

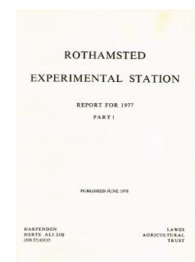
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ROTHAMSTED
RESEARCH

Report for 1977 - Part 1

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D. H. Rees

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COMPUTER DEPARTMENT

D. H. REES

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Personal Secretary

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Sharon E. Yaxley

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Introduction

Past Reports have revealed a pattern of continuous development and growth which is confirmed again this year in the more detailed sectional reports which follow.

This year saw the completion of the Joint ICL/RES Project, a venture whose origins can be traced back to 1974 when studies indicated then that the demand for multiaccess service during prime shift could only be met by the addition of an ICL System 4-72 configuration. Linking the 4-72 to the 4-70 required software facilities not available from the Company. These had to be provided jointly by ICL and the departmental staff and be

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developed locally at Rothamsted. This, the Joint ICL/RES Project, had two main objectives. The first was to incorporate the 4-72 into the service with minimal changes for the users. The second objective was to exploit the twin System 4 configuration in order to maintain a high level of service availability. Thus facilities were developed for transferring users, their work and files between the two mainframes.

After some 6 man years of effort, both objectives have been substantially met and the Department can look back, wiser, but with satisfaction, at this successful outcome. The experience gained by this Project will be invaluable when the Department tackles the problems of replacing the System 4s in the near future.

There is ample evidence of increasing user demands on the service, not least in the way that institutes have continued to expand the terminals connected to the network. When the 4-72 expansion was being considered it had been estimated from the data provided by the users that some 125 devices would be connected to the network by 1980. Plans already exist for connecting 113 devices by March 1978, and requests for additional equipment continue to be received. Whereas earlier the 4-70 had promised to be the bottleneck, it would appear that the limitation of the communication equipment is now a cause for concern. Studies have been attempted to determine the ultimate capacity of this equipment and thoughts have been given to procedures for regulating the situation if and when this limit is reached.

Some of this increased demand arises from a shift of user interest away from numeric computation to more general information processing. A large central facility now provides them with convenient and effective means for storing data both in volume and in time, plus the facilities for retrieving and operating on selections of these data. These developments have been mainly confined to topics of local interest to individual institutes, but work is in hand for sharing a mass spectra central library, searching and retrieval system between those institutes operating such equipment.

Users are also seeking more effective ways of displaying graphical output locally as an alternative to the present off-line system. They are also interested in techniques for incorporating upper and lower case characters for computer output texts suitable for direct reproduction. Investigations into both these problems were undertaken during the year and suitable operational equipment should be available next year.

The implications of microprocessors, that is the computer on the 'chip', is now a topic of widespread interest among the users. There is no doubt that these devices have a role to play in many aspects of research and the Department has made a modest start in exploiting this technique for its own purposes. In this way the Department will also establish the facts about this technique in terms of actual achievements, real costs and unresolved problems.

Therefore 1977 has provided the basis for projected developments into the early 1980s. ARC institutes have hitherto been conservative in their computing applications but all indicators now point to extensive exploitation over the coming years.

For convenience, user institutes are referred to by abbreviated titles throughout the Report (see Appendix I for Glossary).

Sections

The work of the Department is divided between Sections and the Section Heads have general responsibility for the following reports. Anyone seeking further technical information is invited to contact the appropriate Section Head.

Operations Section

This Section is responsible for the management and development of the mainframe, hardware, software and support services.

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The single ICL 4-70 computer had to carry the workload throughout 1976. A second similar computer, the ICL 4-72, was delivered in January and commissioned, tested and accepted by the end of March. The Departmental staff then used it for developing and testing software and systems. This work had progressed sufficiently by the end of August to permit the introduction of the 4-72 into general service, so doubling the capacity.

The workload since the introduction of the 4-70 in February 1971 has increased steadily. Prediction of demand over the next 2 years indicates a system as heavily loaded at the end of 1979 on two mainframe computers as it was at the end of 1975 on one.

Two major projects have been completed during the year. The Joint ICL/RES Project, which started in mid-1975, was completed in December. Message multiplexing (MMX) which enables message traffic to and from users' terminals to be concentrated into a few communications buffers (or ports) in mainframes, reached a usable stage in August, and is now almost complete.

The developments in message multiplexing and those described in previous Annual Reports for handling batch traffic via the Honeywell 716 front end processor now provide an interface for terminal message and batch traffic between the communications network and the large central computers. As a result it is now possible to add further computers either in addition to or in replacement of the existing ones without large changes to the total system.

Operations. The ICL 4-72 was accepted on 23 March after a successful trial conducted by the Technical Service Division of the Central Computer Agency. It was reserved initially for system development work, but by the end of June, Computer Department staff were allowed access via message multiplexing terminals. This relieved the 4-70 of part of its load which was promptly replaced by the external users.

The quarter June–September exceeded 2.1M work units, the highest ever user total, and in the normally less busy summer period. Following user test sessions, the 4-72 was introduced into service on 31 August, and has since supported the four sites (EMRS, GRI, NIAE and NVRS) which have batch terminals. Total work units in the 8 weeks commencing 12 September were over 50% higher than in the similar period in 1976. Over 55% of user work came from RES and NIAE together, and a further 42% from 11 institutes, of which several, including GCRI, IRAD and MRI, have more than doubled their workload.

