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AN INAUGURAL LECTURE

INFORMATION TECHNOLOGY

The Alvey Report and Government Strategy

Frank Land



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AND POLITICAL SCIENCE

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The Alvey Report and Government Strategy

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THE LONDON SCHOOL OF ECONOMICS
AND POLITICAL SCIENCE

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INFORMATION TECHNOLOGY

The Alvey Report and Government Strategy

INTRODUCTION

The title of this lecture "Information Technology: The Alvey Report and Government Strategy" suggests three connected themes. Perhaps the best way to start is to justify talking about these topics at the London School of Economics.

The use of artifacts for the recording, storage, processing and dissemination of information is not new. Indeed it can be said to be one of the hallmarks which distinguishes civilised from pre-civilised societies. The information technology of the title, however, refers to an entirely new range of artifacts, based on electronics, and whose centrepiece is the computer. The availability of the technology profoundly alters our ability to 'handle' information, though we are still in an early stage of discovering how the technology can be used, and more importantly, how it should be used. The technology itself is still developing and changing, and the pace of change is increasing.

To some the capability of the technology implies a revolution, and they talk about a second industrial revolution, in which "brain" work is increasingly taken over by machines, as in the first industrial revolution machines took over the work of human "muscle". Others designate the society we live in today, and even more so the society we will live in in the next decades as the "information society". They point to the increasing proportion of total resources devoted to information handling of one kind or another in the industrial countries, and the increasing proportion of the work force whose jobs are concerned with information.

It will take the historian of the future to tell whether we are witnessing a second industrial revolution, and if we are undergoing a transformation of society in a certain direction which justifies the title "information society". What cannot be denied is that the new information technology is becoming pervasive - pervasive both in the sense of being widely distributed, and in the sense of being in the public's consciousness. Issues relating to information technology have received a great deal of public attention and its effects for good or bad

is the subject matter for debate. 1982 was designated Information Technology Year by the government in order to increase the awareness of the public, and in particular business, of the benefits that could be derived from using the technology. In other industrial countries, too, information technology is regarded as a key economic asset. In a sense the ability to manufacture and use information technology effectively is regarded by many as a precondition for economic success.

The economic and social issues raised through the growth of information technology is clearly an issue central to the interests of a School of the social sciences both in teaching and research. In the last few months, for example, we have been conducting a study on behalf of the EEC, on the extent to which the use of the technology in industry imposes social controls on those who work with and use the technology. This is part of a three nation study, looking at the impact of information technology in Germany, Denmark and the UK.

The second theme - the Alvey report - is a direct consequence of the importance attached to information technology here and elsewhere. The report was commissioned by the Department of Industry last March to help the government decide how to react to the invitation from the Japanese to collaborate with them in their development of the so-called fifth generation of computer systems. Although the government has not yet officially reacted to the Alvey recommendations they have already become the de facto terms of reference for any proposals for research related to information technology. The recently announced initiatives from the Department of Education and Science for an additional spending of 100 million pounds by the UGC and SERC on information technology is couched in terms of the Alvey assumptions and Alvey recommendations.

The initiative asks the Universities to provide places for an additional 600 graduate students in 1983/84, and to make a large increase in its undergraduate intake of computer science students. The Polytechnics, too, are being asked substantially to increase their intake of computer science students. In the Universities the increased number of students are to be matched by an increase of 70 in academic posts - 40 of which are to be primarily oriented towards servicing the extra teaching required, and 30 oriented towards research in the areas designated by the Alvey report. A further 60 such posts are to be funded over the following two years. At the same time (1983/84) the Science and Engineering Research Board will fund 45 extra Research Fellowships in the

Alvey areas. The LSE reacted to these initiatives by making proposals to the UGC and SERC for taking an additional 25 graduate M.Sc students from the UK, and has put forward for consideration a number of research projects. As might be expected, University departments with even the most remote connections with information technology are bidding for the resources being made available by the government.

HISTORY OF GOVERNMENT SUPPORT FOR INFORMATION TECHNOLOGY

Much of the early work on computers in this country was carried out directly under government auspices in the Second World War. Colossus, probably this country's first digital computer, was developed as a special purpose machine for breaking enemy codes. Some important foundations of computer science stemmed from work carried out at the National Physical Laboratories under Turing with the building of the pilot ACE computer. But by the late 1940's and the early 1950's the initiative had passed to the Universities - Cambridge, Manchester and Birkbeck College - and industry - Standard Telephone and Cables, English Electric, Powers-Samas, Ferranti, EMI, Elliott Automation, BTM, J. Lyons and a few others. Some of the industry developments were the direct outcome of collaboration with the Universities of Manchester and Cambridge and with the National Physical Laboratory.

