ROTHAMSTED RESEARCH

Report for 1980 - Part 1

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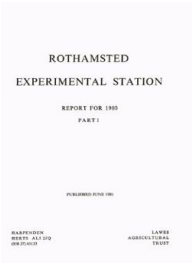

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D. H. Rees

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Introduction

1980 marks the first decade of the present service which began at Rothamsted in September 1970 and eventually extended to some 16 ARS institutes and units in England and Wales. Each of the two previous computing systems had also a service life of about 10 years and the transition between all three has been characterised by a major change in technology. First, the transistor replaced the thermionic valve only to be replaced by the

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small-scale integrated circuits, which are a feature of the present equipment. These, however, became the precursors of the large-scale integrated circuits of today which, because of their low manufacturing costs have stimulated the so-called microtechnology revolution. These in turn will have a profound affect on computing services within the ARC in the coming decade.

Although this technology has only emerged on the public scene during the past 3–4 years, the earliest speculation of its possibilities were discussed amongst computing scientists some 25 years ago. Even when negotiations were taking place for the present mainframe equipment, the following observations were being made at conferences in the mid-60s. 'Computers would become commonplace, small enough and cheap enough so that individuals will be able to afford their own personal computer. This local computer, in all likelihood, will be tied into large computer and communications networks. In addition, each terminal would contain a powerful computer.' We in the Department have been aware of this development and have commented on its potential impact in earlier annual reports.

The communications network referred to at the time relied on conventional speech telephone circuits and although protocols were being developed to improve the reliability of transmissions, the technology was intrinsically unfavourable for the more demanding needs of digital data transfer. Slowly, some say all too slowly, standards have emerged which will secure the effective transmissions of data across the existing analogue network but such is the flexibility of digital transmission that, eventually, all network communications will be carried out in a digital manner, including speech and other analogue signals. Throughout the latter part of the 70s there have been genuine attempts to steer such developments along channels which would eventually lead to international standards. A recent more ambitious and, as yet, unfulfilled venture, is to extend those standards to the equipment interfaces, so that eventually any manufacturer's equipment can be interchangeably linked with any other; this is the so-called Open System Interconnection The responsibility for developing this now lies with the various national and international institutes. Within the UK the Computer Board for University and Research Councils have funded a Joint Network Team to explore and promote these ideas within this scientific community and Rothamsted represents the ARC's interest in this matter.

Yet one cloud remains, a cloud which has been with computing from its earliest days. I refer to the efficient production of reliable software. Despite the remarkable progress that has been made in the development of 'easy to use' programming languages, we are still short of meeting that goal, and therefore, making the new microcomputer facilities more readily accessible to users, even to those who have no basic interest in computing. This is recognised as a national problem and is seen in part due to the shortage of skilled manpower as well as the limitations of software technology, a point confirmed in the NEDO Report '*Computer Manpower in the 80s*'.

One simple persuasive solution is to allow, indeed encourage, scientists to look after their programming needs and interest. This is fine for those who are so motivated and provided the significant, albeit largely hidden, programming costs are ignored. However, programs can often be shared but for this they need to be properly documented so that subsequent support, maintenance and enhancement need not critically depend on the authors. Although this avoids the diversion and repetition of scientific effort much has to be learned about the 'diffusion' processes by which scientists become aware of, and be persuaded to use such common facilities. Also, there is much to be done to design systems which are easy to use, both by beginners and by the more experienced users, in circumstances where needs range from the simple to the complex. Unlike telecommunications, it is less certain that standards can play a role here unless they emerge through the adoption of a new language, which could impose rules resulting

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in the production of software within a firmer, engineering-like discipline. Such a language is under development and if it gains acceptance, more attention can be paid to matters relating to rigorous specifications, production management, maintenance of structural software and modular design discipline. Another unresolved question is the extent to which programs will continue in their present form or, in future, be written 'in silicon' thus exploiting the very large-scale integration technology which is to be the hallmark of the coming decade.

