

UNIVERSITY OF EDINBURGH



EDINBURGH REGIONAL
COMPUTING CENTRE

First Annual Report

(for the period to 31st July 1967)

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Senior Systems Programmer	G. E. MILLARD, B.SC., A.R.C.S. P. STEPHENS, B.A.
Senior Programmer	Miss A. FINCH, B.A. (from 1st October 1967) H. E. WOODMAN, B.SC. (from 11th September 1967)
System Analyst	J. R. INNES

FIRST ANNUAL REPORT
(for the period to 31st July 1967)

Introduction

This First Annual Report covers a period of more than one year, commencing as it does with the publication of the Flowers Report in January 1966. Although the Regional Centre came into formal existence only on 1st August 1966, the whole 18-month period since the publication of the Flowers Report has seen intense activity, firstly in laying the groundwork for what will be a substantial computer installation, and secondly in defining the exact role the Edinburgh Regional Centre is to play and in evolving a co-ordinated development programme covering hardware, software, the provision of accommodation, and the recruitment of staff.

Origins

The establishment of "regional centres" was one of the main recommendations of the Flowers Report (Report of a Joint Working Group on Computers for Research Cmnd. 2883), which proposed that

"each regional system should be based on one medium or large computer of suitable size, forming a Regional Centre at a University or Research Establishment, with similar smaller computers at individual Universities and Research Establishments, the members of which should, when necessary, have access as *of right* to their regional central computer." (Para. 7).

Of the three Regional Centres nominated in the Report—London, Manchester, and Edinburgh—the Flowers Working Group considered that Edinburgh, because of the nature and volume of its own demands and also because of those of the many nearby Research Council laboratories, was an excellent case for treatment as a regional centre along multiple-access lines, including the provision of one or two small satellite computers, and recommended that

"Edinburgh could take a leading role in the development of conversational systems as a matter of national importance. Much of their task would initially be concerned with the administration and planning of what should be an advanced computing network for the considerable and expanding Research Council activities in their neighbourhood." (Para. 179.)

Installation of Equipment

Following negotiations with computer manufacturers, the Ministry of Technology, and the University Grants Committee, it was decided that the Centre's main installation should be an English Electric System 4-75. This will be delivered in September 1968 and will be installed in the first phase

of the University's £2½ million Mathematics/Physics Institute which is at present under construction on the King's Buildings site. As an interim measure funds were provided for the rental of a KDF9 computer which was installed in a specially-constructed temporary building in the central area of the University in December 1966. It has now been agreed that the rental of this KDF9 should be extended until September 1969—a year after the installation of the System 4.

Five-year Plan and First-year Progress

Following the appointment in June 1966 of Dr G. E. Thomas as the first Director of the Centre a five-year plan for the development of the Centre was worked out in increasing detail.

(a) *Equipment.* The specification of the initial configuration of the System 4 installation was the subject of detailed discussion and negotiation with the manufacturers and the sensible extensions to the initial installation were carefully considered. A description of the initial System 4 installation appears in Appendix A to this Report. Subsequent extensions for which sanction has already been obtained from the Computer Board include the provision of a 600 megabyte capacity disc store, which is due for delivery in March 1969, and a Calcomp graph plotter which will be attached initially in December 1967 to the KDF9 and subsequently transferred to the System 4. The major additional capital investment which it is envisaged will be required in the first five years of the Centre's operation comprises the enlargement of core store, the provision of support processors and extensions to satellite processors, and the installation of further communication equipment when the Centre is effectively operating in the multi-access mode. The total capital investment in the Centre (including buildings and furnishings) should, it is proposed, be of the order of £2.6 millions in the initial 5-year period. Of this total, about £1.3 millions has now been sanctioned by the funding bodies.

(b) *Staffing.* A major task during the first year has been the recruiting of staff. Apart from the Operations Manager and 5 junior operating staff who were transferred from the Department of Computer Science, the Regional Centre had to be staffed from scratch. The fact that by the end of the period under review 70 staff were in post and another 16 were under contract to take up duties at a future date indicates the scale of this task, particularly in view of the fact that certain categories of computer staff are nationally in very short supply. The Regional Centre's experience over the initial period confirms the belief that the most serious shortage lies in the area of systems analysis and systems programmers. The special communications and engineering tasks of the Edinburgh Regional Centre have also led to recruitment difficulties. On the other hand recruitment of operations staff has on the whole proceeded most satisfactorily. Analysis of the current and projected establishment of the Centre shows the following figures:

GROUP	IN POST		PROJECTED				
	at 1st August 1966	at 1st August 1967	1967/68	1968/69	1969/70	1970/71	1971/72
Administration and Operations	8	56	71	87	88	88	88
Software.	1	12	29	39	45	48	48
Hardware and Consulting	—	2	14	15	16	16	16
Total	9	70	114	141	149	152	152

From these figures it is apparent that the Centre's efforts will in future be directed principally towards the recruitment of programming and consulting staff.