Although at that time the influence of work carried out in the USA was very important, this country was close behind, and some crucial innovations in hardware and software came from the UK. In the 1950's and the first half of the 1960's there was little indication of a government strategy in relation to the new industry, though Government became increasingly involved as a major user of the technology both in the Civil Service and in public sector industry. Government purchasing power began to be seen as an important factor in the success of the industry. Overall the growth rate of computer purchases was around 20% per annum. But whilst the UK industry was expanding, an increasingly dominant share of the market was taken by American manufacturers, who also began to establish manufacturing facilities in this country, and as a result claiming British status.

The native computer industry reacted to the increasing competition from much larger American manufacturers by rationalisation and mergers. By the mid 1960's the British computer manufacturing industry had consolidated itself into two companies - ICT and English Electric, though military and special purpose computers continued to be made by Plessey, Ferranti, and other companies. The government attempted to help the British industry by

a policy of preferential purchase for its own requirements. Contracts were awarded to UK suppliers unless a foreign supplier could demonstrate significant price or performance advantages, even if the equipment on offer was manufactured in this country.

The growing recognition by Government, that computers and the computing industry were important in economic and strategic terms was signalled by the establishment in the second half of the 1960's of the National Computing Centre and the Computer Board. The NCC was intended to increase awareness in industry of the potential of computers and to set up standards of good practice. It was the NCC which in 1967 awarded the London School of Economics a grant of £30000 to set up teaching and research in Systems Analysis and which resulted in my joining the School from the computer industry. The Computer Board was set up to ensure that all Universities were funded to provide the kind of computer service for research and teaching which was being recognised as essential. At the same time the Computer Board ensured that the British computer industry was given preference in University purchases, even when the University making the purchase would have chosen an American machine.

In the market place American firms continued to increase their share, and the adverse balance of trade in computers became worse. The British companies found it difficult to generate enough surplus to maintain adequate research to keep up with the rapidly changing technology. The government took the initiative in 1967 and forced a merger between the two major British suppliers to form ICL as the single British manufacturer of general purpose computers for the commercial market. At the same time they provided the new company with a grant of thirteen and half million pounds to help in the rationalising of the product range. Subsequently a loan of £40 million was provided for research leading to the development of a new product range. The loan was to be repaid if ICL profitability reached a prescribed level. In practice that level was never reached and after 1984 repayment of the loan is waived. The government itself took a 10% stake in the company, and insisted on nominating a director on the Board. However, the amount of direct control exercised by the government over the running of ICL was very limited. It is interesting to note that at the time of the formation of ICL, and for some years after that, the product range was based on two computers. The ICL 1900 range was first developed in Canada, and the System 4 range, inherited from English Electric was based on a machine, the RCA Spectra 70, which English Electric were allowed to redevelop by RCA under an old established technology-sharing agreement.

The strategy towards the computer industry was in line with the industrial policy of the government in general, which attempted to reorganise British industry through concentration in larger units. If the computer industry received special treatment it was through the single-tender policy of central government giving preference to purchases from ICL.

The increased involvement by Government in the computer industry through preferential purchasing to meet the public sector need for computer power, and through its attempts to restructure the industry, was reflected in Parliament by the establishment of first Sub-Committee A, and subsequently of Sub-Committee D of the Select Committee on Technology. The reports of these sub-committees questioned the wisdom of the preferential purchase policy towards ICL, and suggested that policy should be directed towards the whole industry and not only the manufacturer of mainframe hardware. The reports emphasised the importance of the software industry. But the main thrust of the reports was the stress placed on investment in research and development. The final report recommended government to spend £50 million per year on R & D. into information technology. The government of the day, the Heath government, welcomed the report but maintained its preferential purchase policy and left the level of support for R & D unchanged. After the final report of Sub-Committee D the Select Committee on technology turned its attention to other technologies, and information technology has not had a parliamentary forum for discussion and investigation.

It is reasonable to suppose that those concerned with industrial policy up to the mid 1970's saw the computer industry as a growth industry, and as such one which should receive a certain amount of support. However, the main argument for selecting the computer industry for special treatment was probably based on strategic considerations. Computers had become a vital component of many military systems, and it was deemed important to maintain an independent British capability to provide for that need.