An ARC Computing Committee has been formed and has addressed itself urgently to the formulation of a computing policy for the ARS within which the Rothamsted replacement system will be decided. The continued uncertainty, which has been a feature of previous reports, resulted in a traumatic loss in the highly specialised telecommunications staff and much of this year has been spent on recovering from this difficult position. This has resulted in the blurring of much of the Operations and Telecommunications Sectional activities. Because of this, these Sectional reports have been merged. Clearly the old divisions that have served the Department over the past decade will need to be reviewed, and this will take place as and when the role of the Department is determined by the long awaited computing policy statement.

Operations and telecommunications section

Because of the mutual support that these sections have provided arising from the staffing difficulties their reports will be merged into a single account of their operations, equipment and software developments.

Operations

User work has risen by 10% over the previous year and has also exceeded the 1978 total which was the highest annual total until now. More efficient system operation and less development time has meant that the total load has been contained in the same two-shift

TABLE 1

System utilisation

	1979		1980	
	4–70 %	4–72 %	4–70 %	4–72 %
Production time				
Day supervisor	57·1	56·7	55·0	60·3
Night supervisor	21·2	19·4	25·2	23·6
Housekeeping	10·9	9·7	8·4	7·5
System work*	3·8	7·1	3·8	5·0
	93·0	92·9	92·4	96·4
Non-production time				
Failures (all causes)	4·2	3·7	6·6	1·8
Routine maintenance	2·7	2·9	0·7	1·0
Additional engineering	0·1	0·5	0·3	0·8
	7·0	7·1	7·6	3·6
	100·0	100·0	100·0	100·0
Operational time (hours)	4191	3987	4219	4042·5
Working days	251	251	252	252
Operational time (day·hours)	16·7	15·9	16·7	16·0

* Stand-alone machine usage for developments and testing

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operation, working overtime as necessary (Table 1). The reduced operator staff also supports a Prime 550 commissioned in July and two AM Jacquard J100 systems on the Station, one of which is connected as an RJE terminal and is used by the Statistics Department for data entry and also for some word processing. The other J100 system is used solely for word processing.

Based on resource usage, the Statistics Department is the largest user of the system followed by the remainder of the Rothamsted departments. As will be seen from Table 2,

TABLE 2

Distribution of work by Institutes

	ETU		Jobs		Work Units	
	1979 5 649 206 %	1980 6 170 075 %	1979 385 253 %	1980 407 075 %	1979 12 732 492 %	1980 14 159 489 %
RES						
Computer Dept.						
Systems	19·2	18·6	10·1	11·8	6·7	5·4
Applications	6·3	5·5	13·1	10·8	5·9	5·3
Total	25·5	24·1	23·2	22·6	12·6	10·7
Statistics Dept.	15·3	14·0	9·1	8·3	20·6	18·5
Other Depts.	8·8	12·3	5·0	5·6	8·9	13·8
	49·6	50·4	37·3	36·5	42·1	43·0
NIAE	8·9	10·7	10·5	12·2	8·3	8·9
GRI	7·4	5·5	7·4	5·7	9·7	6·7
MRI	2·8	4·8	1·6	2·7	4·2	7·2
NVRS	5·4	4·5	7·8	6·2	6·0	5·5
EMRS	3·8	3·8	4·7	5·2	3·7	4·3
NIRD	4·8	3·7	6·7	5·6	4·3	3·5
IRAD	3·6	3·7	6·9	8·0	4·5	4·4
GCRI	3·9	3·5	5·4	5·7	4·7	4·4
LARS	1·9	2·4	1·8	2·0	2·3	2·7
LL	1·4	1·2	2·1	2·3	1·5	1·6
WRO	1·1	1·1	2·5	2·3	2·1	2·3
WPBS	0·8	1·1	0·9	0·9	1·1	1·3
Man. Services	1·0	0·9	1·1	1·3	1·2	1·0
SSEW	1·7	0·7	1·5	1·3	2·0	0·9
Others	1·9	2·0	1·8	2·1	2·3	2·3
	100·0	100·0	100·0	100·0	100·0	100·0
Average per working day	22 507	24 484	1 535	1 615	50 727	56 188
Increase over 1979 total		+9·2%		+5·7%		+11·2%

other institute workloads vary over the years and the largest accounts for only 10% of the total load on the two ICL System 4 mainframe computers. Institutes such as MRI and LARS have increased their work throughput substantially, whilst GRI, NVRS and NIRD have reduced theirs. Some work may now be done on local systems instead of on the System 4s, without a compensatory increase in new applications. There is considerable activity in graphical presentation but this is still confined to a small part of the user population, and 'data-base' work is beginning to appear.

