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ROTHAMSTED
RESEARCH

Report for 1974 - Part 1

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Computer Department

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COMPUTER DEPARTMENT

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Introduction

The department is responsible for the maintenance, development and management of central computing facilities to research institutes in England and Wales supported by the Agricultural Research Service (ARS). A limited amount of program and service compatibility with the Scottish institutes is sustained through the direct link with the Edinburgh Regional Computing Centre (ERCC), which provides these institutes with their central computing facilities.

Important new commitments undertaken this year, to be described later, have again focused attention on the present role of the department within the ARS. This computing service, with its centralised file store and extensive communications network, offers opportunities for the co-ordination and dissemination of information on ongoing research which appears likely to play an increasing part in its planning and management. This aspect of computing was recognised by the Agricultural Research Council (ARC) when, late in 1974, it agreed to the hire of a second ICL System 4, to be operational from 1 April 1976. This was done primarily to ensure adequate computing facilities for research workers over the next four to five years.

Increasingly, the department is involved in the application, development and planning of computing facilities at other institutes. However, much of its own planning and forward development remains based on informal and indirect contact with its 'customer'

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institutes. Despite the large investment in equipment and the time required to develop techniques, there are no central planning procedures on which effective staff and service management can be based.

In keeping with previous Reports, there will be little technical description of the content of the work undertaken by the department. The Report is prepared on a sectional basis, drawing attention only to those activities that are of general interest to the reader.

As a final general comment, attention is drawn to the continued staffing difficulties experienced by this department. During the two-year period commencing August 1972, 87 staff of all grades either joined, left, or joined and left the department. This places considerable strain on continuity of work and staff training. There are many reasons for this large staff turnover, but the most common is the attractive salaries they can command elsewhere. Such advantages are not limited to the private sector of industry, as both universities and local authorities can offer more favourable conditions, particularly for the two- to four-year trained scientist, often by creating a computing officer grade with competitive salary and career prospects.

Additional computing facilities

Because of the growing demand for computing from institutes and the evidence of an overloaded central processor, a proposal was made to the ARC's Advisory Committee on Computing to either increase the computing power over the coming years or be prepared for computer rationing. One option was to consider the early introduction of an ICL 2900 new range system, but it was felt that a premature commitment to this could lead to a repetition of the earlier unhappy Multijob experience. Users preferred the continued use of Multijob and the ARC accepted a proposal for a second System 4 to be installed and operational by 1 April 1976. The urgency of this decision was made with the knowledge that ICL had planned to close down their System 4 production line during 1975 and that any delay could have jeopardised this policy.

A letter of intent has now been placed for the supply of an ICL 4-72 but essential building works have first to be completed during 1975, against a very tight schedule.

Computer operations and other services

Equipment. Further enhancements were made during the year, and the 4-70 and Honeywell H716 configuration now stands as follows:

ICL 4-70	
Core store	704 k bytes
Drums	2 × 2.2 M bytes
Disc drives	5 × 7.5 M bytes
	9 × 60 M bytes
Tape drives	4 × 60 kb/sec
	2 × 120 kb/sec
Printers	2 × 750 lpm
Readers	
Card	1 × 800 cpm
Paper tape	2 × 1300 cps
Punch	
Paper tape	1 × 150 cps
Buffers	32 Telegraph
	8 Datel 200
	13 Datel 600/1200
	4 Datel 2400

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Honeywell H716	
Core store	64 k bytes
Disc	2 × 7.5 M bytes
Paper tape reader	1 × 300 cps
Paper tape punch	1 × 150 cps
Terminals	
Teletypes	48
Video display units	7
Serial printers	5
Remote job entry terminals	4 × H725

Operations. Performance is summarised in the usual way in Table 1, from which it can be seen that 1974 closely follows the 1973 pattern. The introduction of Multijob M900 earlier in the year has not substantially improved the position.