Three-shift operation continued on the 4-70 until August, when both computers were formally staffed and maintained on a two-shift basis, with overtime as necessary. A shift supervisor has been appointed in recognition of the increased responsibilities and work to coordinate and control the efficient use of the enlarged system and to take charge of all shift staff. Routine maintenance on the 4-70 is still carried out during evening sessions, but 4-72 maintenance is on Monday mornings. This is made possible as a result of the flexibility provided by the Joint ICL/RES Project software and message multiplexing. These software developments also allow the workload and users to be divided between the two systems, and for each computer to provide a fall back service for all users in the event of a lengthy investigation and repair.

The 4-72 equipment has permitted the users' on-line file storage to be increased from a nominal 360 Mbytes to 480 Mbytes. A further two disc drives, still to be delivered, will be used to improve the performance of the system rather than provide further user file space. However, new applications and user demands resulting from the additional terminals being installed may require a review of their use.

System performance. The development workload has been relatively heavy this year, and together with evening maintenance on the 4-70, has meant that additional hours have

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TABLE 1
System utilisation

	1976	1977	
	4-70	4-70	4-72*
Production time %			
Day supervisor	46.4	45.3	43.7
Night supervisor	27.3	29.9	22.1
Housekeeping	11.6	10.1	10.5
System work	7.2	7.7	14.0
	<u>92.5</u>	<u>93.0</u>	<u>90.3</u>
Non-production time (%)			
Failures (all causes)	1.3	2.0	5.2
Routine maintenance	5.6	4.8	3.5
Additional engineering and unaccounted time, etc.	0.6	0.2	1.0
	<u>7.5</u>	<u>7.0</u>	<u>9.7</u>
	<u>100.0</u>	<u>100.0</u>	<u>100.0</u>
Operational time (hours)	5195	5081	1499
Working days	250.5	250	85
Operational time/day (hours)	20.7	20.3	17.6

*from 31 August 1977

TABLE 2
System failure distribution

	1976	1977	
	4-70	4-70	4-72*
Software			
ICL	92	77	19
RES	20	44	53
	<u>112</u>	<u>121</u>	<u>72</u>
Hardware			
ICL	99	114	69
RES (Ops)	3	1	1
'Other' failures	14	23	8
	<u>116</u>	<u>138</u>	<u>78</u>
Total	<u>228</u>	<u>259</u>	<u>150</u>
Total (All causes)	<u>228</u>	<u>259</u>	<u>150</u>
Total hours lost	70	103	78.75

*from 31 August 1977

had to be worked beyond the two-shift system. This development load has consisted mainly of system work done on the 4-72 (Table 1), though a substantial amount has required the use of the 4-70 and frequently the Honeywell 716 also. The overnight load has increased, and the number of large jobs run has been substantially greater than previously. Special arrangements have had to be introduced to allow the largest jobs to run independently on one of the computers. It is hoped that the reduction in the development load will enable user work to be contained in two shifts until next autumn.

As much of the equipment is now shared between the two computers, routine maintenance time has not doubled as might have been expected (Table 2). Most of the periph-

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eral equipment is still maintained in the evenings during 4-70 maintenance periods. However, the time lost due to failures has increased considerably. The 4-70 hardware has been less reliable though the ICL software performance has been better. The 4-72 hardware has not been as good as expected, but the engineers had improved it by the end of the year. Rothamsted software, of which there have been substantial additions during the year, has accounted for a higher proportion of errors than previously, but again the position had improved considerably by the end of the year. As before, most failures occur during multiaccess sessions, when activity is at its highest. Unfortunately, that is when they are 'seen' by most people since many are working on-line and a relatively large number of jobs are running concurrently. The number of failure-free days has been much lower this year.

Workload. The addition of the 4-72 this year resulted in a marked increase in workload in the latter part of the year. As a result, the figures (Table 3) do not readily lend themselves to comparison with previous years, nor to forecasting. Table 3 gives the workload in terms of work units, which takes account of all user activities and use of computer resources, ETUs, which are a measure of central processor activity but also include user program input and output of data, and the number of jobs or program runs. Comparison of ETUs used is also made with 1976.

System work has been high compared with previous years as a result of the major implementations which have taken place. Included in this value are operations and support activities, and the major part of all systems testing since these all require use of the username SYSTEM. As a result, the remainder of the Department's use is reduced, since this includes all non-SYSTEM work.