The redistribution of work between the two mainframes has taken place so far as has been possible and the loads are now similar. The distribution of work is, however, still restricted as remote serial printers will not now be connected through the FEP as originally intended, though remote batch input devices will be.

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A few communications ports have been added to the 4-72 for the connection of some serial printers and VDUs. Two 60 Mb disc drives have been added to the system, and these are likely to be the last enhancements made. A request for additional memory for the 4-72 was not supported as the cost was high and the anticipated life too short.

The number of System 4 failures has been markedly reduced for both hardware and software, but the reduction in time lost on the 4-72 has been offset by the increase on the 4-70 (Table 3). The change in maintenance supplier and routine maintenance items

TABLE 3

System failures

	1979			1980		
System	4–70	4–72	Total	4–70	4–72	Total
Software	59	51	110	20	49	69
Hardware*	162	190	352	175	107	282
Total	221	241	462	195	156	351
Hours lost	175	146	321	276·5	71	347·5

* Includes power supply and operator errors, etc.

in May has also resulted in a saving of approximately 2% of service time this year. Particularly bad patches on the 4-70 in August and December were experienced and long down times are of concern but offset by better performance generally. The long periods of loss are certainly affecting the users' view of the system availability. The fact that a service is provided on the other mainframe during these periods does not satisfy the user as the number of terminals available which can access both systems (through the FEP) are insufficient. When access is gained there is a poor response from the heavily loaded machine.

The performance of the FEPs, which are separated for interactive and batch functions, has improved over the year, though that of the latter is much less than satisfactory. The identification of hardware failures still proves difficult though poor hardware performance earlier in the year has been rectified. The user image of the interactive system has improved from 94 to over 97% (Table 4). There has been an improvement

TABLE 4

FEP service availability

	Service		USER*	
	1979 %	1980 %	1979 %	1980 %
Interactive 716	95·6	97·9	94·4	97·2
Batch 716	94·0	88·9	92·4	86·9
Interactive 716 +4-70	93·6	96·2	92·0	95·0
Interactive 716 +4-72	94·1	96·6	92·4	95·6

* The user image figure includes an allowance of time for failures for recovery purposes

in the FEP interactive performance, with the number of failures reduced by almost 50%. The last quarter of the year has been better still, but the level of failures is still high. In December, responsibility for maintenance of the Honeywell 716 equipment was passed to the site's maintenance supplier.

The maintenance supplier is also responsible for the network and remote network equipment calling out the appropriate maintenance firms as necessary. This has proved

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to be a satisfactory arrangement and users have reported an improvement in attention to faults. The two areas which gave rise to most aggravation are line and modem faults, and serial printer faults, the latter's MTBF being approximately 250 hours or 25 days. Repair time on printers was very poor (3·5 days) but is now better following discussions with the maintenance firms involved.

Equipment

Mainframes. An additional two EDS 60s have been added to the system and by early 1981 there should be a nominal billion bytes of secondary storage available to users.

