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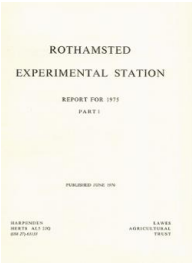
ROTHAMSTED RESEARCH

Report for 1975 - Part 1

Full Table of Content



Computer Department

D. H. Rees

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Introduction

The Department is responsible for the maintenance, development and management of a central computing facility to institutes of the Agricultural Research Service (ARS) in England and Wales. Program and service compatibility with the Scottish institutes is maintained to a limited degree through a terminal linked to the Edinburgh Regional Computing Centre (ERCC). However, the work submitted from Rothamsted is no longer carried out at the ERCC—instead all jobs are now retransmitted to the Northumbrian Universities Multi-Access Computer (NUMAC)—an IBM 370/168 at the University of Newcastle. Results are similarly routed back to Rothamsted via the ERCC. This

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illustrates the flexibility and value of telecommunications as a practical method for sharing computing resources on a national basis. The Department has long shared this view on the importance of these techniques.

Staff and organisation. After reporting staffing problems regularly in previous Annual Reports, it is with relief that I report the resignation of only one Scientific and two Executive Officer graded staff, and the appointment of four Scientific and one Executive Officer graded staff this year. With these new appointments and promotions it was possible for the first time to establish a stable Sectional structure headed by staff of appropriate grades. The Department now functions with an Applications Section (J. D. Beasley), an Operations Section (H. J. V. Gledhill), and a Telecommunications Section (I. M. Richmond). In recognition of its growing importance, a Management Services Section (C. W. Fearne) was also formed during the year.

The Department accepted the responsibility for the procurement and management of all computer equipment linked to the service, and for which the Telecommunications Section has day to day responsibility. The Department has responsibility for its own comprehensive budget which is funded separately from Rothamsted. These tasks have increased departmental administrative duties generally, and it was deemed desirable to nominate C. W. Fearne as the Departmental Administration Officer.

Despite this encouraging position, the Department also forfeited two important posts —a Senior Mathematician and a Performance Analyst—under the ARC Staff Moratorium early in 1975. The loss of these posts is to be regretted because it does hamper the development of specialised areas of expertise which are of long term value to the users.

The Department acknowledges its service role but it also has an important part to play in exploiting and encouraging the use of computers in agricultural research. Staff are expected to keep in touch with the rapidly developing computing scene but it is essential to have a small group of staff committed to the study in depth of the more important topics. However, it has to be admitted that the immediate pressure is for more information retrieval, data base, library searches facilities, and this has changed the emphasis within the Applications Section towards non-numeric computing in general. The appointment of telecommunication engineering staff has opened new possibilities for the development of computer assisted instrumentation. Some of these are likely to involve pattern recognition principles, a process involving quite complex mathematical procedures, and so the need for a strong mathematical base remains. The considerably enhanced capacity and resilience expected of the dual System 4 configuration due in service in 1976 opens up new possibilities for on-line experimental techniques which are going to make new demands on all three technical Sections. The emerging picture, then, is one of closer involvement with research into areas demanding more sophisticated use of the computer but for which staff of appropriate calibre will be required.

Joint ICL/Rothamsted System 4 Project. As part of the contract for the ICL 4-72 the company agreed to set up a Project made up of Rothamsted and ICL staff under the control of an ICL-appointed Project Manager, to design, implement and document new system software for the dual System 4 configuration. This Project has, amongst other things, to provide software for transferring users, their work and selected peripherals, to either system in a controlled manner. When the new service comes into operation later in 1976, institutes will have been assigned to one or other of the computers, thus broadenng the user interface. Under this scheme most of the 4-70 peripherals, augmented by new equipment, will be divided between the two System 4's in such a manner that they can be switched to the alternate system whenever the need arises. If there was a major mainframe failure, the users, with essential peripherals, could be connected into the

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remaining system and the service maintained, albeit in a degraded manner. This ability to switch peripherals also offers interesting possibilities for setting up asymmetric computer configurations to meet a major specialist task.

A key aspect of this development is the decision to appoint a Manager with full responsibility for the success of the Project. Setting up a Project on software appears to be an ideal way of meeting design and timetable schedules, but there are widely differing experiences in this approach. Therefore this attempt to closely manage a Project within the Department is itself going to be carefully monitored so that the experience gained can be a guideline to future major departmental computer tasks. The preparatory work is now well under way and if schedules are met then a comprehensive account should appear in next year's Annual Report.

