THE SELECTION AND TRAINING OF COMPUTER PERSONNEL IN THE UNITED KINGDOM

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INTRODUCTION

We have in Rolls-Royce for a number of years read with interest the reports of the work of the Computer Personnel Research Group, now a Special Interest Group of ACM. We have all been impressed by the determination with which the group has tackled the outstanding problems of staffing Computing and Data Processing departments and with the attention to detail so necessary in work of this nature. I would like to begin therefore by saying how glad I am to be at this Conference and how much I appreciated the invitation of Bob Dickmann to give a paper on the problems of selecting and developing computer staff in the United Kingdom.

I do not think that in the United Kingdom we have any problems significantly different from those encountered in the United States or in other countries who have had some years' experience of the design, development and operation of computer based systems. We have shared, proportionately, the same tremendous increase in the number of computers installed during the last five years. We have made the same mistakes and have reaped the same benefits from computer based systems. We have suffered from the same problems of recruiting and training and retaining competent staff. We have had the same discussions with our colleagues in other departments, we have learned to talk the same jargon and even shared the same jokes about computers.

Although these factors are all the same, and although the problems are the same, the search for a solution has in some cases taken us down different avenues. During this brief presentation I would like to discuss the problems of staffing computing departments in the United Kingdom and the ways in which we are trying to overcome them, and then move on to say something of the methods of selection and development which are currently in use in my own organisation.

THE GENERAL PICTURE

The Growth of Computers

During the last few years two statements have been much in vogue in the United Kingdom. The first is that the underlying growth rate of computer applications is in the region of 15% per annum and the second is that by 1970 we will have so many computers and will require so many managers, systems analysts, programmers, key punch operators and so on.

It is difficult in this field to produce statistics which can be established beyond dispute, but the figure of 15% is a dangerous and an incorrect generalisation and 1970 is now too close to be an acceptable planning horizon. Table I shows the growth of actual computers installed in the United Kingdom from 1963 — 1968 and projects the growth to 1970. There are now two centres of thought about the future. One considers that a plateau has been reached, the rate of deliveries has for the first time for five years overtaken the rate of new orders placed, and that there will be a pause in the early '70s during which a much needed consolidation will take place. The second, headed by the manufacturers, considers that the rate of installation will not only continue but will increase.

These figures can be used only to show the trend. First of all it is possible to spend a great deal of time arguing about what is and what is not a computer. Secondly, computers come in various shapes and sizes. One big computer may replace five small. The trend, however, has been established and it is clear that the staffing problems we already face are likely to get worse before they get better.

TABLE I

Growth of Computers in the United Kingdom

YEAR	COMPUTER INSTALLED	INCREASE OVER PREVIOUS YEAR
1963	403	(321)
1964	724	(447)
1965	1171	(575)
1966	1746	(965)
1968	3750	(1039)
1969	5000	(1250)
1970	6500	(1500)

Staff Required per Installation.

Just as one can argue about a definition of a computer so one can argue about the number of staff required to support it. Table II indicates the generally accepted number of staff of various categories required to support small, medium and large computers. By medium I mean a computer of the approximate size of an IBM 360 Model 40, Honeywell 1200, an NCR 615 — 200 and an ICL 1904A or System 4 — 40. Anything larger would be placed in the category large, smaller in small. The figures in parenthesis reflect my own personal feeling as to the increase in staff which will be found necessary to properly utilise the complex and extremely expensive machines of the so-called third generation. I include these because I feel that, slowly, managements are

TABLE II

U.K. Computer Staffing

	SMALL	MEDIUM	LARGE
MANAGERS	1	3 (3)	5 (6)
ANALYSTS	1	5 (6)	8 (15)
PROGRAMMERS	3	8 (18)	23 (40)
OPERATORS	3	7 (21)	12 (30)
CONTROLLERS	2	4 (6)	12 (15)
OTHERS	–	1 (4)	2 (8)
TOTAL (excl. KPOs)	10	23 (58)	62 (114)

recognising that the major cost of computer based systems in the United Kingdom is that of the hardware. As a result more and more organizations are insisting that their computers are worked twenty-four hours a day, seven days a week, thus demanding more operations and control staff, and in a multi-programming mode which demands more Systems Analysts, Systems Programmers and Programmers.

If the figures are taken as a basis together with the projected increase in the number of computers shown in Table I, the staff requirements in the United Kingdom over the next eight years will be as shown on Table III.

TABLE III

U.K. – National Manpower Needs

	1967	1970	1974
MANAGERS	4780	8450	13330
ANALYSTS	10160	17960	30920
PROGRAMMERS	16330	28900	44570
OPERATORS	11050	19560	29460
CONTROLLERS	7390	13070	20150
KEYPUNCH OPERATORS	50000	81500	122750
OTHER	1180	2090	3750

When talking on a national scale one can only use generalities. A manager in one organisation may be a supervisor in another, or a senior programmer in a third. There is, however, emerging a fairly general consensus of opinion on job descriptions for Computing and Data Processing departments.