Communications processors. Additional buffers were added and some badly delayed 'specials' delivered. This has permitted further progress to be made with outstanding commitments and it is hoped that the planned configuration given in Table 5 can now

TABLE 5

Rothamsted Experimental Station Computer Department
Network equipment (includes 1980/81 requests)

	TTY											
	dial-up	CPS 30/10	VDU	SP	QP	PTR	CR	CTR	TEK	GP	RJE	RC
ARC	1											
AVRI	1	–/3	1	1				1				
EMRS		3/2	3					1		1	1	1
GCRI		2/1	2	1								
GRI		3/2	5					1			1	
IAP		1/–	1	1		1						
IRAD	4	4/–	2	2		(+1)				1		
LARS		3/1		1		1	1					
LL		2/1	2	1		1				1		
MRI		1/3		1			1					
NIAE		6/4	6					1	1	1	1	1
NIRD		3/2	3		1					1	1	
NVRS		4/–	3					1		1	1	
PBI		1/–	1	1								
RES CD		7/–	6		1			1		1	1	1
RES DEPTS	2	7/1	3		1				1		1	
SSEW	3											
WPBS		2/–	1	1		1						
WRO		1/2	1	1		1						
Totals	11	50/22	40	11	3	5	2	6	2	7	7	3

Notes
NIRD RJE is P300 with PTR, LP, VDU, TTY, CONSOLE. RES CD RJE is P550, RES DEPTS. RJE is Jacquard Data Entry System. Other RJEs are H725 with PTR, PTP, LP, CONSOLE.

Key:

TTY	teletype	CT/R	cartridge reader
VDU	visual display printer	GP	graph plotter
SP	serial printer	RJE	remote job entry processor
QP	quality serial printer	RC	remote concentrator system
PTR	paper tape reader	TEK	Tektronix display tube
CR	card reader		

be completed early in 1981. There is clear evidence that the Honeywell H716 processors are now close to their ultimate operating capacity and it is unlikely that there will be any significant additions to the network beyond those already planned.

Prime. The original Prime 300 which had been installed as a development and back-up system to the Honeywell H716 was transferred to NIRD where it is to serve as a remote

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job entry facility to the Rothamsted service and meeting some local computing needs. It has been replaced by a Prime 550 with a 0·5 Mbytes of primary storage and a (6+6) Mbyte and (16+80) Mbyte disc drive, together with a serial printer and local communications facilities. A further enhancement of 0·25 Mbytes primary storage plus an additional (16+80) disc and a magnetic drive will be added to meet the computing needs of the Molecular Structures Department. The Prime 550, in addition to its basic role of backing up the communications processor, is also shared with the Statistics Department and represents a valuable long-needed access to a contemporary computing system. The Prime 550 will also be connected to the Systems 4 service where it is planned to serve as a overflow resource for the main service, thus containing work within the two shifts.

Plotters. Because it has not been possible to fulfil the overall planned development for the network a fresh approach had to be taken to improve the performance of the present working arrangements of the plotters. Error correction, more compact transmissions protocols and more appropriate mainframe software will, it is believed, result in 4-fold gain in the worst case.

Concentrators. This technique has been pioneered on a microprocessor in the Department and was designed to economically provide protected transmissions for interactive terminals. The first version was brought into service at EMRS as an emergency response to excessive line noise which was seriously corrupting transmission, and proved to be so successful that the site cannot operate without it. Another two concentrators will be added to the network in the coming year.

Word processing. Two Jacquard J100 Systems were commissioned in October. One provides seven data entry terminal system for the Statistics Department plus a single word processing VDU and printer to be shared with the Computer Department. This configuration is also linked as a terminal to the mainframe. The second system is an independent word processing unit of eight VDUs and three printers distributed amongst other Departments. Information is stored on exchangeable disc packs compatible with the first system. This enables files to be transferred between the mainframe and the users generally.

Maintenance. The maintenance of all computer and telecommunications equipment excluding the Prime System, has been consolidated into a single more economic contract with the independent company, Data Processing Customer Engineering Pty Limited (DPCE). The service is provided by a residential team of three engineers who have taken over the equipment in a phased manner. It will take a little time before they will have mastered the full complexities of this configuration. This arrangement, however, removes many of the problems arising from interfaces between equipment of different manufacture and the consequential delay in resolving and correcting fault conditions. Routine maintenance of all equipment is now carried out at weekends, thus increasing the availability of the service to users.

Software

Mainframe. After a decade of use, errors are still encountered on the Multijob operating system which still have to be investigated and solutions sought, either locally, or through the company, New versions of the system are also required to deal with both hardware and software changes and this calls for meticulous validation and testing before a working version is released in the service.