The Department has also been deeply involved with the preparation and negotiations on essential modifications to the building to accommodate the new 4-72. An office annexe has been built and is already occupied; provision has been made for two motor alternator sets and for a second airconditioning plant; work is well in hand on an extension to the 4-70 room. This programme of work has to be carried out without disturbance to the present 4-70 service.

It has been the Department's practice over the years to become fully involved in all aspects of computer room design and accommodation. It is time-consuming and requires constant attention to detail. The rewards only appear later when the installation and commissioning of new equipment is carried out in a smooth manner and the performance of the computer and its supporting services is sustained over the life of the service.

Future plans. With so many tasks in hand, it may appear presumptious to be thinking in terms of events in 1980. However, this is in the nature of the work of this Department. For planning purposes it is assumed that a replacement computer will be installed during the financial year 1979–80 and for this yet more computer accommodation is required, together with urgently needed office space. Preliminary investigations have been made on defining the extent and location of these building works.

With the experience of the Multijob system in mind, studies have already started on the specification strategy for the replacement computer with the aim of avoiding any repetition of the early unhappy experience on the System 4. One of the key issues will be the development status of any proposed operating system. There are good reasons for believing that we should avoid being involved with equipment with an operating system which has less than three years exposure to a working user community. There are, of course, other factors to be considered such as the smooth transition of work from the Multijob system to its successor, but the prime objective is to offer our users a service which is at least as good as the present service—and preferably even better.

Sections

The Department's work will now be reviewed on a Sectional basis and in non-technical terms. There is some danger that this may undervalue the quality of the effort put in by the staff concerned but until the concepts and terminology of computing have wider currency it would be remiss to employ the highly specialised computer jargon in a Report devoted mainly to aspects of agricultural research. Furthermore, much of the effort is centred on manufacturers supplied equipment and software and therefore details tend to be specific and local in their interest.

Operations Section

During the year an Operations Section, headed by H. J. V. Gledhill, was formed by amalgamating the following groups:

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Operations (A. J. Boston)
System Programming (R. P. Sharma)
System Support (Mrs. M. Kerry)

The Section is now concerned with the management, service and development aspects of mainframe hardware and software.

Mainframe equipment. The high speed communications controller (ICL model 4385) which links the communications processor to the mainframe, was delivered in March and finally accepted in July. The accumulating delays both in delivery and commissioning, in all amounting to some nine months, have been a factor for the continued delay in the completion of the remote job entry terminal project. This apart, only extra terminal buffers were added to the System 4 during the year.

Performance. There is no generally agreed set of indices for defining the performance of a system. Those given in this and previous Reports have been selected to reflect the main features of the service. Table 1 describes the service in terms of a breakdown by time and this year the percentage total productive hours (69·1 %) shows a marked increase over 1974 (64·1 %), with practically no overall change in the total number of operational hours.

TABLE 1

4-70 performance

	1974	1975
Operational hours	5202	5174
Productive	%	%
multiaccess	43·8	46·3
non-multiaccess	20·3	22·8
housekeeping	19·8	15·5
system work	7·1	4·9
Unproductive		
failures (all causes)	2·7	3·3
routine maintenance	5·1	5·8
additional engineering	0·4	1·2
idle and unaccounted time	0·8	0·2
	100·0	100·0
Working days	252·0	252·0
Operational hours per day	20·6	20·5

In the late summer arrangements were made to keep the computer running continuously from Mondays to Saturdays in order to minimise the number of 'shut downs' and 'starts' per week. The maintenance engineers have suspected that some hardware incidents can be attributed to these changes of state. It is too early to establish the success of this arrangement, but Table 2A does show a reduction of about 17 % in the total number of major system failures in 1975. However, there is no important change in the distribution pattern. The 10·2 % assigned to other causes includes incidents on the mains supply which it is hoped will be reduced in 1976 with the new motor alternator sets. There has been an encouraging drop in the number of failures due to software and it will be interesting to observe the improvement, if any, which follows the work of the Joint Project.