Briefly the following descriptions cover the work of those listed in Table II.

Data Processing Manager. Responsible for Data Processing Services and Data Processing Operations, meeting management needs for data. Plans and controls staff and resources, including Data Processing equipment to meet objectives.

Systems Analyst. Responsible for the design of efficient computer operating procedures and control systems based on agreed input and output to meet management needs.

Programmer. Responsible for developing the detail logic for a segment of a program or programming system and expressing this logic in instructions in the appropriate computer programming language.

Operator. Sets up and operates data processing equipment to prepare reports from well-established programs. Makes specific changes to data or procedures as instructed. (The advent of the work of an operator.)

Control Clerk. Agrees schedules and priorities with user departments, checks data going into the Operations Department and computer output before forwarding it to the user. May also assemble the work for major processing runs.

Key Punch Operator. Punches a variety of information from various source documents. May also be responsible for verification of punched data.

ACTION TAKEN

There is not doubt that computers are news and the staff that are not available are also news. The staff which are not going to be available in 1970 to quote the magical date, are even more news. As a result a large number of organisations of varying shades of opinion and varying degrees of effectiveness have grown up all claiming to be of significant assistance in the production of adequate numbers of staff for the future. For simplicity I have grouped them under six headings:

The Government

The British government is playing an indirect but nonetheless a very important role in the provision of training facilities for Computing and Data Processing staff.

The Ministry of Technology is aware of the problems not only of developing adequate numbers of these staff but also of educating management and other key personnel in the use of computers. This Ministry was instrumental in the setting up of the National Computing Centre in 1966 which has amongst other responsibilities a definite commitment to develop appropriate computer courses.

The Ministry of Education has also played a useful role in encouraging schools, universities and technical colleges to develop and run appropriate courses.

The National Computing Centre

The National Computing Centre was set up by the Ministry of Technology to sponsor and encourage the use of computers in the national interest. One of the aims of the Centre is to ensure that there is an adequate supply of trained personnel to the computer area. In pursuit of this aim a Working Party was established with the following terms of reference:

> To advise the National Computing Centre on projects relating to the productivity and training of staff engaged in designing data processing systems for computers. To define the area where effort is needed in the development of systems analysis techniques and in the education and training of Systems Analysts. To define precise courses of action for progress in these fields, with a view to providing necessary numbers of Systems Analysts in the National Interest.

In 1967 the Centre's System Analysis/Design Working Party published a National Plan for Systems training. This plan is in five stages. (See Figure 1.) Stage 1 covers very basic training in business practice and data processing. Syllabuses have been prepared covering two formal courses these have been distributed for comment before the final syllabus will be completed.

Stage 2 is an experience phase during which the individual works either in the data processing area of his company or is given a general commercial appreciation of his company's organisation and its business systems.

Stage 3 is a further period of formal training, this time of six weeks duration. This course takes the form of a training package and a number have been sold to technical colleges and to commercial and industrial organisations throughout the United Kingdom.

Stage 4 is a second experience phase of between one to two years during which time the trainee Systems Analyst develops and practices the skills which he has been taught during his formal training. At the end of this experience phase he is then ready for further formal training.

Stage 5 provides this training during which the Analyst is exposed to new development in the techniques of Systems Analysis and related disciplines which will help him in his work. The development of this advanced training module is still in its very early stages but is being given the priority of a major project by the National Computing Centre.

