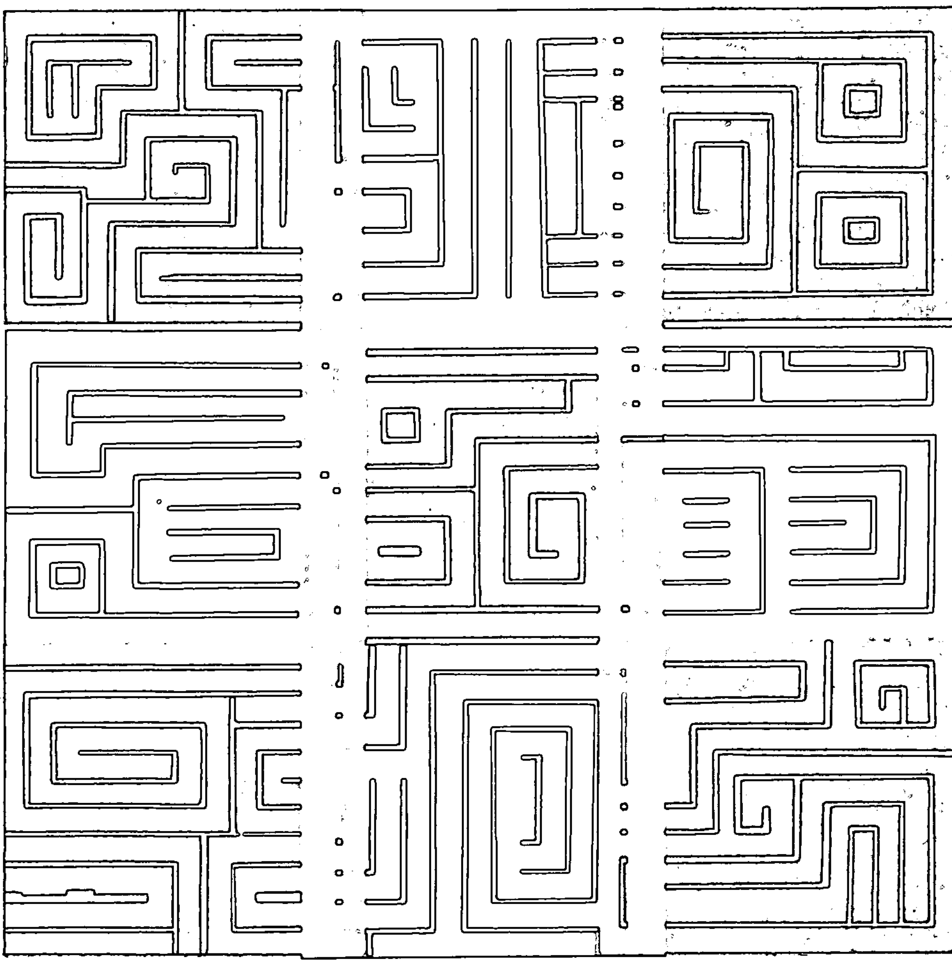
A time for decision? Computing policy and practice in the NHS

FOUR PAPERS BY

S. I. HERBERT · BRIAN W. H. MOLTENO
J. R. ASHFORD · GORDON CUMMING



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Membership of the Health Information Working Party

Professor Gordon Cumming. *Director, Midhurst Medical Research Institute*

Dr A. M. Adelstein. *Chief Medical Statistician, OPCS*

Professor J. R. Ashford. *Department of Mathematical Statistics and Operational Research, University of Exeter*

Dr J. A. Baldwin. *Director, Oxford University Unit of Clinical Epidemiology*

Dr J. M. Forsythe. *Regional Medical Officer, S.E. Thames RHA*

Oriole Goldsmith. *Area Administrator, Coventry AHA*

Dr M. A. Heasman. *Scottish Health Service Common Services Agency*

Professor Ian McColl. *Department of Surgery Guys Hospital Medical School*

B. W. H. Molteno. *Regional Management Services Officer Trent RHA*

D. Poynton. *Area Treasurer, Coventry AHA*

Gordon McLachlan

J. C. C. Smith

A review of computer policy and practice

Prologue

One of the continuing interests of the Nuffield Provincial Hospitals Trust has been the need for, and the use of, better information for management, both operational and clinical, in the general field of health care. An extensive programme of research began in 1943 with the establishment of Bureaux of Health and Sickness Records in Oxford and Glasgow, followed by a number of projects over the next decades aimed at improving the use of medical records. During this period, the Trust was also involved with studies concerned with the introduction of computers in medical care (1). It is currently supporting an experiment in the field of medical record processing using new micro-technology (2). This continuing interest stems from the realization that adequate information, coupled with the skills to use it, are necessary features for successful management and clinical practice which will lead to improvements in health care. It would be satisfying to record that some of the lessons from the published record of this programme had been learned and applied. Unhappily the evidence suggests the contrary.

The straitened economic circumstances of the nation have spilled over into the NHS. In the interest of sustaining patient services, economies have been sought in expenditure on management. This has tended to frustrate the earlier plans to develop the information function in 1974 (3) and the use of resources for information gathering for management has had a low priority. While certainly there have been some achievements since 1974, the inability of many authorities to embark on the development then envisaged, has led to disillusion and inertia. The value of good information has been under-rated in other fields. The continuing, and in many respects distracting, debate about the role of Community Medicine Specialists and their deployment has over-shadowed the undoubted needs of epidemiologists and medical planners for better information. Again, despite the Thwaites Report (4) and the work of the National Training Council and the National Staff Committees, little change in emphasis has yet been introduced into senior management training. As a result, communication between management and computer and information specialists is not sufficiently good to extract the most advantage from modern techniques.

It was against this perspective that the Trust decided to establish a working group to review the state of the art of health services information and to consider what might be possible by way of practical improvements. Since it is inconceivable that any significant developments in information systems could be contemplated without an assessment of the capabilities of modern computers, an integral feature of the review was an analysis of the state of computing in the NHS and the potential of modern computer technology. Analysis revealed issues and uncertainties of some importance.

This book assembles essays by leading contributors in the field of health computing. The first is a comprehensive review, commissioned from Ian Herbert, tracing the history and present state of computing policy and practice in the NHS. In the second Brian Molteno looks at the real nature and effects of computer policy in the last decade, speculating on the room for standardization as a policy objective in an organization made up of many various and autonomous parts. He sees realism, flexibility and diversity as essential components of future policy. In the third essay, Professor John Ashford discusses developments in technology and the opportunities they present for the benefit of future policy and practice. In the final essay Professor Gordon Cumming develops the theme of future policy options and examines the mechanisms likely to be necessary to bring them to fruition. The various strands of these essays are brought together in an Epilogue, identifying the issues to be addressed and indicating an urgent need to re-examine computer policy and practice in the interest, not least but also not alone, of establishing a more effective information base for the NHS.

It is conceivable that the Committee of Public Accounts (5) may wish to follow up its previous examination of computer policy for the NHS. Important changes are also being considered in the range and extent of Government statistical services and the future coverage of health care information is currently under review. In all these matters the future direction of computer policy for the NHS is bound to have a significant impact. It is in this context that this volume, with its analysis of the implications of past policies and pointers to the future, is offered as a timely contribution to the debate.

REFERENCES

1. Relevant publications include: *The Flow of Medical Information in Hospitals* (1967); *Computers in the Service of Medicine*, I & II (1968); *Focus on Medical Computer Development* (1970); *Challenges for Change* (1971); *Foundations for Health Service Management* (1972).

2. *Tenth Report of the Nuffield Provincial Hospitals Trust* (1980).

3. DHSS (1972) *Management Arrangements for the Reorganised NHS* (London: HMSO).

4. *The Education and Training of Senior Managers in the NHS* (London: King Edward's Hospital Fund, 1977).

5. *Eleventh Report of the Committee of Public Accounts* (1980) HC498 (London: HMSO).

S. I. Herbert
Update Ltd
Department of Mathematical Statistics and Operational Research,
University of Exeter

Acknowledgement
Without the co-operation of a wide variety of people from whom information and views have been sought, this report would not have been possible. The cast is too numerous to mention here but it appears as Appendix 1. My grateful thanks to them for the time and effort they accorded to my enquiries. As always, errors or omissions remain the responsibility of the author. I am also much indebted to the staff of the Nuffield Provincial Hospitals Trust and its Health Information Working Group, for their patience, kindness, and encouragement.
Exeter, April 1981

A review of computer policy and practice

Introduction

BACKGROUND

This report is a personal view of computing in the National Health Service (NHS). It provides a snapshot of NHS computer practice and policy today, concentrating on evidence for England and Wales, a brief description of computing practice in Scotland being included for comparison. The problems identified are examined and possible ways of achieving some solutions are suggested.

Earlier publications on NHS computing have been used to provide an historical perspective for this report. For England the foremost (and oldest) amongst these is 'Using computers to improve health services', a comprehensive review of the position in 1972 produced by McKinsey. It put forward a programme for the development of computer services which had a considerable impact on policy in the years that followed. One consequence was the publication by the DHSS of an *Annual Review* of computing in the NHS in 1973 and 1974, a condensed *Profile* in 1975, and a two-part *Synopsis* in 1977. The first volume of the 'Synopsis' included a summary of NHS computing; the second, a catalogue of the hardware and software in use. These volumes contained little quantitative data and no indication of the associated costs. The hardware and software registers have been maintained since then, although the procedure for keeping them up-to-date has been less than perfect; copies of the registers are confined largely to Regional computer units and the DHSS. Since the *Synopsis* of 1977 no general review of NHS computing has appeared although studies of specific aspects, such as computing capital stock, have been conducted on a national scale by individual officers within the NHS. Statistics about computer staff employed in the NHS are collected annually by one Regional Computer Service Officer. Other information is available from the DHSS and Regions but its coverage is limited.

Computing in Wales was not covered by the McKinsey report, but an appraisal of its computer services appeared in the subsequent 'Reviews', 'Profile', 'Synopsis', and hardware/software catalogues. In May 1978 the Welsh Health Technical Services Organization (WHTSO) published the *Report on a Survey of Computing Facilities Required for the Health Services of Wales in the 1980s.* This contained a survey of the use made of the existing facilities but excluded computing used for scientific purposes.

The early growth of computing in Scotland was chronicled in *Focus on Medical Computer Development*, a study of the Scottish scene carried out by Scicon for the Nuffield Provincial Hospitals Trust, published in 1970. Like the McKinsey report it suggested a computer policy and the costs of implementing its recommendations. This was followed in 1972 by *Foundations for Health Services Management*, the report of a study commissioned by the Scottish Home and Health Department (SHHD) from Scicon. This report concentrated more on health service information requirements than on computing. From 1973 onwards an annual report has been issued by the Scottish Health Service Working Group which includes a comprehensive catalogue of hardware with some information as to its use. In March 1980 the Scottish Computer Policy Review Committee issued its report which examined the current situation and gave costed policy proposals.

A number of other analyses of computing in the NHS have appeared, those by Alderson (*A Review of the National Health Service's Computing Policy*, 1976) and Rivett (*Progress in Health Service Computing*, 1975) being most germane to this report. One of the most relevant recent publications is a joint management/staff side study of NHS computer staffs, carried out in 1979. It covered the United Kingdom as a whole, comparing the pay and conditions of service of NHS employees with those outside it.

THE APPROACH USED

A 'computer system' includes not only the central processing unit, but also the associated terminals and peripheral hardware. Networks of computer systems involving more complex interactions of a variety of components are becoming increasingly commonplace. It is probably in the field of process control (imaging, signal analysis, patient monitoring, radiotherapy, and patient measurement) that computer systems have contributed most directly to patient care. But, for the purposes of this study, the consideration of computer systems which form an anonymous, integral part of some larger piece of equipment has been excluded. Such systems cannot normally be programmed by the user, nor do they relate directly to the wider issue of health information. The same is also true of 'turnkey' or 'black-box' systems such as word-processors. (A 'turnkey' or 'black-box' system is one that is installed as a complete hardware and software unit designed to achieve a given function.) Computers devoted purely to medical teaching have not been studied.

The users of computers within the NHS fall into three groups:

National bodies: the main example in England is the Dental Estimates Board (DEB). The Prescription Pricing Authority currently makes little use of computers. The DHSS does some computing on behalf of the NHS, notably running the Staff Superannuation Scheme and processing the Mental Health Enquiry. The Office of Population Censuses processes the Hospital Inpatient Enquiry and cancer registration data collected by the NHS.

The NHS proper: the Regions, Areas, and Districts in England; the Welsh Health Service Technical Organization; the Common Services Agency, Area consortia and Area Health Boards in Scotland.

And, small teams and individuals operating in hospitals, universities and clinical practices.

With this in mind, it was necessary to examine the work and future plans of the three groups, to look at the factors influencing their activities, and to consider the performance and plans of the NHS in relation to the potential scope of computing in the service.

Accordingly contact was made with the organizations controlling the major part of computing resources (i.e. WHTSO, CSA, the English Regions, the DEB, and the major experimental computer projects).

The DHSS provided much information of a statistical and financial nature. Wherever possible, the financial year 1979–80 has been used as the standard for statistical purposes. The task was backed up by a review of the literature available, including circulars and letters issued by the DHSS since 1974. This was particularly helpful in establishing the potential for computing in the health service.

Computing in England—the present

NATIONAL COMPUTER POLICY AND ITS MANAGEMENT

It was during the mid-1960s that the need for a national policy to ensure the introduction of an efficient computer service within the NHS was first recognized. It evolved alongside government procurement policy, which was designed primarily to ensure the survival of the British computer industry. This laid down: that computers more powerful than Atlas, and the computers leading into them, be acquired by single tender from ICL (subject to satisfactory price, performance, delivery, and where relevant, acceptable conversion costs); that other computers be acquired by single tender where compatibility was important, subject to the same provisos; and that, in all other cases, contracts should be awarded on merit, but that at least one British system be included in the tendering process where possible. As a result, ICL 1900 mainframes were chosen as the standard for Regional Health Authorities. In 1977 the position was substantially restated. The ICL 2900 range is now intended to provide the next generation of Regional mainframes. Discounts in the purchase price of mainframe machines have been negotiated by the DHSS with ICL; a saving of about 6·5 per cent has been negotiated for the more recent series of machines.

Following the decision to standardize hardware, a policy to develop standard systems and standard software was developed. Individual Regions were designated as 'centres of responsibility' for specific systems which once operational would be available for use by other Regions. It was assumed (though never actually tested) that this would economize on development effort. Following early experience, it has been usual for the DHSS to provide 50 per cent of the development funds required by the centres of responsibility.

The most recent statement of computer policy is contained in Health Circular HC(77)11, *A Review of NHS Computing Needs.* The review was produced by a NHS Working Group in May 1977. Apart from a revised strategy for research and development (R&D), the changes proposed were limited. It was envisaged that the future pattern of computing would consist of:

> Regional bureaux with links to small local machines in Areas and Districts, carrying out hospital and primary care applications and administrative work;

computers providing a comprehensive service to Districts;

independent systems within Districts dedicated to specific tasks;

systems devoted to specific local scientific and clinical tasks.

The Working Group concluded that the degree of central (i.e. DHSS) control envisaged in the earlier McKinsey Report was not needed, and that computing should be handled much as any other NHS activity. Regions and Areas should prepare computer development plans. Areas and Districts should have a say in Regional proposals, and be aware of the costs of services provided for them by Regions. The DHSS should monitor the NHS to ensure: adherence to the procurement policy; periodic reviews of DHSS and NHS plans and the means for effecting them; co-ordination within the NHS (the selection and development of standard systems and the consideration of other matters requiring a common approach); the creation and management of a centrally-funded R&D programme for the NHS leading to the production of transferable (as opposed to ICL 1900-based standard) systems; and the collection and dissemination of information about NHS computing. The Working Group recognized the need for better information about computing practice and plans if these aims were to be achieved.

The main innovation proposed in circular HC(77)11 was a DHSS/NHS committee structure which since 1978 has attempted to generate and manage computer policy within the service. Exhibit 1 shows the relationships between the various committees and working groups. Computer matters are dealt with by the DHSS Management Services and Computing Division, which also provides the secretariat for the committees. Contact with the NHS is maintained through liaison officers, each one serving several Regions. Ultimately all proposals are referred to the Computer Policy Committee (CPC), which in turn makes recommendations to the DHSS. At the same time the DHSS and CPC have to put any Government policy into effect. Policy decisions are effected (or not) by negotiation with the Regions who carry out the bulk of NHS computing; although the DHSS has the power to issue a directive, one has never been promulgated on computing. The R&D and Technical Committees are supported by various working groups, and report to the CPC. NHS computing staff report technical matters of common interest to the Technical Committee. Individual working groups cover separate topic areas in the field of R&D, such as primary care and hospital administration systems. The

DHSS and NHS may call on the Government Central Computer and Telecommunications Agency for technical advice.

Scientific staff also have an interest in computing, notably in the smaller scientific and clinical research projects. As a result the Chief Scientist of the DHSS nominates several advisers to the three main committees.

COMPUTING AT THE REGIONAL LEVEL

As is apparent in Exhibit 2, RHAs control the major part of computing in the NHS. About half (by value) of the computer equipment installed in the NHS is sited in the Regional computer bureaux. The *raison d'etre* of these units is to provide a service for the Region as a whole, not just for the RHA. A sample of three RHAs showed that about 90 per cent of the total RHA bureau budget was devoted to Area and District work.

By 1976, fourteen Regional bureaux had been set up, all but one based on an ICL 1900 computer system sufficiently large to run the standard systems and using the George III operating system. The one non-ICL machine (a Honeywell 2060) had been ordered before NHS reorganization. At the present time five Regions have obtained ICL 2900s to replace their ageing mainframes although only one Region has disposed of its obsolete machine. Four of the 2900 systems are functioning as if they were 1900s (i.e. they use the Direct Machine Emulation operating system). The equipment destined to replace the Honeywell 2060 is running under the VME/B operating system alongside the obsolete machine.

Most of the bureaux have terminals in the Computer Service Departments for program editing and other internal on-line work, and several also have terminals in other Regional departments. Some Regions have one or more separate computers in their headquarters, including mini-computers for statistical work and engineering design and micro-computers for O&M/Work Study applications. Word processing systems have been installed by several RHAs.

Although the Regional bureaux basically offer a 'batch' service, all of them have one or more terminals in their constituent Areas and Districts. Six Regions have gone one step further and installed separate computers at their bureaux to handle remote terminals. They are usually linked to the mainframe and dedicated to specific tasks. Data not captured remotely are put into a computer-compatible form on key-to-disc equipment, with a few authorities using document readers as well. One or two Regions also have direct data entry facilities.

Most Regions are aware of the opportunities offered by the micro-computer. Four have set up micro-system teams, three of these being supported by a micro-computer workshop with the aim of offering advice to would-be micro-computer users, selecting and supporting standard hardware and software, enhancing awareness of the opportunities offered, and training other computer staff in the art of using microcomputers. A few other authorities would like to do the same but are constrained by lack of resources. An NHS 'micro-club' has been formed and most Regions are represented.

The typical management structure for a Regional computer services branch is shown in Exhibit 3; it resembles that of organizations outside the NHS. In theory the definition of the service to be provided is the responsibility of broadly based user groups, usually one for each application. These frequently centre around one or more enthusiasts, but have as wide a geographical basis as is thought feasible and desirable. There is often a parallel arrangement in the Regional Scientific Officers' Department dealing with scientific matters in general, and in some cases scientific computing *per se*. In six Regions the scientific organization for computing culminates in the Computer User Group (or its equivalent) of which the Scientific Officer is a member; in the remaining cases it leads into the Regional Scientific Committee. It must be remembered that there is no direct line of administrative command to Areas, so that the co-ordination of effort at Regional and Area/District level has to be carried out by negotiation.

Most Regional Computer Service Officers (RCSOs) are situated in Management Services Departments and report to Regional Management Services Officers who are responsible to the Regional Administrator. Five Regions have different arrangements: four have no Management Services Department, the RCSO reporting directly to the Regional Treasurer or Administrator, or (in one case) to the Regional Treasurer for day-to-day management and to the Regional Team of Officers for policy; the remaining Region has a Computer Service Section run jointly by the Management Services and Treasurers Departments through a Computer Management Committee, which also involves the Regional Scientific Officer, Regional Statistician and RCSO.

Regions are responsible for the major part of revenue expenditure on computing, accounting for about 60 per cent of the total. They have three quarters of the established posts devoted to systems analysis and programming. No funds are earmarked for computing at a national level apart from those for the development of standard and 'experimental' systems. Regional revenue requirements for computing come from the Regional administrative budget. Seven Regions charge Areas/Districts for the services they provide for them while the others bear all the costs at Regional level (though the majority of those produce information on the notional cost by Area/District). The running costs of an application are typically apportioned on the basis of the number of records or transactions generated by each user. Most Regions do not charge for system development expenditure, and bears the cost of any under-utilized computer resource. Because it is regarded as management expenditure, Regional non-scientific computing is subject to the current constraints on NHS management costs. Money used for the maintenance and production of standard systems' software is partly refunded by the DHSS, and like the resources devoted to experimental projects, is not counted as management expenditure. Little scientific work is undertaken at Regional level, although some Regions undertake sizeable software developments for scientific purposes, particularly laboratory automation.

Capital requirements are handled in a different way to revenue, and such expenditure is not currently subject to management cost control. Regional bureaux do not have specific capital allocations; computing has to compete with all other projects eligible for the available capital money. Capital for the DHSS R&D programme is provided directly from central funds. Almost all the computing hardware now installed by Regions has been purchased outright rather than leased.

COMPUTING AT THE AREA AND DISTRICT LEVEL

There is a wide diversity of small systems installed at the operational levels about which there is no systematic information; thus only a general picture can be gained. About half of the computing hardware (by value) in the NHS was situated in Areas, Districts and below in Spring 1980, although the concomitant revenue expenditure for the financial year 1979/80 formed only about a third of the total. These figures can be subdivided further to give an indication of the use of resources:

Major projects currently or formerly part of the national computing R&D programme for the service consume 19 per cent of the capital stock and 18 per cent of the revenue expenditure.

The distributed component of Regional plans, excluding scientific work and R&D projects, involves about 9 per cent of the capital equipment and 2 per cent of revenue.

Independent computing in Areas and Districts, excluding scientific work and R&D projects, involves at least 4 per cent of the capital investment and 2 per cent of the recurrent costs; an additional 7 per cent of the revenue total is estimated to have been used to buy bureaux services from organizations outside the NHS.

Scientific work accounts for 21 per cent of the hardware and at least 5 per cent of the running costs. These figures exclude that laboratory computing which is an integral part of the major R&D projects.

Fourteen major projects resulting from the computer experimental programme are now operational in varying degrees. Eight of these have been integrated within the framework of their respective Regional computer service units. Mini-computers are the most common form of hardware, having replaced the remote job entry terminal at Sunderland and the Sigma 6 computer at University College Hospital; the original mainframe is still in use at Addenbrookes. Software development teams are still attached to most of the sites, but are smaller in size than before and are now under Regional control.

In theory, the other six projects are managed by their corresponding Districts or Areas, but in some cases this control is only nominal. The Exeter project is partly funded and managed by the DHSS, since it provides a service for general practitioners. All but one of these six projects continue to use the original mainframe computer upon which the project was initiated. Together they represent the most significant proportion of professional computer staff outside the Regions and DEB, amounting to one quarter of all analysts and programmers.