(c) *Accommodation.* A special temporary building to house the KDF9 computer was erected over the summer of 1966 and will provide adequate accommodation for the machine until the end of the rental period, which has now been extended to September 1969. The accommodation of the Regional Centre staff in Buccleuch Place in the vicinity of the machine, and the provision of adequate data preparation units both in the central area of the University and on the King's Buildings site, proved more difficult tasks for the University whose accommodation resources have been particularly stretched over the past year, and it is very gratifying to be able to report that to date the steady increase in staff numbers has been matched by the provision of adequate and reasonably convenient accommodation. The main data preparation unit in the central part of the University is about to be moved from accommodation in Lothian Street which it has occupied for the past year to the refurbished Alison House which it is hoped will continue to operate as the major central data preparation area even after the installation of the System 4-75 on the King's Buildings site.

The first phase of the University's £2½ million Mathematics/Physics Institute, which will be devoted to the accommodation of the Regional Centre, is scheduled for completion on the King's Buildings site in May 1968. With the installation of the System 4-75 there in the summer of 1968 the majority of the Regional Centre staff will take occupation of new accommodation specifically designed for a major computer installation. For the remainder of its rental period operating staff will be required to run the KDF9 installation on a three-shift basis, and in addition it is envisaged that certain applications programming staff allocated to major projects will be housed within the relevant department or research institute.

(d) *Services.* The KDF9 commenced general service to users at the beginning of January 1967. For a period early in the year a third shift was provided as a temporary measure to assist Glasgow University while its

installation was closed for upgrading, but regular third-shift working for Edinburgh users was not provided until the end of the period under review. During July the third shift was used principally to provide training for new operating staff and it was only from 1st August that a 24-hour service for users generally commenced. The analysis of usage of the KDF9 service during the period January-July 1967 (Appendix B), while showing an erratic picture (for example, because of the incidence of undergraduate courses and University vacations), yet gives some indication of how demand is building up. There is no doubt that early in the year 1967-68 the position will be reached where demand will exceed supply as far as KDF9 time is concerned.

The submission of work to the Atlas computers at Chilton and Manchester University has continued at a fairly steady level, and in addition from July 1967 a daily van service to the Univac 1108 computer at the National Engineering Laboratory, East Kilbride, has been operated, principally for the handling of Fortran programs. Agreement was reached with Edinburgh Corporation for the provision of time on the Corporation's System 4-50 which was due for delivery in the Autumn of 1967—an arrangement which would have been especially valuable in affording to Regional Centre staff early experience of a System 4 machine. English Electric Computers have experienced difficulties however in the production of early System 4 computers and the System 4-50 for the Edinburgh Corporation will not now be available for use by the Centre until after March 1968 at the earliest. Aberdeen University who were to receive a similar machine in November 1967 do not expect delivery until May 1968. The System 4-70 installation due for delivery to the Centre in June 1968 has been delayed by a similar interval and the initial installation at the Centre will now take the form of the 4-75 model with delivery in September 1968.

No satisfactory assurance has yet been obtained from English Electric Computers that they can make available satisfactory services to cater for any overflow on the service commitments of the Centre in the interim period. Every attempt is being made to ensure that the requirements for computer time of the Multi-Access Project are met on prototype installations at the Kildgrove factory of English Electric. The most promising source of spare computer time during the first six months of 1968 would appear to be at Newcastle University where an IBM Model 67 computer with a comparable performance to that of the System 4-75 is now being installed. It is hoped that overflow arrangements will be negotiated with Newcastle before the end of 1967.

One of the Regional Centre's aims is to offer regular data preparation services to users and to provide improved supervision of undergraduate data preparation. To this end considerable effort has been expended during the first year on introducing some order to what has been a very confused facet of computing. After prolonged discussions and correspondence with other Universities and with English Electric, standardised character codes were agreed and the detailed specifications made available to Edinburgh users. A survey was carried out of the existing paper tape equipment held by user departments, and in view of the very low level of mechanical per-

formance of much of this equipment, a contract was negotiated with English Electric to ensure the adequate maintenance of teletypes—the arrangement including the establishment of a small reserve pool of machines. At present over 70 teletypes held by University departments, Research Council institutes or the Regional Centre itself are being maintained in this way, and a gradual improvement in mechanical performance is being experienced. As mentioned earlier in the Report the main data preparation area, which at present is open from 9 a.m. to 9 p.m. each weekday, is about to be moved into Alison House. It is anticipated that this will continue to serve as the main centre for undergraduate work, as well as providing a general service to postgraduate students and research workers. Limited facilities are also provided on the King's Buildings site in the Department of Electrical Engineering and in the A.R.C. Animal Breeding Research Organisation to staff from outside these departments.

Advisory services to programmers and potential users have been provided by staff of the Operations Group. Experience obtained in the first year has revealed that senior staff throughout the Regional Centre organisation will need to spend a proportion of their time in advising programmers and users. The Operations Manager, Training Officer and Service Manager in particular will in future carry responsibility for certain defined levels of advisory service and further experiments will be made with first aid, diagnostic and consulting services intended to assist the user in rapid program development and efficient machine usage.

Effect is now about to be given to the early decision to establish a substantial application programming team in the Centre to work with user departments and to aid the development, and encourage sensible use, of the program library which is being built up. Such professional programmers are uncommon in British Universities at present, but both within Edinburgh and outside the concept has won a welcome.