The Schools and Universities

At present only a small number of schools have recognized the career prospects in Computing and Data Processing. These have started to teach Sixth Formers something of computer technology and computer application.
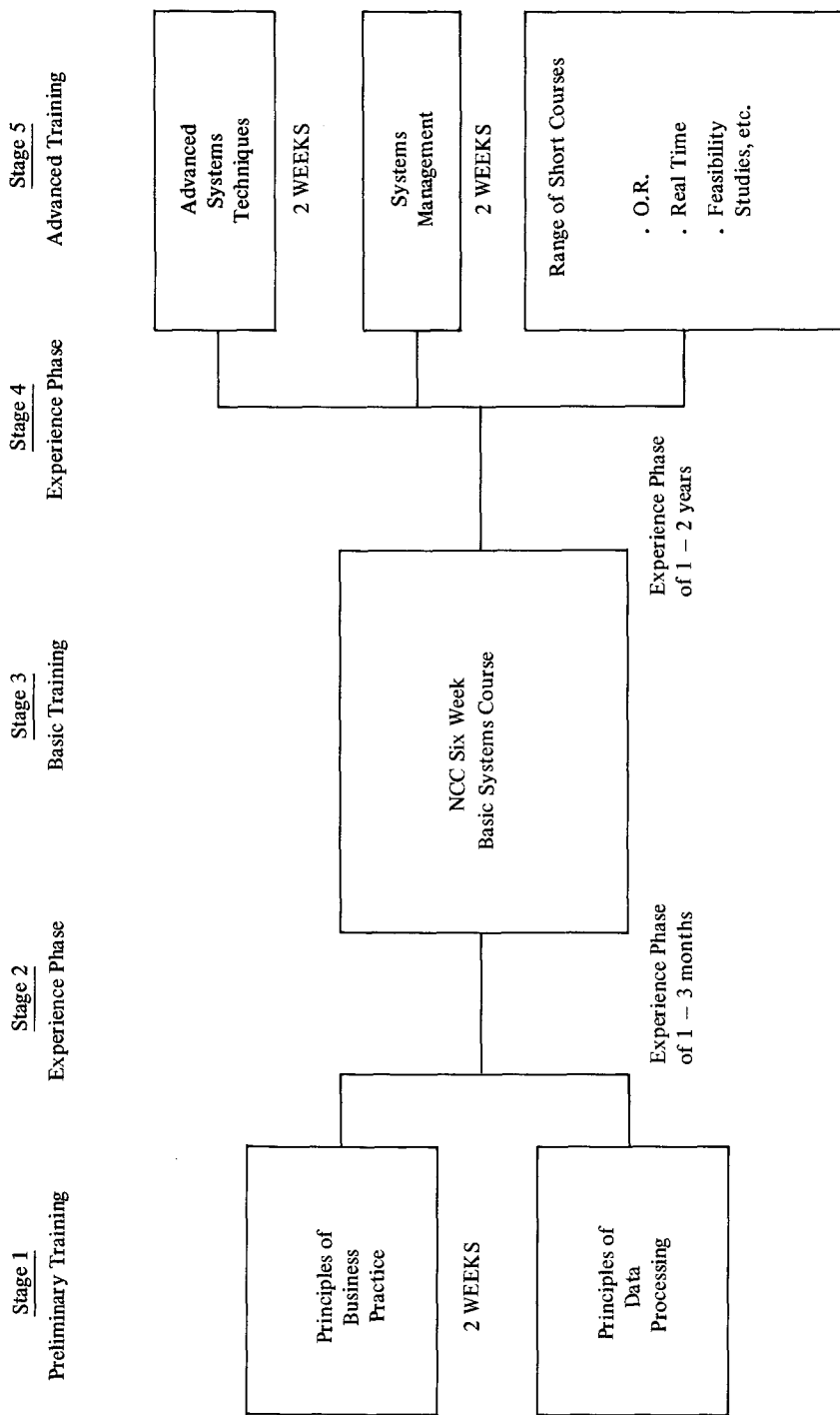
Stage 1
Preliminary Training

Stage 2
Experience Phase

Stage 3
Basic Training

Stage 4
Experience Phase

Stage 5
Advanced Training

Principles of
Business
Practice

2 WEEKS

Principles of
Data
Processing

Experience Phase
of 1 – 3 months

NCC Six Week
Basic Systems Course

Experience Phase
of 1 – 2 years

Advanced
Systems
Techniques

2 WEEKS

Systems
Management

2 WEEKS

Range of Short Courses

. O.R.
. Real Time
. Feasibility
  Studies, etc.

FIGURE 1

U.K. – National Plan for Systems Training

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The technical colleges (technical training establishments which are not of university status) have during the last two or three years started to run courses in Computing and Data Processing subjects. As a generalisation it may be said that they are concerned more with training for the short term than education for the long, the latter being the role of the universities. A number of courses are now being run by technical colleges for both technicians and technologists. Of these the best known are those which lead to a "Technician" Diploma in Computer Studies, a "Technologist" Diploma in Maths, Statistics and Computing and the six weeks NCC basic Systems Course. There have been significant problems in the organisation of the latter of these courses.

The development of this package as a training medium has been rapid, from the establishment of the Working Party to the first use of the package in twenty-three colleges as well as consultants and user organisations took only one year. The fee of approximately 400 dollars is reasonable and is in fact less than half of that charged by consultants. However, the instructors if they are of the requisite standard could earn in some cases twice as much in industry. There is therefore a suspicion in the minds of Data Processing managers that technical college instructors are not up to the best standards of data processing professionals or are not commercially inclined or both. It is true this may only be a suspicion but generally speaking data processing managers are reluctant to entrust the training of their Systems Analysts to the technical college instructors.

Secondly, the very speed with which the package has been developed has made it difficult for the majority of colleges to use it. Finally, the NCC have been encountering problems in creating an effective feedback so that the package may be improved. Despite all these problems the concept is valid and the general feeling is that the NCC, technical colleges and commercial and industrial organisations should work together to create really effective training.

It is to be hoped that the universities will, in the long term provide the key to the solution. The real shortage is that of staff who have been trained not what to think but how to think. During the next decade there will be a rapid increase in the number of students graduating each year and it is to them that manufacturers and users should turn.

Independent Organisations

Of the independent organisations the greatest part has so far been played by the manufacturers. All the manufacturers offer a programme of computer education and there is no doubt that until now they have almost entirely on their own carried the burden of computer education and training in the United Kingdom. The situation is now beginning to change.