The main characteristic of the experimental projects is the provision of real-time hospital/patient administration services. Except for the Oxford project, the installations are sited in the units they serve. The Queen Elizabeth Medical Centre (QEMC), Exeter, and

London projects include terminals located in wards, clinics, laboratories, and administrative offices. Other projects have terminals sited in the latter two areas. The Stoke, Sunderland, and Leeds projects have concentrated on out-patient facilities, the latter two originally using remote job entry equipment. In some instances (notably the Charing Cross, QEMC, and London schemes) the services, or a subset of them, have been extended to other hospitals using remote terminals linked to the home site. Many of the schemes are extending the range of services they provide, and some (notably the QEMC and London projects) provide services for other users, usually in batch mode, including the local District, Area, and Region. One of the more interesting projects is the provision of a minicomputer in the Walsall Manor Hospital for use by medical and other staff, who have designed some of the systems. Terminals have been sited in other hospitals and a wide range of applications are in use.

Most of the equipment located in Areas and Districts as part of the Regional plans is supplied by ICL and linked to the Regional bureaux by GPO lines. This is particularly true of the hardware installed in Area and District offices which comprise little under half the capital stock in this category. Installations range from teletypes through various grades of intelligent devices to complete satellite computer systems with their own terminals in District offices, stores, clinics, and hospitals. They are used for a variety of purposes, although individual systems often handle one application only. Software development is carried out by staff from the Regional bureau, sometimes at the local site. Such uses include:

remote entry of data of various sorts (e.g. HAA, accounting and supplies information);

remote interrogation of data (commonly accounting information) held on the mainframe;

the provision of certain expensive facilities at local level (e.g. fiche/microfilm production, security, copies of local data and large random access files);

full remote processing facilities (e.g. patient administration and stores systems).

In their roles as co-ordinators and consultants, a number of Regions are increasingly selecting and installing 'turnkey' systems for Areas and Districts. As an incentive to potential users, Regional bureaux usually produce any software needed in-house if the application is suitable for replication as a Region-wide standard. The hardware may also be funded partly or wholly at Regional level, especially for pilot installations. Mini-computers and a growing proportion of micro-computers are being installed.

Non-scientific computing outisde Regional computer plans and the former experimental projects is concentrated at District level and below. What exists at Area level is based on mini- and micro-computers dedicated to specific tasks (such as supplies, financial work, and ambulance scheduling) with software developed by the users. Little of the equipment in use is manufactured by ICL. Computing at District level and below, installed in District offices and hospitals, is based on similar hardware obtained and run with local finance. Many small systems developed by their users are in existence, and software is frequently exchanged between users on an informal basis. Of the expenditure on bureaux facilities (estimated at between £1–2 million per annum), the greater part is for those child health applications provided by the local authorities which were responsible for them before the reorganization of the NHS in 1974. The remainder is used for bureaux facilities chiefly devoted to financial work. In the past the use of local authority and bureaux machines was much more extensive.

Scientific systems are situated in the units that they serve. Some are (or started as) 'turnkey' systems based on packages or software transferred from elsewhere and have often been enhanced by technicians in the departments involved. Many of the systems operate in real-time, linked to analytical instruments, cameras, signal receivers, and nuclear treatment facilities. A wide variety of mini- and micro-computers are used, although at least two Regions have selected standard systems for biochemistry work and others are in the process of doing so. Of the laboratory specialisms, biochemistry is the best served by computing, followed by haematology; systems for cytology and morbid anatomy exist but are rare, whilst software for microbiology is even rarer. Scientific computing is funded with revenue from the budgets of the units involved, other work from the administrative budget of the relevant Areas. Capital sums up to £50,000 can usually be spent at the discretion of the relevant AHAs from the capital allocated to it by the Region; over this amount the item must form an agreed part of the Regional Plan.

The large number of small systems in hospitals are generally dedicated to specific tasks. Medical applications dominate the scene and the installations, consisting mostly of mini- and micro-computers, are locally financed. Programming is undertaken by user departments as a rule, although software is frequently swopped between users. Limited use is made of commercial bureau facilities.

COMPUTING ELSEWHERE IN THE NHS

The Dental Estimates Board (DEB) authorizes Family Practitioner Committees to pay dentists for the items of service they perform and this is the major task of their computer department. The computer is an ICL 1904S running under the George II operating system and is thus not fully compatible with the standard Regional Health Authority configuration. There is a large data preparation section of over 200 staff, using paper tape punch/verifiers. The DEB also performs statistical analyses on the dental claims and staff data they collect. The computer unit processes the Board's payroll, and does a little work for two RHAs and one Family Practitioner Committee. The systems and programming staff of 25 are employed primarily to implement the rapid changes needed to the dental payments system. The Computer Manager reports to the Clerk to the Board, who takes major issues to the Board itself, which has a full-time Chairman. The DEB is not represented on the various DHSS/NHS computer committees but obtains its funds for computing from the DHSS as part of the overall DEB budget. In the past the DEB has undertaken various software developments for the NHS, including the FPC system. The value of the equipment installed and the annual running cost of the computer department are given in Exhibit 2.

General practitioners, dentists, and ophthalmic staff have no NHS funds available to them specifically for computing; they are free to spend as much (or as little) as they choose. However, there are two systems relevant to primary care resulting from the DHSS experimental programme. In the Exeter Health District, two health centres have a comprehensive real-time patient record system, with terminals linked to the ICL 1904S of the Exeter Community Health Project; another practice is involved on a batch basis. At Oxford a batch patient registration and medical summary system is used by a number of the practices within the Region, and several outside it. The programme was initiated as part of the Oxford Community Health Project and runs on the Regional installation.

General practitioners are also developing and buying microcomputer based systems privately. Several firms offer package deals providing: patient registers (age/sex and disease); automated recall; and comprehensive patient record and practice management facilities, although few vendors offer the third facility. At least two systems are also available for dentists. The number of practitioners developing their own systems is growing steadily; they are generally based on the cheaper personal computers (e.g. Apple, Pet, and Nascom hardware). The number of practitioners using their own computer facilities, and the associated revenue and capital resources employed, are not known. Significant interest amongst practitioners is, however, evident.

Two reports have recently appeared on the subject of computing in primary care: *Computing in General Practice*, published in 1980 by the British Medical Association, examined the requirements of a general practice and recommended the installation of 100 trial systems in practices of various types and sizes. *Computing in Primary Care*, a report of a working party of the Royal College of General Practitioners, also appeared in 1980. It concentrated on the functional specification of a GP system and examined the political and economic problems involved in introducing computing into general practice.

Three Family Practitioner Committees in different Regions use a computer to maintain their Patient Index. The software used has a common source, and is run on the relevant Region's mainframe in two cases and on the DEB machine in the third. The application is run in batch mode.

THE APPLICATIONS TACKLED

Most of the application software used has been developed within the NHS. Every Region except one uses the National Computer Centre's FILETAB language for file interrogation and report writing. Most use one or more statistical packages (e.g. SPSS, BMD); several use the ICL financial modelling system PROSPER. ICL'S inpatient discharges and admissions package (IDA) is used at a few sites, one on a trial basis, and the CHARTS hospital patient administration system from NCR is being implemented at two hospitals in one Region, and in two others. There is a move towards producing on-line systems in ultra high-level programming languages such as ENGLISH and MUMPS. In the scientific area, especially pathology, the major vendors of systems (such as Wang, Technicon, CTL, and Ferranti) provide 'turnkey' systems—those marketed by CTL and Ferranti being based on NHS software licensed to them by the DHSS. No database systems are currently in use (although MUMPS provides some features of this sort). Mainframe applications are programmed mainly in COBOL with some 1900 Assembler (PLAN) and a little FORTRAN. Applications for mini- and micro-computers are written in a wide variety of languages, including FORTRAN, CORAL, BASIC MUMPS, and PASCAL.

Seven standard systems have been produced. They are: child health; equipment scheduling; estate management (EMIS); Family Practitioner Committee system; standard accounting system (SAS); standard manpower planning system (STAMP); standard payroll system (SPS). An interim standard maternity information system (SMIS) is available, and work on a final version is likely to be started in the near future. There are also plans to produce a standard Blood Transfusion Service System. A national standard stores vocabulary is also available. A standard system to process Hospital Activity Analysis data was proposed but rejected as unnecessary by the Region doing the feasibility study. A standard stores package foundered during the attempt to generate a nationally approved specification.

Each system has been developed and is maintained by one Region as the 'centre of responsibility' (COR), and it is distributed to other would-be users in the NHS for the cost of replication. In general, the DHSS now provides half the cost of development and maintenance, the COR providing the rest. Further details of the standard systems are given in Exhibit 4, including the level of implementation achieved. These applications were chosen from a list of 59 possible applications. The choice of particular systems reflects more the opportunities which have presented themselves rather than a conscious strategy; the coordination between systems developed by different CORs has been poor (notably between payroll, manpower, and accounting). The systems are batch applications written largely in COBOL for ICL 1900 systems running under the George III operating system, although two Regions have modified the child health software to provide local input (one on micro-computers and the other on a mini-computer, using direct data entry facilities). The FPC application is being re-written in a transferable form to run on FPC-based mini-computers.

There is an appreciable number of 'transferable' systems. Unlike the standard systems these do not have their maintenance guaranteed by their source. Arrangements for transfer are less formal and may involve a charge if the donor so wishes. Recipients can (and do) modify the software at will, sometimes as a necessary consequence of transferring it onto different hardware or into another programming language. Amongst the systems available are:

a mainframe stores system now used by two authorities;

a real-time mini-computer based HAA data collection system adopted by two Regions;

two mini-computer based on-line stores systems. Each has been taken by one Region other than the source, and both are being examined by three more Regions;

an out-patient package, different versions of which are now in use at sites in three Regions (the host machine is an ICL 1900 accessed remotely by the out-patient departments);

two accounting systems;

an ICL 1900 to 2900 COBOL conversion aid;

the Phoenix pathology laboratory system which, more or less modified, has been implemented on a variety of mini-computers at eight sites in several Regions. In addition it is used by Ferranti and CTL as the basis of a package to go with their hardware. Several other laboratory systems have also been transferred;

an echocardiogram/cineangiogram analysis program in use at several sites in at least three Regions.

Within Regions there is as much replication of systems at Area and District level as can be achieved. The major part of the software is specific to individual Regions, and (more rarely) to individual applications.

Although it is not possible to determine precisely the proportion of the computer resources devoted to each application group on a national basis, the broad pattern is clear. The Regional bureaux are predominantly used for financial, statistical and administrative purposes; medical and scientific work form the majority of the work-load at Area and District levels, most resources being used by front-line units and their supporting technical facilities. An analysis of all computer use for a sample of five Regions is given in Exhibit 5.

VARIATIONS IN COMPUTER USE

Computing resources are not evenly distributed throughout the NHS. The greatest variation is at or below District level. For example, comprehensive real-time hospital systems are available in only ten Districts, mainly in London; inclusion of less sophisticated systems often covering only part of a hospital brings the total to less than 40. Scientific computing is more evenly spread. Inter-Regional variations of resources for computing are shown in Exhibit 6. One of the largest sources of variation is the small number of experimental projects which are now operational, but even when these are ignored the variations are still sizeable.

Computing in England—the future

CHANGES AND PRESSURES

The forthcoming re-structuring of the NHS (see HC(80)8) will affect computing in several ways. Increased District Health Authority autonomy will make Regional and national co-ordination a more delicate, if not more difficult process. Existing Area-based systems may have to be transferred to District Health Authorities. Various Regional committees will have to be reconstituted and, if full unit representation is to be maintained, could become unwieldy. Last, but not least, decisions will have to be made about which tier of management becomes responsible for the former experimental programme computer units which are at present (more or less) the responsibility of the AHAs. Stringent controls on management costs make the provision of dedicated systems sited alongside the users more attractive to Regions and Districts by cutting down to a minimum the need for additional computer operations staff. The need to limit administrative costs devoted to computing would not be so serious if the method of calculating management costs took into account the non-administrative savings made possible in some applications by using computers, and the charging out of central services to the users.

The Government's computer procurement policy has been modified to bring it into line with EEC directives which support pan-European procurement sources rather than national ones. It is highly probable, however, that the Regional bureaux will continue to purchase ICL 2900 machines over the next few years.

There is little doubt that the demand for computing in the NHS will out-strip the supply, a situation that did not exist in the recent past. The bulk of this pressure arises at the operational level of the service, encouraged by the increasing awareness of the capabilities of modern computers and the advent of cheaper hardware and systems based on mini- and micro-computers. The problem of obtaining satisfactory software can be minimized by the use of sophisticated high level programming languages. Thus it is now feasible for users to have systems in situ dedicated to their applications at a price they can afford. This trend has given rise to an increased demand for consultancy services from the regional computer service departments.

The assumption that an increased use of computers will be beneficial is evident in the attitudes of some of the professional bodies involved with the NHS. The reports of the British Medical Association and the Royal College of General Practitioners were firmly in favour of more computing within general practice. The Royal College of Obstetricians and Gynaecologists is keen to see the National Standard Maternity Information Systems underway, and both the Royal College of Surgeons and the Royal College of Physicians are quietly promoting the use of computer-aided clinical decision making.

A considerable amount of present hardware and some software is now obsolete. This is especially true of the former experimental hospital systems, all but one of which will require new hardware by 1983; and because the software was written largely in assembler languages it will have to be fundamentally re-written for the new machines. In the Regional bureaux both obsolescence and overloading will force the replacement of ICL 1900s by 2900 machines. It is likely that the VME/B operating system will become the standard for the Regional bureaux using ICL 2900 computers, which will also entail a substantial conversion effort for existing systems. There is also a growing need for economy and for the economical provision of facilities which can only be obtained with the newer hardware and their operating systems (such as on-line programming, networking, screen generation, transaction processing and the ability to use good data dictionary and database software).

Pressures of a different kind have built up recently from computer manufacturers and systems and software houses wishing to sell computer products to the NHS. Several firms have entered the market place in the last year or two. The purchase of software and systems has up to now encountered opposition at regional level from in-house computer staff working through their Trade Union, NALGO. Such opposition is less at Area and District level and potential vendors have been more successful.

REGIONAL REACTIONS

A continuing need for regional bureaux using mainframe computers is generally accepted, at least until the next generation of hardware appears. Equally Regions are well aware of the benefits of decentralizing the provision of computer services. At a minimum this implies placing input and output facilities as close to the users as possible; at the other end of the scale it implies installing completely dedicated systems under user control, ultimately perhaps linked to other computer systems to enable management information to be distributed as required.

Regions appreciate that unless they are in a position to meet all requests for computing and consultancy services, customers will look elsewhere, particularly to the large range of 'turnkey' systems coming on to the market. They also recognize that application software needs to be widely used and that, to this end, there has to be as much standardization as possible intra-regionally. Many are openly in favour of local initiatives, but none would want to see a myriad of local incompatible systems which would swamp the creation of a corporate information base. With this in mind, Regions see a need to regulate the growth of computing so that the interfaces between local systems are matched and, if no more, that the wheel is not constantly reinvented.

Eleven Regions have developed comprehensive plans for computing services. Five contain costed proposals for equipment and staff covering the period up to 1982 or beyond, whilst the remainder concentrate more on broad policy rather than on specific proposals. Six of the eleven, including all the more detailed ones, have been approved by their Authorities. One other Region has overall plans in preparation. The degree to which the planning process has involved constituent Areas and Districts has varied.

All plans envisage the provision of distributed computer facilities. In one of the costed examples this is achieved by siting minicomputers (with at least one operator) at Area or District headquarters linked to the Regional bureau. A second proposal envisages mini-computers installed at relevant sites for hospital patient administration, laboratory work, pharmacy and supplies applications, nursing, and FPC administration, with a mini-computer at the Regional bureau to handle on-line accounting enquiries from Districts. A third example (uncosted) involves the provision of a separate Regional computer linked to the existing bureau machine to provide an inter-active service for Districts and Areas handling pharmacy, stores, and budgetary control, as well as providing planning and financial modelling, enquiry and interactive programming facilities at Regional headquarters. A fourth scheme involves a distributed processing network with mini-computers dedicated to specific applications at the Regional office linked to the Regional main-frame, controlling networks of remote terminals and mini- and micro-computers at FPC, District and operational (e.g. stores, hospitals) sites. In this proposal not only is the input and output sited alongside the user, but much of the processing power as well. The plans framed in general terms indicate the same trend towards 'blackbox' systems, be they terminals or computers, centred around the major operational units but linked to the Regional bureaux. One virtue of dedicated 'black box' systems is that the user runs his application *and* the equipment so that separate computer operating staff are not required.

Four of the costed plans are similar enough in form to serve as a sample of NHS thinking, albeit one whose representativeness is unknown. Each of the plans spread their expenditure over different time periods. The total capital sum involved is £17·4 million. The breakdown of expenditure is as follows:

	Percent
Replacement of RHA bureau mainframe	22
Upgrading of the above	6
Other RHA bureau facilities (fiche, micro-workshop)	1
Mainframe at RHA dedicated to distributed work	2
Terminals outside RHA but linked to it	6
Replacement of ex-DHSS hospital project mainframe	5
Distributed computing in DHAs and below	58
	100

This implies that, at a minimum, 71 per cent of the planned capital expenditure is on average earmarked for facilities in Districts and their constituent operational units. (The proportion in the individual plans varies from 28 to 84 per cent.) All the schemes made provision for the replacement of the bureau mainframe.

In two of the proposals it is possible to identify the applications that this investment will include:

		Percent
Finance	distributed	8
Administration	distributed	15
Medical	distributed	38
Scientific	distributed	15
RHA mainframe replacement	devoted to all uses	
Other RHA bureau equipment	devoted to all uses	24
		100

Throughout the plans, costed or not, there is a growing emphasis on medical applications, especially patient indexes and patient administration, even excluding the proportion of mainframe activity devoted to that purpose.

The scale of the investment proposed is large when viewed alongside the historic expenditure. The result would increase the capital computing stock in the four Regions by over 150 per cent by April 1985 at the latest. In fact one plan only goes as far as April 1982, and two of the proposals do not include scientific computing, so that this figure must represent a lower estimate.

Such a development of computing will require software that is reliable and 'user-friendly', especially when dedicated systems are implemented. Great strain will be placed on the existing limited resources particularly software development manpower. In the past, attempts have been made to meet the shortfall with external contract staff, but by July 1980 less than half a dozen such staff were so engaged. To date little work has been given to software houses. Although Regions envisage that much of the software will be produced in-house, there is an increasing willingness to consider the use of whole systems and packages that are commercially provided. One RHA went to tender in July 1980 for pathology, pharmacy, and hospital administration systems; another is doing the same for a nursing information system. Standard systems will also extend their coverage somewhat over the next few years; in aggregate the four major systems (payroll, child health, accounts, and manpower planning) will definitely be implemented by a further 11 per cent of Authorities by 1983 and additional Regions are considering whether to adopt them. The use of mini- and micro-computers has enabled open tendering for equipment since the power of the machines is below the lower limit of the Government's procurement policy.

THE FUTURE OF THE FORMER MAJOR R&D PROJECTS

All but one of the real-time hospital projects will require new hardware by 1983 and software will have to be fundamentally re-written. The exception is the Stoke project, where an ICL 2900 machine running under the VME/B operating system has recently been installed, and the programs rewritten in a high level language (COBOL 74) to use the standard ICL teleprocessing and database packages. As most experiments were started before the Government procurement policy came into effect, the mainframes used did not all come from one manufacturer; only two (at Exeter and Kings) were ICL 1900 machines. It is likely that their successors will be equally varied. Powerful mini-computer configurations are generally favoured as replacements, but one project is actively considering a network of micro-computers. In most cases the intention is to use high level programming languages and commercial software products to replace the idiosyncratic low-level software now in use. Those experimental projects not yet integrated within the Regional computing framework are discussing their status with Regional management, spurred on by the need to obtain Regional sanction of the sizeable capital sums needed for replacing their hardware. Only the older, wealthier hospital foundations can perhaps consider purchasing new equipment from their own funds. Several units are in the process of enhancing their systems to offer distributed computer processing facilities to other users in the locality.

THE FUTURE OF INDEPENDENT WORK AT DISTRICT LEVEL

Independent work at the operational levels is of two kinds; the small mini- and micro-computer systems being installed by individuals and departments dedicated to do specific tasks; and the larger mini-computer systems supported by one or more computer professionals which perform a variety of tasks. The former are not generally co-ordinated at any level higher than the user departments and proliferation seems likely, particularly for medical applications on micro-computers. Local computer units also have plans to expand. The hospital systems are expanding the facilities offered as well as extending the service to other hospitals.

THE SITUATION ELSEWHERE

The work of the Dental Estimates Board is growing slowly. The replacement of the existing mainframe computer is not planned for six or seven years. It is intended in the near future to replace the paper tape data preparation equipment with key-to-disc systems, and to implement batch data dictionary software when it becomes available from ICL. The staff are also looking at the feasibility of providing an on-line index of dentists.

An investigation to explore the use of computers by the Prescription Pricing Authority has been completed. First results indicate that the computerization of manual procedures could be profitable in a small way. The provision of prompt regular feedback on doctors' prescribing habits could produce far greater savings.

In the field of general practice the initiative for co-ordinated action seems to rest with the British Medical Association at present. They are discussing the provision of trial systems with the Department of Industry who have commissioned Scicon to draw up a list of potential suppliers. The General Medical Services committee of the BMA is also having talks with the DHSS about funding arrangements for computing in general practice. Two Regions are interested in computing in general practice, and it is possible that they may develop or become involved in the production of the necessary software. The British Dental Association and the Department of Industry are sponsoring a study to examine how computer technology might aid dental practitioners.

Computing in Wales

STRUCTURE, MANAGEMENT, AND FUNDING

Wales has a scattered population totalling about 85 per cent of that of the average English Region. The management of its services is differently organized. At the head is the Health and Social Work Department of the Welsh Office. Beneath this, and independent from it, is the Welsh Health Technical Service Organization (WHTSO), a health service body which provides services common to the eight Area Health Authorities and fourteen Districts covering the Principality.

After a period of debate the Welsh Office issued a statement on the management of computing in the health service in July 1980 (WHC(80)11). Responsibility was delegated to WHTSO, advised by the Welsh Computer Committee (WCC). The Committee consists of a Chairman and Vice-Chairman nominated by WHTSO, a member nominated by each AHA, and one nominated by the Welsh Office and the WHTSO Computer Services Manager. It may co-opt specialist members, and set up working groups as required. Its terms of reference are:

To advise WHTSO and AHAs on the development of computing services within the Health Service in Wales including the development of services in Areas; and to maintain and update a 5-year plan.

The Committee will report regularly to WHTSO, which will forward reports with comments to the Welsh Office and AHAs. WHTSO will consult AHAs on proposals that have significant resource implications for them, whether directly or through the need for additional funds to be reserved for use by WHTSO. Research and development is conducted as part of the overall DHSS/NHS programme and there is Welsh representation on the DHSS/NHS Computer Research and Development Committee. The Computer Services Manager of WHTSO is a member of the corresponding Technical Committee. There is no Welsh representative on the Computer Policy Committee.