TABLE 3
Distribution of work by institutes

	ETUs		Job Units		Work Units
	1976 3 596 238 %	1977 4 418 583 %	1976 253 883 %	1977 283 570 %	1977 10 418 013 %
RES					
CD					
Systems work	16.4	17.7	8.6	9.8	5.9
Applications	13.9	9.4	17.9	15.8	9.1
Total	30.3	27.1	26.5	25.6	15.0
Statistics Department	17.8	17.6	11.3	11.6	24.3
Other Departments	9.6	11.3	6.3	5.1	10.7
NIAE	11.5	10.3	16.2	15.2	10.0
GRI	6.6	5.7	7.8	6.2	6.7
NVRS	5.2	5.2	11.3	10.0	5.9
EMRS	3.7	3.3	4.4	4.0	3.6
MRI	1.4	2.9	1.2	2.1	3.7
GCRI	1.3	2.8	1.6	2.8	4.0
NIRD	2.2	2.6	3.5	4.0	3.0
NIAB	3.5	2.6	1.3	1.4	2.8
LL	2.6	2.2	2.0	1.8	2.7
IRAD	—	2.0	—	5.0	2.3
WPBS	1.0	0.8	1.3	0.8	1.1
LARS	1.3	0.7	0.8	0.7	0.8
ARC HQ Services	—	0.7	—	0.5	0.7
Others	2.0	2.2	4.5	3.2	2.7
	100.0	100.0	100.0	100.0	100.0
Per working day	14 356	17 674	1013	1134	41 672

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The user workload comprises all non-Computer Department work plus those departmental activities which are carried out on behalf of the ARC HQ. This workload has increased by 21%. The increase in the number of jobs has not been as great (13%), but many more large jobs are now being submitted by users, particularly by the Molecular Structures Department of Rothamsted. The average job size of the Rothamsted Departments, excluding the Statistics Department, has increased from 22 ETUs to 34. The average job size varies considerably from institute to institute, and demands can and have changed quite dramatically. Further significant changes are expected next year.

Programming. The past year has been a particularly active one. In addition to most of the 4-72 Project software and message multiplexing, both ICL amendment tapes 19 and 20 have been implemented. Many other items have also been completed and a new software base—Release 7—has been established.

At the beginning of the year, targets were set for major and minor activities and for systems support. While it was important that certain relatively small items were completed to improve the image of the system for users and operators, other more major items relating to efficiency and flexibility had also been implemented. Either category could easily have consumed all the available resources. Major project activity has accounted for approximately 45% of effort, minor projects for 20% and support for 35%. Extra resource had to be invested in support and so prevented a start on the user file archiving and storage system. Additional effort necessary to complete the 4-72 Project has also delayed improvements in job management.

Staff with considerable experience are needed to ensure that the total system runs smoothly. The departure of trained staff is always a major loss and experience has emphasised the need for backup. This backup is, however, expensive in manpower resources. The loss of two experienced staff during the year means that yet again half the programming group will have an average of less than 1 year's experience.

During the year BCPL has been introduced as a high level language suitable for writing some system programs (Malcolm). It allows a much easier implementation and has also been used for setting up test environments.

Software development. The Joint ICL/RES Project is reported below. The other major item of work completed this year is the connection of communications lines to the front end processor (FEP) to carry all network traffic. The mechanism employed is termed message multiplexing and allows a number of terminals to be connected to the mainframe computer using a smaller number of lines. The concentration is carried out in the FEP and results not only in a considerable saving in mainframe communications equipment but also permits flexibility in directing traffic to the appropriate computer (Coombs and Matthews). Further computers could be added if required.

Multijob did not provide an acceptable mechanism for handling users' magnetic tape requests. The job control language (JCL) has now been expanded and operator facilities added to overcome these problems (Latin). Other improvements have also been made to the software, which interprets the JCL, and for recording events and actions for the remote user and remote operator. (Malcolm and Sharma)

To accommodate lower case and a larger subset, changes are still being made to input and output utilities in conjunction with the Telecommunications Section (Matthews). A program has been written to cater for non-standard codes and permit easy conversion. (Kiss)

Many other minor improvements, test environments and several special test programs have been written as part of normal work but are not reported upon separately. The editor program REDIT has been improved and further enhancements have been agreed with the users via the Computer Services Group. (Thomson)

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The Joint ICL/RES Project. The Joint Project sets out to provide the necessary programs, etc., to enable both the ICL 4-70 and 4-72 computer systems to be coupled together. The coupling is loose, since both systems can run independently with their own user and file base. The experience gained in the Project should prove to be of considerable value when the transition to a replacement computing system is made.

As a result of the project activities, management can distribute the load fairly evenly between the two mainframe computers, and can transfer part or all of the load, including the file base, from one system to the other. Thus maintenance can be undertaken on one computer by transferring all work to the other with a minimum of inconvenience to the user. Should either of the two computers break down totally, as does happen occasionally, a limited service can still be provided to all users on the other. (Mr. B. Gold, ICL)

Most of the programming has been within the operating system itself, and is thus hidden from the user, but some is seen externally. The operators have been provided with commands and programs to assist them in controlling the systems, and the users on one system can access the file base on the other. Batch traffic from remote sites via the front end processor is directed to the appropriate system and output returned. (Coombs, Latin, Malcolm, Matthews, Sharma and ICL staff)

A rigorous system of testing and implementation was introduced to ensure that the service and the users were affected as little as possible by the introduction of major changes to the system. (Sharma)

System support. The Section provided a special operating system for the CCA trials of the 4-72 instead of standard Multijob. It also provided part of the test load, the remainder being engineering test programs and CCA programs (Gledhill, Sharma and Thomson). The experience of CCA staff, as always, was very valuable.