First, the increasing number of computer applications and the increasing sophistication of those applications means that computer education must be broadened and the variety of training courses offered must be significantly increased. In most cases the manufacturers have restricted their efforts to the provision of education for management and training for programmers. They are, understandably, showing little enthusiasm for the creation of, for instance, detailed training courses for operators of 3rd generation equipment or for the training of Senior Systems Engineers.

The consultants, some British, some American offer a range of courses and are prepared where necessary to tailor a course to meet the requirements of a particular customer. The consultant's courses have met with varying degrees of success. The most general complaint is that by definition the consultants advise rather than execute and they rarely have to carry responsibility for their advice. Their courses are therefore often subject to the criticism of being too theoretical and not based on experience.

A small number of very large enterprises have developed programmes of computer education for their own staff. At least two of these, Rolls-Royce being one, offer places on their courses to staff from other organisations. I am sure that you will allow me some licence when I say that I am convinced that this offers probably the best form of training available. Unfortunately, the small number of enterprises able to mount such courses means that a strictly limited number of places can be made available. From Rolls-Royce for instance we are able to offer at present approximately 1000 course places per year. This seems a considerable amount of training to us representing approximately 10% of our training output, but consideration of the numbers of staff required throughout the country makes it clear that we are only making a start. One possible development is the creation and distribution of training packages but these packages must be proved internally in the enterprise before they are marketed and this, of course, is a time consuming process.

Finally we have our pirates who can unfortunately be found among the independent computer programming schools. While a number of these are doing a worthwhile job there are some whose activities have led to discussion in the House of Commons. The Minister of State for Education and Science, Mrs. Shirley Williams, agreed with the criticism voiced and admitted that there was little that could be done in the way of control under the present legislation. The aptitude tests offered to people wishing to attend appropriate computer centres were in some cases worthless and the courses in many instances, although not in all, do not attain recognised national examination standards. It was possible to provide schools with significant recognition from the Department of Education and Science but there was no way of obliging the schools to seek this recognition. The Government hope to encourage eventually schools to come forward for recognition and at the same time to publicise the facts about the teachers of courses of non-recognised schools but it was open to question how far adults could be protected.

British Computer Society

The British Computer Society has this year established itself as the Institute for professional Computing and Data Processing staff in the United Kingdom. This has been achieved against a certain amount of opposition and a certain amount of criticism of the activities of the Society. Standards have been established for professional examinations and it is hoped that the education division will play a full part in making the Society into one of the foremost professional organisations in the country. Mr. Marcus Bridger, the Chairman of the British Computer Society Education Board has said:

As the education board sees its task, we have to show the public at large that society members who qualify for grades of membership are professionally equipped men worthy to rank in their expertise on a level with other professional people. To achieve this the board must set up a detailed scheme of qualifying examinations together with all the machinery of exemptions and periodic reviewing; but additionally and especially in such a rapidly developing subject as computers we should form working parties to investigate needs in different sectors. What, for instance, are the right courses for full-time study in the schools, college, and universities? What are the right courses and training needs for people in business and commerce? What steps should the board take to enlighten the public at large as to the importance of computers and their likely effect on society?

I think I am right in saying that the United Kingdom is the first country to have established a professional body for Computing and Data Processing staff. At the 1964 meeting of the Computer Personnel Research Group Dr. Robert Rich gave a most interesting paper* discussing the pros and cons of establishing computing as a profession. There are a number of people who feel the move of the British Computer society is premature and that, to quote one data Processing Manager "it will be at least ten years before I offer anyone a job on the strength of a British Computer Society qualification." Be that as it may, a very real attempt is being made to set standards and to co-ordinate the efforts of all organisations concerned with the problem of developing computing and data processing staff.

SELECTION

There is not a great deal of evidence to suggest that the selection procedures currently in use in the majority of organisations in the United Kingdom are particularly effective. Some organisations are now paying a great deal of attention to the selection process, but the majority tend to select on a basis of the IBM Programmer Aptitude Test or on hunch. There has been very little validation of either of these selection techniques. Those who use the aptitude test feel that it is reliable guide certainly to the performance of a Programmer during training and probably to his performance in the early part of his career. It is being claimed by a number of firms that the PAT test is not an appropriate instrument for predicting the success in the case of Systems Analysts. Again there are few hard facts to back this supposition. Most of the selection is undoubtedly carried out on the basis of results obtained at schools and universities and one or two interviews which aim to assess the personal qualities and logical ability.

Computer Professionalism: Myth or Fact

Table IV* indicates the background of the major categories of computing and Data Processing staff. These figures were obtained as a result of a representative survey across a number of typical computers users. If the major selection criteria for Computing and Data Processing staff continue to be academic qualifications, an interesting situation will arise in the future when a significant percentage of school and university output will move into this field. Table V indicates the approximate percentage.