The later 1970's saw two major changes. The first was the change that had taken place in the technology through the development of integrated electronic circuitry on the silicon chip. This development had a dramatic effect on the industry. It reduced the cost of providing the basic electronics, between 1960 and the mid 70's, by a factor of 10,000 and the cost of a complete computer system, including basic software, by a factor of over one hundred. This made the technology available to a range of new markets, and it led to a change in the structure of the industry. The producers

of the basic chips - mainly situated in America - became as important a component of the industry as the manufacturers of the computers. On the other hand the ability to produce micro-computers no longer required the massive research and development budgets generated by high turnover companies like IBM. As result a large number of small companies entered the industry successfully.

The second change was the turnaround from industrial growth to recession and industrial decline. The decline in the traditional manufacturing industries in this country resulted in a call for the establishment of new industries - the so-called sunrise industries, characterised by high added-value and based on advanced technology. A prime example of such an industry is the information technology industry, and in particular elements such as software engineering. In practice, however, the dominance of the USA was increasing, and if it was being challenged that challenge came from Japan. The adverse balance of trade in information technology products was widening, and despite Government support ICL was struggling to survive.

A quotation from a report to the Cabinet Office by the Advisory Council for Applied Research and Development published in 1978 illustrates the impact of these changes. Referring to the technological changes the report states "This is the most influential technology of the Twentieth Century", and then goes on "...properly seized and harnessed (the technology) is a potential source of great benefit; if we neglect or reject it as a nation, the United Kingdom will join the ranks of the undeveloped countries." The new strategy of Government in the second half of the 1970's was designed to widen the support for the industry. Through the National Enterprise Board the government established a new software development and marketing company with the aim of providing a major software exporting capability. The new company required, and at first received, support and collaboration from the most important British software companies. At about the same time the NEB provided £50 million for setting up a UK facility for the manufacture of chips by INMOS. INMOS was founded with capital from the NEB and some private American capital. To take advantage of American expertise in VLSI - very large scale integration - INMOS established its main research and its first manufacturing facilities in Colorado, though it has set up a factory for the production of chips in Newport. At present INMOS produces certain special purpose chips in which it has established a leading position, but it is not yet

profitable and has recently had to ask government for a further capital loan. The collaborative software company has failed to make a mark, and its founder collaborators have withdrawn.

The importance attached by Government to information technology in the most recent years is indicated by the fact that it has established within the Department of Industry a Minister with responsibility for Information Technology, and by the launching of IT 82 as the Information Technology year. The government has selected the technology for very special treatment. At a time when education expenditure is being cut, education in information technology has been given a very significant boost, affecting all levels of education from primary schools to universities. A government noted for its dislike of public sector support for industry has put further capital into a company like INMOS. We await its response to the Alvey Report with interest.

In the meantime ICL, under new management, has staged a recovery, and is once again basking in City approval. The new management has followed a policy of extending the product range by collaborative agreements with Japanese and American firms. In the middle of the range they have introduced the Fujitsu Atlas computer. At the bottom end of the range they have adopted the Perq super-micro from the American Three Rivers company. It is clear from the history of developments in this country and abroad that, left to themselves, companies will form alliances with companies from other countries independent of any national policy.

PUBLIC POLICY IN THE REST OF THE WORLD

The dominance of American industry in information technology has had a varying impact on policy in western industrial countries. In France, government policy has been directed repeatedly at an attempt to build a strong, and independent local industry, without succeeding in shaking the dominant position of American companies. The Plan Calcul attempted to rationalise the French computer industry. As in the United Kingdom, the industry allied itself with American firms despite the inducements offered by the Plan Calcul. Other countries, Germany, for example, adopted a less openly nationalistic stance. Nevertheless they provided strong support for their own computer industry by means of a policy of preferential purchases, and by the spending of considerable amounts on university-based research. There is a strong intellectual movement in Europe fostering the concept of total independence from American industry. Even American manufacturers with strong European subsidiaries would not be counted as European by the advocates of the European policy.

In the 1970's this movement led to a major attempt by the EEC Commission to foster an independent European computer industry based on the principal computer companies in France, Holland, Germany and the UK. Four companies - Phillips, Siemens, Olivetti and CII - were persuaded to merge their computer interests in a single company, Unidata. ICL were asked to join the venture, but as the largest independent European computer manufacturer, they felt the arrangement would not be to their advantage, and they declined the invitation. In the event Unidata started to develop a range of computers based on the products of the parent companies. But the conflicts of interest were too great and one by one the parent companies withdrew. The French company CII, set up under the Plan Calcul, later merged with the American company Honeywell. In Germany, Siemens later took over the computer interests of the bankrupt Telefunken, despite a prolonged and costly attempt by the German government to save Telefunken.