Two ICL updates were implemented during the year and these, together with most other developments, were included in Release 7 of the Rothamsted system which now provides a fully up-to-date base for future work. (Thomson and Newbould)

The operating systems on both computers are now running less efficiently following the transfer of some equipment to the 4-72. Some of the efficiency should be regained in the coming year, but will be dependent to some extent on the availability of additional equipment.

Applications Section

This Section provides applications software and packages which are either known or promise to be of value to some users. In addition, it provides the associated documentation, training and advisory services, and offers direct support selectively to users keen to explore new software opportunities. During the year, J. D. Beasley was given the new responsibility for developing and exploiting the major Rothamsted General Survey Program in collaboration with Dr F. Yates.

As indicated last year, the activities of this Section are varied, but the trend for more data handling rather than numeric computation was maintained.

Database Systems. There is growing acceptance of the words 'database system' to describe a situation where a significant body of data has been assembled and stored on computer readable medium together with the programs by which a user may selectively abstract, collate and print subsets of the data. Techniques range from a restricted set of user options on well-defined, structured bodies of data, to almost unlimited enquiries on open-ended bodies of data.

The Department has previously reported on FAMULUS—a program for handling enquiries on bibliographic information—and now in use at several institutes. Modifi-

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cations and error corrections continue, and a Rothamsted version of the University College of London's manual is now completed (Hersom). FILETAB, a system developed by the National Computing Centre (NCC), was influenced by commercial needs, e.g. enquiries about inventories, staff, accounts, etc., and has been used internally within the Department, but little used elsewhere despite two seminars on the subject, including one at MAFF HQ (Verrier). Similarly, there has been no important new application of the taxonomic information retrieval program TAXIR during the year, but it is being used by individuals with specific needs. (Hersom)

The 500 or so subroutines which make up G-EXEC, the Natural Environment Research Council's package, have now been edited, compiled and assembled on the System 4. (Lessells) This work is being done primarily on behalf of the Soil Survey of England and Wales. Early System 4 experience with the package has highlighted operational and performance problems concerned with setting up jobs and accessing records held on discs; both are under active investigation. (Barrett and Lessells)

These retrieval packages were originally designed for specific purposes and much of the interest now lies in assessing their performance when applied to a wider range of tasks. An alternative approach has been to consider those more generalised systems which have been designed independently of the specific context of a practical application. This approach, if successful, dispenses with the need for the specialised packages and offers the prospect of a program standard. The Aberdeen University Database Management System (AUDBMS) is such an implementation and is under active assessment within the Department. (Clarke) In particular it is being used on the following project in association with staff from EMRS.

Geneological and other descriptive data concerning families of plants are now stored on the System 4 and can be selectively retrieved by parentage, offspring and other characteristic relationships. Both the storage and retrieval programs have been written using the AUDBMS. (Casiero, sandwich course student) In addition, the system has been designed to interface with the TAXIR system—should the need arise. However, it is intended to operate within AUDBMS and once proven will be handed over to the Statistics Section, EMRS, who will provide local support and development for the Fruit Breeding and Propagation Departments, for whom this work has been designed. (Casiero and Clarke)

All applications referred to in this section are designed to meet scientific research needs—there will be a reference later (Management Services Section) to other applications designed for scientific information and management needs. Again, they have been carried out either for individuals or groups from a single institute. The next example is therefore significant in that it is being carried out on behalf of a number of institutes.

Mass Spectrometry Retrieval Service. This has grown out of the close collaboration with Mr R. Self, FRI, for a proposed central storage and retrieval service on behalf of the eight ARS institutes now or shortly to be equipped with MS instruments.

Line spectra are now centrally collected and the number available is so large that only computer based searches are feasible. FRI, as part of its MS service to the ARS, has developed a retrieval system on their local computer—but cannot adequately cope with the enlarged central spectral library now available. So it is intended to transfer their programs to the System 4 for direct use but techniques for transmitting data captured on MS equipment directly to RES have to be developed (Telecommunications Section). Meantime, all the MS institutes have been given the opportunity to use, on a commercial bureau, a more extensive Mass Spectrometry Search System (MSSS). The shape of the final service will depend on accumulated experience with these new techniques and

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will be determined by the representatives of the eight institutes concerned, who are members of the ARC MS Panel. (Clarke)

Computing languages. FORTRAN was one of the first of the high level programming languages to be created. With the near certainty of yet another expanded version being accepted as an international standard, its position as a scientific programming language is entrenched for the foreseeable future. Nevertheless, attempts continue to be made to supplant FORTRAN with other languages based on a much sounder theoretical understanding of the basic procedures. ALGOL 68 is potentially one of the strongest challengers to FORTRAN and so an investigation was made on a restricted version of this language during the year. The outcome was not encouraging but this was for operational reasons rather than the merits of the language. (Barrett)

Because of the apparent unassailable position of FORTRAN, methods are being studied which would either expand the range or ease the preparation of programmable problems to be run under FORTRAN. To meet these requirements, RESBOL, a Rothamsted version of the symbol manipulation language compiler SNOBOL, is now being widely used. (Bicknell and Verrier) Not only is this proving to be a useful language in its own right, it is itself used to prepare preprocessor systems for use in conjunction with FORTRAN, and several have been developed by the Department. (Barrett, Bicknell, Clarke and Thomas) Indeed, RESBOL has stimulated a new interest in the preprocessing concept within the Department.

