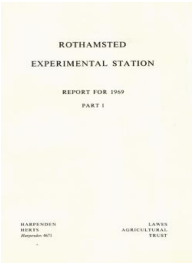
ROTHAMSTED RESEARCH

Report for 1969 - Part 1

Full Table of Content



Computer Department

D. H. Rees

D. H. Rees (1970) *Computer Department ;* Report For 1969 - Part 1, pp 272 - 280 **- DOI: https://doi.org/10.23637/ERADOC-1-124**

COMPUTER DEPARTMENT

D. H. REES

The department is responsible for the centralised computing services to Rothamsted and other institutes supported by the Agricultural Research Council (A.R.C.). In addition to the ORION we used the IBM 360/65 at University College, London (U.C.L.), a keyboard console linked to an IBM 360/65 at Harwell (H.U.W.) and a terminal linked to an IBM 360/50 at the Edinburgh Regional Computing Centre (E.R.C.C.). Comments on the performance of all these are included in this report. Eventually all programs will be transferred to the ICL System 4.70, which will be installed in a new building now expected to be completed by early 1970.

These outside services have been used because the design and software concepts of the ICL System 4 resemble those of the IBM 360 series. There are differences between the respective operating systems but the Fortran compilers are sufficiently alike for programs developed on the IBM computers to be transferred to the 4.70 with little difficulty. However, operating these services has been a major diversion of effort because it has involved staff in many details of the IBM 360 operating system not directly applicable to the 4.70.

Neither of the two multiaccess operating systems proposed for the 4.70 has developed satisfactorily. Both systems failed to meet their original scheduled delivery dates and documentation has been sparse. We have now decided to operate on the Multijob multiaccess system and not to introduce 7R until it has proved its reliability in extensive trials.

The range of tasks undertaken, coupled with the uncertainties about the 4.70, caused the programming efforts to be diffused. This is reflected in the report where programmers have been associated with diverse programs. The hope is that, as the 4.70 situation becomes stabilised, there will be more opportunities to develop programs of general value to users and to explore new computing techniques.

Computing services

Orion. Because of unsatisfactory equipment reliability a new maintenance schedule was introduced in August, which guarantees 34 hours of useful time per week.

Table 1 shows 17% and 16% less useful and total running hours than in 1968. Late working, at 461 hours, was 49% down on 1968. 614 faults were reported, 20 fewer than last year with seven lost working days, one more than last year. The Orion will continue in use until 1971 and there is no intention of allowing the performance to fall below present standards.

As in previous reports the work done is measured in nominal cash terms.

Work was 21% less than in 1968 and, for the first time, excluding experiments analysed, the proportion done by other institutes exceeded that by Rothamsted. For the second year the percentage of Rothamsted's development and productive work decreased by 7% and 3% respectively. The

https://doi.org/10.23637/ERADOC-1-124

TABLE 1

Orion performance, 1968–69 (hours worked)

	Maintained		Unmaintained		Total		%	
	1968	1969	1968	1969	1968	1969	1968	1969
Useful time	1602	1619	905	461	2507	2080	85	83
Faults	307	341	35	13	342	354	12	14
Restarts	62	57	19	3	81	60	3	3
	1971	2017	959	477	2930	2494	100	100
Additional Maintenance					1071	882		
					4001	3376		

TABLE 2

Distribution of work 1968–69 (% total nominal value £000)

	1968 %		1969 %	
Rothamsted				
Development	22		15	
Production	24		21	
		46		36
Other institutes				
Development	9		12	
Production	20		25	
		29		37
Experiments		21		24
Systems		4		3
		100		100
Total work (£000)		385		300

TABLE 3

Replicated experiments and variates analysed 1968–69 (% totals)

	Experiments				Variates			
	1968		1969		1968		1969	
Rothamsted programs								
Data prepared at Rothamsted	71		67		57		54	
Data prepared elsewhere	27		30		40		42	
		98		97		97		96
Other programs		2		3		3		4
		100		100		100		100
Totals		7253		5750		53740		46918
Variates/Experiment		7·4		8·2				

proportion of development is still surprisingly large and for Rothamsted is largely attributed to the continued development of the General Survey Program (G.S.P.). This program was used in the analysis of 12 Surveys

https://doi.org/10.23637/ERADOC-1-124 *pp 3*

and accounted for 6% of the work done. Of the outside institutes, only the National Vegetable Research Station showed a large increase in work, increasing from 7% in 1968 to 17% in 1969.

Fewer experiments were analysed on the Orion since 1965 but the ratio of variates analysed per experiment increased to the high 1967 level. The proportion of experiments analysed prepared at Rothamsted fell slightly but was still more than twice as many prepared elsewhere.