Within the EEC Commission the ideal of the independent European computer industry lives on. Recently the Commission set up its ESPRIT proposals for a collaborative research program to be jointly funded by the Commission and 12 major enterprises in the information technology industry. The ESPRIT proposals are the EEC reaction to the Japanese fifth generation initiative, and look to an independent European development plan. The ESPRIT project is currently seeking research proposals from universities and research establishments.

In America, central Government has for a long time had significant influence over developments in information technology. The influence has been exercised through the vast spending power of the Department of Defence and projects such as the space program of NASA. A good example is the development of the programming language COBOL. COBOL became the most widely distributed and used language for data processing because the Department of Defence refused to accept tenders for the supply of computers unless the supplier had implemented COBOL on his computers. Because orders for several hundred computers were at stake, all hopeful suppliers implemented COBOL. The leading position of the USA in VLSI is at least in part due to the demands made by the space program. In recent years the USA has begun to fear competition in information technology from the Japanese. Already Japanese chip technology is rivalling that of the USA, and in some areas they are achieving a dominant market position. America, like Europe, is reacting strongly to the new Japanese fifth generation initiatives. A Pentagon paper has set out the dire consequences of letting the Japanese take a lead in the

next developments in the technology. There is little doubt that American funding for research into all aspects of information technology will increase, and that suppliers will obtain lucrative defence contracts. The scale of the funding for research and development is high. In 1981 it was estimated to be \$10.8 billion, of which 49% was provided by the government.

The Japanese have for some time worked on a basis of government-industry collaboration, combined with a market oriented program of product development. The Japanese government tends to provide 100% funding for basic research, but as programs move towards the development phase industry and government share expenditure on a 50/50 basis. The main stimulus which led to the Pentagon paper in the USA, the ESPRIT proposals in the EEC, and to the report of the Alvey committee in this country, was the research and development program launched by the Japanese two years ago. This program called for the development of a Fifth Generation of computers to be available in the 1990's. The chief characteristics of the fifth generation are to be the great increase in power stemming from improvements in VLSI technology and new computer architectures, the development of software systems which enable a computer to capture and and manipulate "knowledge", and programming languages based on logic. The increases in computer power aided by the new software would enable the computers to carry out a range of tasks beyond the capability of present day computers. In particular, it is anticipated that the fifth generation technology will be able to cope with unstructured problems in conditions of uncertainty. To do this, developments need to draw heavily on the work done in the field of artificial intelligence.

Because the Japanese have less experience than their competitors in some of the key areas such as artificial intelligence, they have suggested that the fifth generation developments should be carried out in collaboration with other countries. The Japanese government made proposals for such collaboration with the USA, Britain and European countries and invited delegations from potential collaborators to visit Japan.

THE ALVEY REPORT

The Minister for Information Technology, Kenneth Baker, set up the Alvey committee in March 1982, and the committee reported in September 1982. Perhaps the best way to start a discussion on its findings is to quote from the introduction to the report:

"The catalyst to the formation of the Committee was the unveiling last October of Japan's Fifth Generation Computer Programme, and Japan's invitation to other countries, including the UK, to discuss participation in this Programme. The UK delegation to the conference in Tokyo at which the Programme was announced reported back to a conference in London in January (1982), which was attended by a representative cross-section of industrialists and other experts. The scale and cohesiveness of this and other Japanese programmes were seen by this conference as a major competitive threat. There was also the response to the Japanese programme which was bound to be made by the US industry which would create an equal if not greater degree of competition for the UK industry. In the light of these factors the conference called for an urgent study into the scope for collaboration in the UK, geared to our particular strengths and requirements. Our remit was to conduct this study."

The emphasis of the committee's brief was to investigate the "scope for collaborative research programmes in information technology".

The committee identified four aspects of information technology which it regarded as of fundamental importance if the United Kingdom was to take a leading position in world markets. The committee called these the four enabling technologies. They are:

1. Very large scale integration (VLSI), which is concerned with the design and manufacture of the integrated circuits - the chips - on which the whole of modern information technology is based. The technology is still undergoing rapid development, resulting in order of magnitude improvements in speed and capacity for the foreseeable future, combined with order of magnitude reductions in cost per unit of power. At present the USA and Japan dominate both the supply of these fundamental components, and the research and development for future products. The Japanese, in particular, have demonstrated the rapidity with which research ideas can be translated into effective products, mass produced.
2. Software Engineering, which is concerned with the efficient specification and generation of the instructions for the machine. Software is a major component of all IT products, and accounts for an increasing proportion of their costs. Computer

people speak of a software crisis. What they refer to is our inability to build systems except by the use of ad hoc techniques, our inability to verify that systems are soundly based and reliable, the lack of flexibility of software products in their inability to adjust to changing needs, and the shortage of well trained people with the knowledge and skill to exploit the best techniques available. However, this country has a well established software industry, with a world-wide reputation.