TABLE 1
4-70 performance

	1973	1974
Operational hours	5184	5202
Productive time	%	%
multiaccess	40.9	43.8
non-multiaccess	26.3	20.3
housekeeping	17.6	19.8
system work	6.2	7.1
Unproductive hours		
failures (all causes)	2.9	2.7
routine maintenance	3.8	5.1
additional engineering	1.3	0.4
idle and unaccounted time	1.0	0.8
	<hr/> 100.0	<hr/> 100.0
Working days	252.5	252.0
Operational hours/day	20.5	20.6
Total job units	282 047	214 392
Job units/day	1 119	850.8
Average time/job—minutes	1.1	1.5
Failures (all causes)	452	446
Average loss/failure—minutes	20.3	18.8
Average failures/day	1.7	1.8

TABLE 2
System failure distribution

	1973	1974
Total failures	452	446
	%	%
Software		
multiaccess	31.7	33.4
non-multiaccess	12.0	12.3
	<hr/> 43.7	<hr/> 45.7
Hardware		
multiaccess	26.1	31.6
non-multiaccess	18.1	10.1
	<hr/> 44.2	<hr/> 41.7
Operator errors	3.5	0.5
Other causes	8.6	12.1
	<hr/> 100.0	<hr/> 100.0

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The distribution of major system failures is given in Table 2, where, with one exception, the pattern between the two years is again remarkably similar. The marked increase in the number of faults by 'Other causes' is mainly attributed to the exceptional problems encountered during the implementation of the performance monitoring scheme.

The distribution of work amongst institutes, Table 3, similarly shows little variation between the years. The total elapsed time units (etu's) increased by 8% in 1974, and the total job units decreased by 24%. This is taken to confirm the changing pattern of computer usage with users becoming more experienced and effective, thus reducing the amount of program development work which is characterised by the frequent submission of small jobs. Because of this the modest increase in total etu's probably underestimates the underlying growth in computing demand. More detailed examination of the data would show that there has been a marked increase in demand for multiaccess service which, if continued, could not have been met without further additional processing power.

TABLE 3
Distribution of work by institutes

	ETUs		Job units	
	1973	1974	1973	1974
Total	2 824 097	3 015 683	282 047	214 392
	%	%	%	%
Rothamsted Experimental Station				
Computer Department				
Systems work	12.9	18.1	8.4	9.0
Other work	13.0	12.0	15.5	18.3
Statistics Department	21.9	20.1	17.0	12.2
Other departments	5.4	5.7	4.3	5.2
	53.2	55.9	45.2	44.7
National Vegetable Research Station	10.6	11.2	15.3	19.7
National Institute of Agricultural Engineering	10.5	10.2	15.6	14.5
Grassland Research Institute	5.2	5.7	5.1	5.3
East Malling Research Station	6.0	5.0	5.9	4.9
Glasshouse Crops Research Institute	2.9	2.6	2.7	1.8
Letcombe Laboratory	1.7	1.7	1.6	1.3
National Institute for Research in Dairying	1.8	1.2	2.2	1.6
National Institute of Agricultural Botany	3.1	2.8	2.3	1.8
Meat Research Institute	1.1	0.9	0.6	0.4
Others (<1% ETU)	3.9	2.8	3.5	4.0
	100.0	100.0	100.0	100.0

This similarity between the years is also to be seen in both the advisory and documentation services. For example, about 4000 telephone and more than 300 postal enquiries were handled by the advisory services. Sixty-one documents, including a pocket Multijob guide, were produced and distributed to the users. Because of the continued growth of the magnetic tape library, which now stands at 1295 tapes, a more formal control was set up to ensure security for users and to improve operational performance. During the year, 225 tapes were checked for quality on a special tester, and only 25 were rejected. The long-term safety of data stored in the magnetic tape library is now a matter of growing concern with the users. (Boston)

All the punching services have increased their work throughput, notably on behalf of the ARC for both the Project Costing Scheme and the Planning Section. There was a 40% increase in the use of the digitiser service to other institutes. Postal charges increased sharply again during the year, but with the introduction of serial printers at institutes the total costs have been held to about 70% of the 1973 level. This makes the actual savings

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in postal charges equivalent to about 20% of the initial capital outlay for these printers. (Fearne)