For the first time, data is given in Table 2B about the distribution of system failures classified by the supporting authority. It is clear that in those areas where Rothamsted has the prime responsibility, i.e. airconditioning plant, mains distribution, operator errors and its own system software, failures are still in a minority compared with those for which ICL has prime responsibility. Amongst these it is unlikely that there will ever

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TABLE 2A

System failure distribution

	1974	1975
Total failures	446	371
Software	%	%
Day Supervisor	33·4	32·6
Night Supervisor	12·3	8·1
	45·7	40·7
Hardware		
Day Supervisor	31·6	34·0
Night Supervisor	10·1	14·0
	41·7	48·0
Operator errors	0·5	1·1
Other causes	12·1	10·2
	100·0	100·0
Average failures per day	1·8	1·5
Average loss per failure-minutes	18·8	28·1

TABLE 2B

System failure by support authority

	1975	
	Failures	Hours lost
Total	371	173
Support authority	%	%
ICL		
Hardware	48·0	64·8
Software	40·7	15·6
	88·7	80·4
Rothamsted		
Services	4·0	17·3
Software and Operators	7·3	2·3
	11·3	19·6

be a marked improvement in the hardware performance because the company no longer supports a hardware development programme. However, it is still to be hoped that the company will make an impact on failures caused by their software.

The total elapsed time units (ETU's) increased by 18% and the number of job units by 9% in 1975 (Table 3). For the first time NIAE head the list of institutes as the greatest user of the service measured in ETU's and jobs. There is a noticeable change in the position of NVRS in this list. Although both institutes are equipped with comparable terminal devices, it would appear that NVRS, primarily being users of the established statistical programs have, through experience, improved their productive use of these programs and therefore economised on resource use. NIAE is probably still characterised by the continued expansion and development of their own Fortran programs, and in this situation their demand will continue to grow.

None of the tables adequately convey the nature of the service as seen by the users. Some insight might emerge by reporting that there were only 82 (33%) failure-free workings days during the year, during which there was one sequence of six successive working days. Therefore the 371 failures were in fact concentrated on 170 working days, which is an average of over two per day. As about 60% of both hardware and software failures

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TABLE 3

Distribution of work by institutes

	ETUs		Job units	
	1974	1975	1974	1975
Total	3 015 683	3 562 835	214 392	233 268
	%	%	%	%
Rothamsted Experimental Station				
Computer Department				
Systems work	18·1	21·3	9·0	11·1
Other work	12·0	17·6	18·3	16·3
Statistics Department	20·1	15·9	12·2	11·1
Other Departments	5·7	5·5	5·2	4·8
	55·9	60·3	44·7	43·3
National Institute of Agricultural Engineering	10·2	11·8	14·5	16·9
National Vegetable Research Station	11·2	5·3	19·7	13·6
Grassland Research Institute	5·7	5·2	5·3	7·2
East Malling Research Station	5·0	5·2	4·9	6·0
National Institute of Agricultural Botany	2·8	4·1	1·8	1·5
National Institute for Research in Dairying	1·2	1·8	1·6	3·4
Letcombe Laboratory	1·7	1·4	1·3	1·4
Glasshouse Crops Research Institute	2·6	1·2	1·8	1·4
Meat Research Institute	0·9	0·5	0·4	0·6
Others (<1% ETU)	2·8	3·2	4·0	4·7
	100·0	100·0	100·0	100·0
Per day	11 967	14 138	851	926

occurred during the day shift—the users are only too aware of consequences to them of these failures. Therefore there is still much to be done to improve this position.

To summarise, then, growth and usage continues, but with steadily improving hardware and software during 1975 this has been contained within the same number of working hours. However, it was not possible this year to significantly increase the number of terminals on the service, and there is clear evidence of a substantial demand for these devices which will be met following the introduction of the dual System 4 service.

Multijob. Towards the end of the year ICL began releasing a series of amendments and modifications to Multijob M900. When these have been incorporated and checked out the service will then be operating to the standards of the final version of Multijob, M1000. This will still fall short of being the comprehensive error clearance promised last year, and the responsibility for tackling some of the outstanding errors which are still important to Rothamsted has been transferred to the joint ICL/Rothamsted Project Team. With this qualification, however, there can be no denying the improvements which have been made to Multijob over the past year.

Programming Group. During the year, R. Sharma's responsibilities for the operating system have been transferred to J. Thomson, assisted by C. Newbould. All three have been involved in implementing the various parts of the M1000 release which have been arriving throughout the year on the monthly update magnetic tapes sent by ICL. Minor reorganisation of the system has been continuing in preparation for the Job Management suite now in service.