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Further work is being carried out on tasks which will either enhance or add facilities which make the service more resilient and convenient for the user. For example, the 'Mail facility' enables messages to be exchanged between sites, another gives site managers more local control over the allocation of their computing resources. In a 10 year old service such improvements must be limited to modest tasks and are only undertaken after consultation with the users.

Communication processors. With little or no scope for further expansion, effort has been divided between the production of more robust and effective software through the investigation of outstanding errors and improved performance tuning. It has proved impossible to model the complexities of the network and investigations have had to be carried out in sensitive circumstances of a working system. The development of planned ancillary but important aids, which would have greatly assisted these on-line investigations, have been seriously handicapped by the difficult staffing position.

Prime. One such aid was a system for on-line selective monitoring of the network and this was originally written for the Prime 300. This system is now operational on the Prime 550 but will be valuable to the investigation and location of faults within a working network. Furthermore, it will enable the operations staff to direct their own on-line enquiries. The high-speed links between the Prime and the main service is now under development and is the key to the use of the Prime as a reserve resource.

Concentrators. The soundness of the design methodology, as exemplified by the error-free operation of the concentrator for the work, is a significant event in the management and production of software. The design includes facilities for down-line loading and remote diagnostic features which are only now beginning to appear in contemporary network equipment. The portability of the software based on structured designed programs has yet to be tested.

Applications Section

This Section provides advice and support for the transfer and application of packages together with any necessary training and advisory services.

Rothamsted General Survey Program (RGSP). A new version of RGSP has been released ahead of schedule despite persistent staffing difficulties. The Mark 2 version will have extended facilities and considerably greater ease of use and is expected to increase the number of customers from the present 15 UK and four overseas sites. Additionally, funds are being sought to support the next major enhancement.

Many of the formative ideas and aims behind RSGP have always featured in Dr F. Yates' book *Sampling methods for censuses and surveys*. A fourth edition has recently been released and includes a full chapter on 'Computer programs for survey analysis' with particular attention to RGSP's place within the growing number of statistical packages.

Data-bases. An investigation and survey of the future needs of plant breeders for data-base facilities was carried out on behalf of the ARC by departmental staff in conjunction with an outside consultant. The evidence confirmed the widespread interest in these techniques but concluded that a suitable system still awaits the appropriate combination of hardware and software. A limited trial of the Honeywell Multics System at the Avon Computing Centre indicated that this could be a suitable system provided its performance with larger data sets was adequate.

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Metdata. The ARC Metdata system has been loaded with data and is on trial release. An important feature of the system is that the program aids should enable scientists to use these facilities directly, with little or no prior training.

GRASP. The US Geological Retrieval and Synopsis Program (GRASP) is now on trial release. The program has had to be trimmed to fit into the storage partition available for interactive use. The fuller version will be available as a batch operation. GRASP was introduced at the request of the Soil Survey of England and Wales and is also being considered by NVRS for their gene data bank.

Graphics. The principal graphics package, GHOST, has been further developed to include new facilities and to drive new equipment. Several new packages have been added to the library and include Surface II, a three-dimensional display system, a new version of SYMVU and CAMPAC, another display package appropriate for specialised displays. The interest in the presentation of three-dimensional displays has raised technical points on the contouring algorithm used in the various systems. This is being assessed critically.

Training. Eight courses were arranged during the year and a start made on the design of a new type of course intended to describe computing principles and opportunities within a scientific research service.

Management Services

With the ARC Headquarters taking responsibility for future developments in administrative computing at the institutes, no further developments of this Section are envisaged. The present project Costing System will remain operational at Rothamsted pending the introductions of the new service planned for April 1982. It is also expected that the ARC Headquarters will take responsibility for the services to the MAFF Sea Fisheries Laboratories, Lowestoft, and the Department of Agriculture, Northern Ireland.