Operating systems

This section seeks to achieve an improved, more reliable and efficient Multijob operating system; it is also concerned to provide new user facilities, taking account of the rapid changes in technology in relation to long-term user requirements. (Gledhill)

Multijob M900. A new version of Multijob M900 was released early in 1974 and was brought into service by June. Under present ICL policy this is to be the last substantive redesign of the Multijob system. It included an expansion in the number of user names beyond the previous 250 limit, faster access to the catalogued files, and a more generalised queuing facility which had previously been exploited in the new PRINT program (see below). A final version of Multijob, M1000, due in 1975, is only expected to deal with major outstanding errors. Thereafter, error correction will be handled by a small ICL team which will, in time, diminish in number.

The new facilities in M900 have been beneficial to users and must in part account for the more effective throughput noted in the previous section. With the introduction of M900, ICL also introduced a scheme for distributing software amendments on magnetic tape, and this should improve the speed with which corrections can be incorporated. A proposal to set up procedures for routine checking of software amendments has been deferred because of staff problems. M900 has not significantly improved the reliability of the system and the software failure rate has settled down to about the same level as that experienced with M800. This tends to confirm the view that it is the relatively high user and terminal loading of the Rothamsted system which exposes the shortcomings in the software.

PRINT. A generalised queuing system was made available ahead of the release of M900 and was incorporated in this new version of the PRINT program which was released in February. This offers users control over their printing arrangements and in particular made it possible for the department to introduce 165-character-per-second serial printers (Centronics 101A) at East Malling Research Station, Grassland Research Institute, National Institute of Agricultural Engineering and National Vegetable Research Station. A fifth is scheduled for National Institute for Research in Dairying, and similar requests are expected from at least two other institutes. The initial success of this development has recently been marred by poor equipment performance which has been ascribed to unusual component faults. It is expected that this will be rectified by the supplier early in the new year.

REDIT. This, the Rothamsted Editor program, is a comprehensive user facility which offers considerable flexibility in the handling and modification of user faults. It is now the preferred system for most users, and although not yet error-free, meets their needs to a satisfactory level. The users usefully contributed to the design objectives of this program and their experience points to further desirable enhancements.

Job management. Important improvements have already been incorporated into the system for speedy validation of job submissions and prompt reporting of errors to the user. This has removed one of the sources of irritation to users who, in the past, only learned of their errors some 2–3 h after they had submitted their work. Often these were trivial, which, when known, could be promptly rectified.

This, however, is but the beginning of a major redesign of all job management proce-

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dures. The aim is to provide a system which is simpler to use and yet offers flexible, efficient facilities and improves the utilisation of the main computing resource. Users have conservative habits and do not tolerate frequent changes in style. Therefore, in planning this major improvement, account is being taken of its longer term implications, particularly in relation to possible replacement computer systems.

System monitoring. Early in the year there were indications that the central processor was running out of capacity during multiaccess. This was confirmed in a large measure by a local monitoring program. The implications of this on meeting future expansion needs led to a joint investigation with ICL for a more detailed examination of the problem. ICL provided the services of Mr. Roger Edgecombe of the Australian Department of Transport, who had had previous experience with these techniques on System 4. The outcome of this study was a compact but sophisticated program which wrote on to magnetic tape at prescribed sampling rates the settings of key tables which described the state of the machine, for subsequent tabulation and analysis. A considerable amount of data was collected and the immediate issue of the level of central processor activity was resolved. The data confirmed that the average idle time over a typical multiaccess session was as little as 10%, and that there were periods when the processor had no spare capacity. This is the ultimate limiting resource and was a clear warning that no significant increase in the number of multiaccess users was possible without additional processor power. This led to an assessment of future user needs culminating in a proposal for a second System 4 machine, which has now been accepted by the ARC. The remainder of the data has only been cursorily examined, but there is every confidence that this technique is of further value for the monitoring of system performance.