Job management. This suite has involved changes and additions to job steps, supervisor, queues and utilities. It interfaces a set of high level batch job queues between the user and Multijob, classifying jobs by means of an information file under the system

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manager's control. Better control is afforded the operators over jobs requiring private disc volumes, but further improvements to this and to magnetic tape requests for jobs continues. The user is now able to submit an identical job description for either foreground 'interactive' (RIRO) or background (BATCH) running, simply by using the appropriate command. The job description itself has been simplified by providing a default for STORE requirements, and removing the need to specify rank, stream and priority. (Jackson, Malcolm, Sharma and Thomson)

PRINT and PRINT control. Support for the Dacoll serial printer and minor changes relating to the Centronics printers have been built in to the PRINT program. The PRINT control jobstep has been rewritten and now caters for printers which will be attached to the communications processor. (Jackson)

Communications Controller. After many delays and hardware problems, the ICL 4385 High Speed Communications Controller test program was completed and the necessary system software written and tested. This link also interfaces with part of Job Management, to be used later in the 4-72 project. A message multiplexing facility is being defined to permit keyboard-terminal traffic to be connected via the communications processor. (Coombs)

New input and output routines for paper tape have been written to provide a common standard for either local or remote use. (Malcolm and Sharma)

Maintenance. The system is now maintained at a more up to date level than previously, several hundreds of ICL and Rothamsted coding amendments having been applied during the year, as well as new Rothamsted programs. Work has been completed on a 'two-disc' system suitable for the 4-72, and the dependence on the EDS 8 disc channel has been removed. (Thomson)

Accounting. A 'billing suite' of programs has been written allowing statements of work done to be prepared for each username, department and institute. (Vincent) The final testing and necessary alterations are now complete. (Latin) 'Work done' is reduced to a common denominator—the work unit. Work units are calculated for job run, weighted for core usage and for time of day, console connect time and control activity, use of utilities including 'printing' and archiving, etc. This can be extended to include off line rental charges for, say, magnetic tape or discs, etc. Some changes have also been made to the accounting routines to accommodate the billing suite. Further changes are planned to allow a separate and parallel accounting by project. (Gledhill)

Support Group. This Group is essentially a renaming of the former Operations Advisory Group, to give a better description of its function, which is to support the user and his work within the system. The Group monitors regular systems activities such as archiving, accounting and magnetic tape performance. It also provides first line advisory help to users, and deals with registration, allocation of disc space and magnetic tapes. Such a brief account scarcely does credit to the valuable work done by this Group. The following activity data may give a hint as to its importance to the service. During the year there were some 3000 telephone enquiries, out of which some 1500 in depth investigations of problems were carried out—including those submitted locally. In addition to this the Group looks after some 2000 magnetic tape reels including their cyclic use and routine quality control checks. The members of this Group have the most frequent contact with our users and therefore carry the important first-line responsibility for meeting their needs.

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Applications Section

This Section is concerned with supporting and advising users with scientific programming needs. It is in the nature of this service that although members of this Section acquire skills in particular computer topics, they share common tasks and can become involved in detailed aspects over a wide range of programs and problems. As well as meeting current needs, the Section is involved in the assessment of new program packages, often in anticipation of expected future needs. The work pattern in the Section is therefore variable and not amenable to a summarisation. The following reports have been based on work which has been completed and released during the year.

Major projects. A considerable amount of work has been done on Fortran Standardisation and related matters. One of the members, P. A. Clarke, is the Secretary of the British Computer Society Fortran Specialist Group. We have obtained and implemented versions of the Schneck-Angel optimising Fortran compiler and the PFORT Fortran Verifier. These were obtained from the Atlas Computer Laboratory and the Bell Laboratory respectively; the first processes a Fortran program in such a way as to make it more amenable to optimisation and the second tests a Fortran program for features which could affect its portability to other machines. (Clarke)

The Food Research Institute Program for searching of Libraries of Mass Spectra has been transferred from the IBM 1130 and the Mass Spectra Data Centre Database has been loaded. Additional programs relating to Mass Spectrometry have been obtained from Pennsylvania State University and the MAFF Plant Pathology Laboratory, Harpenden. (Clarke)

The SPITBOL version of the language SNOBOL-4 has been obtained and implemented on the 4-70. Release is at present being delayed pending resolution of certain matters affecting licensing. (Bicknell)

Amendments have been made to the DATAD macro to allow the rewinding of line files. This is an example of a lot of work that goes into smoothing out the more accessible deficiencies of the system, making life easier for the users; such pieces of work are rarely reported on individually but they are very valuable nevertheless. K. E. Bicknell and B. M. Hersom have been particularly active in this.