TABLE IV

U.K. Academic and Experience Levels of Recruits

	INEXPERIENCED			EXPERIENCED		
	GRAD.	A.	O.	PROG.	OPERATING	KPO
MANAGERS ANALYSTS SENIOR PROGRAMMERS	20	40		40		
JUNIOR PROGRAMMERS SENIOR OPERATORS		60	20		20	
JUNIOR OPERATORS CONTROLLERS		20	50			30
KPO			100			

TABLE V

National DP Staff Needs as Percentage of Academic Output

	68	70	72	74	76	78	80
GRADUATES	8.0	7.9	6.9	7.0	6.6	7.0	6.8
'A' LEVEL	19.8	19.9	25.2	24.4	19.6	17.4	15.9
'O' LEVEL	13.9	17.1	15.4	14.3	13.1	12.2	11.1

*Graduate includes staff with at least a bachelor degree. A level includes staff who have left school at 18 with the general certificate of education at advanced level. O level includes staff who have left school at 16 with the general certificate of education at ordinary level.

SELECTION AND CAREER DEVELOPMENT OF COMPUTING
STAFF IN ROLLS-ROYCE

Selection

In Rolls-Royce as in the majority of companies in the United Kingdom initial selection is carried out largely on the basis of academic achievement. The computing organisation itself is large, over 1,200 people are employed in Computing and Data Processing departments, and I will therefore talk at a fairly general level considering only two major departments, Computer Operations and Systems and Programming. These two departments are shown in the left and right boxes in Figure 2. Between them they cover ten areas of responsibility.

The majority of staff joining the Computer Operations Departments have 'A' level qualifications. In view of the increasing complexity of controlling and operating third generation equipment and the increasing importance which Rolls-Royce attaches to the Operations Department we also recruit each year between 12 and 15 University Graduates of outstanding calibre. Although we do not specify any one subject or any group of subjects for their first degree course it is interesting to note that the majority of these have read arts rather than science.

In the case of Systems and Programming the majority of staff selected are graduates. Again no one specific subject is demanded and in this area the proportion of arts to science graduates is fairly even.

In all cases the interview and selection procedure is much the same. Candidates who are sent to us by university appointments boards, by schools' careers masters, or who have replied to advertisements are shortlisted on their application blanks. The shortlisted candidates are then called to our Head Office in Derby for interview and are warned that they will need to spend the day with us. They arrive at the Computer Centre at 9:00 a.m. and are welcomed and then given a brief presentation on the Rolls-Royce organisation generally. This is followed by a film covering the major activities of the company after which there is a break for coffee and any questions. After the break they all take the IBM PAT Test, then follows another short break before the candidates are given a detailed presentation on the training which they will be given if their application is successful, and the career prospects which exist for them in our organisation. By this time the morning is nearly over. They do, however, have a short tour round the computer building and then go for a buffet lunch in a nearby hotel. During lunch we invite a number of Systems, Programming and Operations staff to join the applicants so that all the questions on houses, schools, recreational and other facilities can be answered.

After lunch, by which time the aptitude tests have been marked, the interviews begin. Each candidate has an initial interview with a Senior Manager from Computing and Data Processing. This rarely lasts more than one hour and in some cases can be as brief as 30 minutes. The interviewers for both the first and second interview have all attended at least a one-week course run by the National Institute of Industrial Psychology specifically for the Computing and Data Processing departments in Rolls-Royce. The first interview aims to assess the acceptability of the individual to the organisation as well as his technical and managerial potential. One of the more difficult tasks which the first interviewer

Computing and data processing organisation (Company headquarters and Aero Engine Division)
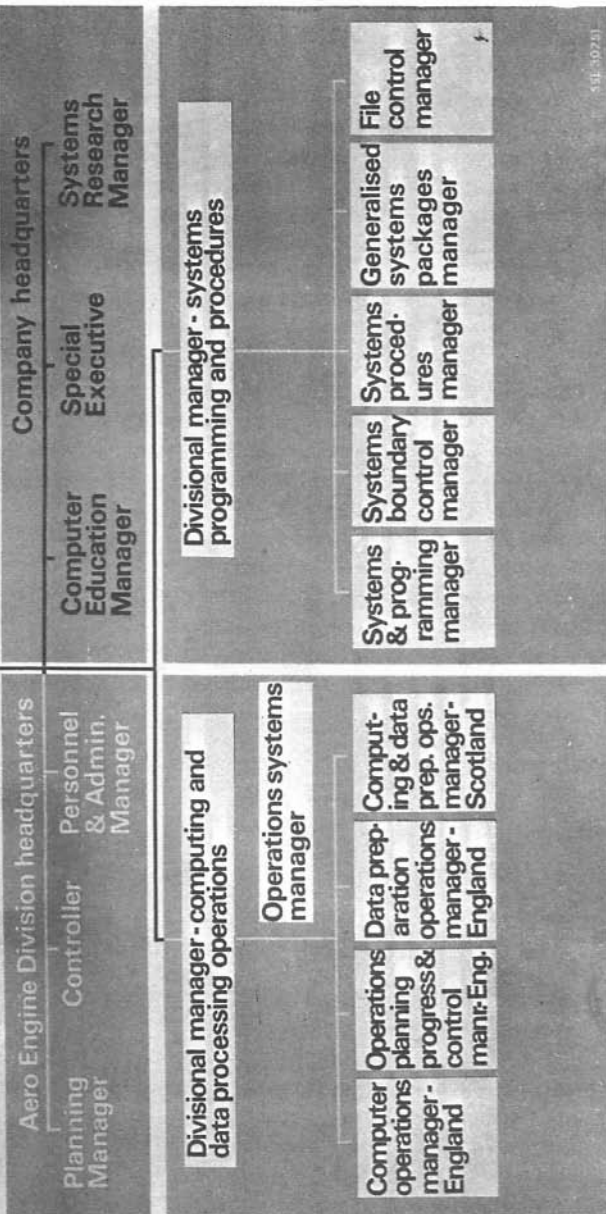
FIGURE 2