Remote Job Entry Terminals. The 4-70 aspects of this project have been badly hindered by the continued delay in the delivery of the ICL 4385 serial line controller. Meantime, design work is proceeding with the definition of procedures. Contracts were signed for the delivery of four Honeywell H725 systems, one each to be located at East Malling Research Station, Grassland Research Institute, National Institute of Agricultural Engineering and National Vegetable Research Station. The specification of the telecommunication protocol and the operating procedures for these devices are now jointly agreed with the company. The implications of the second System 4 configuration have now to be considered.

Applications and system programming

This section is concerned with meeting users' needs for specific (sponsored) programming advisory and training services. It is also responsible for the development and introduction of new application programs, often in anticipation of future user requirements. Staffing difficulties have again limited the opportunities for more frequent contact with the institutes and this may in part account for the modest exploitation of the newly-provided computing facilities. There is ample evidence of the growing interest in computing in research, but more remains to be done to bridge the gap between research needs and computing practice. Closer association with the users is a valuable stimulus for this section. (Beasley)

General programming. The Numerical Algorithms Group (NAG) Library of proven high quality mathematical subroutines has been successfully implemented on System 4 under Multijob. This was done jointly by Rothamsted and a group of seven universities and university colleges. Rothamsted also significantly contributed appropriate user documentation to the System 4 NAG Library Manual. This successful collaboration

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between the universities and research councils seems likely to expand into other computing fields and as such will continue to receive departmental support.

There was a considerable reorganisation and reassignment of the Rothamsted General Program Library, which took account of an earlier survey of computer usage. Sub-routines were removed or replaced and the library tailored to meet known user needs. This, the 'first tier' library, is set up, maintained and documented to prescribed standards. In order to encourage more user participation in exchanging programs a 'second tier' has been set up for more informal submission and usage by users. It is too early to offer any comment on the success of this scheme.

Rothamsted General Survey Program. The Rothamsted General Survey Program (RGSP) is designed primarily for the analysis of investigational surveys. Basically it is a flexible program for the construction, manipulation and printing of multiway tables and as such is also useful for processing other types of data for which such tables are required. All intermediate and resultant tables can be stored for further analysis. Complex data structures can be handled and data can be read from cards, paper tape and previously prepared files. All the commonly encountered types of coding and formats are acceptable.

For convenience, the program has been organised as two parts. Early versions of Parts 1 and 2 have been in use at Rothamsted since 1972 and 1973 respectively. Various improvements and additions have been made in the light of experience and the original manuals are now being revised and reprinted. Anyone requiring further information on RGSP is invited to get in touch with Dr. F. Yates at this department.

RGSP is at present also available on the IBM 370/158 at the ERCC, and on the ICL 4-50 at Bath University, from where it could become generally available to the universities in the south-west. A version is being prepared for the CDC 6400 at Imperial College, London, with the aid of a grant from the Social Sciences Research Council. When completed, this version of RGSP, too, could become available on the large CDC 7600's which are to be found at the University of London Computing Centre and the Manchester Regional Computing Centre.

Many universities already offer the Statistical Package for the Social Sciences (SPSS—Nie, Bent & Hull, McGraw Hill Book Co., 1970) for the analysis of survey-like data. With the increasing availability of RGSP a comparison of the two programs has become inevitable. A test analysis of a social science questionnaire type of survey has shown RGSP to be well suited for the tabulation of this type of data. A paper has been prepared giving a comparison of the performance of RGSP and SPSS on this survey. (Yates)

Sponsored programming. A program has been written to draw chemical formulae on the graph plotter in a form suitable for photographic reproduction in published papers. This work was done to the requirements of the Insecticides Department but should have wider application. Programs have been written to calculate the rates of flow and distribution of radioactive substances within potato plants; to reformat logger data and to translate coded soil profile data into more conventional text. This latter work has been written up and submitted for publication. (Webster and Lessells)

The taxonomic information retrieval program, TAXIR, has been obtained and made available on the System 4. A start on its use has been made with the wheat gene data from the Plant Breeding Institute. A version of the program has been made available to the Insecticides Department for storing information on test results. The bibliographic information retrieval system, FAMULUS, is also available on the System 4, and appears to be arousing much interest.