3. The Man/Machine Interface, defined by Alvey as the instruments for input to, and output from the computer, designed in such a way that they are truly acceptable to the user. In Alvey terms research into the man/machine interface is research into devices for recognising speech and pictures, and for producing speech and pictures. Alvey regards the development of such devices as the key to making systems acceptable to a wide range of users.
4. Intelligent, knowledge-based systems (IKBS), which are in a sense, the centrepiece of the Alvey report. Intelligent, knowledge-based systems have been defined by a panel set up by the SERC as "...systems (which) will process ideas: they will be fully intelligent systems capable of carrying out several complex, incompletely specified tasks, for example image and text description, industrial tool design and testing" and systems which have "inferential procedures for applying this knowledge and reacting to variegated and unreliable inputs in a changing environment". We cannot build systems with these capabilities now, but the Japanese regard IKBS as the ultimate aim of their Fifth Generation Programme. Many of the ideas and products, such as "expert" systems, which are leading towards the ideal IKBS have been generated by the artificial intelligence community in the USA, and to a lesser extent in this country. There is a small body of researchers in this country which Alvey considers to be a suitable starting point for a major push in research and development.

The main recommendations of the Alvey Committee can be quickly summarised:

1. There should be a national programme for Advanced Information Technology, embracing the four enabling technologies. This will cost £350 million over five years, though in the committee's view for some aspects - for example IKBS - a ten year programme is envisaged.

2. The programme should be a collaborative effort between industry, the academic sector and other research organisations. The major funding should come from government, with an overall ratio of government to industry spending of 60%. Where a very wide dissemination of the results is required work would be funded 90% by Government. Other work should be 50% government funded. £57 million would be set aside to support research and training in the universities and polytechnics.
3. The programme needs to be firmly driven. For this purpose Alvey recommends the establishment within the Department of Industry of a new Directorate charged with implementing the programme. In charge should be a Director, hand picked for the job, and with enough authority and autonomy to act "speedily and flexibly". The Science and Engineering Research Council, and the Ministry of Defence should be directly involved in the management and control of the programme strategy.
4. "The programme must be run as a UK effort. Foreign multinationals should participate only where they can contribute a particular asset vital to the programme; where the result of their involvement will be available to the benefit of UK industry as a whole; and where it is guaranteed that valuable technical information will not leak from the UK." The report notes that comparable programmes are in process of being mounted in the USA, in Japan and in various European countries, and that these rival programmes represent a serious challenge to the UK, which must be faced.

The report concludes with a serious warning: "Unless there is action to implement the Advanced Information Technology Programme the prospects of the UK competing successfully in the world IT market will be sharply reduced. The spread of advanced IT applications in the UK will also be constrained. Both of these would be extremely damaging to employment prospects, to our industrial efficiency as a nation, and to our general economic position." The warning has more recently been echoed in a report published in March, by the Information Technology Sector Working Party of NEDO. The report points to the continuing increase in the adverse balance of trade in information technology. The present trade deficit is estimated to be £150 million per year. This, it is suggested could rise to £1000 million by 1990 unless the present trend is reversed. The UK's current share of world markets in IT is only 5%. Unless we act now, the working party concludes, the UK will be out of IT by 1990.

The Alvey report has received wide acclaim from the IT industry and the academic computer science and artificial intelligence community. The government is being pressed to commence implementation of the Alvey recommendations rapidly, to avoid the UK falling further behind its rivals. In those communities and in the Science and Engineering Research Council and its laboratories the report has received de facto recognition and forms the basis for the approval of research applications. It is believed that within Government, too, the overall philosophy of the report has met with approval, though no official response has yet been made.

Before we settle down to mourn our lost economic future if the government refuses to accept the Alvey findings, or to cheer their acceptance, a number of questions need to be asked. Firstly are the assumptions which underlie the Alvey report soundly based? Or do they reflect the special pleadings of an interest group? Secondly are the proposals practical? Or are some of the recommendations more viable than others? Thirdly even if the prognosis is correct, and the recommendations workable, does Alvey represent a complete strategy for the government to follow? Or are there other policies not yet articulated on the scale of the Alvey policies, which are essential if Alvey is to achieve its aim?