has is to identify not only the area in which the candidate can take up his first appointment after training but also to recommend the most suitable area for his development over a three year period. The results of the PAT test are taken into consideration but we would neither offer not reject solely on the basis of a PAT test score.

If the first interviewer is satisfied with the candidate, he forwards him for a second interview to the junior manager who is most likely to have the candidate working for him on completion of his training. The second interview aims to establish logical ability and where appropriate assess experience. I should, at this point, say that we recruit only a very small percentage of our trained staff from outside the Company. In principle we have chosen to develop our own specialists and managers.

Training

The current training schemes for computer staff in Rolls-Royce reflect the efforts made by the Company to realise the concept of opportunity for all in this particular area of work. Training cannot be divorced from other facets of personnel administration. All jobs have been designed as rungs on career ladders and the door is open for each man (or woman) to develop his potential to the extent that he is willing. Although certain parameters govern the process of initial selection, once anyone has joined, the rule of merit obtains and interchange between departments is perfectly feasible and is encouraged. The following fundamental principles, therefore, govern all our training schemes:

1. Training must follow a logical progression.
2. Training consists of formal (off the job) and practical experience.
3. Evaluation of personnel and training methods must be undertaken at all stages.

Systems and Programming

There are three main entries to the area of Systems Development as shown in Figure 3:

1. Graduates with some post graduate experience.
2. Graduates direct from University.
3. School leavers with 'A' levels.

The graduate with experience moves directly to a one year period of PL/1 programming training, details of which I will be very happy to discuss after this presentation.

Graduates direct from University will do a short course in basic business studies (1 week) followed by 4/6 week assignments to areas of the Company which are making substantial use of computer based systems as well as to the Data Processing Operations group. They then join the one year PL/1 programming training course.
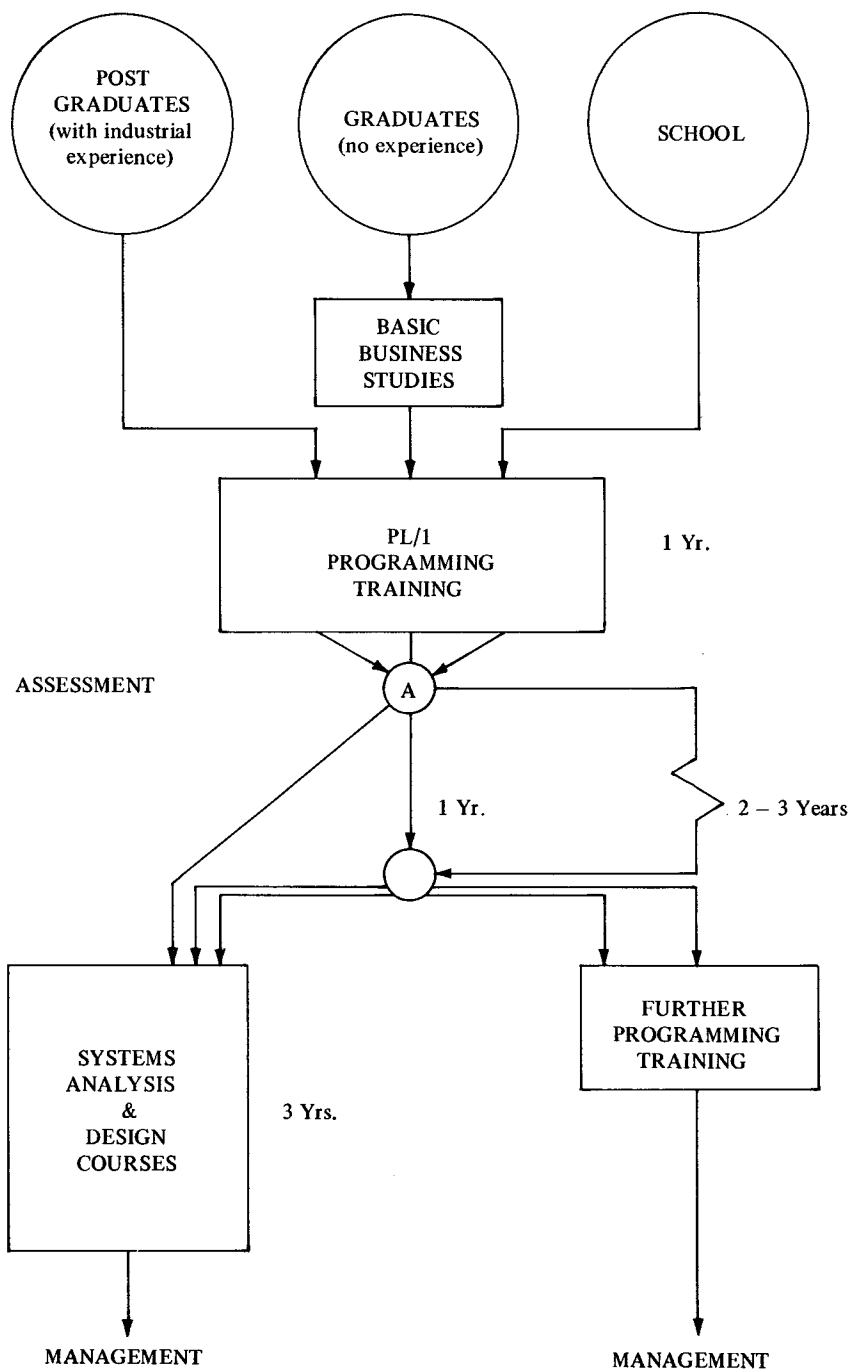
FIGURE 3