(e) *Programming Languages.* Much consideration was given throughout the period under review to the formulation of a sensible policy on the programming languages to be made available on the 4-75, particularly for conversational use.

In the case of the KDF9 there was of course little choice in the circumstances. Atlas Autocode and Algol were made available, with a strong bias towards the former on economic grounds, as the Atlas Autocode compilers were much superior in cost performance characteristics, and operationally Atlas Autocode jobs are much more conveniently handled. It was felt however that certain teaching and research work reasonably demanded Algol compilations, and the reduction in efficiency was accepted in the interests of standardisation on a more universally accepted language.

With the System 4-75, however, the possibilities were likely to be extended to include Fortran IV and Cobol, with PL1 uncertainly on the horizon, and it was clear that the Regional Centre could not provide adequate supporting services for all these languages. It was felt that, as the Edinburgh installation was to be developed as a predominantly conversational system, and as none of the main contenders had yet been approved for general use in the

conversational mode of operation, a relatively unfettered decision to concentrate at Edinburgh on one or at the most two particular higher-level languages could be taken.

The conclusions reached after prolonged assessment of the situation are that initially the Centre should concentrate on the provision and operation of IMP and Fortran compilers for the conversational use of the 4-75. During the year a redefinition of Atlas Autocode, which maintained a reasonably high degree of correspondence with the Atlas Autocode compiler operated at Manchester University and Chilton, was accepted by Edinburgh users, and extensions to the KDF9 compiler to permit the use of cards for input were introduced. For the 4-75, however, it was felt necessary to move to a more advanced variant IMP (Interactive Multi-access Programming language) which has been developed and is being used by the Multi-Access Project as the language in which the multi-access operating system is to be written. Conversion from Atlas Autocode to IMP is considered to be a minor re-training and documentation task; and if certain features of Atlas Autocode are not used program conversion will be automatic. It is hoped therefore that with the relative ease of assimilation of Atlas Autocode programs within the larger framework of IMP, a policy of exclusive use of IMP compilers can be agreed. PL1, it was agreed, had dropped off the horizon for an indeterminate period, following its early experience on IBM 360 machines in the United States. More importantly, it was felt that by 1968-69 the international programming investment and program library provision in Fortran would vastly exceed what had by then been done for PL1, and in view of the scarcity of experienced programming staff it was considered impossible for the Centre not to take maximum advantage of the internationally available library resources. The Executive Committee has therefore accepted a recommendation that there should be set up within the Centre a team to produce, in close association with the team preparing the version of IMP intended for user programming, a conversational Fortran compiler which it is hoped will be in field test before the end of 1968.

Support for Algol and Cobol on the System 4-75 will depend initially on the use of the manufacturer's compilers which have been developed for the 4-70 system. Discussions have been entered into with English Electric with a view to the development of new compilers for Algol and Cobol which would be appropriate to the 4-75 system. It is possible that Bristol University will undertake the task of producing an Algol compiler.

Edinburgh Multi-Access Project

An essential role in the development of the Regional Centre is being played by a joint research project to provide basic multi-access software for the operation of the System 4-75 computer. The project team, which was assembled in the University's Department of Computer Science over the period from August to December 1966, includes some twenty-five programmers provided partly by the University and partly by English Electric Computers Ltd. The Ministry of Technology has placed a contract with the University to the value of £195,000 to provide the financial support necessary

to allow the University to participate in the project, the total direct cost of which is estimated at approximately £350,000 over a period of two and a half years. It is hoped that with the establishment in Edinburgh of a programming team of this size and experience, active research will naturally continue into further aspects of conversational programming, console languages, program debugging systems, computer-aided design, specialised problem orientated languages and future computer system structures.

The multi-access software being written by the project comprises the basic executive system and a complete sub-system. The basic executive system contains the whole of the organisation for sharing the machine's resources among many users simultaneously. It defines the standards to which the writers of sub-systems must conform if their users are to share their material, programs and data, with users of other sub-systems. The complete sub-system contains an on-line text-editing program, a compiler, and an on-line program testing system.

All the programs are being written in a language, IMP, developed locally for software work. At present, the KDF9 is being used for program testing since IMP is available on it, and when a System 4 machine becomes available locally the development work will use it as well as the KDF9.

The main design phase is now drawing to an end with the production of various Technical Specifications, and the emphasis of project work will move on to implementation over the next two months. The major achievement of the past twelve months has been the detailed system design (scheduled for completion 15 months from the effective start of the project—say October 1966) which underlies the production of the System Manual. This Manual was recently circulated for consideration by members of the Technical Committee before presentation to the Management Committee for formal acceptance and publication. A concise hardware specification has been produced and is being supplemented as further information about the hardware becomes available.

On the language front, IMP9 has been in full operational use for three months and is proving robust in performance. It handles both cards and paper tape. The excellent diagnostics provided are a vitally important feature of this compiler, and will prove of inestimable value during the coming months. An enhanced form of IMP9, known as IMP9.5, is now available in an interim version. The IMP50 compiler is on schedule, although a lack of core space on KDF9 is beginning to threaten its development. A narrative description of this compiler has been written.