The Mark 4 version of the NAG library has been obtained and mounted on the 4-70. (Shelley, Dunkley and Beasley)

The FAMULUS set of bibliographic information retrieval programs has been implemented on the 4-70, and is being successfully used by two institutes and by ourselves. (Hersom)

A program to sort linefiles has been written. This considerably simplifies the sorting of small files since it makes it unnecessary to use magnetic tape as a medium. (Hersom)

The plotter software has been redesigned and rewritten to allow for the use of possible future on-line plotters (Beasley) and routines for contouring and perspective viewing have been added to it. (Barrett)

Minor projects. A substantial amount of work has been done on the plotting software, both in providing new facilities and in allowing for the use of on line plotters if and when they become available, and will be more fully reported on next year. (Barrett, Beasley, Bicknell, Lessells and Shelley)

A zonal ultra-centrifuge program was obtained from Mr. J. M. Leach of Pfizers Ltd. and implemented on the 4-70. (Barrett)

A program has been produced which will take two line files and will produce a set of editing instructions which will convert the one into the other. It was produced for the

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comparison operation for the Rothamsted General Survey Program, but may have applications elsewhere. (Barrett)

A guide describing the differences between Standard Basic and the Basic systems available on the Honeywell H716 and the ICL System 4-70 has been produced. (Lessells)

Rothamsted General Survey Program (RGSP). Much of this year's effort has been directed to the consolidation of the Survey Program in preparation for a master version. For example, a revised version of Part I using Real *4 Arithmetic has been released and copies of it and the present version of Part II have been sent for use on the IBM 370 at the Edinburgh Regional Computing Centre and the System 4 at the University of Bath. Also a new version was set up on the CDC 6400 at Imperial College, London, and a copy of this has been transferred to the CSIRO, Canberra, Australia.

It was clear that problems would arise with the existence of versions for each of the ICL System 4, IBM 370 and the CDC range of machines. Therefore work has commenced on the organisation of a master tape from which, with suitable controls, versions appropriate to each of these system ranges could be generated and loaded. There is increasing awareness in the power of this program and during the year enquiries were received from seven overseas and five U.K. computer centres. (Yates, Barrett and Lessells)

Telecommunications Section

This Section is responsible for the provision and development of facilities associated with the telecommunication network. In practice this can be broken down into the day to day running of the telecommunication network, the major remote job entry terminal project, and the investigation into planning of future developments. The appointment of a new Head of Section has enabled a more balanced approach to be taken with these problems and responsibilities within the Section are now more clearly defined.

A second minimal Honeywell H716 system was delivered with 24k bytes of core store and a paper tape reader and line controllers. It is planned to use this for the further development of the network when the original H716 is dedicated to the handling of remote job entry terminal traffic.

The Network. The Section is now fully responsible for all day to day operational problems. During the year the Department accepted responsibility on behalf of the ARC for the procurement and maintenance of equipment which is linked to the central processor but located at other institutes. The Section is now responsible for the overall management of this terminal equipment.

Time Division Multiplexing (TDM) equipment and serial printers were installed at the Meat Research Institute (MRI), the Institute for Research in Animal Diseases (IRAD), and the National Institute for Research in Dairying (NIRD). The performance of the serial printers has been a cause for concern and the position has been exacerbated by the supplier, Core Ltd., going into liquidation. So far it has not been possible to arrange a maintenance contract and we are dependent on the goodwill of the original manufacturer, Centronics Ltd., for assistance in this and other matters.

Remote Job Entry (RJE) Terminal Project. The development of software for the Honeywell H716 communications processor has been a major activity during the year. The software which links the terminals to the processor was completed by the middle of the year and was available to be used for the acceptance trials of the Honeywell H725 remote job entry terminals. The equipment presented no problems but the RJE software which had been supplied by Honeywell did present problems which were satisfactorily

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resolved after negotiation with Honeywell. This experience has highlighted the need for more stringent specification of software in any similar future situation.

There has been a previous reference to the delay in the acceptance of the link controller between the communications processor and the System 4, but despite this most of the software to support the terminal had been checked out by October and the overall testing of the system began in earnest in December. This more extensive testing revealed a serious fault in the Honeywell software which had the effect of shutting down the terminals after some two to three hours of successful running. This setback has prevented the completion of the project this year and hopes are high that we shall go live in January 1976.