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So far we have not recruited school leavers directly to Systems and Programming. It is possible, however, that this year we will carry out a controlled experiment on a group of 12 school leavers who will move directly into the PL/1 programming training course.

On completion of PL/1 programming training, each trainee is assessed in the light of his performance during the course and his expressed career intentions. Graduates who join direct from University will almost certainly spend a further year in programming. The school leavers will spend 2 to 3 years in programming but the graduates who join with post graduate experience may at this point move into the field of Systems Analysis and Design, where they would start with a three weeks' course in basic Systems Analysis and Design and then work for a period of three years in this area during which time they would do further courses. At the end of this time they are ready to take up supervisory or specialist appointments in their chosen field. Those opting for programming would move into the stream in which they would be given further training in either Software or Applications Programming depending on their specialty. Again they would be expected after a similar period of time to move on to a specialist or supervisory appointment.

Operations

Operator training takes three years and is divided into three stages:

Stage I

Part 1 – This consists of 20 weeks intensive training on and off the job. It starts with four weeks in the classroom during which the student has a short induction to Rolls-Royce, moves on to cover computer fundamentals and basic programming using a sub-set of PL/1 written by the Computer Education group specifically for this course.

Part 2 – This consists of 4 weeks field training in the data preparation and other computer operating areas.

Part 3 – This is taken in the classroom. Again it runs for 4 weeks and covers orientation to System 360, Job Control Language, Data Management and the range of utility programmes available to the installation.

Part 4 – This lasts for 8 weeks and consists of further field training made up of working attachments to the Control and Progress areas of Computer Operations.

Stage II

The full stage Operations Training Programme will not be completely effective until 1969. The stage lasts for 18 months to 2 years, the field training is carried out entirely in one of the major departments in the Computer Operations group. During this period 10 weeks classroom instruction is given. In addition to this formal training a number of one day appreciation courses are run to give the Operations Trainee some insight into the main computer applications currently running in the Company.

Stage III

This will again not be fully operational until 1969. The more important, formal courses are however already in existence and have proved successful.

General Computer Training Course for Graduates

The creation of a separate course for graduates of outstanding calibre reflects the emphasis which Rolls-Royce places on the appropriate staffing of the Computer Operations departments. The twelve to fifteen graduates who are selected for this course must at their interview give evidence of outstanding technical or managerial potential and must have a genuine interest in taking up a first appointment in the Operating area.

On joining the Company the graduates spend five weeks in the classroom, the first covers induction and basic business studies, and the remaining four computer fundamentals, principles of programming and basic PL/1. They then do eight weeks field training in one of the Computer Operations departments and then return to the classroom for a further four weeks covering 360 Orientation, utilities, Operating System for 360 and Job Control Language. There is then a second period of field training followed by three weeks of further business studies. The third period of field training leads them into a three week course in basic Systems Analysis and Design after which they carry out their final period of field training in the Operations Group. This is however followed by a five week period during which the graduates are attached to user departments. This completes the course so that at the end of one year the graduate is ready to take up his first appointment in one of the major Operating departments.

It is still too early to assess the effectiveness of this training scheme. so far only a small number of graduates have gone through this type of training and they have in the main done so on an informal basis. This year the course will be formal but less flexible than it has been in the past and we are confident that it will produce the desired results.