Constitutional Position and Committee Structure

The Flowers Report conceived of Regional Centres as being based on one medium or large computer of suitable size forming a Regional Centre at a University or Research Establishment, with similar smaller computers at individual Universities and Research Establishments, the members of which should when necessary have access as of right to their regional central computer. The Edinburgh Regional Centre accordingly, while the University's own computer installation, accommodated in University buildings

and with its staff employed as members of the University staff, has from the outset been looked upon as having a duty to provide a significant computing service to Research Council establishments in the area and in particular to the local Agricultural Research Council institutes. The Centre's involvement with other Scottish Universities is likely to be on the whole more of a consultative nature. Aberdeen University is shortly to have installed a System 4-50 machine and close liaison between the two universities is clearly desirable. Pending agreement on its own computing facilities, Heriot-Watt University has been making use of Regional Centre facilities both for research and for teaching, and has been kept informed to an appropriate degree of developments and policy decisions which might affect its position. The other Scottish Universities have not been significantly involved in the development of the Centre, but some measure of consultation, mostly informal in nature, has been maintained. With regard to the participation of industry and commerce in the Regional Centre's complex, it has been accepted that while it would not be proper for such users to take up a significant proportion of the available facilities, it would be a pity to exclude the possibility of some involvement, particularly in cases where the work being carried out might be of some intrinsic interest to the Regional Centre.

The composition of the Executive Committee, which reflects these varying degrees of interest and involvement in the Centre, is as follows:—

The Chairman, who will be the Principal of the University.

The Deputy Chairman, who will be a member of the University.

The Director of the Centre.

Two other members of the University.

Two members nominated by the Agricultural Research Council.

One member nominated by the University of Aberdeen.

One member nominated by the Heriot-Watt University.

One member nominated by the Computer Board from its members.

One representative of Industry, Commerce, or other relevant local interests, to be appointed on the recommendation of the other members of the Committee.

The full constitution of the Centre which has been approved by the Computer Board as well as by the University Court and the Agricultural Research Council is given as Appendix C to this Report. The current membership of the Executive Committee is included at the beginning of the Report.

Since October 1966, a Users Group has held nine meetings under the Chairmanship of the Director. This Group, which comprises some twenty individuals, is representative of the main categories of users of the Centre's facilities, both on the university side and on the research council side. Over its first year of operation it has functioned adequately as a forum through which the Director could receive advice and reaction on the conduct and development of the Centre's services, and as a channel through which advance information could be disseminated to users on problems and policies. In furtherance of these aims, the minutes of Users Group meetings

have been given wide circulation within the University and Research Council institutes and the attention of users drawn to where the minutes might be consulted. It was at the outset envisaged that the aims and functions of the Group would require review periodically in the light of experience of its working, and that in any case relatively frequent changes in membership might be desirable. Such a review is now being embarked upon, and it has been suggested that additional more specialised groups are required (i) to make regular and more detailed reviews of the performance of the operational services of the Centre, and (ii) to control the development of an effective and comprehensive program library. The consensus of opinion however, at least within the Users Group itself, is that even if those additional Groups are established, the Users Group can continue to play a valuable role in aiding the smooth development of the Centre.

Analysis of Usage

An analysis of the usage of the KDF9 computer during its first seven months of operation (January-July 1967) is given in Appendix B, together with a list of user departments. Glasgow University's use, amounting to 182 hours over the period January-March 1967 when their own KDF9 installation was closed for upgrading, has been excluded from these figures, as their work was handled by their own operating staff during the (at that time) unused third-shift period.

The main trend disclosed in the principal table is a steady increase in usage over the period by all categories of user outside the Centre itself, the sole exception being undergraduate teaching where the incidence of University vacations is reflected by considerable fluctuations in usage. On the University side (excluding undergraduate teaching) there has been approximately a 40-50 per cent. increase over the period in the amount of time used, but the monthly total of users has remained almost stationary, whereas on the Research Council side the monthly total of active users has almost doubled with a corresponding increase in the time used each month. The difference may be largely explicable by the fact that there existed in the University even before the advent of the Regional Centre a substantial body of active users making use principally of the Atlas machines at Manchester University and Chilton, while the Research Council institutes in the area had not been blessed with even the promise of easy access to a major machine. It is interesting to note that while the average length of jobs differs little between University users (3.59 mins.) and Research Council users (3.25 mins.), there is a substantial difference in the average amount of time consumed over the seven-month period by University users (168 mins.) and by Research Council users (259 mins.). (These figures exclude undergraduate teaching usage which is clearly untypical in length of run (1.01 mins.) and average amount of time used by each user (14.25 mins.). The most obvious explanation of this difference of course is that the typical Research Council user is a full-time research worker while the normal member of the University staff has an approximately equal allegiance to teaching duties and research work. This may be an oversimplification, as many members of the

University staff conduct their research through research students, and indeed research students and research assistants form a not insignificant proportion of the 274 Edinburgh University users. It is clear that to assist the projection of future demand, particularly on the University side, a more sophisticated categorisation of users and usage must be put into operation. This has been done with effect from 1st August 1967, and it is hoped that with such an analysis over a longer period than the initial seven months of the Regional Centre's operation it will be possible to draw more reliable conclusions about the likely pattern of demand.