U.C.L. The U.C.L. service was the main prop for the program testing service and 422 visits were made to the Centre and 2461 jobs were processed. Because of the delay in getting file handling procedures set up on the Edinburgh computer the U.C.L. service was operated in parallel with the Edinburgh link for the larger jobs. This will shortly change in favour of Edinburgh, but the U.C.L. service will still be required for selected scientific and non-numeric programs.

H.U.W. An on-line teleprinter link to the IBM 360/65 at the UKAEA, Harwell, was set up to improve Fortran testing and to provide operational experience of a kind similar to that planned for the Rothamsted multi-access service. The service was delayed 3 months and has largely been replaced by the new link to Edinburgh. It has been used by the Institute for Research in Animal Diseases and the Radiobiological Laboratory who, for their convenience, use terminals at Harwell. Although it was used less than planned, three valuable lessons were learned which are relevant to our future multiaccess service:

(1) the importance of lucid and detailed instructions, well presented and trusted by users,
(2) the need for a computer based message and broadcasting system that keeps the user informed on the status of his work and of the system in general,
(3) the performance of the G.P.O. lines require vigilant attention to detect transmission errors.

E.R.C.C. As a major improvement to the program testing service an IBM 2780 terminal was rented and linked to the IBM 360/50 computer at the E.R.C.C. where 5·5 hours of computer time was provided daily under the A.R.C.–E.R.C.C. agreement. This terminal, which has a card reader and a lineprinter, uses Datel 2400, the fastest public G.P.O. data transmission service, on a part-time leased private circuit. Checks are made by equipment against transmission errors and when necessary transmissions from the 2780 terminal are repeated eight times before the transmission is abandoned.

Three other terminals are connected to the computer and work is loaded either through terminals or directly at the Centre. All work is assembled into a common job mix for batch processing. Jobs loaded from remote terminals are given priority, which speeds the job turn around time. From a sample of jobs run, turn around time ranged from about 15 minutes to more than an hour depending on the computing requirements of the job and the work load at the Centre.

https://doi.org/10.23637/ERADOC-1-124

Jobs not finished when the G.P.O. circuit closes down are run to completion and the results stored on disc files ready for immediate transmission to the terminal when the G.P.O. circuit next opens. Until recently jobs were submitted or re-submitted from packs of cards, but there is a new system facility for storing program modules and data sets on disc files. These files can be linked into a working program using only a small set of job control cards transmitted from the terminal.

Terminals of similar power will be installed at some of the outside research institutes during the later stages of development of the Rothamsted multiaccess system, and the experience gained with this link is a most valuable pointer for the future. Tables 4, 5 and 6 summarise the performance of the system between 6 October and 31 December 1969.

TABLE 4

General performance

Working days	60	Days with incidents	51 (85%)
Nominal connect hours	300	Lost hours	87 (29%)
Incidents	101		
Incidents/day	2	Lost time/incident	52 minutes

An incident is defined as having occurred when transmission ceases to be effective. Transient faults, which were corrected either by the operator or by the equipment, are not recorded, and no attempt has been made to adjust for restart time. Also the terminal was often repaired when the circuit was closed and this repair time is not included and the tables present a favourable view of the performance of the link.

TABLE 5

Work throughout

	Total	Per job	Per day
Jobs	1535	—	26
Cards Read	301000	197	5017
Lines Printed	380000	249	6333

Table 4 shows the general performance of the link and Table 5 gives the volume of work. Most jobs were program development runs in which input cards are copied to the output as a check that the program has been correctly loaded. Hence the number of lines of output is closely correlated with cards input. Making an allowance for the system messages, the average new output generated per job would be contained on a single page. Assuming the same proportion of cards read to lines printed, the present load represents about 36% of the theoretical maximum capacity of the terminal and link. Under practical conditions the actual card reading speed

TABLE 6

Breakdown by source (% total)

	Terminal	Link	Computer	System	Total
Incidents (101)	15	48	9	28	100
Lost hours (87)	7	71	12	10	100

https://doi.org/10.23637/ERADOC-1-124

is about 100 cards per minute, and on this basis about 50% of the capacity of the line was used.

Table 6 shows that troubles on the G.P.O. circuit are the major source of incidents. In one week alone 20 hours 25 minutes were lost. This is much below the expected performance of the line and the G.P.O. are investigating the reasons. Further difficulties were encountered when establishing which part of the chain from the terminal, the link, the computer or the computer system, was at fault. Inexperienced operators rely greatly on the staff at the computer centre when difficulties arise.

Measurements of computer usage. The management of a computer service depends on information on a wide range of activities. Having defined suitable user and management objectives, the problem is to relate these to the feasibility and cost of collecting the required data.