The Department contributed to the development of the FORTRAN standard through the activities of Alan Clarke, who was formerly Secretary and remains a member of the British Computer Society's FORTRAN Specialist Group, which acted as the National Committee in this matter. He has extended his interest to studies which may one day lead to comparable database standards.

Computer graphics. As predicted last year, the program DRAW, which was originally developed for displaying chemical structures, is proving to be a versatile tool. Documentation has been issued and it is now available to users in general. (Bicknell and Thomas) By courtesy of Dr J. A. Vince, Middlesex Polytechnic, the PICASO graphics programming suite has been mounted in the system and is being investigated as a method for producing three-dimensional graphical representations. The first results are encouraging but there are examples which reveal that such displays can be beguilingly misrepresentative. (Bicknell)

Work is in progress on behalf of the Field Experiments Section (FES) for the production of actual experimental field layouts on the graph plotter. It starts with the output of a program which provides the design and randomisation information which, together with ancillary instructions, are converted by a program written in RESBOL to produce DRAW instructions leading to the actual field layout. The specification of this program is well advanced (Bicknell, with Dyke, FES) and a start has been made on the program implementation. (Thomas)

Later in the year our attention was drawn to a commercially available Graphics Option Controller. This is a hardware device which can convert a character video display unit (VDU) into a graphical display unit. These two modes are interchangeable and can be controlled either through a program or manually. There is the prospect of an interactive facility which will transfer to the mainframe the co-ordinates of a point identified by the intersection of two cursors on the face of the unit. The elements of this system have already been demonstrated to users and have aroused considerable interest. It is believed that this could be a valuable tool in the analysis of biological research data on a

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computer, where a graphical display can offer more insight into an analysis than the corresponding sets of tabular values.

Training and Advisory Services. During the year it was necessary to strengthen these services and Mrs. C. Thomas, who was already contributing on a part-time basis, was designated Training and Advisory Officer to support the Senior Training and Advisory Officer, P. J. Verrier. This enabled the team to pay more attention to reviewing and enhancing the training programme and program advisory services.

User documentation is being brought up to date and a list of documents circulated during the year appears at the end of the Report (Appendix 2). A course on 'The Introduction to Multijob' is available on video tape and was presented in this form at nine institutes. During the year about 170 staff attended such courses. Plans are in hand for similar introductory video tape courses for RESBOL and BASIC—a simple programming language. However, these will not be recorded until there has been a live presentation of the courses.

The new documentation issued during the year is listed at the end of the Report and a first draft of a BASIC programming manual has been completed. The first draft of a RESBOL manual is substantially complete. Both are expected to be published early in 1978. (Verrier)

With the increasing experience and confidence of users, the advisory service is dealing with more complex situations arising from a more ambitious use of the computer. As a result there is a steady demand for the production of special purpose routines and programs by all members of the Section.

Six issues of the *Newsletter* amounting to some 160 pages of news, views and information, were issued during the year, and eight institutes were visited to discuss current and future application programming needs.

The work of this Section has been well received by the users but it must be sustained if the cohesion of the service is to be maintained.

Rothamsted General Survey Program (RGSP). This has been chiefly a year of consolidation. At the beginning of the year a master source file existed and contained most of the alternative versions for CDC and ICL System 4 machines and some of the alternatives for ICL 1900 series machines. The CDC, System 4 and ICL 1900 series alternatives have been completed; a few errors have been traced and eliminated. A System 4 version called 'Mark 1A' was prepared from this master source early in the year and has been used in production work at Rothamsted since May. Simultaneously a version was prepared for the IBM System/370 at Cambridge, which should be available for service early in 1978.

A CDC version of Mark 1A was prepared and sent to CSIRO in Australia during July. Since the incorporation of CDC alternatives into the master source was not quite complete at Mark 1A, the version in use at the CDC 6400 installation at Imperial College has been pre-Mark 1A throughout most of this period. A version subsequent to Mark 1A is now being sent there in preparation for the formation and release of Mark 1B.

A pre-Mark 1A version was sent to the ICL 1900 installation at Queen Mary College, London, in early 1977. Initial progress with this version was good but it rapidly came to a halt for reasons still not fully understood. Partly as a result of this difficulty, it was decided to create a 'simulation version' which could be run on the Rothamsted machine but would embody many of the features of an ICL 1900 version, but at a level subsequent to Mark 1A. Versions of Mark 1A have also been made available to the University of Bath for production of an ICL 2900 range version and to 'inQuiry', Minneapolis, USA, for production of a DEC-10 version.

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An interface from RGSP to release 3 of GLIM has been produced. This enables tables produced by RGSP to be read by GLIM. It is available for use with Mark 1A if required and will become an integral part of RGSP at Mark 1B.

Usage of RGSP. RGSP is known to be in productive use at the following sites: South West Universities Computer Network (Bath University, Bristol University, Exeter University, University College, Cardiff, and University of Wales Institute of Science and Technology), at the Edinburgh Regional Computer Centre, on the NUMAC system at Newcastle University (for the benefit of University users throughout the country), at Imperial College, London, at CSIRO in Australia and at the University of Western Australia. Not a great deal is known about the depth of usage but the general pattern seems to be of a small band of dedicated and enthusiastic users at each site. There are suggestions that its use in the South West exceeds that at Rothamsted; the same may be true elsewhere.