COMPUTING PRACTICE TODAY

The Computer Services Branch of WHTSO acts much as a Regional Computer Services Branch, providing central computer facilities, co-ordination, software, and consultancy services to the Welsh AHAs, but with more direct control over their computing activities. An ICL 1904S running under the George III operating system acts as the bureau mainframe, backed up by key-to-disc data preparation equipment and a micro-fiche capability. Terminals attached to the mainframe are used by the system development staff at WHTSO. Alongside is an ICL 2903 on which software for the Area machines is being developed. WHTSO employs almost all the professional computer staff in the Welsh health service, apart from one or two in one Area and those connected with medical education.

Computer work at WHTSO is run mainly in batch mode, with the notable exception of hospital patient administration. The bureau machine is linked to terminals in six hospitals across Wales and holds the patient master index for each one. Wales participates in the DHSS/NHS standardization programme and is responsible for the standard Child Health and Equipment Scheduling systems. WHTSO also runs the Standard Accounting system. In May 1980 standard systems had achieved 32 per cent of the potential implementation. The division of revenue expenditure by system is given in Exhibit 7, and is comparable with an English Region. WHTSO does not have a micro-computer workshop or any staff devoted to micro-computer applications. The staff structure at WHTSO is much like that of an

English Region (see Exhibit 3). The costs of the WHTSO bureaux are given in Exhibit 8.

There is rather less computer equipment at Area level and below in Wales than there is in England, though it must be remembered that the average Welsh AHA only contains a population of 300,000, as opposed to 500,000 in England. One Area has two moderate sized mini-computers, one devoted to budgeting and another on which an FPC system is to be developed. The remaining independent computing in Areas and District is carried out on smaller systems, including 11 mini-computers and 55 micro-computers known to WHATSO. A significant proportion of these small machines are used for scientific purposes. Equipment worth just over half the value of the independent effort (see Exhibit 8) has been installed in hospitals and linked to the WHTSO bureau to run the Welsh standard hospital patient administration system. The equipment comprises mini-computers and intelligent terminals, and the application is partly on-line and partly batch (being run overnight on the WHTSO mainframe). The local hardware and operational costs are met by the Area involved.

COMPUTING PRACTICE IN THE FUTURE

The evolution of a strategy for computing in Wales commenced with a seminar in July 1976 at which the Welsh Office, WHTSO and Area representatives discussed likely future demands for computer services in Wales. This started a process of discussion and work, including a survey of Area requirements and a detailed sizing of the current and future workload of the WHTSO bureaux machine. It culminated in May 1978 in the publication of: *The Report on a Survey of Computing Facilities Required for the Health Service of Wales in the 1980s.* This examined various ways of satisfying the needs, priced them with the help of several hardware manufacturers, and selected one providing a distributed Area-based system. It was envisaged that each Area would have a computer linked to the central WHTSO bureau. Data preparation for central processing and storage would be devolved to Area level. Data on the WHTSO bureau machine would be available for local retrieval on the Area systems. This solution gave the lowest capital and revenue requirements—apart from the provision of a single batch bureau for all Welsh work (except hospital patient administration) which was not considered suitable in view of user requests for local computing facilities. Acquiring Area machines will enable the desire for local computer facilities to be contained within an overall plan based on compatible equipment. The workload anticipated in 1985 is estimated to be about a third greater than in 1980. The capital requirement for the proposed scheme was £2,900,000, broken down as follows:

	Percent
Central bureau system (replacement of ICL 1904S)	50
Communications	3
Area Systems	13
Terminals to the above	5
Hospital hardware / Communications } for patient administration systems	26
	100

Expenditure is equally divided between central and local applications. The plan would more than double the installed capital computing stock. Revenue costs would increase by about a third in real terms.

This policy was endorsed in circular WHC(80)11 and is slowly being implemented. Individual AHAs will be responsible for deciding their own computing needs, but 'to ensure technical compatibility of any possible new equipment and to avoid duplication of equipment, they should first discuss any proposed installation with WHTSO, and in particular they should utilize services that can be provided by WHTSO'. Had the proposals not found favour with the Welsh Office the risk that some Areas would have gone their own way would have increased significantly. The costs of the WHTSO bureau and the Area machines are to be met from central Welsh Office funds but AHAs will bear their operational costs and those of any other local equipment.

WHTSO will take delivery of a dual ICL 2966 in 1981. Four ICL ME29 computers will be bought in March 1981, three for Areas and one for developing Area systems at WHTSO. The WHTSO machine will replace the ICL 2903 already there. Two more Areas have opted for ICL 7500 equipment which will probably be linked to the WHTSO ME29. The initial ICL 2966 installation will enable concurrent development under the VME/B operating system and the running of operational work under the George III operating system. It is appreciated that the provision of software will consume an increasing proportion of system costs, so that software implementations will have to be replicable if costs are to be contained: hence the emphasis on standard Area and hospital hardware. The original cost allowed for an increase of 50 per cent in the resources allocated to systems development staff. Part of this rise is accounted for by the need to convert systems from George III to the VME/B operating system.

The first application will be an on-line stores system developed by ICL-Dataskil and first implemented in the South Western RHA. The patient administration system is being extended hospital by hospital as Areas find the funds required. Implementations are firmly scheduled at two further hospitals. It was envisaged in 1978 that it would be implemented at a further 13 sites. WHTSO are investigating the use of the Information Processing Architecture communications protocol offered by ICL to link the Area and hospital equipment to the ICL 2966 system. The major new software development in hand at the moment is the production of the Pre-school and School modules of the National Standard Child Health Systems, closely followed by work on hospital use statistics such as Hospital Activity Analysis and the Mental Health Enquiry. ICL 1900 to 2900 conversion work will shortly be carried out on a terminal connected to a nearby local authority's 2900. Apart from using systems developed or procured by WHTSO, Areas will be able to develop as much or as little local software as they please, using WHTSO as consultants.

The report published in 1978, and subsequent plans, give little attention to scientific computing other than suggesting that dedicated systems at the sites of the operational requirement, often linked electronically to analytical and other instruments, are the best solution.

Research and development in England and Wales

INTRODUCTION

Research and development (R&D) in NHS computing over the last decade has centred around the DHSS experimental programme launched in 1967. Prior to this, medical researchers had been using computers for some years. There had been a wide range of experimental computers used on survey work, laboratory automation, the study of prescribing habits and hospital systems at the London Hospital, Queen Elizabeth Medical Centre, Stoke Hospital, and other sites. This was assisted by finance from several sources.

The McKinsey Report published in 1971 suggested what the objectives of an R&D programme should be, and related them to the profile which each project should follow. First was an experimental phase to determine whether an application was useful, desirable, and feasible. Next came a development stage to turn feasible applications promising good cost/benefits into operational model systems. The implementation phase followed in which the model systems were put into operation throughout the NHS with only minor changes. All projects should be subject to strict evaluation before being allowed to pass from one stage to the next and, although local objectives must be given due weight, it was important that the systems should fulfil national requirements.

THE DHSS EXPERIMENTAL PROGRAMME

Experimental projects fall into two groups: the major projects, concerned in the main with hospital patient administration, and the small projects. The former involved some 20 schemes. There was heavy emphasis on real-time working, to the extent that some applicants felt it necessary to submit proposals along such lines in order to be successful. The small projects were chiefly clinical or scientific in nature and total over 40 to date. As shown in Exhibit 9, nearly one half of these projects have been concerned with analytical laboratory work. Most of the earlier projects started life in the hands of a few enthusiasts. Almost all the major hospital projects were (and are) run by the teaching hospitals, and the same is true of a substantial proportion of the small schemes. The apparent duplication of applications is reduced when one realizes that in several cases similar functions were being tackled in different ways and using different concepts. However, since the experimental programme was built upon separate 'bids' for funds rather than a comprehensive strategy much duplication is evident. Thus, for example, each hospital administration system included unique software to maintain a patient master index.

As a result of the McKinsey report the original five year limit on the life of the experimental programme was abolished in the early 1970s. Funds for hardware were provided by sponsor departments within the DHSS, as were running costs until the hardware was installed after which the costs were met under the arrangements for financing the revenue consequences of capital schemes. Projects started after 1976 were given funds for a limited life. Management of the major projects was by steering committees involving the DHSS, the operational unit and others.

As is usual in experimental programmes, there were problems. Development schedules and estimates turned out to be optimistic, especially for the larger projects. The cost of the experimental phase of the original 15 projects was estimated to be £13 million. In 1971 seven of the projects were terminated. By April 1st 1978 the remaining eight were estimated to cost £20 million or, after making allowance for inflation, about double the original forecast of £6·8 million. All the major schemes were behind schedule, by as much as three years in one case. A few projects were abandoned, notably the project at King's College Hospital to computerize clinical records which was dropped in 1974 after £1·4 million had been spent, the hospital not having used the system since late 1972. It is worth noting that over a dozen other applications at King's have continued using both the original hardware and the ICL 2904 which succeeded it. Another casualty was the 'Three Laboratories Project', an attempt to develop a comprehensive clinical laboratory system, and one of the largest scientific clinical projects. Several of the other small projects were also terminated.

In 1976 the experimental programme came under the scrutiny of the Parliamentary Committee of Public Accounts which was critical of the overspending and late delivery of operational systems. From that date, DHSS interest in major project R&D declined. Arrangements were made to taper off the financial support given to existing projects from central funds, putting the burden for continued operation of the projects on to the local Districts. The intention was that projects should become part of the Regional computing framework, but staff were given the option of choosing their employers and many projects elected to become part of the local District instead. By 1979/80 central funding of the original projects had ceased, except for the Exeter project (which is transferring its GP system on to a practice-based mini-computer), Charing Cross (where the system was being extended to another site), and the Trent FPC system.

In 1977 a 'new' R&D policy was put forward (HC(77)1). It introduced the concept of X, Y, and Z sites. Experimental development would take place at X sites, development of software from one or more X locations into model systems at Y sites, and the software would then be implemented at one or more Z sites. There was, of course, no reason why any site might not function as both X and Y for a particular application. The emphasis was to generate well written, well documented systems to put into the 'shop window' for examination by would be Z sites. Invitations for research projects were requested through the Regions; all ideas put forward would require the backing of the Region concerned. This policy resulted in relatively few applications for X or Y type work and those which the R&D committee did receive and approve were, with one or two exceptions, rejected by the DHSS or Computer Policy Committee. Proposals for clinical and scientific R&D continued to be generated and progressed.

If there have been failures there have also been limited successes, although only one of the major applications has yet been transferred to another site (the ultimate goal of the R&D programme). Of the small projects, several have been turned into more or less transferable systems. The outstanding examples are the cineangiography/echo-cardiography analysis package at the Brompton Hospital, the 'Phoenix' clinical laboratory system, and the Leeds computer-aided diagnosis system. The first and last mentioned have been implemented in other units at home and abroad.

Since the early 1970s the DHSS has been trying to organize the evaluation of the experimental programme. Emphasis was initially placed on 'before-and-after' comparative data but the problems of isolating the causes of changes of performance, especially when development times have been long, have been formidable. The results of a study were published in April 1977, *An Interim Report on the Evaluation of the NHS Experimental Computer Programme*. It produced little in the way of concrete results. In February of that year a working group was set up to devise a more meaningful way of evaluating the work. The use of standard criteria of performance which could then be measured in the field was subsequently recommended. A team of evaluators set about identifying the performance criteria in association with the actual and potential users of the computer systems being assessed, and their conclusions were published in June 1979, *The Handbook on the Management of Performance Criteria*. The report established criteria against which the R&D projects should be assessed. Some of these studies are now complete and published, but most of the major projects are still under investigation. The objective of establishing performance criteria was to assist potential users of the systems to judge their merits.

At present the R&D programme and policy are in some difficulty following the lack of success of recent attempts to encourage new applications. The possibility of devolving the management of some projects (to the Research Councils) is now being considered.

OTHER RESEARCH AND DEVELOPMENT WORK

Some experimental work has been done by the DHSS itself, with the provision from 1978 until recently of a micro-computer workshop to encourage the use of micro-computers within the NHS. Several sets of hardware were obtained and seminars and demonstrations given to NHS staff. The hardware is now used within the DHSS or has been 'loaned' to a Region with a micro-computer workshop of its own.

Software has also been developed in academic institutions within the NHS. Developments include various clinical chemistry software (e.g. University College Hospital's 'Socrates' system), and the general practitioner systems developed at Nottingham University Medical School and Exeter University. The largest example is probably the University College Hospital patient administration system which, after the DHSS withdrew support, was transferred to a smaller computer (PDP 11/70) and re-written in MUMPS. Elements of the system are to be transferred to Southend Hospital's system by North East Thames RHA. St Thomas's School of Community Medicine is producing a micro-computer based general practitioner system. The immediate objective is to produce a teaching aid but the long-term objective is clear: to develop a package at a price that general practitioners can afford, at least in health centres or group practices. Various general practitioners are at work on their own behalf.

In terms of the original DHSS objectives, the systems produced by industry as R&D products are also relevant. Other than those systems already mentioned, IBM is working on a primary care project in conjunction with staff at Sheffield University, and Health Computing Limited is also developing a mini-computer based general practitioner system.

Last, but not least, there is the development work carried out by the NHS itself, in the main by Regional computer service units but also by other organizations and individuals at all levels. This effort has resulted in considerably more transferable systems than the official R&D programme has produced and is very diverse, ranging from mainframe financial systems to micro-computer applications written by general practitioners.

Experience elsewhere—Scotland

STRUCTURE, POLICY, AND MANAGEMENT

Scotland, with a population of about 5·2 million, is slightly larger than the biggest English Region and is divided into 15 Health Boards and a Common Services Agency which is part of the Health Service. Scotland differs from both England and Wales in having no Family Practitioner Committees, the equivalent role being exercised by the Area Health Boards (AHBs) through a committee of general practitioners. The 15 Areas differ enormously in population, the largest (Glasgow) containing about a million people, the smallest (Orkney) only 21,000.

In 1974 the Scottish Health Service Planning Council approved a policy for developing administrative computer applications in Scotland, building on and rationalizing the work started by the Regional Hospital Boards and others before the SHS was reorganized in 1974. The plan implemented some of the features proposed in two reports produced by Scicon, *Focus on Medical Computer Development* published in 1970, and *Foundations for Health Service Management* which appeared in 1972.

The policy was to create five computer bureaux run by AHB consortia each having a fully compatible, similar sized computer system. Another such system was to be installed for the Common Services Agency (CSA) whose Information Service Division (ISD) would co-ordinate long-term development and plans. Two AHBs were unwilling to join the consortia arrangements so that the Scottish Home and Health Department (SHHD) could not implement the scheme fully. Two results followed: the CSA system was deferred until 1976 and then (because of financial restrictions) reduced in size. In the event, seven computers, not five, were installed between 1974 and 1976 and they were of two different types. The SHHD gave considerable capital support for this exercise, funding some installations completely and providing funds for the upgrading of others. The remaining computers were financed by the AHBs concerned, initially on a rental basis then subsequently purchased. With the attempt to standardize hardware came a commitment to develop standard software for national applications, and a national computer research and development programme. Both these activities were financed centrally by the SHHD through the consortia and AHBs.

Below consortia level the AHBs were free to implement additional computer facilities as their needs and resources dictated, although there was a requirement that projects over £10,000 be put to the relevant AHB for approval and be notified to the CSA. Under this cost limit, the CSA and the AHBs only asked to be informed.

The management structure for SHS computing is described in Exhibit 10. Responsibility for generating and administering policy has been devolved by SHHD to the Information and Computer Services Advisory Group (ICSAG) which advises both the SHHD and AHBs on computer topics. ISD plays a more positive role in many matters (e.g. standard software development and R&D), and tends to communicate directly with SHHD rather than via the CSA management structure, notably through requests for standardization and development funds originating from the Advisory Panel on Information Policy (APIP). Recommendations from ICSAG are submitted via the Scottish Health Service Planning Council to the SHHD and go from there to the Scottish Office and the Secretary of State for approval.

ICSAG set up the Computer Policy Review Committee in October 1977 to formulate a policy for the 1980s. It consisted of personnel drawn from University computer science departments and computer centres together with chief officers from AHBs. The Review Committee in turn created a technical working group to advise it, comprising computer professionals from ISD and AHBs.

COMPUTER PRACTICE TODAY

The three existing Consortia, involving ten Health Boards, vary considerably in size (unlike the grouping originally proposed) and provide a service for geographical areas ranging from about a million inhabitants to just under two million. All are equipped with ICL 1903T configurations which have been significantly enhanced since they were first installed. In anticipation of becoming a consortium centre Tayside AHB also installed an ICL 1903T and it has continued in use even though the consortium was never formed. The Highland and Grampian Boards purchased an ICL 2903 system, each of which have since been upgraded to ICL 2904s, as has the machine at the CSA. Computing for the Orkney and Shetland AHBs is handled by Grampian AHB and on-line equipment is installed in both island Areas. Western Isles AHB is served by the West Coast Consortium. The total value of the seven mainframes is about £5·25 million at 1978 prices.

The running costs of the service come from the administrative budgets of the host health boards. Consortia costs are divided among the member AHBs on an ad-hoc basis which is reviewed annually. In 1979/80 the seven centres cost about £2·4 million, about half of the expenditure being for staff. £360,000 was incurred by the CSA on 'bureau' services at the Scottish Office and a small amount went to other bureaux for the production of microfiche and to University computer centres for computer time. £460,000 of the total revenue requirement was provided by the SHHD for the R&D and standardization programmes.

The functions of the Consortia and Area computing bureaux are essentially the same as those of an English Region although the scale of each operation is smaller. The CSA installation services its administrative needs (e.g. the payroll and personnel functions) as well as some of its specialist requirements (notably the Blood Transfusion Service and Prescription Pricing Division). In a wider context, the ISD of the CSA provides an advisory and information service to SHS computing as a whole, keeping a watching brief on technical advances and on development elsewhere. Thus, for instance, the ISD liaises with the 'Microprocessor Club' run by the English health service and arranges seminars and demonstrations.

The workload of the seven centres is mainly carried out in batch mode, but all the ICL 2904s have direct data entry facilities. In addition to Orkney and Shetland, six AHBs have direct data entry mini-computer based subsystems, some attached to the consortia mainframes. Several other applications are also on-line to them. The remaining data preparation equipment is key-to-disc, supplemented at the West Coast Consortium by an optical character-reader dealing with payroll input. Three of the ICL 1903T systems run under the George II operating system, the West Coast Consortium having changed to George III within the last year.

As in England, almost all the application software used by the Scottish health service has been produced in-house, although extensive use is made of the NCC Filetab package and several sites use statistical packages. The number of source statements estimated to be in use in 1979 at the various centres are:

COBOL	669,027
PLAN	162,295
FORTRAN	107,324
FTL6 (NCC's FILETAB package)	54,089
ALGOL	449
RPG2	182

Some of the Consortia use structured programming techniques for new software.

About three-quarters of the analysts and programmers employed in the SHS are based at the seven centres, totalling 133 staff. Vacancies average about 7 per cent, concentrated in the West Coast Consortium, the greater majority being for middle grade posts. Most of the empty posts appear to be for systems development staff and in some places the shortage is so severe that operational systems may be at risk.

The work of the CSA, Consortia and Area systems is predominantly administrative and financial; a breakdown is given in Exhibit 11. There are four standard systems in Scotland and eight other transferred systems which are likely to attain standard status (see Exhibit 12). The two laboratory systems are alternatives. A national diagnostic data validation file based on the ninth revision of the *International Classification of Diseases* is also available. The child health system is a modified version of the English/Welsh system. The manpower statistics system was developed by the ISD. The standard payroll system is universally used. All the standard systems operate in batch mode and are written for magnetic tape in COBOL with some PLAN. The Patient Master Index application may be updated and interrogated in batch or on-line mode; it has been exported to the DHSS, Northern Ireland, and Salford AHA in England. The mechanism for producing, funding and transferring these systems is similar to the English model, although SHHD offer more assistance with transfer costs. However, as the financing of Centres of Responsibility did not start until 1978, the two financial systems were initiated with local funds. The production of transferable systems is being conducted under the SHHD development programme. About half of the ongoing costs were devoted to running and developing standard systems in 1978/79. The percentage is probably higher now.

Other than the seven installations dealt with above, the *Eighth Annual Report* of the Scottish Health Service Working Group shows that 104 computer systems are in use at 68 sites. An analysis of the hardware, application areas and staff is presented in Exhibit 13. The overwhelming majority of the systems are dedicated to single applications, the significant exceptions being the direct data entry facilities employed for a wide variety of purposes at the six Areas, and the ICL 1903A bureau at the Western District of the Greater Glasgow Health Board. The latter also accommodates some overflow from the Glasgow Consortium. Many of the systems are on-line to equipment and terminals of various kinds. Management arrangements are diverse: 13 installations are under AHB control, the remainder under that of the unit in which they are used. Funding comes from a variety of sources including AHBs, SHHD (as R&D money) and local unit management budgets. The capital value of the hardware involved is not readily discernible but is probably between £0·5–1 million. Of the 45 or so systems development staff involved (a quarter of the SHS total) nearly half are working on medical applications and a further quarter on laboratory systems, the remainder being involved in various other areas.

Scotland has a comprehensive computer development programme, which in May 1980 comprised 19 projects, 17 of which were already funded by SHHD. The remaining two were new applications. The total funds available in 1980/81 were £630,000 plus a further £150,000 spent by the Chief Scientist's Office. The largest project is based in the Glasgow Western District where an ICL 1903A system has formed the nucleus for the development of hospital systems. As this machine is increasingly used for Greater Glasgow Health Board Consortium work and other operational systems, the support for it from central funds is being reduced. The remaining projects include standard systems (e.g. a financial management package), the transfer of packages elsewhere (such as the proposal by the Glasgow Royal Infirmary to implement the University College Hospital system), and new or ongoing development work. One of the most interesting projects is the investigation of database usage being conducted by the Grampian AHB for the SHS as a whole. The work employs the database package run on the Aberdeen University Honeywell system, but is intended to be transferred to the available software on ICL 2900 hardware. Grampian's development of a pharmacy stock control system, now live, has generated considerable interest amongst other AHBs in Scotland as well as in the DHSS, who hope to arrange a demonstration of the package to English health authorities.

COMPUTER PRACTICE IN THE FUTURE

The impending reorganization of the Health Service in Scotland is likely to involve the abolition of some Health Districts and the merging of others. It is not likely to affect computing plans significantly.

Although there is less evidence in Scotland of the demand for computing exceeding supply, perhaps due to more central initiative and control, the pressures referred to in relation to computing in England are also evident. The existing equipment is becoming obsolete and is in some cases overloaded. The desire of some AHBs and Consortia to enhance or replace their computer systems is becoming clamant, as is the demand for up-to-date software and operating systems.

For these reasons acceptance in December 1980 by the Secretary of State for Scotland of the recommendations of the Computer Policy Review Committee set up by ICSAG is apposite. The proposals took into account the comments of the Parliamentary Committee of Public Accounts published in December 1979 which were critical of the failure of the SHHD to establish fully the consortia computer centres and urged 'that in any future instance the health authorities shall be left in no doubt that the Department (SHHD) will not shrink from that course (i.e. compulsion) if it be necessary to ensure that NHS funds will be used to best advantage'. The report published in March 1980 advised:

(a). The formation of six Consortia to cover all AHBs and the CSA, as opposed to the current three. Only one AHB, Lanarkshire, objected to the suggested arrangements. With the Consortia would come the gradual development of local networks to suit the needs and pace of each individual member.