On the Orion the unit of work was calculated as a nominal cash value, done by measuring the duration and extent of use made of the various Orion resources, to weight these resources by some cost function and produce a total cost. This worked because the Orion operating system provided the essential information. The situation on new computers is more complex and there are, as yet, no working procedures for measuring work load or performance. Yet the need to do so, especially with a multi-access service, is clear and this problem will have to be solved. In the meantime, the simplest measure of work load is the number of jobs run and these are given in Table 7.

TABLE 7

Usage of external computing services

		U.C.L.		E.R.C.C.		Total	
		Jobs	%	Jobs	%	Jobs	%
RES							
Computer		1099		493		1592	
Statistics		746		237		983	
Others		44		203		247	
	Subtotal	1889	76·8	933	60·8	2822	70·6
NIAE		322		214		536	
EMRS		141		159		300	
NVRS		35		92		127	
GCRI		13		29		42	
NIRD		31		47		78	
IRAD†		26		1		27	
SOIL SURVEY		4		—		4	
GRI		*		60		60	
	Subtotal	572	23·2	602	39·2	1174	29·4
Total		2461	100	1535	100	3996	100

* Own arrangement with U.C.L.
† Also uses H.U.W.

The notion of a job is that of an entity of work, which except for the operating system, is independent of any other loaded program. There are, of course, large jobs and small jobs and time is an obvious measure to

https://doi.org/10.23637/ERADOC-1-124

associate with a job. The question is which time to record. It could be the central processor time, the elapsed time of the job or the connect time from the terminal. All are important in determining the share of the computer resources taken up by the job. An analysis of the outside services by these factors was not possible because the information was not available.

The number of jobs run seems large, but the total of the U.C.L. service is approximately a week's work on their computer, and the same is probably true of the Edinburgh total. These services are available to other institutes and they account for 29% of the jobs run. Considerable advice and assistance was given to more than 40 users both at outside institutes and at Rothamsted. (Gledhill, Bicknell and Clarke)

Programming

Extended Mercury Autocode (E.M.A.). Additions were made to the program to handle interleaved data from two or more amino acid analysers sharing common data logging equipment. Investigations continued into methods for dealing with spurious data values. The program started to be used routinely for the Institute of Animal Physiology in December. (Bicknell)

Penman's evaporation formula was computed weekly for L. W. Wellings, Gleadthorpes Experimental Station for use in an irrigation experiment. To safeguard this service against machine failure the Orion version of this program was transferred to the U.C.L. computer. (Clarke)

Work continued on G.S.P. to remove residual errors and to improve operational efficiency. The following are examples of added new facilities:

(1) repeat analyses on successive batches of data,
(2) improved methods for transferring and storing batches of tables and for making trial runs,
(3) additions to the instructions for combining tables, and for printing sets of tables in parallel columns.

A section of G.S.P. was successfully compiled and run on an I.C.L. 1907 at The Royal Aeronautical Establishment, Farnborough, from a modified Orion E.M.A. source program. (Yates)

An E.M.A.–Fortran translater program, developed by Mrs. Linda Aitken (E.R.C.C.), is available on the Edinburgh link. So far as possible, this translates E.M.A. programs line by line into equivalent Fortran. Where this is not possible the E.M.A. source text is replaced by a call to a subroutine. When this fails, the E.M.A. line is marked as not translateable. Subroutines are written either in Fortran or some other suitable language. It is now being used in an attempt to translate the General Survey Program. Because the method of making subroutine calls increases the program size and running time, our strategy is to restructure G.S.P. in E.M.A. and test the restructured program on the Orion before using the translation program. At our request Mrs. Aitken altered the translation program to eliminate calls when dealing with E.M.A. integer units. Both improved the performance of the section of the program tested, shortening the central

https://doi.org/10.23637/ERADOC-1-124

processor time on the IBM 360/50 from 30 to 8 seconds. Comparable times on the Orion and the ICL 1907 were 42 and 7 seconds. (Yates and Clarke)

The translator was successfully used on small programs but has yet to be proved on a large program. There is still uncertainty about the final size of the completely translated G.S.P. but it is expected that it can be contained within a 100 000 byte partition of the 4.70 core store with increased space for tables.

We acknowledge the excellent co-operation received from Mrs. Aitken. Responsibility for exploiting the program further rests in the department. (Clarke)

Fortran. Most of the jobs were run using either the Watfor or Fortran IV (G) compilers on IBM 360 series computers. Eventually these programs will run under the ICL Fortran compiler which, regretfully, is not completely compatible with either. A list of these differences will be circulated. (Bicknell)

Application programs usually requiring complex calculations were written for workers at Rothamsted and elsewhere. (Bicknell, Clarke and Thomson)

Special purpose programs for U.C.L. and the Edinburgh link were prepared. (Clarke)

A generalised input and validation program has been prepared for tapes produced by data logging equipment from the East Malling Research Station, Glasshouse Crops Research Institute and the National Institute of Agricultural Engineering. (Clarke)