Within the University the proportion of users coming from departments outside the Faculty of Science is quite substantial (17.8 per cent.), but their usage remains a relatively insignificant proportion (6.6 per cent.) of total University research use. A partial explanation of this disproportion may lie in the fact that certain experienced users, for example those with large survey programs, have found it expedient to continue for the most part with the Atlas computers. More generally it has been suggested that the introductory programming courses hitherto run in the University have not been sufficiently geared to the needs of non-scientific users who may require a slower and more closely supervised introduction to planning and programming work for a computer. Possibly the incorporation into programming courses of guidance on the analysis of problems together with the development of the Regional Centre's application programming service to users (mentioned earlier in this Report), will contribute to a significantly increased demand from users outside the Faculty of Science.

Appendix B also includes a summary of the use made in the period January-July 1967 of the Atlas machine at the Science Research Council's Chilton laboratory.

Charging Systems

The total demand from University and Research Council users for computing time and other Regional Centre services is now beginning to exceed what can be made available through the Regional Centre, and it is anticipated that such a situation will be the norm, except possibly for a brief period when both the KDF9 and the System 4-75 are simultaneously in full operation. The Executive Committee has accepted in principle that some form of charging or allocation system is necessary, and that the operating staff of the Regional Centre cannot be expected to control access to the machines without the benefit of clearly-formulated guidance from the body ultimately responsible for policy decisions relating to the Centre. It is planned that a comprehensive scheme will be in full operation from August 1968, although some partial measures may be provisionally introduced before that date.

Direct restriction of access to services is relatively novel in the British university environment. Many research workers reasonably regard ready access to computing facilities as important as access to a good library, and of course much university research is unsupported by any research grants, being conducted as part of their normal duties by members of staff and their

research students. Also it is important not to discourage exploratory or short-term work, especially by departments which are not regular or experienced users. Any "charging system" must cater for such users, whether by the allocation of grants to users to buy time, or more simply by incorporating an allocation system within the charging system. One advantage of a system based on money rather than on units of time is that the real cost of computing is brought more effectively home to individual users, who might in certain cases compare the cost unfavourably with the costs of carrying out their work by alternative methods. On the whole, however, there seems no necessity to use money exclusively in preference to time. What is required is to ensure the full and efficient use of the available facilities (by the encouragement, for example, of the technical improvement of programs with a view to savings in time), and to allow a conscious decision as to the most desirable balance between research and teaching, or among different subjects, in the allocation of limited computing resources. Undergraduate teaching in computer programming and computer science already constitutes a significant demand on the resources of the Regional Centre, and proposals for the 1967-68 session by the University Departments concerned reveal a much higher rate of growth in this category of work than in any other user category. A decision on the future scale of support for undergraduate teaching is an integral and urgent part of the institution of a charging or allocation system.

It is realised that there are many complications in operating a charging or allocation system, not least in relation to research projects sponsored by outside bodies, but the Executive Committee has accepted that to allow almost uncontrolled access, particularly in a situation of demand exceeding supply, would lead to an impossible position. It is hoped that full details of the proposed initial scheme will be published shortly.

Edinburgh as part of the National Picture

The parallel development of the Regional Centres nominated for London and Manchester has not yet reached a state at which sensible comparisons can be made with the position at Edinburgh. In London University the staff of the Atlas Computer Service have in recent months been charged with preparing the ground for a Regional Centre organisation. The Directors of the Edinburgh Centre and of the Atlas Computer Service have met on three occasions and information has been exchanged on the administrative and organisational features of both Centres. No opportunity has yet been provided for similar exchanges with the prospective Manchester organisation. Until permanent authorities for the conduct of the Manchester and London Regional Centres are designated very little further action can be taken to relate the work at Edinburgh to other Centres.

The communal needs of the Scottish Universities have been the subject of a specially constituted Committee on which the Regional Centre has been represented. A Report has recently been submitted by this Committee to the Computer Board which contains recommendations considerably in excess of the current University and Regional Centre provision so far supported by the Computer Board. In particular a large conventional batch processing

installation is recommended which would have a capacity at least equivalent to the System 4-75 to be installed at the Edinburgh Regional Centre.

Certain special relationships have been established with other Universities in England, Scotland and Wales which are to instal System 4 computers. Discussions among these Universities have so far been concentrated on programming languages, and a Committee under the chairmanship of Professor Michaelson of the Department of Computer Science at Edinburgh has met on several occasions to discuss a co-ordinated approach to the manufacturer on various issues. We should plan to maintain an intimate relationship with these universities in the development of programs.

University College, London, and Manchester University have installed IBM System 360 computers of equivalent performance to the System 4-75. There are many common features between the IBM and English Electric computers and information is exchanged regularly with the staff at London and Newcastle.

The S.R.C. Atlas Computer Laboratory at Chilton continues to provide an overflow facility for work which is uneconomically done on the KDF9 at Edinburgh or requires programming languages which are not available on the KDF9. Advice has been regularly obtained from the staff of the Chilton Laboratory during the initial stages of establishing the Regional Centre and certain limited multi-access developments now being pursued at Chilton are being studied with interest.