Staff, conferences and courses

There have been ten staff resignations this year, including, in the scientific grades, I. M. Richmond (PSO), R. P. Morton (SSO) and G. G. Starkins (ASO) of the Telecommunication Section, P. T. Matthews (HSO), Operations, and the following in the Executive Officer grades, Mary Proctor (HEO) and Janet Sparkes (EO) of the Management Section and Cora Cottrell of the Operations Section. Joan Callaghan (Personal Secretary) also resigned her post. G. R. Smith was promoted to Chief Operator (HEO) and A. B. Hearmon (EO) promoted to the Operation Advisory Service. J. Summerfield (ASO) joined the Applications Section.

Staff turnover is a particularly difficult problem to manage under the handicap of a highly competitive demand for experienced computer staff. The following Table 6 is a summary of the turnover of scientific and executive grades during the life of this service since the Department was formed in 1968.

TABLE 6

Years in Department	In post	Resigned
11+	9	—
3–9	15	17
0–2	5	22
Total	29	39

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The Department has been particularly vulnerable to staff who join, often with good academic qualifications, but then leave for industry. There is, nevertheless, a secure core of staff on whom it has been possible to build continuity of service.

D. H. Rees attended the International Federation for Information Processing's Conference held at Melbourne, Australia; H. J. V. Gledhill organised and attended the ICL System 4 Conference on 'Data Management' held at Eastbourne; K. E. Bicknell presented a paper at the Eurographics 80 Conference, Geneva, and P. A. Clarke attended the International Conference on Data Bases held at the Aberdeen University, the Inter-University Software Committee Workshop on Data Base Software at Southampton University and the International Standard Organisation: Meeting of Fortran Experts held in Amsterdam. Several members attended management and other specialised training courses and supported technical and standards committees.

Publications

Book

YATES, F. (1980) *Sampling methods for censuses and surveys* (4th edition). London: Griffin, xvi, 458 pp.

General Paper

BICKNELL, K. E. (1980) Draw—a graphical program with the ability to draw a chemical formulae. *Eurographics 80 Conference Report*, pp. 129–138.

Research Paper

DUNCKLEY, A. ANTONIN, W. J. F., WHITE, R. F. & WOOD, J. (1980) Soluble leaf proteins of virus infected tobacco (*Nicotiana tabacum*) *cultivars*. *Biochemical Society Transactions* **8**, 70–71.

APPENDIX 1

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 CD	Rothamsted Experimental Station, Harpenden, Computer Department.
SSEW	Soil Survey of England and Wales, Harpenden.
WPBS	Welsh Plant Breeding Station, Aberystwyth.
WRO	Weed Research Organisation, Oxford.

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APPENDIX 2

(*a*) *Documents published*

Program Guides	
PG/127/5	NAG library Mark 7
PG/153	Short-term Archiving—the NOAH program
PG/154	Graphics with GHOST
PG/121/3	APPEND
PG/26/3	GROWAN/GROWF
PG/81/9	GENSTAT
PG/155	MAIL
PG/108	DEDPRT (Dedicated File Print Program)
PG/79/7	NDFHK
PG/110	DISCAT
PG/156	The Site Managers' Utility
Program Manuals	
RGSP 21	The Rothamsted General Survey Program Part 1
RGSP 22	The Rothamsted General Survey Program Part 2
System Guides	
GSYS/32/2	Using Jobinput Macros
GSYS/33	Writing and Testing Jobinput Macros
GSYS/20/6	Library Material Held Online
GSYS/27/2	Documentation Check List
Amendments	
DA-FEP/1/2	Users' Guide to the Front End Processors (FEP) and FEP Devices
DA-FEP/1A/2	
DA-FEP/2/2	
DA-FEP/3/2	
DA-FEP/4/2	
DA-GSYS/23/15	Multijob Command List
DA-GSYS/23/16	Multijob Command List
DA-GSYS/21/4	Remote Printer Guide

(*b*) *Training courses*

Introduction to MULTIJOB (three courses)
MULTIJOB for the experienced user (two courses)
Introduction to FORTRAN (two courses)
Introduction to SNOBOL (one course)
Introduction of the services provided by COMP and STATS DEPTS at RES (two courses)

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