not necessarily enjoy the detail. He relishes the variety of his activities although he recognises that they are but a poor substitute for the continuing happily-married retirement he would have had but for the early death of his wife. Speaking of his situation, he said 'everyone needs to be wanted and wants to be needed – a good marriage has both. So one should retire if happily married. If one is not (happily) married, one must construct a life where, demonstrably, somebody needs you'. He is not active in church life, but his perspective on religion is a world-wide one, reflecting the broad view which is so much his trademark. He is a compassionate man whose interest in animal welfare is reflected in his work for the World Society for the Protection of Animals and the People's Dispensary for Sick Animals, and his latest book *Animal Welfare and the Citizen*.

The Public Orator at Reading, on the occasion of the award of his higher doctorate, said of him: 'His arguments are impeccable and eloquent: it is therefore difficult to avoid seeing his point of view which seldom seems to be a personal one but an inescapable consequence of an analysis which leads to only one satisfactory solution. Before presenting these arguments, he will have listened and will have been patient. Above all, he is a man of great humanity who tirelessly continues to give all his time and his considerable intellectual and diplomatic skills to the service of others'.

▲ *Sir Colin Spedding*

FOUNDATION NEWS

Learned and Professional Society News

The 1999 Salary Survey in respect of the staffs of learned and professional societies is available at a cost of £10 per copy, as is the Register of Learned and Professional Societies 1999 at a cost of £15. Both have involved a considerable amount of work additional to the continuing tasks of producing the bi-monthly Newsletter, organising the programme of bi-monthly seminars and workshops and giving general legal advice.

The recent newsletter contained an occasional paper on a review of the development of learned and professional societies which was the basis of a paper given at the Saturday workshop Briefing for Trustees which attracted twelve participants. Plans are in hand for a seminar on Societies and Lifelong Learning, a joint seminar with the Association of Learned and Professional Society Publishers, and the Learned and Professional Societies' Annual Luncheon to be held on 12 October when the guest of honour will be Lord Neill of Bladen QC, who is the Chairman of the Committee on Standards in Public Life.

The Foundation has also convened two working parties: one has discussed subscriptions and the benefit rule in respect of deeds of covenants, while the other is considering issues in relation to the budget and the review of charity taxation.

Newly Joined Associate Members – January to April 1999

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ENGINEERING AND WORLD POVERTY

The Foundation held a lecture and dinner discussion at the Royal Society on 15 December 1998 on the subject: "Engineering & World Poverty". The Rt Hon The Lord Jenkin of Roding was in the chair and the evening was sponsored by Aerial Group Ltd and the Foundation's Shared Sponsorship Scheme (Comino Foundation, Esso UK plc and Glaxo Wellcome plc). The speakers were Mr John Hodges, Chief Engineering Adviser, DFID, Professor George Fleming FEng FRSE, Senior Vice-President, Institution of Civil Engineers, and Mr Jon Lane, Director, WaterAid.

Mr Jon Lane*

Summary: In his contribution, Mr Lane said that for centuries engineers and scientists had made technical contributions to reducing poverty. Now the problems of poverty were mainly political, not technical. Engineers and scientists had an active but broader role to play.

Introduction

I am a Chartered Civil Engineer, committed to engineers playing a full role in global society. This paper gives my personal view as a practitioner in the field, not a rigorous academic or global overview.

I start with some historical reflections on poverty, then discuss the role of engineers in ending world poverty, then contribute some thoughts to stimulate debate.

Historical reflections

15,000 years ago everybody in the world lived in poverty: life expectancy was low, infant mortality high, people's control over their environment was minimal.

Then prehistoric engineers improved animal migration tracks to make roads, technologists used skins and wood to make boats. These works contributed to agricultural societies' abilities to produce surpluses, which in turn enabled them to support non-productive specialists including scientists.

Those scientists pioneered medicine and invented writing: arguably the two major factors in societies' further development over the centuries. Because of these factors, civilisations around the world slowly evolved at different rates. We think of science as universal and global, but it has caused societies to grow apart.

On a more recent timescale, our medieval ancestors in this country still led unpleasant lives. These lives are now vastly improved. One can debate the relative importance of the rediscovery of Greek culture in the Renaissance; the development of canals; the invention of steam power; even the advances in 19th Century public health engineering. One point is clear, that in all these areas, science was influential in enabling our society to alleviate poverty.

In Western society, we are now living at the highest material standard in human history. Last month, the 80th anniversary of the Armistice caused considerable discussion in the media. Many commentators observed that our society has become hedonistic and greedy, and is increasingly dominated by multinational commercial interests: was that what our grandparents' generation fought and died for?

Looking across the world now, we observe that while we can study water on the Moon and Mars there are still more than 1 billion people on earth who lack water and more than 2 billion who lack sanitation; while we experiment on ageing in space, countless people die before they have a chance to age. Vast numbers in other countries still live as our medieval ancestors did here.

These are unacceptable inequalities between societies. They are getting worse not better, as the 1998 Human Development Report describes so lucidly. Among the future challenges that will exacerbate inequalities are:

- climate change
- increasing population
- environmental deterioration
- over-consumption

Poor people always lose out because inequalities are caused by greed and selfishness on the part of the rich.

The role of engineers

How can we engineers and scientists help to meet these challenges and eliminate world poverty?

I believe that we are privileged to be well educated, and we have a duty to use our knowledge and skills to help others. Engineers are well-placed to help because we are highly respected in developing countries (unlike, some might say, in this country).