THE CRITIQUE

The Alvey report states that its proposals rest on five propositions:

1. "The world IT market is one of major growth. The UK needs to capture the largest possible share of this market, but on current trends its share will decline." Alvey points to the potential size of the market and its opportunities for employment and by implication for profit.

All the evidence suggests that the Alvey assessment of future trends is accurate. But does the main proposition hold? Does the UK need to have a greater share of this market? It could be argued that it is more important to have access to the technology than to manufacture it. The most important factor in terms of economic success may be that industry, commerce and administration learn to make effective use of the technology, whatever its source.

Alvey seems to argue on the basis of the first proposition that this country must develop its technical capability independently of its main competitors. The report suggests a programme which, with its insistence

on a national effort, and its prohibition of leaks, smacks almost of a Manhattan Project. Alvey does go on to allow for a possible cooperation with the ESPRIT proposals of the EEC. But it does so on a limited and restricted basis.

An analysis of the behaviour of the computer industry in this country and in Europe indicates that technology sharing agreements and commercial collaboration with the industry of countries regarded as our competitors can and does work. The agreement between ICL and Fujitsu provides the UK with a capability in basic circuit technology it would otherwise not have. It provides industry with an alternative source for large machines and reduces dependence on American suppliers. It makes available to ICL, and through ICL to this country, Japanese expertise, and some of the money spent by the Japanese government in its support of the Japanese computer industry. Similarly, collaboration with American manufacturers makes available to the UK a portion of the vastly greater sums provided by the US government for research, than could be provided by a national programme many times the size of that proposed by Alvey. A policy which actively seeks collaboration would have to recognize that UK expertise would have to be shared with the foreign collaborators. A policy of competition based on nationality may well turn out to be a zero sum game: and the game is likely to go to those who have the highest cards now. A policy of collaboration is more likely to be a non-zero sum game. It can be argued, however, that collaboration is not possible unless there is a strong native technology base which is at the leading edge in the research and development.

In the end the argument for a nationalistic policy in relation to IT may be based more on strategic thinking than on economic thinking. The fear, which is expressed explicitly by Alvey and which appears again and again in comment from Europe, is that reliance on a competitor's technology would leave the UK (and Europe) vulnerable to a withdrawal of that technology.

Perhaps the strongest conclusions which can be drawn from this discussion is that an effective presence in IT industry is desirable, in the first place, because it increases the possibility of collaboration on equal terms with our competitors. In the second place, it provides an opportunity for the growth of a profitable industry, and the creation of new jobs. In the third place, it reduces dependence on foreign suppliers and thereby provides a measure of strategic independence. The case for insisting, as Alvey and others insist, that the UK must have a strong and independent IT industry is not proven.

2. "A necessary, though not a sufficient, condition for reversing this trend, and increasing our world penetration is that we have competitive levels of achievement in certain fundamental enabling technologies." These technologies are: VLSI, Software Engineering, Man/Machine Interface, and IKBS. Alvey recognises that the four enabling technologies do not encompass all the technologies or skills needed for success, but that without these four no future is possible.

Alvey's phrases are forthright: "The issue before us is stark. We can either seek to be at the leading edge of these technologies; or we can aim to rely upon imported technology; or we opt out of the race. The latter we do not regard as a valid option. Nor is reliance upon imported technology practical as a general strategy." An alternative strategy based on finding industrial partners, even from countries regarded as competitors, is not excluded by Alvey, but very little weight is given to it.

3. "These enabling technologies, and the infrastructure and systems which connect and exploit them, can be identified now."

It is not difficult to criticise details of Alvey's programme for the four enabling technologies.

The concentration, in its discussion of a programme for the man/machine interface, on voice and image input and output devices might be considered absurdly narrow. The deeper implications in terms of skills, job satisfaction and the quality of working life, which are crucial if the technology is to be used successfully, are totally ignored. The belief illustrated by the programme to "develop a set of reliable tools/techniques/guidelines for rapidly and effectively analysing the decisions of human experts in order to produce a detailed, formal and accurate description of the decision process", displays a suprising ignorance of real world decision environments and decision processes, and ignores most of the work carried out in the past few years on decision support systems.

The insistence, in the section on software engineering, of standardisation by means of Integrated Programming Support Environments, and the choice of the UNIX operating system as a basis for such an environment might be considered unnecessarily restrictive at this stage of developments in systems engineering. UNIX is widely used in research establishments, but has had little impact outside the research community.

There are many issues relating to the details of the programmes which should be the subject of further debate, and it is to be hoped that the Alvey proposals are not regarded by anyone as a set of frozen specifications. In the meantime much of the Alvey research is well founded, and provides an excellent starting point for detailed research proposals.