This has been a major departmental project and it is clear that there are many lessons to be learned concerning the organisation of the total system. In particular, the need for better estimation of the time taken to develop software is paramount and the recognition that much of our software will be on the critical path of any project is now more widely understood.

No attempt has been made to quantify the performance of the Honeywell equipment because of the continual changes and modifications which have been made to the equipment and software during the year. There was some early concern about the performance but undoubtedly the processors promise to be highly reliable and weekly availability in excess of 99% has been recorded. (Moore and Swan)

Software TDM. The possibility of software TDM emulation in the communications processor was considered. If successful a considerably economy in hardware could have been achieved and suitable programs were written and tested. From this it was concluded that the computer capacity required was too large to be cost-effective and so the investigation was closed.

Experimental Packing Switching System (EPSS). The Post Office have recently introduced an experimental packing switching system which is a technique by which a message is broken up into discrete packages complete with destination header information and then 'posted' to its destination over a switched network. These packages need not necessarily go along the same route but the system is responsible for ensuring that they arrive at their destination in an orderly manner. This technique will be of considerable importance in the future and in particular could be a more effective way of linking users to national resources. As several universities are linked into this experimental system it was deemed important that Rothamsted should also gain early experience with this technique. It is therefore planned that we shall have a link installed into the London Package Switching Exchange by next summer, giving us access to a number of other computing centres.

Graphics. The service only provides an off line graphic facility located at Rothamsted. There appears to be interest by users in having a graphic facility at their institutes and so a study of requirements and available equipment will be undertaken next year. As a preliminary to this a program is being written for a remote plotter and this will be run at another site on an experimental basis.

High quality printing. No facility exists within the service for the production of high quality printed documents, for example masters with upper and lower case characters for subsequent reproduction. Investigations have started into the possibilities of linking an electric typewriter as a terminal in the network and to use this in conjunction with

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editing software on the mainframe to produce a system which will provide complete documentation preparation, correction, printing and be retained on file.

Interactive traffic. At present all interactive terminals, e.g. teletypes and videos, are connected to the mainframe through a communications controller on the System 4. This controller contains all the buffers and is now physically full and any additional buffer involves the purchase of a second expensive controller. Therefore for cost benefit reasons and in order to contain the network facilities within the communication processor system, it is intended to concentrate this traffic into the communications processor and to pass it to the System 4 over a small number of high speed lines. Considerable examination and initial design for this project has been carried out during the year and work will begin in earnest once the batch traffic software system has reached a sufficient state of reliability. This is important to the future growth of the network although there always remains the option of expanding the communication control facilities.

Micro-processor based terminals. The design and reliable manufacture of complex processing systems using large scale integrated (LSI) techniques has reached the stage where their role must now be seriously considered. The most common use of LSI techniques is to be found in the rapid growth in the use of small hand-held calculators. Increasingly LSIs are being attached to other terminals and thus enhance the scope for these devices. It is fashionable to use the term 'intelligent terminals' to describe these LSI terminal systems and a proposal has been made, in conjunction with NIRD, to use the video based Honeywell MTS 7500 system for local information retrieval tasks and as an alternative to the TDM for linking other terminals into the service. Much has yet to be learned about these techniques but undoubtedly they will have an increasingly important role covering a variety of tasks and equipment.

Management Services Section

The Data Preparation services handled 11% more cards and provided 12% more time on the digitiser equipment. Including Rothamsted, 11 institutes used both these services. There was a marked deterioration in the ERCC link, where availability fell from 84·9% in 1974 to 73·3% in 1975. There was no single explanation for this, but undoubtedly the transfer to NUMAC introduced a number of teething problems which are gradually being resolved. Certainly the records show that about 75% of all losses can be attributed to either the software or equipment at the remote end of the communication link.

The first complete analysis of the 1974–75 Project Costing data was finished during the summer. A number of difficulties were encountered, of which the failure to get in reports from all institutes at a given time is perhaps worth noting. A start was made on the preparation of the master files for the Department of Agriculture, Northern Ireland, who are planning to apply the same project costing rules to their own research services. Generally speaking, the output has been welcomed at institutes and there is some indication that research workers, too, appreciate having their work evaluated in this manner. Further work needs to be done on these data, notably in the abstraction of various summaries, but such development is still awaiting the appointment of an experienced System Analyst and COBOL Programmer.

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