The usage on the Rothamsted service appears to be divided between GRI, IRAD, MAFF Plant Pathology Laboratory, and the Rothamsted Statistics Department. It appears to be used for the routine analysis of agricultural surveys.

The Seychelles 1977 Census was analysed using RGSP. The Census was conducted in August, the bulk of the data reaching Rothamsted on cards in September; late returns were punched here early in November. By the end of December all the data had been loaded on to the computer, validated, corrected as necessary and consolidated and over 300 tables and combined tables have been despatched to the Seychelles. This work has been carried out by Mr. T. C. Jones, Chief Statistician, Republic of Seychelles, in collaboration with ODM and J. D. Beasley. Mr. Jones visited the Department during the summer in order to familiarise himself with RGSP, but much of the work was successfully done by correspondence. This exercise is seen as a demonstration of the power and flexibility of RGSP.

A Prospectus describing RGSP has been prepared and copies can be obtained directly from the RGSP Secretariat at Rothamsted.

Telecommunications Section

The Section is responsible for all aspects of the development, maintenance and operation of the FEP, and the network, including its associated terminal equipment.

As in previous years staff turnover has caused problems which have resulted in development schedules slipping. However, this did not hinder the major development task, interactive traffic software, from reaching operational status.

Operations

Network equipment. For the second year, funding approval for the purchase of network equipment was late. A new procedure has been agreed which should overcome this difficulty. A summary of the terminal position at the close of the 1977/78 financial year is given in Table 4.

The pattern of terminal growth has changed considerably during the life of the network. It was expected that initially teletypes would provide the interactive access and remote job entry (RJE) terminals the batch facilities. Two factors dictated changes. Firstly, the visual display units (VDU) are now cheaper than teletypes, their lack of hard copy being offset by a much higher character display rate. Secondly, the static number of RJE's confirms that many of their functions can be provided by directly connected batch terminals, whose lower cost offsets the poorer data security given by the simple parity checking.

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TABLE 4
Planned distribution of connected telecommunications terminals by March 1978

	T/T	VDU	SP	QP	PTR	CR	Ct/R	RJE
RES								
CD								
Operations	2	4	—	—	—	—	—	—
Telecommunications	2	1	1	—	—	—	—	—
Applications	5	3	—	1	—	—	—	—
Others	7	—	—	1	—	—	—	—
ARC	1	—	—	—	—	—	—	—
AVRI	1	—	—	—	—	—	—	—
EMRS	3	1	—	—	—	—	—	1
FRI/JII	2	—	—	—	—	—	1	—
GCRI	1	1	—	—	—	—	—	—
GRI	3	2	—	—	—	—	—	1
IAP	1	1	1	—	—	—	—	—
IRAD	5	1	1	—	—	—	—	—
LARS	2	—	1	—	—	1	—	—
LL	3	1	1	—	1	—	—	—
MRI	2	—	1	—	—	1	—	—
NIAE	7	3	—	—	—	—	1	1
NIRD	3	2	1	1	—	—	—	—
NVRS	4	3	—	—	—	—	—	1
PBI	2	1	—	—	—	—	—	—
WPBS	2	1	1	—	1	—	—	—
WRO	1	1	1	—	1	—	—	—
Others (Dial-Up)	5	—	—	—	—	—	—	—
TOTALS	64	26	9	3	3	2	2	4

T/T – Teletype; VDU – Visual Display Unit; SP – 160 cps Printer; QP – Upper/lower case Printer; PTR – Paper Tape Reader; CR – Card Reader; Ct/R – Cartridge Reader; RJE – Remote Job Entry Terminal.

TABLE 5
Network performance—incidents on network

	1976	1977
1. FEP		
(a) Software	96*	249**
(b) Hardware	17*	27**
Totals	113	276
2. Terminals		
(a) Teletypes	21	39
(b) Visual Display Units	12	14
(c) Serial Printers	35	64
(d) Links	49	98
Totals	117	215

* 1 July – 31 December 1976

** Estimated annual total

Predictions for next year show that the network will continue to grow, and given the present device distribution, several links to the institutes will require to be upgraded. A fundamentally different solution may emerge from the microprocessor project described later.

A summary of the network performance is given in Table 5. It is difficult to draw meaningful conclusions as individual problems mask trends.

The very high number of software FEP incidents was due to the testing and inclusion into service of the interactive traffic subsystem. The hardware failures largely occurred

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at the beginning of the year and were due to disc problems. The disc head has now been modified and the problems have not recurred.

Most of the increased number of terminal failures are a consequence of the disturbance arising from the reconfiguration of the expanded network.

FEP System

RJE Subsystem. This subsystem has performed satisfactorily, although the transfer of incorrectly formatted files did produce a large number of failures early in the year. Work was carried out to trap such files but given the core store limitations on the FEP the problem was eventually solved on the mainframe. These efforts were successful and from the latter part of the year the overall crash rate on the FEP was reduced to an average of one per week. However, the introduction of the interactive traffic subsystem towards the end of the year had a detrimental effect on the performance.

