

2. Relatively small calculation capacity at medium speed, but large input and output availability.
3. Because of the diversity of local authority work, the ability to store a large program—at least 2,000 operations and preferably more.
4. For larger authorities, magnetic tape or film storage for record keeping, and a random-access store for items of information required frequently by the staff for reference purposes. The ability to obtain this information, either independently of the computer or automatically through the computer centre, with a minimum disturbance of computer working time.
5. Reliability—this is very important during initial program testing and when jobs with an absolute deadline such as payroll are subsequently performed.
6. Inbuilt checking circuitry making programming easier, and control of the system more simple.
7. So designed as to make programming as simple and quick as possible.
8. Minimum installation cost, which means the use of the latest techniques to reduce heat emission and also power supply costs. It also means that equipment susceptible to dust conditions such as magnetic-tape units should have inbuilt filtration, thus avoiding the necessity for complete air filtration of a whole machine room.
9. Finally, a reasonable price, commensurate with these requirements, and one which would enable an average local authority to show savings within a reasonable time.

I cannot claim that this is a comprehensive list, but I think that it embodies the main features for which local government is and increasingly will be looking for from computer manufacturers. Supported by a growing interest in this new field of aids to management, I am sure that the manufacturers in the years ahead will do their best to meet local government's needs.

Conference Paper

Symposium on the Selection and Training of Programmers— I : A Business User's Approach

by H. W. Gearing

INTRODUCTION

We had been interested in following the development of electronic computers since 1949–50, when we discussed the matter informally with representatives of N.P.L. and N.R.D.C. At earlier dates, the Company had been faced with various problems of selecting and training staff to operate specialized automatic equipment: we have an Education and Training Division which supervises the selection and training of apprentices for the various skills required in our factories, and special attention is given also to the selection of management trainees from those leaving the universities. For office work, we have encouraged junior staff to take continuation courses; where it was a question of operating complicated office machinery, as we knew it up to 1950, we found little difficulty in training young people of normal intelligence to use the available equipment to the best advantage. A particular example arose in 1940–41 when we began our Powers 65-column installation in an area well removed from the normal channels of office equipment training: we were then obliged to fall back on the local grammar and senior schools, who provided girls which we trained to deal with all aspects of the work. Some of these girls became demonstrators and instructors for the manufacturers, when they married and moved away from Worcester.

COMPUTERS

In 1954 we began to consider the possible applications of computers to business and we received interesting reports from the American Management Association on what companies were proposing to do in that country (A.M.A., 1954, 1955, 1956). Subsequently we also received the report of a conference held at Wayne University in June 1954 (Jacobsen, Ed., 1955), which stressed the educational problems introduced or enlarged by the arrival of computers. Dr. Householder, who is with us today, was a contributor to this. It seemed to us that the best appreciation of what these machines might do, having regard for our background of experience with other office equipment, would be obtained partly from reading the reports of business applications, and partly by making a closer study of a scientific computer; in the autumn of 1955, two of us therefore attended an introductory programming course on the EDSAC computer. The lecturers on that course were Mr. E. N. Mutch and Mr. M. Bridger; most of the other members of the course were working on problems in pure and applied mathematics; their disclosure of what the machine could do opened our eyes very widely; this course gave us such an appreciation of what the machine *might* do, that on occasion we were led to disbelieve some of the proposals in the papers which we had read!

The potential business user, when he has discovered what these machines, as a class, might do, has to consider whether the work of his company will justify a computer. If so, what jobs are likely to be best applied to it, and finally, what sort of equipment does he need. Very soon, he appreciates that he cannot decide how big a machine is needed, nor what kind of ancillary equipment is required, until he knows what jobs are to be done; he cannot be certain how to do them until he knows which machine is likely to be available. With the exception of the 32-column input to DEUCE, the Rothamsted modified Elliott 401, the pilot-ACE, and a numeric 80-column card input to LEO, there was an unbelievable slowness in fitting punched-card input channels to British electronic computers.

The information which we received has led us to wait until we found equipment which could be linked to our existing office machinery, on the organization of which we had already spent many hours of work.

The experience of scientific and business computer users in America, which we were privileged to see at first hand in the spring of 1956 (Gregory and Gearing, 1959), and the experience gained by several members of our staff who attended introductory courses on Elliott, English Electric, Ferranti and Leo equipment, led us to the decision to recruit a nucleus of full-time programmers, who would have training on several machines. The formation of the London Computer Group (later merged with The British Computer Society) provided a means whereby our staff could mix freely with people doing similar work in other companies, to exchange experience through the London study groups.

In deciding what kind of people to recruit for this work, our friends working on scientific computers were inclined to recommend that a university degree be regarded as a desirable qualification. Those who had made an early start on the applications of computers in business had, however, stressed the importance of knowing a lot about the organization into which the computer was to be introduced. We now have a nucleus of five programmers; three of these are people who have had some years' experience in the Company on organizing routines for accounting machines; two others have come to us from the university or mathematical and statistical work in industry. We are finding that a mixture of Company internal experience and fresh training in statistical methods and mathematics is working well. Courses which have been arranged at Cambridge, Leeds, London, and other Universities will provide the foundations for future recruitment of people trained not only in statistical methods and mathematics but also in computer operation.