However, there are a few more important issues relating to the choice of the four enabling technologies, and the treatment of these in the report. The first of these relates to the choice of Intelligent Knowledge Based Systems as the central enabling technology. The treatment of IKBS in the report is excellent. It emphasises the importance of bringing the user into the research programme, and puts forward a wide ranging programme for demonstrator projects. The suggested programme for research is well thought out, and does not underestimate the problems that have to be faced. But behind these proposals is the assumption that the future use of computing will follow the IKBS path. And behind that assumption lie some rather doubtful epistemological and behavioural propositions. As yet there is little evidence from the market place, or from research, that all, or even most applications of the technology will benefit from the IKBS approach. There is a need to divert research resources to look at alternative approaches to the use of the technology such as that offered through the concept of decision support systems. At this stage in the development of the technology it may well be worth while to "shadow" some of the proposed demonstrator projects using IKBS, with projects which seek alternative solutions to the problems the IKBS has been set up to solve.

The second question relates to the omission from the list of enabling technologies, of communication technology. Communication technology, such as fibre optics, satellite communications, communication protocols, public and private networks, have a central role in the computer systems of the future. The communication industry is an important national resource. All the other technologies selected by Alvey interact with communication technology.

4. "We require a strong domestic capability in these technologies since we cannot depend on other countries supplying them." This proposition is supported in the report by the suggestion that putting reliance on foreign industry would throw away the investment in manpower and capital already made in the UK. Further, technology supplied from abroad would require domestic expertise if it is to

be properly utilised, and finally, relying on foreign manufacture would throw away the opportunity for competing successfully in world markets for IT.

The supporting statements do not seem to address themselves to the main proposition which is concerned with the risk of other countries withholding technology from potential UK users, or of foreign suppliers not making the technological progress which UK industry has a right to expect.

5. "To achieve the capability a national collaborative effort is required. This means Government backing." The proposition is supported by the arguments that because of the intrinsic difficulty and complexity of the technology no single organisation has the know-how to make progress on its own, or can spare the necessary resources for what are high risk and long lead time projects. However, there are sufficient technical resources available in the UK to pursue the development programme collectively.

The case for a collaborative effort between industry, academia and other research establishments has been widely accepted by industry and commentators on the Alvey report. The conclusion Alvey draws on the kind of direction and control the project should have, and the method of financing the programme has given rise to more discussion. Is a Directorate within the Department of Industry the appropriate mechanism for steering the programme?

Perhaps more important than the location of the Directorate, is its style and orientation. It is essential that those who steer the programme have primarily a market and organisational orientation and not only a research or technology orientation. The Director must be someone who has a basic scepticism for the claims of the technological propagandists, and who has an understanding and sympathy for the social issues raised through the spread of the technology. This issue is highlighted by looking at the kind of people who were chosen to sit on the Alvey committee, and to work on its working groups. All but one of the non-civil service members of the committee represented suppliers or research interests. All members of the working groups represented the same interests. Of the 115 organisations which are listed as having provided substantive inputs to the committee only three can be said to represent the user rather than the supply or research side of the industry. The three were ICI, the CEEB and the Hospital for Nervous Diseases. The outcome of this selection is bound to be a one-sided viewpoint of the problems, and a set of proposals which favours certain kind of solutions over others.

Other questions are raised by the Alvey insistence on using Government funding to provide 60% of the money resources of the programme. It is accepted that the education part of the programme needs to be fully funded through the DES. One critic has suggested, however, that the capital market should make itself responsible for funding much of the collaborative research. It is suggested that a special fund should be established by institutions like the pension funds to allocate resources to high risk programmes. The involvement of the capital market in the programme will ensure, it is suggested, a more market oriented approach to the research and a more urgent approach towards getting results. It is important that small as well as large enterprises have access to the supply of venture capital. A capital fund geared to the provision of venture capital may achieve this more successfully than a Directorate inside the Department of Industry.

Other countries have used their capital markets to better effect than the UK. In the USA high risk, high technology companies, can obtain venture capital. In Japan the banks appear to be prepared to take a much longer view over investment returns than are the banks in this country. Perhaps a reorganisation of the capital market is as important to the successful development of IT, as the best research proposal.

SOME ADDITIONAL PROPOSALS

The recommendations of the Alvey report are grounded on the five propositions we have just analysed. But there is a sixth proposition, as important for the future of information technology and this country, as any of the five set out in the report. The sixth proposition which Alvey might have articulated if the members of the committee had thought it was within their terms of reference is:

6. "Without a base of knowledgeable, successful users of Information Technology in this country, the IT industry cannot compete in world markets." It is only through the effective application of the technology that the suppliers can learn to produce the products the market wants. And the best market for that purpose is the domestic market.