The Atomic Energy Authority operates a number of large-scale computer installations and work at several locations is relevant to the development at Edinburgh. In particular the Harwell Laboratory has installed an IBM System 360 computer to provide a multi-access service and there has been a regular exchange between staff at Edinburgh and Harwell over the last twelve months. The installations at Culham and Risley are also developing multi-access systems based on the KDF9 and System 4-70 computers and meetings have been held with staff concerned at both installations.

Meetings have been held with the G.P.O. department concerned with the provision of a National Data Processing Service and it has been agreed that regular contact should be maintained in connection with the use of English Electric computers and components. The Engineering Department of the Post Office has suggested to the Ministry of Technology that a more formal relationship should be established with a University environment such as that at Edinburgh to assist them in their own development of a multi-access system.

Meetings have been held with various members of the Computer Division of the Ministry of Technology and with the National Physical Laboratory. In particular the Ministry of Technology convened a meeting at Edinburgh in January of this year at which a large number of computer specialists were invited to comment on the proposed method of development at Edinburgh. The Ministry of Technology subsequently published a Report of this meeting.

The Regional Centre has become a subscribing member of the National Computing Centre, which has been established by the Ministry of Technology

over the same period as that covered in this Report, and expects to benefit from the advisory, training, and library resources now available.

Future Development.

Reference has been made elsewhere in this Report to the establishment of an application programming team within the Centre and the foundation of a committee to direct the development of an effective and comprehensive program library. The results of these provisions should become evident in the coming year and with the appointment of a program librarian in December 1967 active steps will be taken to encourage users to employ previously developed and tested programs wherever possible. The program library committee will be in a position to co-ordinate programming activities across University and Research Council departments and if the large potential programming effort available at Edinburgh is effectively harnessed the elements of a useful library should be in existence when the System 4-75 processor arrives in September 1968.

The exploitation of key programs in the Edinburgh Program Library will depend on the ease with which they can be extracted from the system. The large capacity fixed disc store to be installed in March 1969 will enable a proportion of the frequently used library programs to be held permanently available for on-line reference by a user of the 4-75 processor. The remaining capacity of the disc store will hold programs still under development or test, and their ready availability should encourage a number of users to participate in the development and test procedures and so accelerate the process of producing a general purpose program.

The staff of the Regional Centre will become directly involved in the engineering and programming aspects of various data transmission and data capture developments in the next few months. No significant practical experience will however be obtained until the communications multiplexors associated with the 4-75 processor are delivered by English Electric at the end of 1968. In the following months the number and variety of terminal equipments attached to these multiplexors will be dictated by the rate of progress with the multi-access software. It is expected that from April 1969 onwards users requiring on-line access to the 4-75 processor and associated disc and tape storage will wish to instal their own terminal devices, on the basis of experience obtained with equipment provided from a small pool held by the Regional Centre. Financial provision for this pool of equipment and line connection equipment to support an expanding population of on-line users has now to be negotiated with the Computer Board to ensure equipment availability for October 1968 onwards. The performance characteristics of the 4-75 processor and its initial multi-access network should have been measured by October 1969 and from that date longer term data transmission and data capture projects will be supported.

If the processing, information retrieval, and communication capacity of the Regional Centre is to develop at a growth rate of between 1.5 and 2 per annum (specified as typical in the Flowers Committee Report of January 1966), then additional plant will be required at regular intervals and according

to some long-term system design. The recent merger of English Electric Computers and Elliott Automation has led to the formation of a joint product planning team which is already considering the future products required to support the continuing development of installations such as that now projected for Edinburgh in 1969. Planning for the necessary investment and the system extensions of the 4-75 configuration has been delayed as a result of the uncertainties arising out of the merger, but discussions are now proceeding with the manufacturer and the Computer Board with a view to securing the development of the installation up to April 1972.

Staff Membership of Outside Bodies and Committees

DR THOMAS

1. Committee Member of the Scottish Universities Computer Services Committee.
2. Permanent Guest Member of the Agricultural Research Council Advisory Committee on Computing.
3. Member of the Directors of University Computing Laboratories Committee.
4. Member of the I.F.I.P. Proceedings Committee.
5. Member of the Edinburgh Arrangements Committee for I.F.I.P.
6. Member of the Scottish Area Users Committee of the National Computing Centre.
7. Member of the Executive Committee of English Electric Computers Users Association.

MRS BARRITT

1. Member of the City and Guilds Advisory Committee for the Training of Computer Personnel (and relevant syllabus, examination and National Co-ordinating Committees).
2. Member of the British Computer Society Working Party No. 4 on Education in Schools.
3. Member of the Committee set up to advise the Scottish Association for National Certificates and Diplomas.
4. Recently asked to join a committee being set up by the Secretary of State for Scotland to review the implications of Computers for Schools in Scotland.
5. Member of the B.C.S. Advanced Programming Discussion Group,

MR DAY

1. Member of the English Electric Computer Users Association System 4 Programming Sub-Group,
2. Member of the Universities Working Party of System 4 Computers.
3. Member of the Fortran Teaching Standards Group A.C.S. London.
4. A Regional Centre Representative of the Elliot-N.C.R. Applications Group.