We have recently tended to concentrate our attention on applying a particular computer to the extension of certain sales analysis work, and to preparing for certain other jobs such as a closer control of part of our current materials stocks and the forward stock position; these jobs are not at present as fully mechanized or as speedily done as we believe we would like to have them. Our

trainee programmers, after completing the manufacturer's course, have first been asked to write programs for models of those jobs on which they will ultimately be engaged. These simplified examples have provided good programming experience, and for the later recruits, when coupled with the reading of other people's programs, have provided a foundation for more serious work.

A BUSINESS-USER APPROACH

I would like to mention nine points, to be borne in mind, on the selection and training of programmers, by those who are contemplating the installation of computers for business data processing.

1. *Mix* the knowledge of the business with a fresh academic approach.
2. Ensure that all your programmers know and *understand* the detailed operation of the machine and its ancillary equipment. Anyone who is not prepared to make this effort is likely to be a passenger.
3. Choose *plodders* who will attend to detail, rather than those who may be very bright but be inclined to spend too long searching for short cuts.
4. See that there exist facilities for your programmers to *exchange* experience with those who are programming computers for scientific work.
5. Encourage the *study* of systems and machines other than those likely to be installed or available to your own company, in order that the staff may learn of techniques used with other equipment, which might be developed for use within the organization.
6. *Allocate* the individual jobs to be programmed so as to make the best use of the individual's past experience and ability; the manager must of course take final responsibility for the flow chart of each job and for the co-ordination of card forms, magnetic-tape records, etc.
7. Lay down rigid rules for the filing of *working papers*. Each job, when the program has been developed, must be understandable by any trained person in the organization. Allow extra time if necessary after a program has been tested, to ensure that the flow charts are fully annotated, even to the point of stressing the obvious, that the sheets containing the machine orders are clearly documented as to the meaning of each block of program and cross-referenced to the main flow chart. Ensure that a concise specification of the job, such as Mr. T. R. Thompson has often stressed (Thompson, 1958), is filed on the front of the working papers, followed by a synoptic flow chart which will enable the newcomer to the job to appreciate quickly the broad outlines of the operation.

8. Encourage the philosophy that *time* may be afforded to write elegant and flexible programs, as a program well-written may only have to be written and developed once. This involves the introduction of as many variable parameters as possible, which is more easily attempted after a model has been studied.
9. Finally, I would recommend all companies to consider the recruitment and training of programming staff, well *before* they *order* their computer. In the case of the medium-sized company, which is not able to find any member of the staff able to supervise this work, help may be sought from one of the consultancy firms, who, as Mr. de Paula has indicated (de Paula, 1959), are now prepared to supervise the initiation and development of this work. Leo Computers offer a similar service, backed by several years of experience in business applications, and the two punched-card groups have specialist staffs available for such work. This will enable a much better *internal* appreciation of the facilities available on different machines to be made before the equipment is actually ordered. If it is possible, one may then program simplified versions of some of the jobs and run them on service bureaux machines; then the pitfalls which have beset some of our brave pioneers, both in England and America when programming their real jobs, may be avoided.

This list, which does not purport to be complete, is very similar to the list one might draw up for training people in other office routines, such as the installation of costing systems; point 7 is particularly related to experience in accountancy and statistics, where it is essential that working papers be filed so that detail may subsequently be retrieved. This is often an irritation to the enthusiastic scientific type of individual, until after a few years, he realizes that some care in filing will help his own work later!

REFERENCES

- GREGORY, R. H., and GEARING, H. W. (1959). "Electronic Computers as Tools for Management in the U.S.A.: 1956," *Computer Journal*, Vol. 1, p. 179.
- DE PAULA, F. C. (1959). "Programming Services and Advice for Prospective Computer Users and Others," *Computer Bulletin*, Vol. 2, p. 87.
- A.M.A. (1954). *Integrated Data Processing through Common Language Machines*.
- A.M.A. (1955). *Electronic Data Processing in Industry: Special Report No. 3*.
- A.M.A. (1956). *Electronics at Work (Pioneering in E.D.P.): Special Report No. 9*. New York: American Management Association.
- JACOBSEN, A. W. (Ed.) (1955). *First Conference on Training Personnel for the Computing Machinery Field*. Detroit: Wayne University Press.
- THOMPSON, T. R. (1958). "Four Years of Automatic Office Work," *Computer Journal*, Vol. 1, p. 106.

Above all, after obtaining introductory guidance from those who are available to help us in the educational and consultancy worlds, one should see that as much of the work as possible is done *within* one's own organization and that the working papers are filed in such a way that *all* the experience obtained is available to new members of the programming staff, as they are recruited when the work expands.

A WORD TO SCIENTIFIC USERS

I would add a request to those working in the scientific field. It is ultimately the business and manufacturing industry of this country which is going to provide the money for new developments. When writing up your technical papers for publication, try to give a summary in plain English indicating the possible or actual applications of the work. It will be an excellent training for the young scientist or mathematician who aspires to a management post, or a directorship of a laboratory, to explain what he is doing to the laymen, who may have to provide the cash. It may also mean that an application of the techniques may be found in another discipline.

ACKNOWLEDGEMENTS

I would conclude by acknowledging the help which my division has received from discussions with computer manufacturers, educational establishments such as the Cambridge University Mathematical Laboratory and the Northampton College in London, and the general impressions collected from innumerable discussions with computer users in various industries in America and the United Kingdom. I hope that our comparatively brief experience, which I have recorded above, may be of use to those who may now be faced with the setting up of a programming team for business applications of computers.