(b). That Honeywell, IBM, ICL, and Univac be invited to tender for the Consortia mainframes. The first machine would be installed at the new CSA-based Consortium centre, linked to the other sites through terminal equipment during the transition period, and used as the national conversion centre. All machines would be funded by SHHD.

(c). That the SHS recruit additional staff to support the conversion teams.

(d). That ICSAG set up a Steering Committee, supported as necessary by technical advisory groups, to supervise the transition, and that the Computer Advisory Branch of ISD should actively co-ordinate SHS computing, and that resources be made available for this job. SHHD should consider appropriate action for firmer control over computer policy and expenditure.

(e). That all patient-identifiable data be transferred from external machines to SHS equipment as soon as possible.

(f). That the terms of reference of Centres of Responsibility for standard systems be more clearly defined by SHHD, and adequate finance be made available to develop them.

As a result of issuing an operational requirement to the manufacturers listed in (b) above, but bearing in mind the Government procurement policy, the Secretary of State for Scotland has authorized the SHHD to purchase six ICL 2966 systems at a reported price of £4 million. The operating system to be used will be VME/B, but the George II or George III operating systems will be able to be used alongside VME/B which will reduce the period of time during which old and new machines must be running together. If all goes to plan, the first system will be installed in October 1981 and the last by 1985.

In response to recommendation (d) a Computer Policy steering Group has been created to advise SHHD on the transition arrangements. It is estimated that software conversion will take about 70 man-years. Standard systems will not only be converted but also redeveloped to take advantage of the new facilities available under the VME/B operating system. At the same time the SHHD has issued a directive on computer procurement. All projects worth more than £10,000 must be sent via their AHB to ISD for approval. If they amount to less than £100,000 the CSA may authorize the AHB to give them approval: if permission is withheld, the application will be referred to SHHD.

Schemes over £100,000 will be treated as any other capital project and be approved and funded by SHHD. This procedure will apply to all computer systems whatever their purpose.

It is anticipated that all work involving patient identification will be transferred to SHS equipment by 1985; at present some is processed on University equipment. A new committee reporting to ICSAG, the Standard Computer Systems Committee, has been set up to administer the standardization of software. Membership comprises SHHD, ISD, senior officers from user departments, and a representative of the computer managers. Beneath this group will be a Computer Processing Committee for each standard system, comprising computer personnel and the project director. Such groups already exist for the payroll and financial management systems.

The development programme will continue. Computers are being introduced into primary care but caution is being advised until the result of the BMA initiative is clear. The CSA is taking an increasing interest in micro-computers and is working with the NHS microclub to publicize their uses and properties. It is also liaising with the

CCTA, which has produced a list of approved micro-system manufacturers.

Below the Consortia, AHBs will evolve as indicated in recommendation (a) bearing in mind the new procedure for requesting capital for computing.

Some outstanding issues

PAC INTEREST

In December 1979, the Parliamentary Committee of Public Accounts (PAC) examined 'the use of computers for finance, administrative and statistical work in the NHS'. The PAC restricted its attention to the progress made with the hardware and software standardization and, in an endorsement of those policies, urged the DHSS to ensure that standard systems were used more widely in the NHS.

Little attention was paid to the vast amount of expenditure and effort spent on computing in the NHS that does not come within the standardization policies. This omission casts doubt upon the PAC's conclusions insofar that they are applicable to a limited area of activity. Moreover the Committee was not led to address issues which to many seem more fundamental to the progress of computing in the NHS, such as the present realities of the standardization policies, whether the resources devoted to computing are adequate to meet the potential need, whether computing resources are being used for the right purposes, and whether new technology is being effectively exploited.

STANDARDIZATION POLICIES

The hardware standardization policy has been applied with some success—the ICL 1900 mainframe configuration was widely adopted by the Regional bureaux, and as those machines have become obsolete there is a general move to replace them with mainframe machines from the ICL 2900 series. The PAC perceptively questioned the relevance of the criteria of 'satisfactory price, performance and delivery' when, in the absence of real competition, it is difficult to make true comparisons with hardware supplied by alternative manufacturers. What is evident, however, from an analysis of computing in the NHS, particularly at sub-Regional levels, is the wide diversity of hardware currently in use. This trend is bound to continue, given the technological change which encourages decentralized provision of computing facilities based on smaller computers. The continued utility of a rigid hardware standardization policy is in consequence very much open to question.

The policy to develop and adopt standard software systems has been less successful. There can be little doubt that there is no wish to duplicate development when it can be avoided. There are a number of possible approaches to developing systems for common use, which have important implications concerning the degree of flexibility in systems design, programming and operational use. At the most general level it is possible to conceive and develop a standard functional design for a computer system which will consist of a statement of the problem to be tackled including a description of the necessary data inputs and the desired outputs. The actual hardware and software with which such a standard functional design might be implemented would not be specified and different approaches would be expected depending on local circumstances and preferences. To the ultimate users, such variety would be irrelevant since all systems would undertake the same task and produce the same products. At a second level, it is possible to develop a standard functional design as in the most general case, but to specify as well the format of data input and output structures (including file layouts) and any interfaces. Under this approach it would be possible to vary the hardware configuration upon which such a system would run, and allow discretion in the writing of software. At the final level of standardization, that adopted within the NHS, both the hardware and software are standardized as well as the systems design.

It has been generally assumed that the approach to standardization adopted for the NHS would prove the most economical in terms of the resources for developing computer systems. It is evident, however, that a large measure of antipathy towards the standard systems has grown up amongst potential users. This manifests itself in the relatively low level of implementation of standard systems (about a third of the Regional bureaux work is based on running standard systems). It is difficult to substantiate claims that standard systems are inefficient and expensive to run, but having to cater for diversity of requirements and options within one system would tend to produce such characteristics. There are more serious grounds for questioning the assumption that the most economical approach for maintaining the system once it is developed is for the centre of responsibility to have sole responsibility for making any changes.

Even with the payroll system, where changes in payment details must be applied uniformly through the NHS, significant resources are often committed within each Regional bureau to administering 'first aid' to the system. It is noteworthy that the key assumptions have not been adequately tested, particularly since they continue to form the basis for national policy.

An alternative to standard systems is the development of 'transferable systems', an approach which falls somewhere between the first and second categories above. Transferable systems involve less rigidity in their application and use than the standard systems. For the future this would seem to be a more promising direction, given the previous observations on the effects of technological change and the evident trends in hardware development. If the development of standard systems was (arguably) a sensible approach when computing was centralized on bureaux mainframes running in batch mode, then the development of transferable systems would appear to be the most promising way of exploiting the characteristics of the new technology. A necessary feature of such an approach must be the collation and dissemination of information about those systems being developed throughout the NHS to avoid duplication through ignorance.

In the context of overall efficiency it is necessary to question whether it is right to devote such significant resources to the major hospital projects still in existence from the experimental programme. Other than the University College Hospital System, which was developed in its present form locally outside the R&D programme, none of them are likely to yield a transferable system without fundamental re-construction. Many of the projects now require significant funds to replace their obsolete hardware. The Research and Development Committee rightly rejected bids from some of the projects for replacement capital. Whether RHAs will be able to deny such powerful lobbies remains to be seen. There is no doubt, however, that within these projects there exists a large body of expertise which could be of considerable benefit to computing in the NHS as a whole.

TRANSITION FROM ICL 1900 TO 2900 COMPUTERS

The transition from the obsolete standard hardware configurations (ICL 1900 series computer using the George III operating system) to the next range of standard hardware (ICL 2900 series computers probably using the VME/B operating system) will necessitate considerable effort in converting existing systems. In 1977 a working party of Regional Computer Services Officers, including representatives of ICL and the DHSS, was established to consider the extent of the problem. Its report, which was submitted to the DHSS Computing Technical Committee (paper TC(79)39) recommended that:

> the Centres of Responsibility for the standard accounting system, the standard payroll system and the standard child health system should state when they intend to change to ICL 2900 computers (using the VME/B operating system) and that these three systems should receive 'special and individual consideration, and if necessary conversion aids such as early access to 2900 equipment';
>
> that the standard manpower system should not be developed further on 1900 equipment;
>
> that the remaining systems be recompiled using a version of the COBOL language compatible with the new machines;
>
> the use of the VME/B operating system on 2900 computers should not be imposed on users by centres of responsibility; the transition to the VME/B operating system should be achieved using to the full the transition aids available for George III and VME/B;
>
> redevelopment of the standard systems should be permitted during conversion, but improvements might not be retrospective to the 1900 versions of the systems;
>
> 'centres of responsibility should cease to maintain 1900 versions after decommissioning their 1900s'. The last anticipated 1900 user would then assume responsibility for maintenance.

To date, of the five ICL 2900 systems installed in Regional bureaux only one (at South Western RHA) uses the VME/B operating system. No standard systems are yet available which run under the VME/B operating system, and there has yet to be a national commitment to adopt the VME/B operating system as the standard. Some of the existing standard systems are being reconstituted using a compatible version of the COBOL language, but target dates for transition to running under the VME/B operating system have yet to be set. (The reluctance to change to VME/B seems to result from the level of effort required and the apparent inefficiency of that operating system. The problems are accentuated by the shortage of systems development staff. But certain features of ICL 2900 computers cannot be used unless that operating system is employed.) The problems of transition have been eased by the announcement in late 1980 of the ICL 2966 computer which can run both George III and VME/B simultaneously (a feature which caused WHTSO to replace its order for an ICL 2972 computer with one for a twin ICL 2966 system). The five existing 2900 computers cannot be enhanced to 2966 machines.

It is evident, therefore, that conversion presents serious problems and requires a co-ordination of effort throughout the NHS that is by no means apparent. A decision on which operating system to employ is required. A co-ordinated response on timetables and effort is necessary from the centres of responsibility for standard systems. Some assistance from central funds to support conversion may be available, but support to maintain obsolete 1900 standard systems is also necessary. The suggestion that the last anticipated 1900 user be responsible for maintenance once centres of responsibility have changed to 2900 machines seems to be impractical.

DO RESOURCES MATCH NEED?

The last attempt nationally to establish requirements for computing in the NHS was carried out by the DHSS study group responsible for HC(77)11: *A Review of NHS Computing Needs.* Several Regions have since carried out their own surveys. It is evident that the demand for computer facilities and services exceeds the present supply. In the current circumstances of constrained administrative costs, under which heading expenditure on computing falls, the prospect of significant increases in financial resources for computing seems small irrespective of what benefits might result.

An equally significant problem is the shortage of systems development staff, for which the NHS is in direct competition with the rest of the public and private sectors. At present about 15 per cent of established posts in England, and 12 per cent in Wales, are vacant. The range about these average values is wide: one of the London Regions has a shortfall as high as 51 per cent. The situation was most critical in 1978 and 1979, when the running of operational systems was at risk in several authorities. The problem is currently less severe as a result of a recruiting campaign to attract staff from other NHS disciplines (e.g. work study and medical records), and the worsening economic climate which has reduced the competition from elsewhere. The situation could deteriorate again as the recession eases.

Within this general picture a more serious situation is evident with regards the experience of software development staff employed in the NHS. Of the total about one sixth are designated trainees, and a much larger proportion have been in post for less than one year. In the Yorkshire Region, the latter account for about half the total, a level which is not exceptional. The SE Thames Region has calculated that 354 man-years (net) of experience have been lost since 1976. The picture is one of high staff turnover, particularly in the middle grades, with experienced staff devoting an appreciable part of their time to training new entrants (on average, only about 30 per cent of analyst/programmer time is devoted to new work). The causes appear to be:

The lower pay and poorer conditions of service than in external organizations (one factor deterring non-NHS sector staff from applying for NHS jobs is that they are not eligible for removal expenses). The situation is notably better where there are few competing employers (for example, the Dental Estimates Board in Eastbourne has no problem with staff retention).

The limited promotion prospects to the higher grades; turnover in those grades is low and promotion into other NHS disciplines is rare.

The poor intellectual appeal of NHS computing.

This situation is self-perpetuating and is a major factor causing low morale, with its effect on the quantity and quality of computer services. The prospects for improvement over the next few years are limited.

ARE RESOURCES USED FOR THE RIGHT PURPOSES?

A few Regions are attempting to examine the cost/benefit ratio of costing proposals, only pursuing those applications which yield positive returns. Such a technique has not been applied to the majority of the systems now operational, and might provide surprises if it were. The approach is not without its drawbacks. Many of the benefits of computing are difficult to quantify (the attempt to evaluate the experimental programme was testimony to this fact), and it is difficult to realize savings from computerizing manual procedures. Some systems may only achieve their full potential as a result of changes in methods caused by the introduction of computers; the benefits of some systems may only be indirectly related to computing. The balance between costs and benefits is subject to developments in technology, such that what seemed doubtful in the past may later become highly desirable.

In practice, most applications are selected by negotiation between interested parties. Development resources are allocated to those applications whose sponsors are prepared to meet the running costs (and in some cases the capital costs) and, given the limited development resources, to those applications which offer the prospect of being replicated on a wide scale. The portfolio of potential applications thus becomes a subjective creation. Those interests which can exert most influence on the Regional bureaux stand the best chance of having resources committed to their applications.

The potential and realized computer applications in the field of health care are listed in the various exhibits and appendices of this report. The topics are not exclusive: thus patient registers can be constructed on a geographic basis, serving all users, or by separate indexes for FPCs, hospitals, and child health. Similarly, computing in general practice can be approached through the parent FPC register or treated as a stand-alone system for each practice. Certain gaps in the coverage are detectable even from a cursory examination. There is scope to extend the coverage of an FPC system into the work of the constituent practices for purposes such as: age/sex registers and recall systems. The application should also handle both the medical and nominal index. The scale of the FPC system is open to question; Regional or local implementations are obvious alternatives. Local solutions have the advantage of reducing confidentiality problems to a manageable level. Most of these features are examined in the Final Report of the Joint Management Committee of the FPC Computer Project undertaken by Trent RHA.

There is a need in England and Wales to examine the possibility of a single geographical patient index to support a wide variety of patient-orientated applications, such as hospital, FPC and child health systems. In Scotland the Tayside Master Patient Index system links primary and secondary care; the possibility of linking the Scottish version of the child health system to the Tayside Master Patient Index is being considered. In this context the implementation of the Tayside system in Salford AHA could form the basis for further experimentation.

More work seems necessary on the possibility of computerizing patients' medical records. The main problems here are twofold: the structure of the medical records, and the man/machine interface. Since the much publicized failure of the King's Project, efforts in the field have been understandably but regrettably sparse.

In the field of management, a number of areas are worth exploring. For example:

financial information

transport scheduling

capital project appraisal

capital programme modelling

The Financial Information Project underway at the West Midlands RHA presents one promising practical approach to the first area. Work on ambulance scheduling has been carried out by several organizations.

The potential for applying computers in general practice could be significant, if the evidence of the reports of the British Medical Association, the Royal College of General Practitioners, and the attitudes of many GPs can be taken as being indicative of the general position. There are, however, a number of problems which need to be resolved. The basis for funding computing in general practice needs to be decided. The development of a multitude of different systems operating on different data structures could deny the possibility of capturing comprehensive data on primary care, which would be a sad loss. What is required is the definition of a common data-set which different systems would adopt as a standard. It may already be too late for such an initiative.

Regional computing plans place increased emphasis on medical applications, in particular on patient administration systems. An important requirement for the NHS is the development of a 'turnkey' hospital patient administration system which is modular and can be extended in response to local requirements. There are several existing systems (WHTSO, Northwick Park Hospital, University College Hospital, Southend Hospital, Guy's Hospital), but none appear to have all the desirable properties listed above. The use of computer-aided diagnosis could be extended, both in terms of wider use of existing applications and to other potentially rewarding areas of morbidity. Developments in this direction will require a greater involvement of clinicians in the management processes affecting computer investment.

IS NEW TECHNOLOGY BEING PROPERLY EXPLOITED?

It is pertinent to examine some particular aspects of the new technology and their use within the NHS, since the potential benefits could be significant. Such aspects include:

micro computers;

communication/networking facilities; and,

the newer design techniques and facilities such as structured system design and programming, database packages and very high level languages and development aids.

It has to be remembered, though, that investment in new technology can only be made at a rate permitted by the available resources. It is important, therefore, to evaluate demands and ensure that those of the highest priority proceed within the minimum resources available.

There is already considerable use of micro-computers in the NHS. Their introduction has come from the initiative of Regional bureaux as well as individuals at the operational levels. Being a new technology, users tend to be enthusiasts, and thus the geographic spread of developments is considerable. At Regional level the exploitation of micro-computers has been held back by a shortage of development staff and resources for hardware. Two Regional bureaux have had attempts to start micro work-shop facilities rejected, and another is frustrated by recruitment problems. One or two Regions are reluctant to venture away from ICL hardware because of the problems they face in interfacing non-ICL equipment with the bureau mainframe. Experience elsewhere suggests that although this may be the case, the rewards of doing so more than offset the difficulties, and that the problems are less than those which have been associated with mini-computers. There is an apparent lack of interest in some areas, which points to an obvious potential for a better exchange of ideas between Regional bureaux.

Very few Regions, if any, are planning to network computers of various sorts, other than on a hierarchical basis. WHTSO is examining the use of ICL's Information Processing Architecture to link Area and hospital equipment to the central ICL 2966 system. One unit is thinking of implementing an automated pathology laboratory system using the concept of the 'Cambridge ring circuit'. One of the former major experimental projects is considering replacing its mainframe with a network of micro-computers.

Structured design and programming techniques have been employed in Regions for some time. Eight Regions use the technique on all new work; four do not; and two are hoping to introduce the methodology soon. Two Regions used to use the techniques but found that once staff were trained and competent, they could command such better salaries elsewhere that they left. In one case this involved the loss of an entire software team of five people. One Region offers training on the topic to the NHS as a whole.

Database usage in the NHS is at the embryo stage. The Stoke project is investigating the use of a database package within its converted hospital system, and North West Thames RHA is considering the possibility of commissioning a consultant to look at the potential of database usage within its payroll system. In November 1980, an NHS Working Group on databases, consisting of Regional officers and a representative from the Stoke project, reported and made the following recommendations:

> that the major standard NHS systems be developed using a common database employing the IDMS package on ICL hardware.
>
> that a standard NHS Health Care Data Dictionary should be produced. Commercially produced systems would only be approved if they conform to this standard. (An earlier offer by East Anglia RHA to start work on this was delayed for two years by a shortage of staff, although there was little pressure from other Regions for its completion. The project is now proceeding locally).
>
> that DHSS should negotiate with ICL for better licensing terms for IDMS and other data analysis software.
>
> that a database consultancy group be set up to serve the NHS. It should be funded centrally and have executive power. It should report to a central body concerned with the NHS computing.

The interest in very high level languages is growing. CMC REALITY equipment and the associated ENGLISH language are in use for several applications in England and Scotland (e.g. HAA data processing, stores systems, and hospital patient administration systems). The package ADMINS II has also been evaluated by two Regions. Although not as comprehensive, the direct data entry facilities on ICL 2900 series are widely utilised. The MUMPS language is widely used on a local scale, notably in Oxford and North East Thames Regions, and will shortly be used extensively by Trent for FPC, hospital and laboratory applications.

There are some obvious gaps in technical coverage, for instance the need to examine the application of Prestel-type services (for example to disseminate information on drugs), and to assess the potential of voice recognition. Such areas are worth examining as part of a strategy for research and development.

If one gathers together the most advanced thinking and planning on computing in the health services the picture is exciting. But it is difficult to deny that the spread of effort is very patchy and that much could be done to ensure a more comprehensive response to the advent of new technology for the benefit of health care.

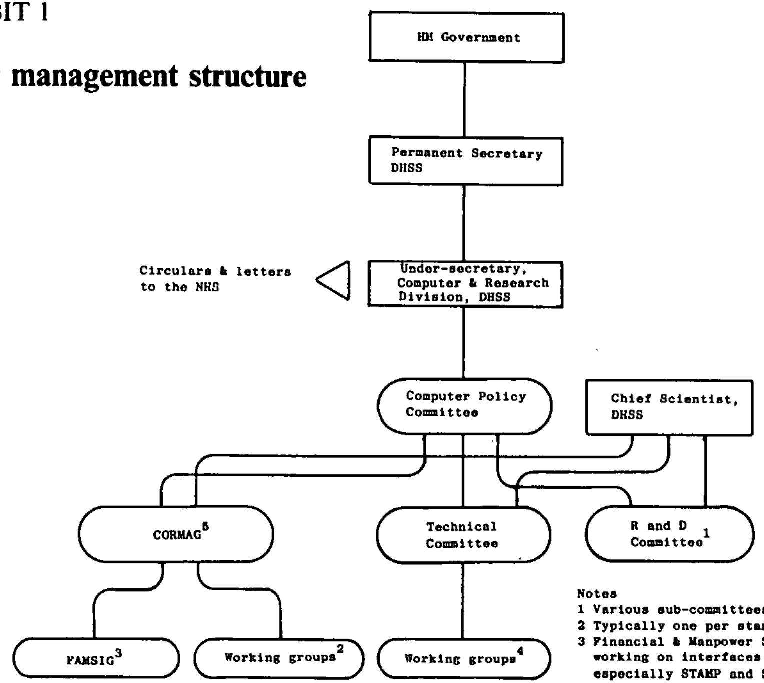
Exhibits and appendices

EXHIBITS

APPENDICES

EXHIBIT 1

DHSS/NHS computer management structure



Notes

1 Various sub-committees, eg one for Primary Care

2 Typically one per standard system

3 Financial & Manpower Services Information Group working on interfaces between standard systems, especially STAMP and SPS

4 Has working groups of RCSOs on: ICL 1900-2900 transition, ICL 2900s, Programming techniques, Documentation standards, Databases, System software, Operations, Micro-computers

5 Centre of Responsibility Management Advisory Group

EXHIBIT 2

A breakdown of computing effort in England by organization

			Computing[1] capital investment May 1980, valued at purchase prices, £000s		Revenue spend[2] out-turn 1979/80, £000s	
(1)	Part of Regional Plan	RHA Bureaux	14,249	44%	11,719	59%
(2)		Area/District HQ	1,290	5%	170	1%
(3)		Front line units (chiefly hospitals)	1,478	5%	224	1%
(4)		Major ex-R&D projects	2,826	9%	1,136	6%
(5)	Outside Regional Plan	Major ex-R&D projects	3,227	10%	2,347	12%
(6)		Area/District HQ front-line units	1,234	4%	400	2%
(7)		Area/District bureau use	n/a	n/a	1,512	7%
(8)		Scientific work	6,680	21%	822	5%
(9)		DEB	752	2%	1,436	7%
		Totals	31,736	100%	19,766	100%

NOTES

(1) The capital and revenue figures do not include any accommodation costs but do embrace ancillary equipment used for data preparation, telecommunications, etc., which is concentrated in the Regional bureaux, the DEB, and to a lesser degree the major experimental projects.

(2) The revenue spend does not include time devoted to programming, etc., by persons not designated as computer staff. This applies particuarly to categories 3, 6 and 8.