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┌──────────────┐
│  INDUCTION   │                1 Wk
│  AND BASIC   │
│  BUSINESS    │
│  STUDIES     │
├──────────────────────────┐
│                          │
│  COMPUTER FUNDAMENTALS   │    4 Wks
│ PRINCIPLES OF PROGRAMMING│
│        BASIC PL/1        │
└──────────────────────────┘

                                Field Training I (8 Wks)
                                Computer Operating

┌──────────────────────────┐
│                          │
│     360 ORIENTATION      │    4 Wks
│        UTILITIES         │
│     O.S.      J.C.L.     │
└──────────────────────────┘

                                Field Training II (8 Wks)
1 Yr                            Progress

┌──────────────────────────┐
│        FURTHER           │    3 Wks
│    BUSINESS STUDIES      │
└──────────────────────────┘

                                Field Training III (8 Wks)
                                Control

┌──────────────────────────┐
│    SYSTEMS ANALYSIS      │    3 Wks
│      AND DESIGN          │
└──────────────────────────┘

                                Field Training IV (8 Wks)
                                Data Preparation

                                CUSTOMER AREA
                                (5 Wks)


                                FIRST ASSIGNMENT (1 Yr)
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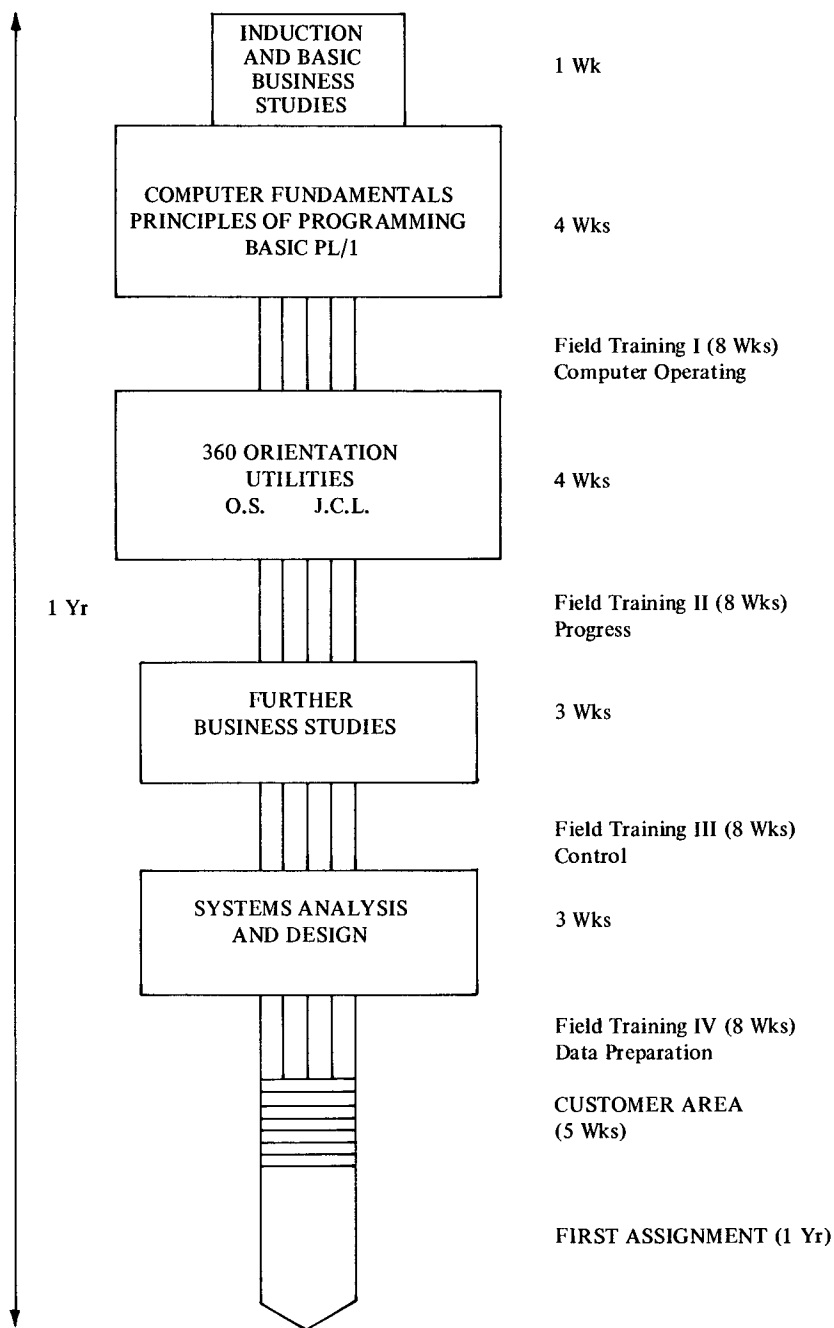
FIGURE 4
General Computer Trainees (Graduates)