If this proposition is accepted as valid, a number of consequences follow. Perhaps the most important is that it identifies a further enabling technology - Systems Analysis and Design (SAD) - and a programme for research and education in that technology.

Systems Analysis and Design is concerned with the process of identifying the information needs of an organisation and developing a system which combines the capabilities of the human operator with the facilities provided by information technology, so as both to meet the operational needs of the organisation, and to provide the human operator with a high quality of working life. Experience with existing information technology, and existing systems analysis and design methods, provide evidence that the implementation of effective systems is difficult and complex. Much more research is needed on the actual impact of information systems on organisations and their employees, on methods for the measurement of effectiveness, on the impact different analysis and design methodologies have on the implementation process, and on the way organisational variables affect the successful use of information technology. At the same time there is a need to develop and try out new methods, tools and techniques of analysis and design, methods which can themselves utilise the new techniques coming from the field of IKBS and Software Engineering. The research will complement and interact with the research programmes in IKBS and the man/machine interface.

The philosophy which underlies the Alvey strategy, and indeed underlies much of government strategy towards information technology in the past, is one of technology push. The approach assumes that a good technological innovation will find a market and emphasises the supply side of the industry. Resources are made available for product design and development. The assumption is that the market has to be educated to understand what the technology has to offer. This principle is illustrated by the Alvey recommendation for demonstrator projects. The object of a demonstrator project is not primarily to help the technologist understand a user's needs, but to demonstrate to the user that the technology can be of value to him.

There is little evidence that a pure technology push approach can work in a situation where market needs are uncertain and undefined. In the ethical drugs industry technology push has been known to work. Drug companies have produced new drugs and then persuaded the market to buy them. But the suppliers have prior knowledge of the diseases which still need treatment. The suppliers of information technology know far less of their potential market.

The alternative approach is to look to the user to define his needs, and then to engineer products to meet that need. The success of that approach was illustrated by the American space programme, and both the Japanese

and French attempts to develop their IT industries rely heavily on assessments of what the user of the future may require. However, a market led approach can only work effectively if the user has some understanding of what the technology can provide.

What this analysis suggests is that the optimum strategy for the development of information technology must rely on a dual approach. One approach - the supply side, technology push approach - has been well delineated in the Alvey report. The other approach - the complementary market led approach still needs definition. What is needed is to take a number of organisations, and as part of a collaborative research programme, to investigate their corporate plans for a long period ahead in order to identify the way they will need to develop information systems to help achieve those goals, and the kind of IT which may support the information needs. It is possible to suggest a number of studies of this kind. For example a study should look at a large government system such as that for the collection of taxes, and untrammelled by the normal guidelines for a systems study investigate possible tax systems of the future. Another study could look at the needs of small businesses in the future, and others at different application areas, and different types of organisation. Funding for such studies would have to be provided out of the funds for the new IT initiatives. Such studies would help to ensure that the development of the technology is congruent with the needs of the market place. At the same time it would help to increase the technologists understanding of real world problems, and the user of information technology potentials.

CONCLUSION

The Alvey report has defined what is probably the best possible programme for building an information technology Concorde. Perhaps the IT Concorde would be a world beater and totally successful in market and economic terms. Perhaps the IT Concorde would halt the decline of the UK economy. To the builders of the Concorde aircraft it was obvious that the next step in air transport should be the supersonic passenger airliner. Are the designers of the IT Concorde making the same mistake as their aerospace counterparts?

What is needed, surely, is a programme which builds up technological capabilities on a wide front, with as much flexibility in terms of end purpose as possible. At the same time the programme must have a component designed to ensure that the technological capability produces the products which the real-world users actually need. If that product turns out to be the IT Concorde, nothing

will have been lost. But if the product needed turns out to be different, or if, as is more likely, it turns out to be a range of products with a range of facilities, we will have an opportunity to select those elements which give us the best chance of gaining a world market.

The most important modification to the proposals then are, firstly, to recognise that we can no longer use national borders to define a programme, and to encourage instead international collaboration based on a strong domestic industry. Secondly, to introduce into the programme Systems Analysis and Design as a crucial enabling technology. Thirdly, to reconsider the list of enabling technologies to check whether communications technology should be included, and fourthly to establish a complementary programme of collaborative research into the user needs of the future. The Alvey programme supplemented by these proposals, would have a good chance of achieving the goals which the Minister set for it.