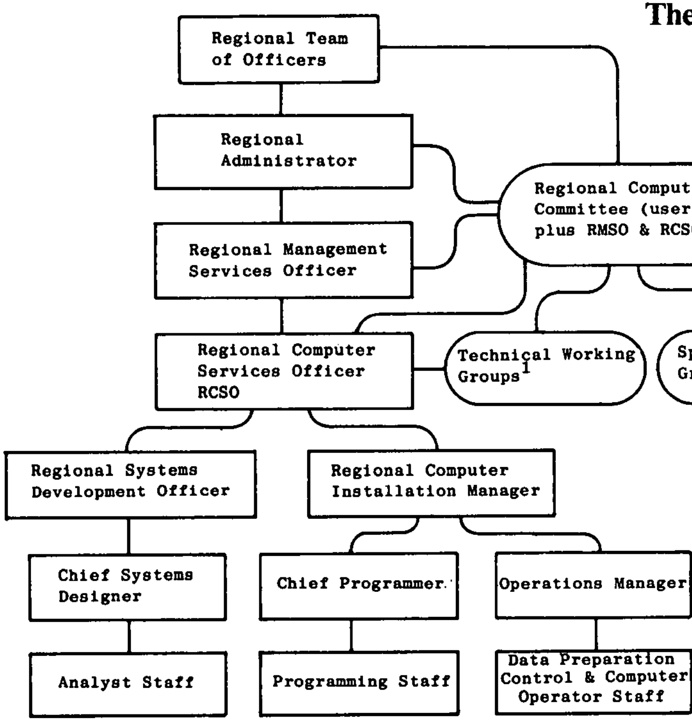
(3) The data on computer installations in category 6 is known to be incomplete: many stand-alone systems in hospitals have been missed. Neither is the extent of the shortfall known; it might amount to £2m. in capital terms.

(4) For some installations in categories 6, 7 and 8 it has only been possible to include an estimate of the maintenance costs (at 12% of the capital value) as the revenue expenditure. This applies to 43% of the total revenue in category 3, 33% of category 6, and almost all of category 8. The totals for these classes are therefore underestimates.

(5) Category 6 information was completely unobtainable for one Region, category 7 for five, and category 8 for 3. In each case the Region has been assigned the average expenditure for that category of the Regions which do have data. Hence the totals are estimates only.

EXHIBIT 3

The structure of computer management in a RHA



Notes

Not all RHAs have Regional System Development Officers and Computer Installation Managers. The breakdown into analysts and programmers with distinct line managements is commonly disappearing. Some staff are designated analyst/programmers, but more often analysts & programmers are formed into project teams, usually (but not always) headed by an analyst.

1. Mainframe Replacement etc
2. Includes payroll, personnel, child health etc.

EXHIBIT 4

Standard computer systems in England and Wales

System	Centre of Responsibility	Estimated Out-turn Costs, £000s to 1.4.81	Estimated Out-turn Costs, £000s in 1980/81	% Central Funds	% of Potential Users on it by 1.4.81	% of Potential Users on it by 1.4.83	Comments
Payroll (SPS)	North Western RHA	742	230	48	70	78	
Child Health (V & I)	WHTSO	544	210	34	60	60	Is basis of Scottish system. E. Eire thinking of taking it.
Accounting (SAS)	West Midlands RHA	1,103	460	49	56	63	
Manpower (STAMP)	Wessex RHA	294	100	49	33	33	COR has said will only do 3 modules of 8.
Equipment Scheduling	WHTSO	83	13	0	40	40	
Estate Management (EMIS)	Northern RHA	126	38	50	10	10	
HAA (Maternity) (SMIS)	Northern RHA	52	20	50	20	20	Interim System.
Supply Vocabulary	N.W. Thames RHA	54	32	50	34	34	A standard dictionary, not system.
FPC Study	Trent RHA	131	0	42	1	1	Not really a standard system.
Payment of Creditors	Trent RHA	2	0	50	0	0	Defunct.
Total or Average		3,131	1,103	47	40	42	

NOTES

(1) An additional £90,000 has been spent on training, all from central funds. The total estimated expenditure to 1.4.81 is £3,201,000. The number of potential users of each system is 14 Regions, plus WHTSO, plus DHAs, totalling 222.

(2) The data on implementation has been obtained from 'The Regional Administrators' View of the Future (of Computing)', 5.11.80. The financial details were supplied by the DHSS.

EXHIBIT 5

Computing resource usage by application group in England, 1979–80

Based on data obtained from the East Anglian, South East Thames, Trent, Wessex and Yorkshire RHAs.

Application Group	Regional Computer Services Departments % Total Revenue Costs	Estimated Regional Total, % Total Revenue Costs
Finance	37	28
Administration	5	4
Statistics	12	9
Patient Administration	3	17
Scientific	2	7
Medical	11	12
Other	4	3
System Development	26	20
Totals	100	100
Percentage Revenue spent on Standard Systems	27	20

NOTES

(1) Administration includes supplies.

(2) Statistics include HAA, Cancer Registry, Maternity Information, etc.

(3) Patient Administration includes hospital systems such as that at Addenbrookes, including the laboratory work there.

(4) The biggest Medical application by far is Child Health.

(5) The values for computing outside the Regional Computer Services Department suffer from the same problems as are described in Exhibit 3, so that some application groups are systematically under-represented. This applies to Scientific and Medical Computing.

EXHIBIT 6

Regional variations in computing resources

Values are expressed per £10 x 10^6 of Regional Turnover, 1979/80, including FPC and Capital Allocations.

	RHA Computer Services Unit Data			Estimates for Whole Region		
Regions	Capital Stock 1980 £000s	Revenue Spend, Out-turn 1979/80 £000s	System Devl.Staff	Capital Stock 1980 £000s	Revenue Spend, Out-turn 1979/80 £000s	System Devl.Staff
East Anglian	23	16	1.1	46	23	1.1
Mersey	21	13	1.0	?	?	1.0
Northern	16	15	0.5	23	16	0.5
NE Thames	18	16	0.8	55	32	1.3
North Western*	26	12	0.5	40	14	0.5
NW Thames	16	13	0.8	46	22	1.2
Oxford	42	29	0.9	53	31	0.9
SE Thames	25	24	0.8	51	34	1.2
South Western	31	22	0.8	55	33	1.4
SW Thames	25	24	0.8	33	30	0.8
Trent	11	9	0.7	26	15	0.7
Wessex	23	21	0.9	42	23	0.9
West Midlands	15	14	0.8	53	29	1.7
Yorkshire	12	12	0.7	20	13	0.7
English Averages	21	16	0.8	41	24	1.0
Wales	25	30	1.0	40	32	1.0
Scotland	44	25	1.4	?	?	1.8

NOTES

(1) All capital stock valued at purchase prices.

(2) RHA Computer Services Unit figures not necessarily comparable, as two Regions include the equipment and staff at remote sites in Regional costs. The figures are therefore not quite the same as those given in Exhibit 2, so that the figures here are higher by £630,000 of capital stock, and £300,000 of revenue expenditure, 4% and 2.5% of the respective totals.

(3) The total Regional values are built up from data given in Exhibit 2, and incorporate the same approximations and shortcomings.

(4) For Wales 'RHA' means WHTSO, and 'whole Region' is all of Wales. For Scotland 'RHA' is CSA, Consortia and AHB computing, and 'whole Region' equals all of Scotland.

EXHIBIT 7

Computer resource usage by application group at the WHTSO Bureau, September–October 1980

Application Group	% of Total Revenue Costs	% System Development Effort
Finance	31	11
Administration	5	7
Statistics	12	18
Patient Administration	6	9
Scientific	5	1
Medical	10	23
Other	2	31
System Development	29	n/a
Totals	100	100

Standard Systems consume 23% of the Total Revenue Costs.

NOTES

(1) Administration includes supplies.

(2) Statistics include HAA, Cancer Registry, Maternity Information, etc.

(3) Patient Administration includes hospital systems.

(4) The biggest Medical application by far is Child Health.

EXHIBIT 8

Breakdown of computing effort in Wales

			Computing Capital Investment 1980, valued at purchase prices £000s		Revenue Spend/Out-turn 1979/80 £000s		Comments
1.	WHTSO Bureaux	Part of Welsh Plan	1,151	63%	1,373	94%	All devoted to Welsh Hospital Patient Administration System
2.	Front-line Units (i.e. Hospitals)		196	11%	24(e)	2%	
3.	Independent Computing		488	26%	59(e)	4%	Includes scientific and other work on 12 minis and 55 micros.
	Totals		1,835	100%	1,455	100%	

NOTES

(1) All figures exclude the costs of accommodation.

(2) Revenue costs for categories 2 and 3 are in estimate of maintenance costs only, at 12% of purchase price per annum, and do not include any other running costs (stationery etc.). The figures are therefore an underestimate.

EXHIBIT 9

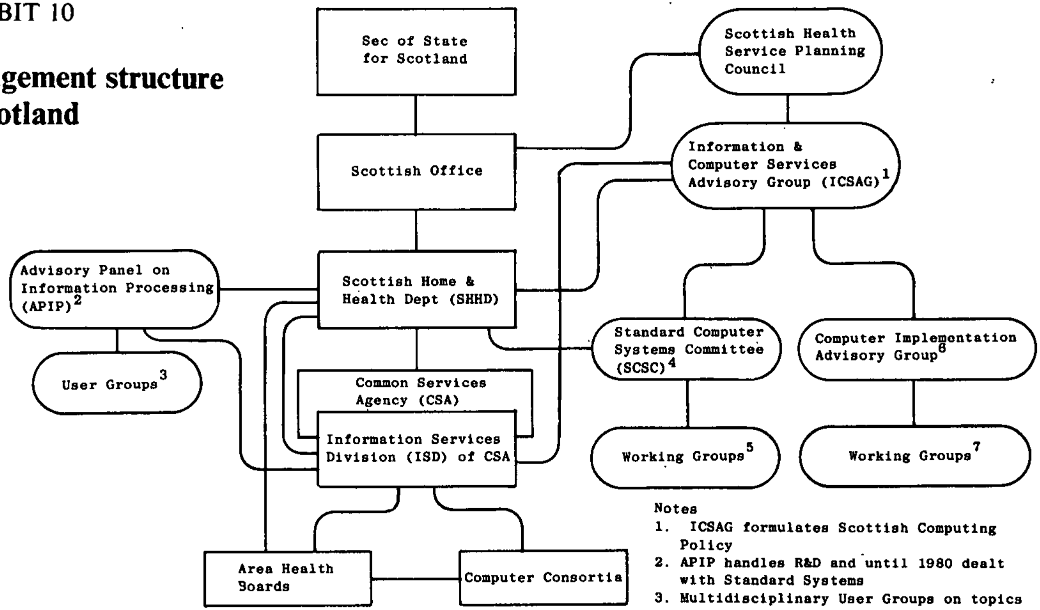
A summary of the Scientific and Clinical Experimental Programme

Topic	No. of Projects In Total	No. of Projects Ongoing	Cost to date Out-turn £	% of Total
Laboratory work (including SNOP coding)	19	4	2,039,015	63%
Patient Monitoring	4	1	221,358	7%
Clinical Measurement	4	-	78,946	2%
Signal Analysis (ECG & EEG)	4	-	266,592	8%
Radio-diagnosis and Therapy	3	-	228,266	7%
Clinical Decision-making	2	1	111,687	3%
Patient Interviewing/ testing	2	2	27,092	1%
Other	3	1	286,551	9%
Totals	41	9	3,259,507	100%

Derived from Data supplied by the DHSS

EXHIBIT 10

Computer management structure in Scotland



Notes
1. ICSAG formulates Scottish Computing Policy
2. APIP handles R&D and until 1980 dealt with Standard Systems
3. Multidisciplinary User Groups on topics such as Pathology, Patient Indexes, Hospital Systems
4. SCSC founded late 1980
5. Computer Processing Committees for each Standard System
6. To oversee 1900 to 2900 transition, founded late 1980
7. Various Technical Working Groups including the SHS Computer Working Group

ISD is represented on ICSAG, APIP, SCSC and the Computer Implementation Advisory Group
APIP also liases with the Chief Scientist at CSA
ISD also acts as technical assessors to SHHD and ICSAG

EXHIBIT 11

Computer resource usage in Scotland

Application Group	% Total Revenue Expenditure
Finance	45
Administration	-
Statistics	21
Patient Administration	8
Medical	17
Other	9
	100

These figures include work carried out by the AHB and Consortia Computers, CSA, with the development funds from APIP and at the Scottish Office Computer Centre on behalf of the SHS. Based on Table 7.3 in the 'Report of the Computer Policy Review Committee of the Information and Computer Services Advisory Group' (1980).

EXHIBIT 12

Standard and transferable NHS systems in Scotland

System	Type of System	Centre of Responsibility	% potential users at 1.4.81	Comments
Payroll	Standard	Tayside HB	100	
Financial Management	Standard	Southeast Consortium	93	
Child Health	Standard	Greater Glasgow HB	13	Modified version of English/ Welsh system.
Manpower Statistics	Standard	West Coast Consortium	100	Developed by ISD initially, based on data in payroll files.
Annual Accounts (Form 5)	Transferable	Greater Glasgow HB	100	
Hospital Activity Statistics	Transferable	Southeast Consortium	20	
Neonatal Records	Transferable	Tayside HB	100	Run at Tayside for all AHBs.
Community Health Index	Transferable	Tayside HB	40	Part real time.
Pharmacy Stock Control	Transferable	Grampian HB	7	Real time on DG mini-computer; in use at three sites, centres round a CTL minicomputer.

Laboratory System 1	Transferable	Tayside HB	?	
Laboratory System 2	Transferable	Greater Glasgow HB	?	On DEC minicomputer, not transferred yet.
Diagnostic Validation	See comment	Greater Glasgow HB	?	A transferable file, not system.
			Average = 60	

NOTES

(1) The potential users consist of all 15 AHBs, plus CSA for the Payroll and Financial Management Systems, apart from Neonatal Records which is run centrally for all of Scotland. As the number of laboratories in Scotland is not known to the Author, the % of potential implementations achieved for the Laboratory Systems cannot be given.

(2) The two Laboratory Systems are mutually exclusive.

(3) The number of sites having the Diagnostic Validation File are not known.

(4) Usage data is derived from the 7th and 8th Annual Reports of the SHS Computer Working Group.

EXHIBIT 13

Computing in Scotland and outside the CSA, AHB Headquarters and the consortia

Applications		Computer Systems Nos.	%	Development Staff	Comments
Medical/Patient Statistics		5	5	6	
Patient Administration		3	3	-	1 System for Primary Care, 2 for Hospitals
Hospital Patient Servicing		3	3	2	
Scientific:	Laboratory Work	27	26	10½	
	Radiotherapy	4	4	1	
	Imaging	11	11	3	
	Medical Physics	8	8	2	
Medical:	Patient Records	7	7	1	
	Other	23	21	20	E.g. Signal Analysis, Pulmonary Function, Computer-aided Clinical Decision-making.
Other		13	12	-	E.g. Systems in CSA for Prescription Pricing and Blood Transfusion Service.
	Totals	104	100	45½	

Equipment Used	No.	%	
Mainframe	1	1	
Minicomputer	69	66	
Microcomputer	25	24	
Other	9	9	Includes some data collection equipment and calculators.
	104	100	

NOTE

The data preparation/collection systems at 7 AHBs have not been included in these figures; the figures have been worked up from data in the 8th Annual Report of the SHS Computer Working Group, July 1980.

APPENDIX 1

Organizations and people consulted

ENGLAND

Charing Cross Hospital Project
Mr. H. Sinclair, Project Director

Dental Estimates Board
Mr. J. Bryant, Computer Manager

DHSS, MSC4 & 5
Mr. J. Alsop, SEO
Mr. J. Hart, PRIN
Mr. K. Keen, PRIN
Mr. K. Kemmit, SEO
Mr. T. Maddison, Asst. Sec.
Mr. D. Murray, PSCO
Mr. D. Polley, Under Sec. MSC Div.

DHSS, Finance Branch
Miss S. Novit, HEO

Dept. of Mathematical Statistics & OR, University of Exeter
Professor J. Ashford
Dr. C. Spicer, Research Fellow

Department of Medical Statistics, University of Newcastle-upon-Tyne
Professor D. Newell

St. James Infirmary, Leeds
Dr. F. De Dombal

East Anglian RHA
Mr. A. Cassidy, RMSO
Mr. P. Westcott, RCSO

Exeter Community Health Project
Mr. J. Sparrow, Project Director

Guy's District Computer Centre
Mr. C. Weatherstone, Manager

Health Computing Limited
Mr. A. Tully, Managing Director
Mr. C. Waywell, Technical Director

Mersey RHA
Mr. A. Faulke, RCSO

NALGO
Mr. H. Bayley, Asst. National Organiser, Health Staff

North East Thames RHA
Mr. P. Locke, RCSO

Northern RHA
Mr. W. Barron, RCSO

North West Thames RHA
Mr. C. Bishop, RCSO

North Western RHA
Mr. J. Batchelor, Princ. Asst. Regional Treasurer
Mr. I. Duncan, Asst. Management Services Officer
Mr. K. Howarth, RCSO

Office of Population Censuses & Surveys
Dr. A. Adelstein
Dr. J. Folwell

Oxford RHA
Mr. C. Cook, RCSO

Queen Elizabeth Medical Centre
Mr. P. Hills, Project Director

Royal College of Nursing
Margaret Lee

Royal College of Physicians
Dr. P. Emerson, Chairman of Computing Working Party on 'Mathematical Methods to Assist Clinical Decision Makers'

South East Thames RHA
Mr. L. Carter, RCSO

South West Thames RHA
Mr. W. Hedges, RSDO
Mr. N. Vincent, RCSO

South Western RHA
Mr. P. Reed, RCSO

Stoke Hospital
Mr. A. Nash, Project Director

St. Thomas's Hospital Project
Mr. M. Nelson, Project Director

The London Hospital
Mr. J. Rosen, Project Director

Trent RHA
Mr. B. Molteno, RMSO
Mr. J. Payton, RCSO

Wessex RHA
Dr. H. Badman, RSO
Mr. G. Guest, RMSO
Mr. A. Norman, RCSO

West Midlands RHA
Mr. P. Bishop, RCSO
Mr. J. Kwok, Microcomputer Project Team Leader
Mr. P. Saxon, RSDO
Mr. C. Whitt, Asst. Regional OR Officer

Yorkshire RHA
Mr. J. Dale, RCSO

SCOTLAND

Common Services Agency, Information Services Division
Dr. M. Heasman, Director
Mr. D. Leckie, Computer Adviser

WALES

WHTSO
Mr. M. Baird, Chief Programmer
Mr. M. Page, Computer Services Manager
Mr. D. Salter, Finance Officer

Welsh Office
Mr. M. Holbrook, Finance Division

APPENDIX 2

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APPENDIX 3

Terms of reference of DHSS/NHS Computer Committees

The relationship between the various committees is given in Exhibit 1.
The information was provided by the DHSS, MSC4 Division.

THE COMPUTER POLICY COMMITTEE

Terms of Reference:

1. To advise the Secretary of State on all aspects of computer policy in the National Health Service.

2. To guide the Research and Development Committee on the direction and content of an R&D programme and to receive advice from it.

3. To make recommendations on the allocation of Departmental resources for computing in the National Health Service.

4. To determine systems which should be standard and deemed transferable and establish a programme for this purpose, especially in relation to User Specification.

5. To supervise progress of the Computing Technical Committee.

6. To consider and advise on related matters referred to it from time to time.

THE COMPUTING RESEARCH & DEVELOPMENT COMMITTEE

Terms of Reference:

1. To explore ways in which NHS computing might develop.

2. To propose, co-ordinate and monitor an R&D programme.

3. To obtain information on existing patterns of health care computing and consider proposals for new R&D work.

4. To establish working groups, if necessary, to study and report upon specified areas of investigation and to co-ordinate and direct their activities and monitor progress.

5. To report to the Chief Scientist as and when required.

6. To consider and advise upon related matters referred to it from time to time.

THE COMPUTING TECHNICAL COMMITTEE

Terms of Reference:

1. To make recommendations to the Policy Committee on technical aspects of computing in the National Health Service.

2. To identify the characteristics of technical components and operational requirements of NHS systems.

3. To determine the range of standards, techniques, training requirements and other technical procedures which would facilitate the development and maintenance of NHS standard/transferable systems.

4. To provide a forum for the discussion, promotion and exchange of information in good computing practice.

5. Subject to guidance from the Policy Committee, to initiate such technical studies and establish and direct such working groups as are required to carry out 1-4 above.

6. To report to the Policy Committee as and when required.

7. To consider and advise upon matters referred to it from time to time.

CENTRES OF RESPONSIBILITY ADVISORY GROUP - CORMAG

Terms of Reference:

1. To discharge on behalf of the Computer Policy Committee, with appropriate advice, management of centres of responsibility, in respect of standard systems.

2. To provide advice to the Computer Policy Committee or initiate specific activities, when required, concerning the standardisation program.

FINANCIAL & MANPOWER SYSTEMS INTERFACE GROUP - FAMSIG

Terms of Reference:

1. To co-ordinate the development of SAS, SPS and STAMP.

2. To provide a forum for resolving issues on the integration and interface of these systems with particular reference to:

   (i) the determination of functions which are applicable to each system;

   (ii) the specification of data which is to be passed from one system to another;

   (iii) the effect of changes in the requirements of one system on either of the other two;

   (iv) timescales where they are mutually dependent.

3. To report to CORMAG as required and in particular to refer up any issue on which agreement cannot be reached.

APPENDIX 4

Major projects in the DHSS/NHS Computer R&D Programme

The information was supplied by the DHSS (MSC4 Division) and the Project Staff themselves.

		Spend, out-turn, £000s. Up to 1.4.80		in 1979/80		R&D Funding Started
		Capital	Revenue	Capital	Revenue	
Addenbrooke's Hospital, Cambridge	Hospital Patient Administration and Servicing	463	1,440	-	170	1968/9
* Charing Cross Hospital, London		585	1,817	-	339	1968/9
Hope Hospital, Salford		-	-	7	69	1978/9
* Liverpool Royal Infirmary		590	1,075	-	116	1968/9
The London Hospital		902	3,896	-	691	1968/9
North Staffs Hospital, Stoke-on-Trent		770	3,401	-	510	1968/9
Oxford Hospitals		528	1,346	-	18	?
Queen Elizabeth Medical Centre, Birmingham		836	3,252	837	458	1968/9
Southend Hospital, Essex		65	192	-	20	?
St. Thomas's Hospital, London		495	2,354	-	400	1968/9
University College Hospital, London		345	1,591	-	159	1968/9
	Total	5,579	20,364	844	2,950	

* Royal Devon & Exeter Hospitals - as above + provision of services to 3 health centres	1,041	3,360	-	550	1970/1
* Trent RHA Family Practitioner Committee System	175	263	-	81	?

Notes

(1) Spend is total exenditure on project, including accommodation, by all parties concerned.

(2) Not included are projects for which financial data was not supplied by the DHSS, viz.:

Computer Trials at the Prescription Pricing Authority	started 1978/9
King's College Hospital,	terminated in 1974 after spending £1.4 million
Guy's Hospital/Essex University Community Health Project	terminated in the early '70s after spending £250,000
The United Manchester Hospitals Project; Hammersmith/Kensington Study	cancelled early on in the life of the projects
Other joint proposals with LAMSAC	proposed in the early 1970s.