General purpose routines for the program library were written. (Bicknell and Clarke)

Basic assembly language. A generalised input program was prepared that loads data from 5, 7 and 8 channel paper tape and punched cards from local devices, and eventually from remote terminals. The program will assemble these inputs as files and provide means to connect these files to a user's program. This has been written for a batch processing operating system but has to be made compatible with the multiaccess operating system. (Sharma, Mr. C. Dewick (ICL) and Rees)

Several other routines were prepared for the program library, all in a form suitable for use in a Fortran program. (Bicknell and Clarke)

Systems. Modern computing systems are controlled by operating system programs which are usually provided by the manufacturer and largely determine the effectiveness of the computing system to the user. There are three systems planned for the 4.70—7J, which is a basic batch processing system; Multijob, an initial multiaccess system with many features in common with 7J; and 7R which is a much more powerful multiaccess system. Members of staff allotted areas of special study on all three systems, will deal with queries, give advice and undertake additional programming as required. We were able to influence some features in the closing design stages of 7R (Rees and Gledhill). From experience with

https://doi.org/10.23637/ERADOC-1-124

the on-line links, extra facilities, such as better communication between the users and the centre, will have to be added. (Thomson)

Program packages. These are groups of programs that provide a complete and comprehensive facility of general value to users. ICL are offering a few packages on the 4.70. There are many on other machines and if they could be transferred to the 4.70, would be valuable additions. Transferring large programs is rarely straightforward, and the ensuing responsibilities for documentation, maintenance, advice and modification demands much effort. Because of this only two conversions are currently being attempted—the Continuous Systems Modelling Program, C.S.M.P. (Bicknell and Rees), and a suite of crystallographic programs (Coles, Pedology Department). The transfer of C.S.M.P. is being attempted in collaboration with E.R.C.C. and if successful will be available exclusively on the System 4 computers at both centres. This is a very important package which increasingly finds favour with users. The following examples indicate the scope of the work:

(1) Simulation of a lamb growth and grass crop management scheme.
(2) Simulation of plant physiological processes such as the diffusion of CO_2 and water movement in plants.
(3) A non steady state model of elution and absorption of substances in the soil.

All of these have been processed in some degree on an IBM 360.

The crystallographic package is being tackled in collaboration with the A.R.C. Unit of Structural Chemistry and the Pedology Department with the assistance of the computer department on technical computing problems.

There are many other interesting packages (for example, techniques for elucidating structure in organic compounds), information retrieval schemes and map drawing and contouring programs. No attempt has yet been made to convert these packages but in preparation for this future commitment a systematic study is being made of the compatibility of ICL System 4 and IBM 360 operating systems. (Thomson)

Preparations for the ICL System 4.70

Buildings. Both the completion of the building and the commissioning of the air-conditioning plant are late and the delivery of the 4.70 computer has to be postponed to 1970. Equipment reliability is of paramount importance in a multiaccess computing service, and much attention was paid to all services in the computer rooms. (Rees and Fearne)

Equipment. Remote teletype terminals were ordered for 16 outside institutes making a total of 22 consoles and one video display, to be connected on line to the computer during the initial phase of the multi-access service. An additional eight G.P.O. lines have yet to be installed to connect the outside users. Three IBM 029 card punches and one

https://doi.org/10.23637/ERADOC-1-124

IBM 056 card verifier were delivered, and three Creed Envoy 8 channel paper tape punches and one Datek Verifier will soon be delivered.

Advisory and publication services. Most of the outside institutes were visited to exchange ideas on immediate and future developments (Gledhill). Four issues of the Newsletter were prepared and 120 copies of each circulated (Mary Edwards). The User Liaison Committee met and a Fortran advisory service was set up with reserved sessions for telephone enquiries from outside institutes. (Bicknell and Thomson)

Program testing and punching services. A more formal method of presenting requests for punching programs or running jobs was introduced because of the increased demand for these services. For example, card usage on the punching services has increased from 180 000 (1968) to 440 000 (1969). (Fearne and Margaret Whittingham)

Courses, committees and working parties. Arrangements were made for over 60 people, including 30 from outside institutes, to attend Fortran programming courses. Members of the department attended company training courses and visited System 4 installations. The department is represented on all committees and working parties related to the ICL System 4 computer.

Staff

H. J. V. Gledhill was appointed. As part of the contract with International Computers Limited for the new computer, Colin Dewick joined us for a year to help with programming.

D. H. Rees attended the joint I.E.E./I.E.R.E. Conference on 'Computer Science and Technology'. F. Yates attended the 37th Session of the International Statistical Institute in London and presented a paper on his General Survey Program. He was appointed Senior Research Fellow of Imperial College and made an Honorary Fellow of the British Computer Society.

https://doi.org/10.23637/ERADOC-1-124 *pp 10*