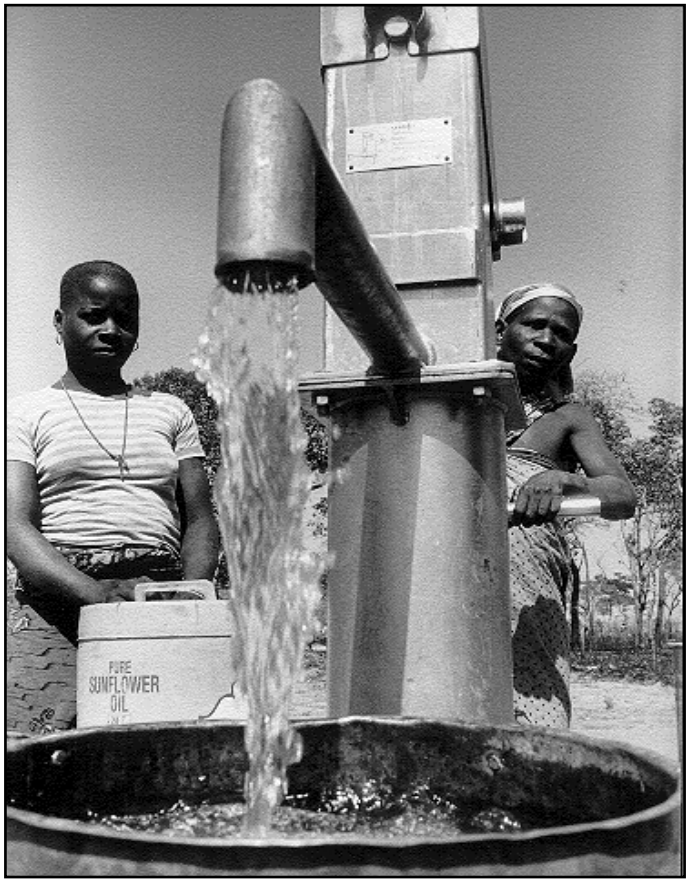
Here are four suggestions for action by engineers and scientists to tackle world poverty

1. Use our natural strengths in solving problems and taking practical action in low-cost, low-technology work. Engineering of this sort may be small-scale but it is far from trivial. It makes a real difference to poor people's lives and builds up their confidence and power.
2. Build up human resources in the developing countries by working alongside our professional colleagues, not talking down at them.
3. Learn humility. We do not always know best but can often learn from the technical ideas of the people themselves.
4. Most importantly, acknowledge that staying within our technical field is insufficient because the major challenges are political not technical. Although engineers are often said to be bad at listening and dealing with people, we must contribute to wider debates and influence the policy makers. Hence we can educate

▲ *Gerald David and Dr Eric Duckworth, both representing the sponsors at the event.*

** Director, WaterAid*

▲ *Fig. 1. Fugu Alale and Awini Apam collecting water from the old source at Zeog-Bukin, Bolgatanga – site of well construction. Courtesy WaterAid/Caroline Penn.*



▲ *Fig. 2. Collecting safe water from a WaterAid-funded handpump in Mozambique. Courtesy WaterAid/Jenny Matthews.*

▲ *Fig. 3. Newah director Umesh Pandey, Newah technical officer Ruhi Wagle, NGO President Chhli Kumari Sharma with the Project Management Committee discuss plans for a new gravity scheme to serve 35 houses and one school. Courtesy WaterAid/Caroline Penn.*

the public in the UK also, so they can appreciate the important issues of world poverty.

Some thoughts to stimulate debate

Here, in a brief question and answer format, are some contributions to stimulate debate on engineering and world poverty:

What are the more efficient ways of overcoming the problems of alleviating poverty?

Work with people, rather than doing things to them. Regard poor people as active agents of change not passive recipients of aid. Promote appropriate technology that can be maintained (noting that low technology solutions typically cost one tenth or one hundredth of the cost of high technology solutions).

How can the problems be identified on the ground, and where can the ideas come from to rectify them?

Identifying the problems is not difficult: the people themselves, local non-governmental organisations and governments can identify them. Typically the problems are a complex mixture of technical, social and political issues and hence the solutions come from all those fields together. (In Tanzania, for example, many villages have a diesel-powered water pump which is not working and an identically diesel-powered maize mill which is working: why?)

What are the best ways of ensuring most aid helps now and invests for the future?

Educate women (arguably the single most important factor in eliminating poverty). Build a strong civil society with a culture of accountability. Influence politicians. Improve health (and hence reduce child mortality, which will in turn reduce population growth).

One example that encapsulates all these ideas is the humble latrine. One of the most useful features of human life on this planet, it contributes to health, privacy and convenience. But why are there no votes in sanitation, and should this always be so?

Is it largely a matter of information and expertise being passed – networking and technology transfer?

20 years ago WaterAid (and others) thought this, but now we see it differently. Technology transfer from the North to the South is not the whole answer. We must encourage more South-South and South-North transfer. Plenty of good ideas exist but are not being used because too many educated engineers and scientists abhor simple ideas. Human resource development is vital but does not just equate to North-South information transfer.

Conclusion

For centuries, engineers and scientists have made technical contributions to reducing poverty. Now the problems of poverty are mainly political not technical: we engineers and scientists must therefore play an active but broader role in eliminating poverty from the world.

▲ *Fig. 4. The humble latrine.*

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