(3) R&D expenditure generally ceased on March 31st, 1979, apart from those projects marked with an *. The 1981 DHSS Handbook gave the 1979/80 R&D expenditure as £137,000 on capital goods, and £1,103,000 on revenue finance.

APPENDIX 5

Scientific and clinical projects in the Computer R&D Programme

The information was provided by the DHSS. Asterisks indicate those projects still in progress in March 1981. The costs are both revenue and capital, but exclude accommodation.

	Hospital/Centre	Project	Cost £	Duration
		International Organisation for Standards: Technical Studies	350	1979/80
	King's Mill Hospital, Mansfield	Clinical Chemistry: Haematology/ Pathology	21,629	1974/75-76/77
*	Killingbeck Hospital, Leeds	Patient Monitoring: Physiological Variable Processing Systems	54,652	1978/79-
*	University of Leicester	Microcomputer-Aided Cognitive Assessment of Psychiatric and Neurological States: Clinical Testing	4,000	1979/80-
*	Microprocessors (Mickie)	Patient History Taking	23,092	1978/79-
	Middlesex/ Addenbrooke's Hospitals	Radiotherapy Treatment Planning	88,280	1972/73-76/77
*	Northwick Park Hospital	Histopathology (Systematized Nomenclature of Pathology (SNOP)	34,869	1972/73-
*	" "	Transfer of the Histopathology (SNOP) System	8,835	1979/80-
	Poole District General Hospital	Elliott 903 Computer Trials: Pathology	31,000	1969/70-73/74
	" "	3-Lab Project: Clinical Chemistry/ Pathology	290,637	1972/73-77/78

	Hospital/Centre	Project	Cost £	Duration
*	Queen Elizabeth Medical Centre, Birmingham	Problem Oriented Management of Patients: Hypertension/Clinical Decision Making	91,147	1974/75-
	Royal Free Hospital	EEG Reporting: Physiological Signal Analysis	117,520	1971/72-77/78
*	Royal Lancaster Infirmary	Transfer of Phoenix System: Pathology	43,858	1977/78
	Royal Marsden Hospital	Nuclear Medicine (Medical Physics): Radiotherapy/ Treatment Monitoring/ Nuclear Medicine/ Patient Outline	111,976	1968/69-78/79
	St. Bartholomew's Hospital	On-line Acquisition of Data, Processing and Display: Patient Monitoring	72,396	1968/69-73/74
	St. Peter's Hospital	Patient Monitoring	19,210	1970/71-72/73
	St. Richard's Hospital, Chichester	Echocardiograms: Transfer from Brompton: Clinical Measurement	3,900	1977/78
	St. Stephen's Hospital, Chelsea	Elliott 903 Computer Trials: Pathology	32,487	1969/70-71/72
	Sheffield Royal Infirmary	Elliott 903 Computer Trials: Pathology	69,739	1969/70-73/74
	University College Hospital	Elliott 903 Computer Trials: Pathology	99,577	1969/70-73/74
	" "	Clinical Chemistry and Haematology (3-Lab Project): Pathology	403,757	1972/73-76/77
	" "	Documentation of Socrates Computer System: Clinical Chemistry/Pathology	4,000	1977/78-78/79

Hospital/Centre	Project	Cost £	Duration
University College Hospital	Medical Physics	285,351	1971/72-78/79
Warwick Group Laboratory	Elliott 903 Computer Trials: Pathology	84,268	1969/70-73/74
Wythenshawe Hospital	ECG Reporting: Physiological Signal Analysis	124,263	1974/75-78/79
Addenbrooke's Hospital	Haematology Computer System: Pathology	301,188	1970/71-78/79
" "	ICU Monitoring: Patient Monitoring	75,100	1971/72-72/73
Airedale General Hospital	Acute Abdominal Pain Diagnostic Probability System: Clinical Decision Making	20,540	1974/75-77/78
Brompton Hospital	Analysis of Cineangio-grams and Echocardio-grams: Clinical Measurement	63,496	1974/75-77/78
City General Hospital, Stoke	Computer-Aided Pulmonary Functions Analysis System	9,000	1979/80
Derby Royal Infirmary	ECG Reporting: Physiological Signal Analysis	14,430	1975/76-77/78
Edgware General Hospital	Transfer of Warwick Computer System: Haematology/ Pathology	1,400	1977/78
Fazakerley and Walton Hospitals	Clinical Chemistry Remote Computer: Pathology	57,590	1973/74-78/79
Good Hope Hospital	Management Inform-ation Radiology	28,010	1973/74-75/76
Hammersmith Hospital (RPMS)	Elliott 903 Computer Trials: Pathology	71,739	1969/70-73/74
" "	3-Lab Project: Clinical Chemistry/ Pathology	287,063	1972/73-76/77

	Hospital/Centre	Project	Cost £	Duration
*	Hammersmith Hospital	Phoenix Computer System: Clinical Chemistry and Haematology	121,859	1977/78-
	Hammersmith Hospital	Venous Angiograms: Radiology	2,550	1977/78-78/79
	King's College Hospital	Clinical Chemistry: Pathology	73,520	1969/70-76/77
	Walton Hospital	ECG Reporting: Physiological Variable Processing	10,379	1975/76-78/79
*	Royal Post-Graduate Medical School	Development of Micro-processor Application (Technical Study)	850	1978/79-

APPENDIX 6

Terms of reference of SHHD/SHS Computer Committees

The relationship between the various committees is given in Exhibit 10. The information was supplied by the Information Services Division of the Common Services Agency.

COMPUTER POLICY REVIEW COMMITTEE

Work completed in Spring 1980 and now defunct.

Terms of Reference:

1. To receive evidence (possibly including site visitations) from Health Boards, CSA, SHHD, DHSS and the Central Computer and Telecommunications Agency (CCTA) and to review the current policy in the light of the need for the replacement of major Health Service Computers over the period 1980/1985.

2. To make recommendations on the replacement policy to be followed during this period.

3. To supervise a technical study.

4. To report to ICSAG no later than December 1978.

ADVISORY PANEL ON INFORMATION PROCESSING - APIP

Terms of Reference:

'To advise the Director of the Information Services Division on the use of computers in the Health Service in Scotland and, in particular:

- to advise as required on the implementation of health service information processing policy and on individual applications for support for new projects within the framework of that policy.

- to receive and consider annual reports from on-going computer projects, and from any other projects that may be set up in future.

- to advise on the monitoring and evaluation of projects.

- to advise on the implementation of standard procedures in health service information processing.'

INFORMATION & COMPUTER SERVICES ADVISORY GROUP - ICSAG

Terms of Reference:

'to advise the Scottish Health Service Planning Council on policy relating to information services, including computers, in the health services.'

APPENDIX 7

Computer development projects in Scotland

Information supplied by the Information Services Division of the Common Services Agency.

Hospital/Centre	Project	Ends	Total Awarded to 31.3.81 £
APPROVED BY THE COMPUTER RESEARCH COMMITTEE OF THE CHIEF SCIENTIST'S ORGANISATION, COMMON SERVICES AGENCY.			
Dundee Limb Fitting Centre	Clinical Application of the Television/ Computer Gait Analysis System	Oct. 1981	37,654
Dept. of Medicine, Royal Infirmary, Edinburgh	Radionucleides in Cardiovascular Investigation	April 1981	30,569
Dept. of Diagnostic Radiology Western Infirmary, Glasgow	Ultrasonic Tissue Characterisation	Jan. 1983	60,629
Southern General Hospital, Glasgow	Development of a Diagnostic Decision System for Dyspepsia	Oct. 1980	96,194
Glasgow Royal Infirmary	Computer-assisted Reporting of Electrocardiograms	June 1981	180,802
Dept. of Bio-medical Physics & Bio-engineering, University of Aberdeen	The Display and Analysis of Clinical Radionucleide Images	June 1981	8,576
Dept. of Medicine, Western General Hospital, Edinburgh	Computer Analysis of Instantaneous Pressure and Velocity Signals to Assess Ventricular Contractility in Heart Heart Disease before after Surgical Treatment	Nov. 1981	27,609
" "	Real-time On-line Computation in Studies of Lung-function in Treatment of Lung Cancer	Dec. 1980	4,170

Hospital/Centre	Project	Ends	APIP Funding 1980-81 £
<u>APPROVED BY THE ADVISORY PANEL ON INFORMATION PROCESSING (APIP)</u>			
Inverclyde Royal Hospital	On-line Minicomputer-based Inpatient Administration	Sept. 1982	30,300
Forth Valley HB	On-line Minicomputer-based Inpatient Information	March 1982	10,000
Glasgow Western District	Computer Project based on an ICL Mainframe	March 1982	150,000
Greater Glasgow HB	On-line Minicomputer-based Laboratory Data Processing	March 1983	23,500
Greater Glasgow HB	Twenty-four hour ECG Regional Service	-	3,000
Grampian HB	On-line Minicomputer-based Patient Records	March 1982	26,900
Grampian HB	On-line Inpatient Administration using AHB ICL 2904	March 1982	28,600
Grampian HB	On-line Pharmacy Stock Control on a Mini-computer	Sept. 1981	42,900
Grampian HB	Investigation into Database Software Use on University of Aberdeen Mainframe	Sept. 1982	38,600
Monklands DGH	On-line Patient Record System on Minicomputer	March 1984	25,500
Lothian HB	Mainframe-based Patient Records and Patient Record Linkage Study	March 1983	43,600
Tayside HB	On-line Patient Record Information	March 1982	51,400
Tayside HB	Laboratory Data Data Processing on a Minicomputer	March 1985	20,600
Medical Research Council	Radioimmunoassay Project	March 1982	4,500
Vacation grants, 1980-81			10,000

Computer policy

Mirage or necessity?

Brian W. H. Molteno
Regional Management Services
Officer, Trent RHA

Computer policy

Mirage or necessity?

The contemporary state of computer policy and practice in the NHS has been comprehensively reviewed by Ian Herbert. But it seems equally pertinent to consider how the NHS came to feel the need for a policy and whether its main characteristics have been shown to be soundly conceived and, more importantly, justified by experience. Persistent and widespread criticism suggests that the objectives, however attractive they seem, have proved difficult to attain and may even be unattainable, given the heterogeneous nature of the NHS. Should the policy be modified or abandoned? These issues are examined from the viewpoint of one who has been at the sharp end of NHS computing.

The early 1950s saw the initial experimental applications of computers to routine office work and administrative tasks as compared with their previous, almost exclusive use, in scientific applications. That these tentative beginnings would explode rapidly into widespread usage was perhaps unforeseen, or at best slowly realized. At all events, it was not until the early 1960s, in the face of a rapidly expanding use of computers in its own services and a sharply rising investment of public funds, that the Government began to consider the need for a policy on procurement.

At that stage government, in its widest sense, found itself using a wide range of computers, mostly incompatible and incapable of communicating with each other. More important from a national viewpoint, the traditional policy of open tendering had allowed foreign manufacturers to win a large slice of government business to such an extent that the future viability of the UK computer industry seemed palpably threatened. Moreover the apparent price/performance advantages of 'imported' systems was somewhat illusory and artificial, aided as it was in many cases by substantial government development subsidies in the countries of manufacture. Thus, from the mid-sixties a government procurement policy was formulated, operating a kind of preference system for UK products compared with those of foreign competitors. This had the effect of channelling substantial government funds towards home industry. In the early 1970s this policy was further tightened to prescribe purchase by single tender of all computers over a given size, subject only to assurances about performance, from ICL (in which the Government had now acquired a direct financial interest). Though now overshadowed by EEC regulations calling for more open competition, Government procurement policy has had a profound impact on NHS computing for at least ten crucial years.

It is from such beginnings that a computing policy for the NHS as a whole began to emerge. It may be seen that the case for a coherent policy derived principally from issues of importance to central government rather than those of the user. Possibly for much the same reason, committees charged with the task of formulating policies for the NHS have been and are still convened and serviced by the DHSS. Whilst the NHS has had direct representation on those committees there have been difficulties in securing the participation or regular attendance of chief officers. The reasons for this may not be as obvious as they seem. In practice the resolutions of such committees tend not to have been wholeheartedly endorsed nor universally acted upon by Health Authorities. The formation of a new committee serviced by the NHS and reporting to RHA Chairmen has been generally welcomed as a step forward. But the way ahead for the development of computer policies needs to be founded as much upon a clear understanding of what is possible as upon what seems desirable. And it has to be considered against the background that NHS expenditure on computing has so far never exceeded 0·5 per cent of total NHS expenditure. This has made it difficult for those responsible for planning and managing the service as a whole to give much more than passing attention to computer policies.

The strands of present computing policy may be described as having three objectives:

(a) to comply with government policy for buying computer equipment, and to obtain discounts by bulk purchase—standard hardware;

(b) to enable computer programs as far as possible to be written once only for the whole NHS, thus avoiding the costs of duplicate development inherent in the use of incompatible systems—standard systems and software;

(c) by the use of standard data, to provide central government with easy access to consistent information across the whole NHS—standard data.

These objectives have been pursued under guidance from the committees referred to above, and have recently been reviewed in response to some questioning, with a result which appeared to endorse the validity of a broad standardization policy. The main thrust of the dialogue with MPs in the Committee of Public Accounts has been to examine the performance of the NHS in pursuit of policy objectives, but not to question the validity of the objectives themselves.

In his paper John Ashford points out that the NHS computing scene now includes the use of mini- and micro-computers which do not have the characteristics of large mainframe computers for which NHS computer policy was formulated and argues for their extended use. Certainly availability at very low prices from a multiplicity of sources makes single-tendering and nationwide discount arrangements no longer a feasible policy. Moreover their very cheapness means that that duplication of their development matters far less, if at all. All this is true, and the sector of computing within which it applies is certain to grow. On the other hand, the mainframe sector still exists and will not disappear quickly. There are two main reasons for this. First, there is a substantial investment in financial and manpower systems which can more cheaply be carried forward from existing to new mainframe computers than they can be re-written for mini- or micro-computers. Secondly, the new mainframe computers have a much better capacity to provide information through local terminals and may thus blunt or divert some of the demand for local small computers.

All three objectives for NHS computer standardization policy listed above seem attractive. On the other hand, the first may be subject to reservations insofar as government procurement policy may change in response to EEC requirements; the actual discounts obtained are not very significant. Again, the third, standardization of data and access to it, is obtainable by means other than hardware standardization and is not dependent upon it. Nonetheless, the second objective, in which the Committee of Public Accounts seems to have been particularly interested, appears to remain intrinsically very valuable. If Wales and the 14 English Regions were able to pool their resources for computer system development, each could, in theory, have access to new systems at one-fifteenth of the cost of separate developments. What has been the outcome from pursuing this ideal over the past ten years?

Despite the positive endorsement of standard systems in the official review, there is a substantial body of professional opinion in the NHS which remains extremely critical of what has been achieved. Many feel that their criticisms have not been heard; partly because the DHSS and the PAC have pursued an examination of the NHS's performance against the objectives, without questioning the objectives themselves, and partly because the NHS authorities most involved in implementing the policy (and by implication accepting it) have been those in receipt of most of the central funds deployed in support of it. This second difficulty has been aggravated by the fact noted earlier that, for those authorities not in receipt of central funds, there have been many issues of far greater importance than computing to be considered.

The critics' view may be summarized as follows:

The policy assumes that 15 NHS Authorities shared at one time a common need to develop certain computer systems. In practice, by the time the policy was formulated, many Authorities already had working systems, tailored to meet their own requirements and not designed to suit the whole NHS. This manifestly goes a long way to explain why standard systems have not been universally adopted by all authorities. Had the underlying assumption held good, each Authority would have offered some developments in the common interest, in exchange for receipt of ready-made systems from the others. In practice, the DHSS evidently found it necessary to encourage contributing regions with central funds, thus entrenching a minority of fund-receiving 'COR' regions, and leaving staff in the others exposed to the possibility of missing out from the mainstream of NHS developments.

To get the whole NHS to agree to a common system for any purpose, and then to develop a system which meets all the detailed requirements (such systems are likely to aim high to accommodate all variants) is likely to take a long time. The proof of this is that, where no previously acceptable system existed, the creation of new systems has been very seriously delayed, or abandoned (e.g. Child Health and advanced modules of STAMP) or where an existing system was available, it has been adopted without regard to its suitability as a nationwide standard (e.g. payroll).

The policy implies that any regional computer section is capable of acting as a development centre on behalf of the whole NHS—a role which was never envisaged when those sections were set up. Even if the standards of performance of all sections were uniform and high, it is doubtful whether anyone contemplating an integrated computing capability for the whole NHS would have chosen to set up 15 centres. Certainly the centre(s) developing payroll, accounting, and manpower systems would require careful co-ordination from the start in pursuit of integrated systems. As it happens, the NHS started separate developments in three regions, and only set up a co-ordinating committee as an afterthought.

The policy assumes that the NHS can save money by arranging for one authority to maintain each system, and to arrange for its transfer to new computers on behalf of all. In practice, 'remote' maintenance has proved expensive and agreement on sharing the costs of transition has yet to be found.

In general, the critics are saying that NHS computer policy has failed to lead to a set of systems which meet its objectives. Although the criticism relies mostly on questioning the assumptions underlying the policy itself, the suspicion remains that the NHS has somehow failed to meet an objective of which the benefits seem simple and undeniable—namely, to 'avoid re-inventing the wheel'.

Is the NHS incompetent in this respect? It may be argued that, by failing to match the prevailing terms and conditions for employing computer specialists, the NHS has deprived itself of access to the best professional advice. However, the difficulties with standard systems seem to have arisen from problems of organization and not from lack of professional excellence in the systems produced.

Is the NHS intransigent in continuing to give over-riding priority to the perceived needs of individual authorities as against the common need? To a large extent many would agree that this is a 'besetting sin' of the NHS in general. In the computing field however it may be claimed that what appears as 'intransigence' is in fact a set of unavoidable characteristics, which make the chosen computer policy impossible in practice, however desirable in theory.

The NHS has inherent characteristics which explain why it cannot act uniformly or behave in a consistent manner as if it were a single commercial enterprise controlled by a holding company. Firstly it is very large. There is no other organization approaching its size as an employer of people. Secondly, it is a 'loose confederation of conflicting interests' which aims at patient-care objectives which are hard to define and impossible to measure, Inevitably and consequently it exhibits a high degree of local autonomy and variety.

In keeping with these characteristics, the NHS employs a wide variety of office practices to meet superficially 'common' aims. For example, its wages offices have to prepare pay for groups of staff whose pay and conditions are nationally uniform—yet variations in wages office practice are so great and so entrenched, that they represent as great an obstacle to the achievement of standard data as does the absence of, or limitations on, standard computer systems for payroll. Thus because office procedures are far from being standard throughout the NHS, no standard computer system is ever likely to achieve a perfect fit. And attempts to cater for all variations—the all things to all men approach—inescapably result in highly complex systems which have less appeal.

If these explanations seem like 'special pleading' it is worth reflecting upon what has happened in other organizations. Do similar considerations explain why there is no standard payroll system for all Civil Service departments? Are the circumstances of the Water Authorities so different that no attempt was made when setting them up to co-ordinate or unify their computing initiatives? Has the National Coal Board or ICI or a majority of other large, nominally unified, organizations actually created single coherent computer services arrangements? Rolls Royce did so—and what happened?

If the individual autonomy of NHS authorities and a consequential variety is accepted as a proper aim—and present Government policy leans strongly in this direction—an appropriate computer policy would recognize that no monolithic NHS computer enterprise is feasible.

A realistic policy should be based on the actual situation which the NHS faces. It has inherited from the standard systems policy some fairly comprehensive mainframe systems for payroll and accounting. Although not all regions use them, those which do, face a common problem in transferring the systems from 1900 to 2900 equipment. There is a long-felt need for a clear and binding contract between COR and user regions. Probably the only way to make such a contract binding would be by linking it to inter-regional payments.

All regional and some other authorities employ computer staff whose services are in great demand for the development of systems which meet local needs. It needs to be recognized that local arrangements are more likely to produce good computer systems than could any nationwide enterprise. They already operate in something like a free market economy insofar as they import, for local modification, systems written elsewhere both from within and beyond the NHS. The healthy tendency to look for a best buy might be reinforced by a general agreement that user authorities should pay employing authorities for the services of computer specialists.

The growing tendency for systems to be offered on equipment directly operated by the user and capable of being amended or even designed by the user, calls for a more widespread dispersion of computer specialists across the NHS. This underlines the need for a reversal of the centralist philosophy which underlay the standard systems policy.

The idea of some form of centre of excellence for NHS computing is attractive. More generously endowed than a single regional computer section, such a centre might seem better able to build a really powerful set of integrated systems for accounting, manpower and payroll with a well managed database and flexible enquiry facilities. However, it is now too late for the NHS to start again in the field of large mainframe systems. Even had a start been made much sooner on a different technical basis, the enterprise would still have encountered all the variety and autonomy of user authorities. Systems for mini- and micro-computers can on the other hand be very efficiently constructed by small teams.

It may be argued that some sort of specially funded 'development organization' would be able to develop more ambitious and ultimately more rewarding projects than could any existing health authority. Against this, the dangers of funding developments which are not constrained by the need to meet immediate operational objectives, have been well illustrated by some of the early experimental hospital computer projects. The really relevant research and development in computing relates to hardware and software, and may be seen as the proper province of the manufacturers and software houses. Applications systems development is, as the name implies, something that comes *after* R&D, and applies hardware and software which should have been fully developed and proven beforehand.

One of the original objectives for both government and NHS computer policy, was to foster the collection of standard data, so that consistent aggregations could be readily available at all levels. It may now be seen that large standard computer systems were an unwieldy tool for achieving this. The objective remains valuable, but may be pursued more directly by seeking agreement on data definitions while leaving health authorities free to process the data in whatever way suits them. It is to be hoped that the Standing Group on Health Services Information will tackle its remit in this spirit.

Whilst government, the department and the NHS may seem slow in coming to terms with the lessons of the last decade, surely it is not too late to formulate a policy, if policy there need be, which aims to get the best out of the resources and organization actually available? Such a policy must recognize the autonomy and variety of the health authorities, more numerous in the future than the past. One important aid to this would be to end central funding and require user authorities to pay for all the developments they believe to be necessary. Computing technology is again accelerating dramatically and opening up prospects that could not have been envisaged a decade ago. If the opportunity is to be grasped, it calls for a policy of great flexibility rather than the rigidity pervading that of the last decade. Even if that policy had been perfect it can hardly be expected to survive, as some seem to believe possible, in the next decade.

Computers in medical care

The challenge of the microprocessor

Professor J. R. Ashford
Head of Department of
Mathematical Statistics and
Operational Research,
University of Exeter

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INTRODUCTION

Amongst the great variety of technological changes which have taken place in advanced industrial societies during the past decade, the advent of the microprocessor will almost certainly lead to the most fundamental and far-reaching consequences. The 'silicon chip' and other similar devices have caught the public imagination in a way which has few parallels in the recent past. The pocket calculator and the digital watch, which have already become familiar features of everyday life, are widely recognized as early applications of a technology which is destined to invade many types of human activity. Typically smaller than a thumbnail and costing only a few pounds, such devices rival the computing power of a large room full of electronics of only ten years ago. Their potential is effectively unlimited, not only in fields to which computers are currently being applied, but also in applications which have not so far proved susceptible to digital processing techniques.