The serial printer version of the 2780 RJE package, produced by Honeywell, was accepted after a satisfactory trial. The line printer version has not yet been completed and awaits the solution to a hardware fault on the line printer.

Although the four RJE's were connected to the FEP, they were controlled by commands which were serviced directly by the mainframe. This created operational problems which were solved when a corresponding set of control commands was implemented on the FEP as part of the interactive traffic subsystem. (Morton)

Interactive Traffic Subsystem. The initial development phase of this software had been completed in summer 1976. Trials began when the matching System 4 software was available early in 1977. The introduction of the software into service followed the same pattern as the RJE subsystem. Scheduled user trials expanded gradually into continuous running as the reliability improved and by the end of the year the bulk of the interactive terminals were being supported on the FEP. (Morton) Running of the system has highlighted two problem areas. Firstly, the loss of the FEP due to hardware failure for more than an hour is unacceptable. Secondly, the sharing of the processor between two complex real time processes (the interactive and RJE subsystems) leads to interactions which degrade the reliability of the system. We therefore plan to assign one subsystem to one processor. In the event of a major failure of a processor, the system can be reconfigured to maintain the interactive service. The availability of such a system should match the availability of the mainframes.

Development. Following last year's practice, development tasks within the Section are designated as either primary or secondary.

Primary developments

Batch terminals. Although the card reader for MRI is still at Rothamsted for development purposes, user interest in directly connected batch terminals has been high. The communications protocol has been extended to cover both input and output of data. A hardware telecommunications interface has been specified and a design completed by a contractor. A wider range of devices is now available, i.e. paper tape reader, card reader, and a cartridge read/write unit. The cartridge is expected to be especially valuable in the data logging area. The initial software design has been completed and the main development phase will begin in early 1978. (Bassill)

Microprocessor based terminals. Progress on this project has continued throughout the year. The communications protocol between the FEP and the microprocessor has

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been developed and coding of this is taking place. The design and testing of the special purpose operating system has been completed. The original fault diagnostic system has been retained to facilitate the further system testing. It is expected that inhouse testing of the foreground multiplexing system will start in March 1978. (Moore)

The dedicated background system, the Honeywell MTS 7500, which is used for local file creating and editing, has been completed and is in use at NIRD in a stand alone mode. Spooling of these files to RES is achieved by use of a modified version of a teletype emulator. In the light of this initial experience NIRD have redefined this requirement and the package will be modified. This ability to simply modify this software demonstrates the flexibility and value of such a system. (Richmond and Bojtos)

Mass Spectrometry Retrieval Service. The bulk of the MS users now have their own stand alone data acquisition systems and therefore the requirement is now for a central service to provide searching of large data banks that cannot be handled on the sites' small systems. A joint project between FRI and the Department is in the process of being set up with the aim of producing a trial system at FRI (see Applications Section Report). Telecommunications equipment related to this exercise has been ordered. (Richmond)

Secondary developments

EPSS. Phase one, the line protocol software to enable the FEP to accept and transmit packets of information from the central exchange, has been completed and accepted by the Post Office. Phase two, the call protocol to enable machine to machine conversations, has been investigated; however, further progress has been limited as staff have concentrated on primary tasks. (Moore).

High Quality Printer. The original concept of this project was to utilise an IBM Golfball typewriter as an on-line printer using a special applique unit. In practice it was found that the unit adversely affected the performance of the typewriter and proved difficult to adjust and hence maintain. This approach has been overtaken by the acquisition of 'daisy wheel' printers in the Statistics Department and at NIRD. Although these printers require a greater capital outlay they were specifically designed for the duties proposed and it is expected that a superior performance will result. We are studying how these devices could be integrated into the existing system.

Development H716. Additional equipment has been purchased which will enable this system to act as a standby to the operational computer. For reasons given earlier, the development system will eventually be brought into the service to support one of the subsystems. This presumes that arrangements for further development will be made available.

Management Services Section

This Section has a broad supporting role to the computing service, and is increasingly involved in management tasks on behalf of outside bodies.

ARC Project Costing Scheme. The year end computer analysis for the financial year 1976/77 was completed by the end of May. Reports for the first two quarters of the 1977/1978 financial year have also been issued, but were late due to increasing delays in the returns from some institutes.

Several programming changes were made to improve error reporting messages and to meet the needs of the non-ARC users of the Scheme. (Fearne, Proctor and Cooper)

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The Section is working directly with the Department of Agriculture, Northern Ireland, and the MAFF Sea Fisheries Laboratory, Lowestoft, analysing costing returns for them on a regular basis. (Fearne, Cooper and Ford)

Seed store management. A new seed store has been erected and commissioned at the PBI, Cambridge, to provide central secure vermin-free storage for the seed handled by PBI staff. Most seed will be held in conditions which should maintain the viability of stocks for at least 20 years; deep freeze storage is also available for longer storage of more valuable seed. Once established, it is expected that initially up to 40 000 seed lots could be deposited but this total could expand by an order of magnitude after 5 years. On this initial and prospective scale of operation, a computerised stock control system is essential for:

- (a) the management and maintenance of seed deposits,
- (b) the routine preparation of catalogues on current seed stock holdings.