Bicknell spent a month in Nigeria designing and implementing a program for an IBM 1130 computer for the storage and display of data relating to the disease state,

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over a period of time, of cocoa pods, located in a three-dimensional co-ordinated system. The aim was to provide the research worker with the facility to explore this data for possible patterns which may account for the dispersion mechanism of the disease. The program is now substantially complete and results are awaited.

Arrangements are now in hand for the transfer of the mass spectrometry catalogue and search program from the Food Research Institute to the Rothamsted computer. This will enable research workers to undertake their own assessment and interpretation of the data provided by the mass spectrometry service relative to a much larger file base of known compounds.

Telecommunications

This section provides the engineering and specialist software support for the development and expansion of the communications network which links institutes into Rothamsted. This section has continued to make satisfactory progress, despite the handicaps of continued delays in equipment delivery and the failure to recruit a replacement for the Section Head who resigned earlier in the year.

The communications processor, a Honeywell H716, was delivered on schedule and passed its acceptance tests before the end of March 1974, despite the prevailing industrial and power supply difficulties. Unfortunately, the vitally important link between the System 4-70 and the H716—the ICL 4385—continues to be delayed. This has badly disturbed the carefully scheduled remote job entry project and it is unlikely that these terminals will now be operational before the end of 1975.

A contract was signed late in the year for the first batch of four remote job entry terminals, eventually to be placed at East Malling Research Station, Grasslands Research Institute, National Institute of Agricultural Engineering, and National Vegetable Research Station. The department was made responsible for the assessment and recommendation for these terminals, but its recommendation was fully supported by the institutes concerned. The decision was made to purchase Honeywell H725 systems to ensure maximum compatibility with the H716 central communications processor. The terminals will be delivered late in March 1975 but are unlikely to pass final acceptance tests until early summer.

As with so many engineering developments, closer working with the details of a problem often leads to important design changes. This remote job entry project is no exception, but future developments continue to be proscribed by the difficult staffing position. With the decision to install a second System 4 there is a new urgency to investigate techniques by which both systems can be coupled into a single service to the users. In addition to this major development, there could be a need to deploy the network as a further form of inter-institute communication.

Administrative computing service

The ARC had earlier implemented a project costing scheme at their headquarters using a small local computer. This attempted to assign the costs to projects so as to provide data for the commissioning of research under the new customer/contractor arrangements. There were limitations in the original scheme and this department was invited to take responsibility for the design and operational aspect of a new project costing scheme. A revised specification was prepared by the department and was implemented, under contract, by J. Harwell Data Processing Ltd.

Considerable emphasis was placed on extensive checking of the initial data for both errors and internal consistency. No analysis of the data could proceed until reported errors had been acted upon. The output is structured to provide summaries by institutes,

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by departments within institutes, and by projects and services within departments. All cross-costing between departments and institutes is explicitly shown. The costs themselves are broken down into scientific and supporting staff salaries, equipment, maintenance, overheads, etc. Much of the data for this scheme is derived from institute budgets and forward estimates and the research worker has only to report his effort as a percentage of his time spent on identified projects.

A comprehensive acceptance test schedule was designed and constructed within the department and included independently calculated results for a number of pseudo institutes, departments, etc. The program suite was finally accepted in mid-November. Since then, master record files have been created and live data for the period April to June 1974 is being processed. As expected, the first exposure of live data has revealed a large number of errors, all of which are currently being scrutinised and corrected by the ARC. The first complete quarterly analysis is now expected by early January. Although initially there will be some exceptional demand on computing resources, it is not expected to be excessive once the system has settled.

This program was written in COBOL, a widely used language for this type of problem. The first intention is to get the present scheme fully operational and then to review the position in the light of working experience. It seems likely that further additional administrative computing may be requested in the future. The availability of a second ICL 4-72 system certainly makes it feasible to consider new tasks in this area. (Fearne)

Publication

RESEARCH PAPER

- 1 YATES, F. (1975) The design of computer programs for survey analysis—a contrast between the Rothamsted General Survey Program (RGSP) and SPSS. *Biometrics*, 31, June, 1975 (Special Memorial Number for George Snedecor.)