The purpose of this essay is to review some of the ways in which microprocessors might be applied in the field of medical care. Starting with a survey of the evolution of computer systems since they were first introduced almost thirty years ago, the essential similarities and differences between microprocessors and conventional computers within the National Health Service (NHS) are then considered and some suggestions are made as to why the hopes of the medical computing enthusiasts have not so far been realized. An indication is then given of ways in which the new technology may be applied to solve some of the current problems of the NHS.

THE HISTORICAL PERSPECTIVE

The electronic digital computer emerged as an effective device for performing calculations in the early 1950s. The ability of the computer to follow through a complex programme of computations at very high speed offered obvious advantages to the scientist and the most significant applications of the first generation of computers were in the field of scientific research, particularly atomic energy. The early computers were based upon the radio and telecommunications technology of the 1940s. They were large, unreliable and expensive and were better suited to the performance of elaborate calculations than to the handling of large quantities of data. The preparation and checking of programs called for great intellectual skill and the use of the computer was effectively restricted to the scientific community. The commercial potential of the computer was regarded at this time as very limited and the main impetus to development came from government-supported defence requirements.

Having become established initially as an expensive and complicated piece of scientific equipment, the next stage in the development of the computer involved the extension of the field of application to cover commercial data processing tasks. The punch card, which was already in general use in conjunction with mechanical sorting and tabulating equipment, was adopted as the basic data input medium. Advances in solid-state technology and in the use of magnetic tape (and later magnetic disc) information storage media produced very significant improvements in the power and versatility of the computer, particularly for handling large quantities of data. Concurrent with these improvements in 'hardware', the introduction of 'automatic' or 'high-level' programming languages removed some (but not all) of the difficulties of preparing programs of instructions. At this stage, it became apparent that the commercial implications of computers were very great. Companies, such as IBM, which already dominated the market for business equipment, moved into the computer field and capitalized on the rapidly growing demand.

The third generation of computers appeared in response to the need to separate the processes of data acquisition and input from those of computation and output. The airline reservation problem, which calls for the allocation of seats on particular flights booked from a wide variety of retail sales outlets situated perhaps thousands of miles apart and on a timescale limited to seconds rather than hours, is perhaps the classic example. To achieve this goal, the close integration of telecommunications and computer technology was required and this presented a formidable challenge to the computer industry. The solution originally adopted involved one (or several) central computers, servicing up to possibly one hundred terminals over telephone lines or radio links. In order to carry out this task, the greater part of the computational power of the central computer was involved in so-called 'housekeeping' operations, including polling terminals, accessing data files and at the same time presenting an orderly stream of tasks for the computer to undertake. This phase was characterized by further developments in hardware, notably in transistor technology. However, the main problems were presented by the preparation of the error-free 'systems software' necessary to provide a 'real-time' service from terminals remote from the computer. Very large financial resources were required to produce effective third-generation systems and many major companies withdrew from the market, leaving IBM as the dominant organization. In the United Kingdom a series of mergers of existing companies, such as Elliott, English Electric, and ICT produced a single, state-financed corporation, ICL, which was given some protection from US competition by the 'computer procurement' policies of successive governments. In the early 1970s, the future seemed to lie with the large systems, which are referred to as 'all singing and dancing' by the computing fraternity. Such systems tend to be complicated and expensive and, because of their complexity, somewhat unreliable.

The running of third-generation systems typically calls for the employment by the computer user of large teams of programmers and systems analysts to provide and maintain the programs required. Indeed, by the early 1970s more than half of the investment in a typical third-generation machine was taken up with the provision of software. At this stage there was also a tendency on the part of the computer companies towards 'unbundling' hardware and software, so that the 'systems' programs necessary to carry out the basic functions of the computer tended to be marketed separately from the machine itself. The process of writing the 'applications' programs required to carry out specific tasks in conjunction with the programs provided by the manufacturer has remained in a somewhat primitive state, resembling a craft industry rather than a science. Indeed, it is remarkable that this essential but human aspect of computing has advanced so much more slowly than the hardware technology. Although computer science emerged as a separate academic discipline during the 1960s in most of the developed countries, this imbalance is a clear indication of the failure of the theoreticians to give due emphasis to the real problems of the industry. Unfortunately, this lesson has still not been properly learned by university computer science departments, which have continued to concentrate upon the academically respectable aspects of the subject at the expense of the more useful ones.

The next stage in the development of computers, which constitutes the fourth generation, involved further evolution, from systems consisting of a central computer connected to 'intelligent' terminals (i.e. terminals capable of carrying out certain calculations independent of the central computer) to very elaborate networks of computers and terminals. These changes have given even greater emphasis to telecommunications as an essential part of computing. Unfortunately, progress in this country has been retarded by the lack of responsiveness of British Telecom, which has inherited monopoly powers in this important field of communication. Whilst large organizations have to some extent been able to ameliorate these difficulties by the use of private data networks (some involving space satellite communication systems), the fact that the public telecommunications service has been expensive and obsolescent in technical terms has acted as a real deterrent to the growth of computer networks. Such networks should ideally enable information to be shared cheaply between many users and computations to be carried out more effectively as a result.

As a reaction to this further complexity of design and operation, a simpler type of system, labelled the 'mini-computer', was introduced in the mid-1970s. Mini-computers tend to incorporate more advanced technology than the conventional computers which are currently available and therefore are generally smaller in physical size. They do not, however, differ in any major way in terms of hardware and, although the software required is in general less complex, the larger mini-computers are very similar to medium-size conventional computer systems. The established computer companies, anxious to protect their investment in existing technology, were slow to enter the mini-computer field, and as a result, several new firms have tended to dominate this particular niche in the market. In the face of competition from the mini-computer makers, the cost of computing of all types has fallen considerably faster than would otherwise have been the case.

THE MICROPROCESSOR

The next and most recent stage in the evolution of computing technology is the microprocessor. This term covers a range of devices incorporating techniques such as large-scale integration (LSI) of electronic circuits, which have greatly reduced the physical size and unit costs of computing. At the same time, reliability has greatly increased and the stage has now been reached in which systems of considerable power based entirely upon solid-state components are available. The pace of development is very rapid and the competition between different firms is intense.

The manufacture of microprocessor hardware is dominated largely by North American corporations such as Texas Instruments, which were not previously prominent in the conventional computer field. In order to take advantage of the cost savings associated with mass production, there is great pressure to find new outlets for the technology. The explosion in the sales of pocket calculators and of electronic watches and clocks which has already taken place in this country is now being followed by a massive growth in the sales of 'home' computers and of 'intelligent' toys and other devices which have already saturated the market in North America. Existing computer companies have also been involved in these new developments, but in general have been unable or unwilling to compete in the mass market which the newcomers have identified and are developing with great energy. British firms have participated in what has been termed the second industrial revolution only to a very limited extent, although some manufacturing and assembly (largely for foreign companies) has been carried out, taking advantage of the supply of cheap and relatively well-qualified labour which is available. The State has recently decided to enter the manufacturing field by setting up the INMOS company, but, in this highly competitive international environment in which the life of a product is reckoned in months rather than years, doubts have been raised about the prospects of making a significant impact in the market.

Notwithstanding the concentration of hardware manufacture in the hands of a few large foreign companies, a very real opportunity does exist in this country for the development of complete systems based upon the available supply of cheap and reliable components. This process involves the identification of an application for which a market may be developed, the purchase of the necessary components and the preparation and testing of the programs required to carry out the defined task. The complete system can then be sold in the same way as any other consumer or commercial product. Word-processor systems, which are currently replacing the conventional typewriter, are a good example of this trend. In this way, it will be possible to harness the pool of computer programming and systems expertise which now exists in Great Britain and which constitutes in the 1980s perhaps the country's main technological asset. The human resources are certainly available and the challenge is to apply them in an effective way.

In terms of function, the microprocessor does not differ in any essential way from the conventional computer. Indeed, microprocessors are following a very similar path of development to computers, although at a greatly accelerated pace. The fact that the early microprocessors were very limited in capacity and versatility is merely a reflection of their primitive state of development at the time. The microprocessor-based hardware which is currently coming onto the market is capable of performing most of the tasks carried out by conventional computing equipment. The lack of investment in systems software for microprocessors, which was previously considered to be a further obstacle, is also proving to be an illusion. The current generation of microprocessors includes systems which are effectively a carbon-copy of existing conventional computers. As a result, it is possible to benefit from the considerable investment which has already been made in software and 'applications' programs. Irrespective of such deliberate imitation, high-level programming languages and other software are now available for microprocessors.

In comparison with conventional computers, microprocessors have three main advantages—cost, reliability, and physical size—any one of which may be decisive in increasing the range of possible applications. Because of the benefits of technological progress and of mass-production, the capital and running costs of a microprocessor per unit of computing power are very much lower than those of a conventional machine and are likely to fall even further in the immediate future. This means that microprocessors can be employed in circumstances in which cost considerations rule out the use of a conventional computer. Because of the variety of marketing policies of different suppliers of computing equipment and the very high loading of the price of some conventional computer systems to cover research and development, precise comparisons are difficult to make. However, reductions in unit cost by a factor of ten have already been achieved and by a factor of one hundred are within easy reach. As a result, it is now possible to contemplate the use of the microprocessor in a dedicated role, for a specific and limited range of applications. Because of cost considerations, most users were in the past forced to regard the computer as a versatile device which must be employed for a wide variety of different purposes in such a way as to obtain the maximum performance possible from the available equipment in order to justify the expense. Microprocessor hardware is now so cheap that such penny-pinching attitudes are no longer necessary or even realistic. A microprocessor can be allocated to each specific set of tasks and the programmer and systems analyst need not (and probably should not) strive to achieve the most economical and elegant use of the available resources.

The effects of this abundance of cheap hardware upon the organization and staffing of computer installations are likely to be profound. The product need no longer be one which requires a large and expensive team of computer experts to assist the user to obtain an effective service. Instead, the customer should hope to purchase a complete system, comprising the microprocessor and other hardware (which will be relatively cheap), together with all the systems and applications programs necessary to carry out the defined task. In order to exploit economies of scale, microprocessor-based systems should involve some degree of standardization of programs as well as of hardware. This must inevitably involve an element of sacrifice on the part of the customer, but on balance the cost savings are likely to be more than adequate compensation in most cases, particularly as cheap hardware is now available as a substitute for more expensive software. The result of these changes must be a transfer of expertise from the user to the supplier of computer systems. This point is unlikely to be overlooked by existing computer staff and it is to be expected that the removal of career prospects for employees in computer-user organizations will generate some resistance to the transfer from conventional to microprocessor technology. In an age in which each application can justify its own dedicated microprocessor, the need for complex, multi-purpose systems must be reduced, and with it the intellectual challenge which such systems generate.

In terms of reliability, the new technology represents a great advance on what has gone before. Experience has shown that the mean time between failures of a typical currently-available microprocessor system can be as high as a year (of continuous operation), even if magnetic disc mass storage facilities are included. The systems which do not include moving parts promise even higher standards, although it would be rash to assume that failures of hardware or software can ever be ruled out. If hardware faults do occur, service is likely to be restricted to the replacement of a defective 'board' (set of integrated circuits) and the job specification of the computer service engineer is likely to become less exacting.

The reduction in physical size of hardware associated with the new technology affects all components except the terminals at which humans (or other systems) interact with the computer. No longer will it be necessary to provide expensive, air-conditioned 'temples' to house the equipment. Apart from the terminals, the accommodation requirements for microprocessor-based systems are minimal. This will further reinforce the tendency towards the dissolution of the computing 'empires' which have grown up within many public and private organizations during the past twenty years. If this step serves to remove some of the obstacles which have been placed between the users of computing services and the information which they require, it can only be a great advantage.

As far as the physical location of computing services is concerned, the advent of the microprocessor calls for a re-assessment of the conventional third- and fourth-generation systems, in which computing resources are concentrated at some central point in the interests of economy, information and results being transferred to and from remote terminals over telephone lines and other links. In so far as there is no sharing of data between terminals, it will be possible to replace such systems with separate and unconnected microprocessors at each terminal location. This will have the very real advantage of reducing the costs of data transmission using the public network. In addition, control of the computing process will be restored to the user. Any transfer of information to third parties will then depend upon a conscious decision by the user, whether or not his microprocessor is physically linked to other computers.

COMPUTERS IN MEDICAL CARE

Since the late 1960s many tens of millions of pounds have been spent upon the application of computers in medical care, through two main programmes covering respectively 'large' and 'small' computers. The 'large' computer programme was based upon third-generation machines and for the most part was concerned with hospitals. The 'small' computer programme involved second-generation computers in a limited range of applications, such as the hospital laboratory. Both programmes were originally funded directly by the Department of Health and Social Security (DHSS) and the DHSS also exercised very detailed control of these so-called 'experimental' projects through the allocation of finance and in other ways. Both the original conception and the subsequent execution of the DHSS computer development programme have been widely criticized within and outside the NHS. Certainly, there is very little tangible evidence of a reasonable return on this investment of public funds. On the other hand, there is no doubt that the lessons of the past do enable the opportunities for and the constraints upon future action in this direction to be clearly identified.

In the first place, it is self-evident that no new development within the health care system can hope to be successful unless it commands the support of both the providers and the consumers of health care. The broad principles of what is and what is not acceptable within the NHS depend upon a combination of both political and professional pressures. The politician must, by definition, react to what he perceives as public opinion if he wishes to retain office, and it is an unfortunate feature of life in this country that the computer is regarded in many quarters with both scepticism and suspicion. On the one hand there are very genuine fears that large organizations, and particularly central government, will make use of computers and other technically advanced information processing devices to the disadvantage of the individual. The conspicuous absence of general legislative action on data protection on the part of successive governments has served only to stimulate the public disquiet. The NHS, which from time to time provides services for most of the population, has tended to be a focus for this discontent. On the other hand, the providers of care now appreciate that their own personal and professional interests may be at risk if detailed information about their work is, through the use of computers, made available to the public or to third parties. In combination, these attitudes are such as to militate against any general, large-scale sharing of information about patients and their medical care, notwithstanding the obvious clinical merits of the 'integrated medical record' and the equally obvious potential contribution of an accessible and relevant data base about patients to more effective management of services. To be acceptable in the present political climate, computing systems must be self-contained, directed towards specific and well-defined purposes, and clearly under the control of the professional medical interests (which are still of good standing with the electorate).

Secondly, the NHS is an organization which is effectively managed 'from the shop floor'. Although the DHSS continues to occupy a somewhat ambiguous role as a sort of head office for the NHS and, as the only source of finance, exercises some degree of general control, all major decisions concerning individual patients and the use of particular resources are taken by doctors and other professional staff at the local level. The local decision-makers are motivated by local factors, centred upon the benefit to their patients and their own personal and professional satisfaction. Investments in computing must compete with other types of expenditure on these terms if they are to be made on any general basis. The DHSS experimental computer programme was in a very real sense imposed upon these local decision-makers from a higher level of the system. Experience has shown that in these circumstances the return upon investment tends to be reduced and that the local support and enthusiasm which are essential for successful implementation tends to be eroded.

The third main issue is the general shortage of finance in the NHS, which most informed observers expect to persist for the foreseeable future. The expansion of more scientific hospital-based acute care continues to reflect the inevitable progress of medical science. As a consequence, the demands from this sector of the health care system will continue to grow and will also continue to compete for the very limited pool of resources available to the NHS, an increasing proportion of which is already earmarked for under-financed non-acute services. It is clear that further large sums of money for computing will not be available unless they reflect the result of conscious decisions at the local level. It follows that, unless computer applications are perceived as being desirable to local decision-makers, they will not be implemented.

Apart from the factors that pertain directly to the structures and organization of the NHS, other important issues should not be overlooked. The DHSS experimental computer programme involved the purchase of basic computing equipment and the development by NHS staff under NHS managerial control of extensive systems and applications software. This procedure runs directly counter to normal practice regarding the supply of scientific equipment. Typically, the NHS acts as the customer for systems developed and supported by commercial interests. The DHSS is often involved in setting standards and the NHS in providing the original ideas and the opportunity for development and testing, but responsibility for the product rests elsewhere. Whatever the merits of public enterprise in this country, large central government departments sharing responsibility in an ill-defined way with operating service authorities do not have a notable record of success in this type of activity. Experience suggests very strongly that the development, production, and marketing of complex scientific systems are best left to commercial organizations, whose viability and indeed continued existence depends upon making the right decisions at the appropriate time.

THE MICROPROCESSOR IN MEDICAL CARE

The main obstacles to the wider application of computers in health care may be summarized as cost, confidentiality, and control. As far as the first factor is concerned, the reductions in the initial price and in the support and running costs of microprocessors are likely to ensure that investment in computing is able to compete with other types of investment in health care. Indeed, if the NHS really has the will to realize all the savings in labour which might possibly be achieved, the microprocessor offers the best available opportunity of controlling the escalating costs of both scientific and supportive medical services. The microprocessor also makes possible a practicable solution to the problems of confidentiality. The low cost of individual microprocessors means that large, integrated systems are no longer mandatory on cost grounds. It follows that separate, self-contained computers can be used for each particular application. Different machines can of course be connected to form a network if this is thought to be in the medical interests of the patient, but the spectre of the large integrated system under non-clinical management has been removed. As far as control is concerned, the operational demands made by a microprocessor-based computer system can be made on the same scale as the other activities of the various working groups, such as hospital departments or general practices, which form the front line of the health services. Specialist computer support need not be required, and the doctor or other professional with no computer training can expect to make effective use of a system of this kind. This change in the environment of the computer has both real and psychological advantages. The removal of the barriers which now exist between the user and the typical large, integrated NHS computer system is certain to increase the enthusiasm of the clinicians, administrators and other decision-makers for this particular form of technology.

Turning from general principles to specific proposals, it is possible to identify a variety of possible fields of application of the microprocessor. Perhaps the most important of these involves the storage, modification, and retrieval of the patient clinical record and various activities which are based upon the information contained therein. Probably the greatest progress to date in this respect has been made in the field of general practice, and microprocessor-based systems to serve both single-handed and group general practices are now under development. These systems have built upon experience gained in the NHS experimental programme. They are centred upon the patient clinical record, which is structured in a flexible way appropriate to the approach of the general practitioner. They also provide the facility to deal automatically with correspondence (e.g. referral letters to hospital doctors, instructions for patients), to provide the lists of patients and analysis of data necessary for the practice of preventive medicine and to cope with a variety of administrative tasks within the practice. The development of the GP systems to cover particular hospital specialties represents a logical further stage. Specially-designed systems will be required to deal with the particular problems of hospital practice in the various specialties, but it should be possible to design these as a family sharing many common programs and data structures.

A second major potential field of application is that of acute patient care, in which the process-control capabilities of the microprocessor can be exploited. Computers have already been used in applications such as intensive care to monitor patient signs and symptoms and to register an alarm if defined limits are exceeded. The microprocessors can also be used in a more positive sense to vary patient or equipment parameters in a programmed way. For example, in renal dialysis (which is amongst the most technically-advanced and labour-intensive forms of hospital care) the use of microprocessors as an integral part of the monitor is now under active consideration. In this way, it will be possible to achieve a regime which is effective in terms of minimizing the period of the dialysis without causing excessive patient discomfort.

The microprocessor has many possible uses in the health services outside the field of direct patient care. Obvious examples include indexes for conventional medical record systems, stock control in stores and pharmacies, staff training and allocation and data processing of all kinds. Activities such as planning, which must involve the consideration of large quantities of data, are currently made more difficult by the absence of any significant computational facility at local level and could clearly benefit from microprocessor-based equipment for handling data such as Hospital Activity Analysis and various other statistical returns concerning resources and activity.

THE WAY AHEAD

At the present time the application of computers to patient care in the NHS stands at a cross-roads. The record of the past decade can in no sense be regarded as satisfactory. Present policies for the promotion of medical computing have reached a manifest impasse: a sharp change in direction is required. At the same time, the opportunity exists to learn from past experience and to take advantage of technical developments which were not (and could not have been) foreseen when the present policy was formulated more than ten years ago.

In the first place, there is a very real need for the NHS to have access to competent and impartial technical advice and, for a discipline which is developing as fast as computing, this must involve an element of practical experience at the frontiers of the subject. The standard device of setting up Advisory Committees has been proved to be ineffective in the medical computing field and it is doubtful whether any benefit would have resulted even if all the advice from this source had been taken. The best practicable solution appears to be the establishment of a central NHS medical computing laboratory, on the lines of the specialist laboratories run by the major Research Councils. The framework under which such a laboratory would be set up should permit the recruitment of competent staff whose job specifications should be such as to avoid the professional stagnation which is usually engendered by a purely administrative role. The main task of the laboratory should be to promote viable applications of computers in the NHS.

It is self-evident that the development of systems of this kind must be carried out in full co-operation with the medical, administrative and other staff who are to use them. The marriage of the technological skills and expertise with the requirements of the user is a delicate process. In practice, university science departments are probably the most promising catalysts, but this task is probably outside the range of ability and experience of DHSS-supported health services research groups associated with university departments of social and community medicine. Existing NHS computer projects are also a possible source of technical expertise, although the ethos of the small, self-contained microprocessor application runs counter to their more monolithic structures. However, if this is done, care should be taken to ensure that assumptions based upon the technology of 'yesterday's world' are not allowed to distort the choice of applications and methods.

Subject to these general principles, there are two main tasks for the laboratory to perform. In the first place, the necessary research must be set in motion. Inevitably, this must involve the identification and funding of small groups of enthusiasts with the necessary skills and experience. Success is likely to lie with small teams, 'travelling light', without the dubious benefits of the ponderous structure of advisory groups, steering committees, working parties, and detailed central control which has emasculated much previous DHSS-sponsored medical computing. The sums of money needed to bring a given application to the stage in which it can be implemented are relatively small. The formal requirements of public accountability can surely be satisfied by the initial assessment of the application for funding, combined with periodic reviews at intervals of no less than one year. For obvious reasons, there must be deliberate duplication of major applications.

Given an adequate background of research, the next step is to ensure that successful projects are developed to the stage at which they can be sold commercially. The requirement is to bring the ideas of the research teams to fruition in the commercial sense, to ensure that the product reaches the market place. This means that at least one, and preferably several, firms must be persuaded that a profitable market for the product exists. Many microprocessor-based computer systems will be aimed at the international (rather than the national) field, but the participation of the NHS may be decisive, particularly for British companies. All these steps should be designed to provide the opportunity (without any element of compulsion) for the managers of the health services to invest in computer systems if they so desire. The discipline of consumer satisfaction is essential if the right products are to be developed and is greatly preferable to the provision of systems designed and approved by some central authority far removed from the front line of medical care.

In the absence of any monolithic central policy, it is likely that a variety of micro-processor systems will be introduced to cover a range of clinical and non-clinical applications within the NHS. Such developments should be encouraged, by the matching of local financial contributions from central funds or in other ways. If this is done, the NHS as a whole will be in a position to profit from individual initiatives. The opportunity to evaluate alternative approaches and to ensure that the minimum necessary degree of standardization takes place should not be lost. A delicate touch will be required to ensure that the results of individual enterprise are not blighted by insensitive control. New institutions and mechanisms for the sponsorship and surveillance of microprocessor applications are required. The record of the Science and Engineering Research Council in similar high technology fields suggests that considerable improvements over the existing DHSS-based research management are feasible.