MR NICHOLAS

1. Member of the English Electric Computer Users Association KDF9 User Group.
2. Member of the English Electric Computer Users Association System 4 Users Group.

MR MILLARD

1. Member of the English Electric System 4 Operating Systems Working Party.
2. Member of the Committee of the Edinburgh Branch of the British Computer Society.

INITIAL CONFIGURATION OF THE SYSTEM 4-75

Central Processor

One 4-75 Central Processor with Timer check
Control typewriter and console.
Scratch pad store (300 μ s).
Store reservation hardware.

One Multiplexor channel with 9 trunks.

One Single channel control unit with 1 trunk.

Two Multichannel control units—one with 3 channels and one with 2.

458, 752 bytes of 1 μ s core store (interleaved; accessing, 4 bytes/cycle).

Low Speed Peripheral Equipment

Two 800 cpm card readers with binary image option (80 and 51 column cards).

Two 1500 cps paper tape readers and control unit.

Two 750 lpm line printers and control units (132 cols., fully buffered).

One 150 cps paper tape punch and control unit.

*One Model 564 graph plotter (31" paper: 300 steps/sec).

Backing Storage

One Device control unit for 7 and 9 track magnetic tape units.

One Device control unit for 9 track magnetic tape units.

Four High speed magnetic tape units (120 Kb/s).

One 7-track magnetic tape unit (60 Kc/s)—rented.

Two Device control units for replaceable disc stores.

Six Replaceable disc stores (7 $\frac{1}{4}$ million bytes each; 156 kb/s).

*One Device control unit for magnetic drums.

*Two Magnetic drums (2 M bytes each; 820 kb/s; 10 ms average access).

†One Device control unit for large fixed discfiles.

†One Large fixed discfile (600 M bytes; 550 kb/s).

Communications Equipment

*One Multiplexor communications control unit (for up to 112 lines).

*Four Telegraph buffers.

*Two Synchronous modem buffers.

Items marked † will be delivered in March 1969.
Delivery of items marked * has yet to be confirmed.

APPENDIX B
ANALYSIS OF KDF9 USAGE—JANUARY-JULY 1967

Category of User	JANUARY	FEBRUARY	MARCH	APRIL	MAY	JUNE	JULY	TOTAL	Percentage of total usage (excluding Regional Centre's own use)
1. All categories									
No. of users	317	425	335	331	314	466	276	873	
No. of jobs	3688	5259	4804	4351	4601	6313	4857	33,873	
Time used (hrs./mins.)	367.43	364.19	363.25	299.19	308.13	425.45	495.13	2623.57	
2. University of Edinburgh (excluding undergraduate teaching)									
No. of users	134	142	149	146	140	131	136	274	
No. of jobs	1525	2080	2259	1743	1522	1946	1732	12,807	
Time used (hrs./mins.)	87.58	97.24	119.44	101.52	101.43	133.7	123.56	765.44	58.1%
3. University of Edinburgh—undergraduate teaching									
No. of users	120	205	93	98	88	229	35	438	
No. of jobs	866	1535	530	627	1196	1308	126	6188	
Time used (hrs./mins.)	15.49	17.9	6.25	8.42	32.37	21.45	1.36	104.3	7.9%
4. Heriot-Watt University									
No. of users	—	—	—	—	2	5	3	6	
No. of jobs	—	—	—	—	29	8	66	103	
Time used (hrs./mins.)	—	—	—	—	6.45	1.11	5.58	13.54	1.1%
5. Research Councils									
No. of users	17	24	26	30	29	32	31	45	
No. of jobs	217	443	553	468	527	755	625	3588	
Time used (hrs./mins.)	10.5	23.40	25.6	25.46	23.27	51.23	34.54	194.21	14.8%

Category of User	JANUARY	FEBRUARY	MARCH	APRIL	MAY	JUNE	JULY	TOTAL	Percentage of total usage (excluding Regional Centre's own use)
6. College of Agriculture and Forestry Commission									
No. of users	—	2	2	1	3	4	3	4	
No. of jobs	—	10	22	14	12	29	20	107	
Time used (hrs./mins.)	—	0.19	0.34	0.33	0.36	1.1	1.28	4.31	0.3%
7. Commercial users									
No. of users	1	2	3	3	4	4	4	6	
No. of jobs	3	20	53	46	56	57	61	296	
Time used (hrs./mins.)	0.3	0.35	1.3	0.55	1.11	1.59	3.48	9.34	0.7%
8. Multi-Access Project									
No. of users	17	15	13	15	13	17	15	25	
No. of jobs	175	219	177	147	217	479	365	1779	
Time used (hrs./mins.)	13.59	31.43	40.45	22.6	19.8	45.15	52.35	225.31	17.1%
9. Regional Centre (maintenance overheads and training)									
No. of users	28	35	49	38	35	44	49	75	
No. of jobs	902	952	1210	1306	1042	1731	1862	9005	
Time used (hrs./mins.)	239.49	193.29	169.48	139.25	122.46	170.4	270.58	1306.19	—

USAGE OF CHILTON ATLAS (JANUARY-JULY 1967)