Such a system has been designed within the Section in collaboration with PBI staff and a suite of programs prepared and tested. Certainly for the initial phase the Section will also be responsible for data preparation, computer operations and the updating and security of the computer files on a weekly basis. The system is also designed to provide a user enquiry service based on lot description. (Proctor and Cooper)

Library—Current Serials List. A system designed, programmed and now operational within the Section, as a regular service to the library, maintaining the list of current serials and producing on demand quality copies suitable for circulation of complete list or selected subjects, in upper and lower case characters. (Fearne, Proctor, Cooper and Ford, with Mary Nash, Library)

Inventory control. A program with updating and sorting facilities was prepared for inventory control of departmental equipment and subsequently adapted to include listings for all equipment on site at other institutes but connected to the computer network. (Fearne, Proctor and Ford)

Data preparation services. There was a 17% increase in the number of punched and verified cards produced by the Section during the year, this service being used by ten other institutes and ARC HQ.

There was a new demand for the preparation of textual material on punched paper tape as input to programs using the high quality printer.

Staff and Visits

During the year 12 staff left and 14 joined the Department, a total of 26 staff movements. Of these, A. Bojtos, C. E. Coombs and M. L. R. Denman, Scientific Grades, and Catherine Newbould, Executive Officer, resigned, and P. Matthews, W. Ip and G. Starkins, Scientific Grades, and Mrs. Pat Ford, Executive Officer, were appointed. As a sign of its maturing years, the Department also had its first staff retirement, D. Royle, Messenger, and lost one of its longest serving Senior Data Processors, Mrs. Wendy Brackin.

A new ICL System 4 User Association was formed and now deals directly with ICL independently of the other Computer Users' Association. This new Association continues to receive the full support of the Department; H. J. V. Gledhill was elected Chairman of its Multijob Sub-Group.

Staff attended the following Conferences: K. E. Bicknell—Graphical Methods in Statistics; H. J. V. Gledhill—Datafair; D. H. Rees—International Federation for Information Processing '77 (Toronto, Canada); I. M. Richmond—Institute of Electrical

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and Electronic Engineers Comsac '77 (Chicago, USA); W. Moore—Structured Design. D. H. Rees extended his Canadian trip to include visits to Agricultural research departments and computing centres in Toronto and Ottawa.

Publications

GENERAL PAPER

- 1 CLARKE, P. A. (1977) Guest Editorial: Future FORTRAN Developments. *ACM SIGPLAN FOR-WORD FORTRAN Development Newsletter* 2, 34–35.

RESEARCH PAPERS

- 2 BEASLEY, J. D. & SPRINGER, S. G. (1977) The percentage points of the normal distribution. *Applied Statistics* 26, 118–121.
- 3 CLARKE, P. A. (1977) The CODASYL FORTRAN Database Facility – A Summary. *Database Journal* 2, 21–23.

APPENDIX 1

Glossary of Institute abbreviations

The following is an alphabetical list of abbreviations used in the Report, together with their full title and location.

ARC	ARC Headquarters, London.
AVRI	Animal Virus Research Institute, Woking.
EMRS	East Malling Research Station, Maidstone.
FRI/JII	Food Research/John Innes Institutes, Norwich.
GCRI	Glasshouse Crops Research Institute, Littlehampton.
GRI	Grassland Research Institute, Maidenhead.
IAP	Institute of Animal Physiology, Cambridge.
IRAD	Institute for Research on Animal Diseases, Newbury.
LARS	Long Ashton Research Station, Bristol.
LL	Letcombe Laboratory, Wantage.
MRI	Meat Research Institute, Bristol.
NIAB	National Institute of Agricultural Botany, Cambridge.
NIAE	National Institute of Agricultural Engineering, Silsoe.
NIRD	National Institute for Research in Dairying, Reading.
NVRS	National Vegetable Research Station, Wellesbourne.
PBI	Plant Breeding Institute, Cambridge.
RES	Rothamsted Experimental Station, Harpenden.
RES CD	RES Computer Department.
WPBS	Welsh Plant Breeding Station, Aberystwyth.
WRO	Weed Research Organisation, Oxford.

APPENDIX 2

Documents published by the Computer Department

Program Guides		
PG/141	Program DRAW	K. Bicknell, C. Thomas
PG/143	A Quick Guide to REDIT	P. Verrier
PG/144	A Guide to RESBOL	K. Bicknell, P. Verrier
PG/145	Program CMPARE	I. Barrett
PG/146	Two Aids for Debugging FORTRAN Programs	I. Barrett
PG/147	Sorting Routines	B. Hersom
System Guides		
GSYS/15/2	Use of Private Disc Volumes (PVOL)	A. Kiss, R. Sharma
GSYS/20/5	Library Material Held On-Line	J. Beasley
GSYS/22/2	Library Material Held Off-Line	J. Beasley
GSYS/26	Paper Tape Handling on the Rothamsted System	J. Spreull
GSYS/27	Documentation Check List	J. Beasley, P. Verrier
Miscellaneous Guides		
GLAN/2/4	DATAD Modules	I. Barrett
PM/3	DRAW Program Manual	K. Bicknell, C. Thomas
MJ/4/3	Introductory Guide to Multijob	P. Verrier