Progress towards the rapid and effective application of computers within the NHS depends upon a combination of two main factors—intelligence and demonstration. Both the potential users and the potential suppliers must be made aware of the opportunities which currently exist and of the implications of technological changes as they occur. At the same time, steps must be taken to encourage the demonstration of new types of application. These activities are essentially complementary and must be closely co-ordinated if they are to be fully effective.

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Towards a policy for computing

Professor Gordon Cumming
Medical Director, The Midhurst Medical Research Institute

Towards a policy for computing

In the mid 1960s, the development of computing in the NHS received a stimulus which had little direct relationship to the needs of health care but was mainly concerned with the health of the British computer industry. Consequently, experimental computer applications had to be speedily identified at a time when such activity was in its infancy and in a milieu which was not vociferously demanding the offered service. It was not therefore surprising that many visions, seen through a glass darkly, were destined never to be realized. The experimental programme had its failures and its successes, from the failures important lessons were learned, whilst the successes created further problems—a situation which is perfectly normal in experimental work and is indeed its whole basis.

It must be acknowledged that any experimental programme involves a measure of uncertainty about outcome and that many of the consequences of trying to introduce computers into hospitals could not have been foreseen. Further, in the true spirit of experimentation, negative results are perhaps as important as positive ones. Nonetheless it is surprising how little impact the successful projects have had within the NHS even where success generated a clamant clinical demand for the services they provide. This pinpoints the difficult transition from an experiment with a natural life span to a service commitment in perpetuity. This problem of transition remains largely unresolved.

One necessary step before the widespread application of a system resulting from successful experiment is some formal means of assessing its value. This apparently simple task has proved formidable. The original concept of comparing the situation before the experiment with that after has proved a chimera. Perhaps this is not unconnected with the present situation in the administrative service of the NHS which is illuminated in the paper by Brian Molteno. Current work on this problem is moving in the direction of performance specification and some progress here may be expected. The need for separation of the adequacy of performance of the system from that of the task performed highlights the problems of task definition—a matter having little relevance to computing, some relevance to information, and determined almost entirely by managerial method.

Because expenditure of public money was involved, it came as no surprise that some failures to achieve expected results attracted the attention of the Public Accounts Committee. The history of that encounter is documented in the paper by Ian Herbert. The difficulties illuminated by the PAC report led the DHSS to devise a Computer Policy Committee served by a Research and Development Committee which in turn formed numerous sub-groups to advise in specific areas. These committees were drawn from all sections of the service where computers might have an impact and were hence thought to be representative of the service. The concept that a wide franchise leads to adequate representation, whilst being the backbone of representative government, becomes dubious when applied to a committee seeking to represent the great diversity of interest to be found between and within different groups of the service. Indeed many now question whether it is possible to devise a body that is truly representative of all the complex interests encompassed within the NHS. Perhaps such ambitions should be abandoned.

A strategy was designed after reviewing the history of the main computer experimental projects over the country as a whole. The Committee considered how best to encourage the development of promising new systems, which led to a plan and procedure to consult the NHS authorities, the hypothesis being that these were the ultimate 'customers' for the results of research and development. The mechanism proposed was to offer to those interested in computers the opportunity to set out their needs and how they proposed to satisfy them. Money would then be provided for suitable projects. A fundamental principle in this strategy was that all systems supported should be 'transferable'.

It was accepted that the strategy had to be implemented within the existing administrative framework of the NHS. While funds are channelled from central Government, the fourteen Regional Authorities in England are almost autonomous with no formal system for them to develop common strategies. It has been unusual for Regions to generate innovative projects other than separately. It is conceivable that projects could have been designed and developed centrally, and passed to the NHS when operational; but it was taken for granted within the Committee, for practical political reasons, that it would be undesirable to move in a direction that would have traduced regional autonomy. The Regional Authorities were, of course, well represented on the Committee by a mixture of disciplines. Thus, in such a forum it is unlikely that the general principles of regional autonomy and Authorities' hegemony would be overturned.

A major problem in implementing the strategy was that funding for projects costing in excess of £30,000, although centrally approved, had to be provided by 'sponsor agencies', which are various arms of Government who actually provide the money for expensive projects. One of the lessons which had been learned from history was that unless the spending agency had an involvement in the project, frequently no further money was available to maintain the experiment when it finished. Too often the scheme then collapsed and the research investment was thus wasted. It was decided, therefore, that the regions had to show financial interest in the projects and that all suggestions had to be routed through regions to guarantee a financial involvement. Towards the end of 1978 Regional Authorities were invited to submit their projects in a somewhat detailed format which has not been without criticism by its recipients, but was devised to avoid as far as possible the many pitfalls already identified by experience. Replies were to be given in one year, with the intention that they would then be ranked in order of importance to the Health Service as a whole, the front ranks then being funded by the system.

The outcome of this procedure was perhaps surprising, and certainly disappointing, since the number of projects offered was miniscule and either based on advanced and extremely expensive technology or else were pedestrian or unsuitable. The strange contrast between the evident desire of the service to take advantage of computer technology and the poor response elicited by the new system suggested that some defect existed.

One policy accepted by the Computer Policy Committee was that of standardization—a view subsequently endorsed with some enthusiasm by the PAC. Seemingly the prima facie case for standardization rests upon the perceived disadvantages of no standardization. Several standard systems have been devised by various Regions but their adoption by others has been surprisingly small. The experience in Scotland was rather different where standard systems, for instance in payroll, are countrywide. The differences in outcome between Scotland on the one hand and England and Wales on the other as described by Ian Herbert's paper may be worth further study, though one suspects that organizational coherence in Scotland may have played a major part.

In his paper Brian Molteno shows that standardization as a policy is not without its critics—particularly among the professionals charged with implementing it. Even so it seems clear that, whilst standardization is a necessary part of a policy for computing, it is not of itself a sufficient policy and the question arises as to what further addition might be necessary to make a policy more complete.

Looking at the present situation, it is clear that the great bulk of computing effort is directed towards mainframes and their support. A conflict of interest exists in such machines between the providers of systems and their users. Users wish to have friendly and simple systems that suit their own requirements, whilst providers tend to offer shared facilities on large systems with more potential for future development. This latter calls for sophistication of approach and since this gives greater job satisfaction, a bias exists in this direction. In the private sector this conflict is solved by bureaux offering alternative systems with fees which cover development costs. Conflict between prospective users of limited mainframe facilities is perhaps inevitable. The machines are managed by Regions who see, perhaps quite properly, that their principal users must get priority, so that projects from Treasurers' Departments tend to get to the head of the queue whilst direct patient-oriented applications bring up the rear.

Two processes have led to computer system development in the NHS. The first type has been a system for a single user, such as a biochemical laboratory or even a hospital and this process has in general been effective, though a great deal of further work has been required of a second user in modifying and adapting it to local circumstances. The second method has been to identify a group of users with similar needs and to set up a committee to direct a development project to satisfy that need. Whilst ponderous and relatively ineffective this method does move towards the objective of transferability. Neither approach is entirely satisfactory and there is a need to explore other avenues for system development.

Whilst painful lessons were being learned, the rate of technological advance quickened and with the present already different, the future will be more so. The paper by John Ashford attempts to look into the future and to suggest a direction in which development might proceed, and the organization structure which he suggests is worthy of study. The changed situation means that the pressure for computer services can now be relieved at a local level, since District Authorities can readily purchase small computers for dedicated functions and become independent of the regional service. Since technology has changed the ground rules and presented us with an opportunity (or a threat) it is pertinent to enquire how the technological revolution is to be led.

The principle of standardization, espoused by the Computer Policy Committee, is worthy of pursuit, but brings in its train a conflict with the principle of transferability. Standard systems are, almost by definition, large and long in gestation, whilst transferable systems should be rapidly conceived and inexpensively delivered if they are to find wide acceptance. Whilst standardization and transferability are both valid objectives, it may be necessary to vary the content of each for a given project.

The needs of the NHS for computer assistance can be identified fairly readily, despite the evidence obtained when these were routed through the regional channel, and it should be possible to satisfy those needs without the necessity for specialist computer skills at the point of installation.

The key to the policy should be success in a small area, frequently repeated. Success means providing a system at a low price which works. Such systems would be of use not only in the United Kingdom, but would constitute a saleable commodity overseas. Industry has many marketing skills, together with others, and a computer policy should certainly include an industrial contribution. Given that the United Kingdom is not devoid of skills, and that the problems are susceptible of definition, the question arises as to the most effective structure to oversee the effort. The approach which has been employed to date has been that of a committee structure, and this has some disadvantages. A committee will of necessity represent diverse interests, and a common goal is difficult to identify, as recent experience demonstrates. The need for continuity of work and skills in the body being steered is often prejudiced by a committee structure with its changing membership. An important problem is in the nature of the executive arm of the committee, which historically has been the prerogative of the staff of the DHSS who, in spite of their dedicated involvement, find themselves distanced from the experience and attitudes of the ultimate users. However, two circumstances make this a less than optimum solution. The first is the policy of the present administration to disengage from centrally directed action and the second relates to the nature of the Civil Service. The great strength of the Civil Service has always been its generalist approach. In computing R&D this strength is perhaps a weakness, and perhaps the last thing we need is a generalist executive arm to a specialist Committee.

An alternative organizational solution might be to hand all development to the regions, and this would satisfactorily meet the disengagement policy currently being pursued. The concept of centres of responsibility located within regions in essence pursued this organizational solution but was shown, at least in respect of computer R&D, not to work and in other areas to enjoy only limited success.

A third possibility is to utilize existing organizations to carry out R&D under contract from central government. Thus the universities and the Research Councils could be contracted to develop solutions to specified needs. The problem here is who does the specifying and who chooses what activity to fund. It seems clear that the current answer to both these questions would have to be the DHSS, with the objectives raised above being valid.

Most of these difficulties might be avoided if a fourth possibility were considered. This is to create a separate institution, after the fashion of a Research Council. This would have its own governing body, with representatives from the Regions, from industry, and government departments. More importantly a director would be appointed, guided perhaps by a small steering committee, and with authority to pursue computing R&D. As well as a governing body, such an institution would require resources and these would come from the DHSS and its sponsoring agencies, from health authorities (Regions and/or Districts) and Industry (including computers, medical equipment, pharmaceuticals and the health building).

The institution would pursue the policy set out above, with arrangements for staff interchange in the NHS for education and for dissemination of information. The test for such an arrangement would be its success, and this (or an alternative) would become apparent in a few years. Success could then be exploited and failure terminated.

Epilogue

The effective deployment of computers is now regarded as vital to the well-being of any large scale organization. How successful have been the policies and practice governing their use in the NHS? The foregoing essays examine this question from different viewpoints—an overall review of policy and practice in the past decade by an independent observer (Herbert), an operational view of administrative computing (Molteno), an academic view of present philosophies and future opportunities (Ashford) and a clinician's view of computing research and development (Cumming). The theme running through all the essays suggests that, in England and Wales at least, the NHS has not, in the event, been well served by the policies of the last decade.

Given that it would be difficult to find fault with the objectives underlying, and the benefits expected from, the principle policy thrust towards standardization, why has the outcome been, paradoxically, so disappointing? The possible explanations are many. Few would deny that ponderous committee structures have played their part. At the same time the variety and high degree of local autonomy enjoyed within the heterogeneous structure of the NHS may be seen to make it difficult to achieve the agreement and commitment essential to the successful implementation of a standard approach. On top of this, technological advance now offers prospects that were unthinkable a decade ago. All these considerations point to the need for some radical changes in thinking which take full account of the real problems of applying computers in the NHS and allow policies to emerge which are sensitive to its widely varying needs.

DAVID AND GOLIATH—MICRO AND MAINFRAME?

Present policies and practice have been built upon the assumption that it would be right for the NHS to rely mainly, if not exclusively, on large scale computer systems serving a variety of needs and customers. It must be acknowledged that there were persuasive arguments to support that view and there is ample evidence that it prevailed in many other large scale organizations. Whether in the light of the unique organizational characteristics of the NHS that assumption was valid, particularly in view of the impetus that it lent to the development of standard systems, may be open to doubt. Certainly it was conceived as the best way of exploiting the technology of the day. But advances in technology have now produced a new and extensive range of computers with characteristics (low cost, high power, small size, and high reliability) significantly different from those of their predecessors. Such characteristics, as Ashford points out, are bound to present a formidable challenge to the dominant position hitherto occupied by the large mainframe systems of the past decade.

A much wider distribution of computing facilities is now possible. Mini- and micro-computers may be appropriately sited in the units they serve—performing either single (dedicated) or a limited range of tasks. Linking such computers in a network offers potential benefits in the sharing of data and the provision of information for management, clinical, and epidemiological purposes. The cost benefits of such systems also seem likely, both directly and indirectly, to compare favourably with those of large systems performing similar tasks. Where can this be seen to lead? Whilst large systems are likely to continue to offer, for some years yet, the most cost-effective approach to particular applications (such as payroll), they seem bound to constitute progressively a diminishing proportion of the total computer effort.

Large scale systems are, by nature, complex. Their intricacy and sophistication has been found to slow the pace at which new applications can be assimilated, thus engendering a sense of frustration among many, particularly in the clinical and patient services field, who are anxious to use computers in support of their activities. In this context, advancing technology may be seen to have a liberating effect. And with liberation a rising demand for computing services may be predicted with some degree of confidence.

FINANCING DEMAND—WHO DECIDES?

The question immediately posed is whether the necessary financial resources will be forthcoming to match increasing demand. Past experience is not encouraging. In aggregate terms 0·4 per cent of NHS turnover in 1979/80 was spent on computing—less than on printing and stationery. This level of expenditure might be reasonably compared with that spent by industry (1·5 per cent) or by local authorities (2 per cent). Whilst the true significance of such comparisons may be doubtful, the subjective impression is that the NHS has some leeway to make good. There is little evidence to suggest that the NHS has enjoyed much success in assessing the appropriate and justifiable level of its investment in computing. The level that emerges is largely the result of a number of independent decisions reached under the influence of highly variable and unrelated criteria. Moreover, the general thrust towards standardization has inevitably resulted in large tranches of the available resource being channelled towards the development of standard systems with administrative computing, understandably perhaps, consuming the lion's share. Whilst several potential sources for funds are theoretically available, including for example special DHSS allocations for R&D and systems development, Trust funds, research grants etc., the major part of the expenditure is, in practice, found from the annual allocations to Regions. Regions have thus been dealt a powerful hand. As the arbiters of resource distribution and as the managers of the large scale systems, it is hardly surprising that regional considerations have had a powerful influence on the outcome.

Whether the level of expenditure on computing should continue to be determined largely by Regions is now openly challenged. Many believe that such an arrangement, heavily top-downward, does not allow proper scope for the recognition of the needs and opportunities arising at the operational level. It is forcibly argued that Districts are far better placed to assess needs and priorities and that decisions on these issues ought not to be unduly influenced by considerations somewhat removed from the effective delivery of patient care.

THE DISTRICT ROLE

A change in this direction can certainly be expected to alter the pattern of investment. But its effect on the overall level may only be marginal, given that constraints on public expenditure seem likely to continue. This underlines the necessity for coherent strategies and plans for the development of computer services to be formulated at all levels of the organization; the identification and evaluation of possibilities; the determination of priorities and, generally, the assurance of good value for money. Just such a task has evidently proved fairly intractable in the past—as witness attempts to evaluate the experimental programme. The real benefits to be expected from the introduction of computer based systems are notoriously difficult to identify and quantify. Traditional notions of cost analysis are often unhelpful and estimates of expected savings tend to prove illusory. Nonetheless a rising demand for services against a background of limited resources compels the discovery of answers to these problems.

Much of this burden seems likely to fall in the future on the shoulders of the new District Health Authorities—given that greater district autonomy is a principle objective of the present restructuring of the NHS. Granted a larger measure of independence, Districts will no doubt seek to decide for themselves both the type of computing services needed and the source from which it is obtained. Regional bureaux might therefore expect to become less and less the provider of first resort while Districts turn increasingly to the considerable body of expertise available outside the NHS. Potential value will be seen in some quarters in the incentive provided by greater competition. Others, and especially those responsible for safeguarding the public purse, will be more concerned at the risk of a free-for-all leading to costly mistakes. Greater freedom will inevitably confer heavier responsibilities. Whether Districts will in practice be able to command the skills necessary to discharge the tasks described in the previous paragraph is, at least, debatable.

FINDING THE SKILLS

Concentration of computing activity in regional bureaux has enabled regions to develop a considerable core of professional expertise. And it will still be needed to ensure the effective maintenance and development of the present large systems which are very much in a transitional phase. But the role of the regional experts can be expected to evolve from that of main supplier of services towards one of providing the technical support necessary to increasing computer activity at the operational level. The potential asset of a continuing body of professional expertise is undeniable. But there are doubts whether in reality it will be sufficient for all needs. Similarly there must be doubts whether Districts would themselves be able to provide or recruit staff to make good any shortfall. Attracting and retaining computer professionals of the desired calibre has proved a difficult task in the past. Inflexible salary and manning structures have not encouraged the belief that the NHS offers attractive career prospects. Loss of highly skilled staff to other organizations is a common experience. Whilst some measures might be taken to mitigate this situation, it seems unlikely that computing, as a supporting discipline, will ever be able to command the same priority, in terms of the rewards offered, as those disciplines which are regarded as essential to the NHS' primary task. This line of thought suggests that there are practical limitations to the extent to which the NHS can provide, in-house, all the skills it requires and that accordingly it will need to look increasingly for support from outside its own organisation. This may perforce be the only option open to some districts and indeed preferable to attempting to recruit directly. At the same time, however, it is vital that the NHS retains its position as an informed purchaser by safeguarding its capacity for judging the quality and relative merits of the services on offer in the external market.

CAMELS OR HORSES?—COMMITTEES AS CO-ORDINATORS

Although the NHS offers a sizeable and buoyant market for computing services, it seems not to have made its presence felt as strongly as might have been expected in the developments that have taken place worldwide in the field of health computing. One explanation for this state of affairs may be found in its inherent inability to harness its collective resources and act in a coordinated and decisive way. Molteno and Cumming underline the difficulties experienced in attempting co-ordination by means of committees. Both lay considerable emphasis on the heterogeneous nature of the NHS structure, the autonomy of its constituent authorities and the independent line pursued by its many professional groups. In consequence there are almost insuperable obstacles in the way of establishing any kind of co-ordinating body which is universally regarded as truly representative and whose findings command general support and acceptance. Less difficulty is seen with committee structures that are more recognizably independent of central government interests, though it is clear that such interests cannot ultimately be ignored. A parallel may be drawn in this respect with the role and working of the Local Authorities Management Advisory Committee (LAMSAC) which acts as a focussing mechanism on computer development and operational matters in local government. Whilst the analogy may be useful, the circumstances in the NHS are so different that LAMSAC is unlikely to provide a satisfactory model. In search of a solution the NHS has in recent months remodelled its Computer Policy Committee along lines which confer a measure of independence from central government with direct links to the established decision-making structure. Whether this will prove more successful than its predecessors remains to be seen. It is difficult nonetheless to resist the view that such bodies can at best expect to have only a limited impact. The gravest doubts centre on their ability to provide an effective focus for the promotion of a realistic programme of research and development in the health computing field.

In this context Cumming outlines the case for an independent body along the lines of a research council or institute which brings together the professional and technical resources of industry, commerce, the universities and the NHS in a co-ordinated attack on computing issues emerging in the NHS field. Such a body could also readily function as a centre for the exchange of ideas and information. Not least it could provide a much needed reference point on health computing both for the NHS and central government. Establishing such a body need not incur the penalties of an unwieldy bureaucracy or excessive cost. Staff might be seconded from the NHS and other participating bodies. Whilst its costs might initially and mostly have to be met from central funds; demonstration of its effectiveness ought quickly to lead to a readiness, in their own interests, of NHS authorities, industry and commerce to contribute substantially to its running costs. In the longer run its value might be judged by its success in promoting cost-effective systems in the NHS and in exploiting the export potential for such systems in the world market.

POLICY—RETROSPECT AND PROSPECT

There may be room for differences of view about the future scope of health computing activity. But there can be little doubt that the era of the dominant large scale system is drawing to a close. The challenge presented by advancing technology in the shape of highly cost effective micro-computers is irresistable. If support for that view is needed one need look no further than the recent decisions of ICL and IBM to enter the micro-computer market in a big way. And in much the same way as its procurement policies were designed to support the British computer industry in the 1970s, the Government has again pronounced its intentions of lending support to the development of micro-chip technology in industrial, commercial, and business applications. For the NHS there are other, probably compelling, reasons why the opportunities offered by the new technology, should not pass unheeded. It happens, perhaps fortuitously, to open wide the opportunities for harnessing computers to a range of operational activities which have somewhat languished for support in the era of the mainframe machine. Importantly too, many, if not most, of such applications are directly concerned with the delivery of health care rather than its administration. The contemporary restructuring of the NHS with its emphasis on district autonomy pulls in the same direction. It is there that the demand for micro-computer services is most likely to burgeon. Falling hardware costs with rising processing power and the increasing availability of software packages will undoubtedly transform the economics of computing bringing it within the range of district resources.

What then of the policies that have held sway in the last decade? Their cornerstone has been standardization. There are those who still appear to be committed to its preservation—not least the DHSS and the Committee of Public Accounts. Though it must be said that the PAC appeared to be understandably more concerned with the lack of success in securing widespread implementation of the policy than with its intrinsic merits and relevance. Regional authorities, especially those who, as Centres of Responsibility receive substantial sums for the development of standard systems, may also be thought to have a vested interest in preserving present policy objectives. Such a position might be defensible if standardization had been a resounding success. The evidence, unhappily, suggests otherwise. The development of standard systems has been surprisingly long in gestation, the take-up disappointingly low with in consequence a poor return on a considerable investment. If the inherent variety of the NHS has already proved a barrier, how can standardization be expected to accommodate the even greater variety presented by current reorganization?

Whatever its strengths and weaknesses standardization may be seen to be a natural product of the era of the large mainframe. If, as the portents suggest, the end of that era is in sight, standardization as a main policy objective should perhaps be gently laid to rest.

What, then, might take its place? There is a case for continuing effort in appropriate fields towards the development of system specifications and data structures designed to fulfil particular and common tasks but with implementation left to local choice. There is strong support too for a policy designed to encourage the development of 'transferable' systems whose intrinsic merit and cost-effectiveness would determine the level of take-up. On the other hand, there are many who question the need for any form of central policy, believing that market forces can be relied upon to determine the outcome. This suggests that some form of Darwinian evolution might be appropriate in the field of computing where the rate of mutation and the generation of new species is particularly great. Provided that the NHS has sufficient skills and expertise to act as an informed purchaser, it might be left to survival of the fittest to ensure that the best services and applications are used.

Clearly the ingredients of any future policy, if policy there need be, are not easy to identify. What is much more important is to be clear about the objectives. If these can be unequivocably stated, the means will perhaps become self-evident. Prominent among such objectives must be a determination to ensure that the potential benefits of the new technology are not lost to the NHS and that the thrust towards distributed computing is recognised and exploited. In these circumstances, the mechanisms created for coordinating action and promoting healthy development assume a crucial importance. The weakness of committees as effective instruments of change in the NHS is notorious. If their survival is unavoidable, they need powerful reinforcement. In this context the notion of an independent research and development body offers probably the best way forward if the opportunities now in reach are to be grasped.