	No. of jobs	Time used (hrs./mins.)
January	41	11.46
February	181	9.35
March	113	15.58
April	165	18.36
May	108	6.30
June	30	4.53
July	17	2.07
TOTAL	655	69.25

LIST OF USER DEPARTMENTS

(a) *University of Edinburgh*

Accountant's Office	Machine Intelligence and Perception
Agriculture	Mathematical Physics
Animal Genetics	Mathematics
Applied Linguistics	Mechanical Engineering
Applied Psychology Unit	Medical Physics
Architecture and Planning	Metamathematics Unit
Research Units	Meteorology
Astronomy	New Testament Language
Biochemistry	Physics
Botany	Politics
Chemical Engineering	Preventive Dentistry
Chemistry	Psychology
Civil Engineering	Radiodiagnosis
Computer Science	Social Medicine
Economic History	Social Sciences Research Centre
Economics	Statistics
Electrical Engineering	Technical Mathematics
English Language	Veterinary Physiology
Forestry and Natural Resources	Zoology
Geography	
Geology	

(b) *Research Council Institutes*

- ARC Animal Breeding Research Organisation.
- ARC Unit of Animal Genetics.
- ARC Poultry Research Centre.
- ARC Unit of Statistics
- ARC National Institute of Agricultural Engineering.
- MRC Unit for Research in the Epidemiology of Psychiatric Illness.
- MRC Unit for Research in the Clinical Effects of Radiation.
- NERC Oceanographic Laboratory of the Scottish Marine Biological Association.
- SRC Royal Observatory and Seismological Research Centre.

APPENDIX C

CONSTITUTION OF THE EDINBURGH REGIONAL
COMPUTING CENTRE

1. The Regional Computing Centre will be operated by the University Court of the University of Edinburgh, through an Executive Committee, and under the immediate management of a Director.

2. The Executive Committee will be appointed by the University Court, and will in the first instance consist of:

- The Chairman, who will be the Principal of the University.
- The Deputy Chairman, who will be a member of the University.
- The Director of the Centre,
- Two other members of the University.
- Two members nominated by the Agricultural Research Council,
- One member nominated by the University of Aberdeen.
- One member nominated by the Heriot-Watt University,
- One member nominated by the Computer Board from its members.
- One representative of Industry, Commerce, or other relevant local interests, to be appointed on the recommendation of the other members of the Committee.

The term of office of the Chairman, Deputy Chairman and Director will be of indefinite duration; other members will retire after three years' service, subject to possible re-appointment.

The Secretary to the University and the Secretary of the Agricultural Research Council will receive papers and minutes and will be invited to attend meetings of the Committee.

3. The Executive Committee will be responsible for advising the Court and the Agricultural Research Council, and where appropriate the Computer Board, on the general policy of the Centre, and for recommending from time to time the system and scale of charges to be adopted, and the allocation of financial responsibility between interested parties.

4. Statutory meetings of the Executive Committee will be held once each University term.

5. The Executive Committee will report to the University Court and the Agricultural Research Council as required, or as it thinks necessary, and will in any case submit an Annual Report to both the University Court and the Agricultural Research Council in full detail in the first month of each University session.

6. The Annual Report will be transmitted for information to the other Research Councils and major users of the Centre, including the University of Aberdeen.

7. The Committee will be appointed annually in the first month of each University session.

8. The Secretary to the Committee will be a suitably qualified member of the staff of the Secretary to the University.

9. Members of the staff of the Centre of academic or senior administrative grades will be appointed by the University Court on the recommendation of the Executive Committee.

10. Technical, Secretarial, and other ancillary grades of staff will be appointed on the recommendation of the Director in accordance with the accepted practice of the University.

11. All members of the Centre staff will, so far as practicable, hold their appointments on the same or comparable scales of salary and other conditions as members of the University in corresponding or comparable grades.

APPENDIX D
Income and Expenditure Account for the year 1st August 1966-31st July 1967

<i>Expenditure</i>		<i>Income</i>	
Salaries, National Insurance and Superannuation :		Sale of Computer Time (see Note) :	
Administration Group	£15,358	Multi-Access Project	£2,572
Operations Group	22,136	Other	919
Software Group	7,526		
Consultancy Group	2,162		
	<u>£47,182</u>		
Travel and Subsistence :		Computer Board Grant for KDF9 Rental	£3,491
Administration Group	£1,055	A.R.C. Grant	18,487
Operations Group	504	U.G.C. Earmarked Grant	30,000
Software Group	202	University Court Supplementary Grant	40,000
Consultancy Group	206		5,000
Computer Materials	£1,967		
External Service and Maintenance	14,587		
Rental of Equipment	10,277		
Hire of Computer Time	19,036		
General Expenses and Materials	3,806		
University Fixed Charges	5,817		
	<u>6,400</u>		
		Balance of Expenditure over Income	12,094
			<u>£109,072</u>

NOTE : The total value of invoices issued for computer time in the financial year 1966-67 was £6,011, of which only £3,491 was paid by 31st July 1967. As this was the first year of operation there was no compensating overlap from the previous year which would produce a more realistic figure for the sale of computer time.