AUTOMATIC ELECTRONIC MACHINES

At an ordinary General Meeting held on 16 December 1957 a discussion took place on Automatic Electronic Machines.

The President (Mr C. F. Wood) announced that the meeting had been called in order that a picture might be given, through the eyes of actuaries of different experience and interests, of the discussion at the Electronics Seminar held in October in conjunction with the Fifteenth International Congress of Actuaries. Mr Bailey was a member of the staff of a composite office and was principally concerned with a life department transacting a substantial volume of pensions business; Mr Baker represented the life department of a composite office dealing with ordinary assurance, and Mr Duval was responsible for an industrial and ordinary office. Mr Ramm was not in the insurance business; he was involved in retail trade. Lastly Mr Usherwood had been Chairman of the Electronic Computers Committee since its formation. He had been intimately involved in the organization of the meeting.

Summary of written and spoken remarks

Mr W. G. Bailey restricted his remarks to the media used for recording, the means of putting records into a form suitable for computers, the computers available and printing devices.

Input. The problem was to match the speed of input with that of the mathematical and logical sections of the installation. Magnetic tape was 50–70 times faster than punched tape or cards. Punched cards, however, had the advantage of (*a*) easier verification, (*b*) sorting independently of the computer and (*c*) simplicity of random access. Hence, it could be argued that original data might be prepared on punched cards and translated to magnetic tape for input to the computer. Machines, still somewhat expensive, were available for such conversion, but several would be needed to match the direct magnetic tape input. All three types of input—punched cards, punched tape and magnetic tape—were governed by the speed of the key operator working manually converting original data to the chosen medium. In some circumstances that dependence could be minimized by the creation of paper tape as a by-product of the formation of original documents. Research was being directed towards a method of reading direct from original documents.

Output. The same three media as for input were available and also direct (or on-line) printers. The fastest printers were claimed to print lines of 120 characters at a rate of 1000 lines per minute. But that was only a fraction of the speed at which the computer would write magnetic tape, which indicated the advantage of output onto magnetic tape for processing on independent (off-line) printers.

Computers. Computers could roughly be subdivided into:

(*a*) those operating on punched cards, and
(*b*) those using magnetic tape.

Punched card computers could be further subdivided according to size into three main groups of which the first two were plugboard programmed. The third class of punched card computers and both groups (medium and large) of magnetic tape computers were stored programme machines.

The size of storage and the speed of access to storage limited the number of operations which could be performed by the computer in a single run. The magnetic drum as a sole means of storage had its limitations since the average access time was between 5 and 10 msec. Cathode-ray and magnetic core were much faster, but cathode-ray was not too reliable. Multiple runs were very damaging to cards.

Random access storage. Means have been sought of producing records which permit a ready access to an individual record without the disadvantages of cards or schedules. Several types were available, e.g. magnetic disks, tape drum and magnetic tapes, and research was being carried out on micro-film, short lengths of magnetic tape, and photoscopic storage. All those devices were, however, expensive and in spite of their capacity would not cope with truly large numbers of, for example, policies in force.

Choice of computer. An American author has suggested that in choosing a computer the following five questions should be asked:

(1) Was the computer reliable and accurate?
(2) What facilities were there for efficient engineering control?
(3) Was the instruction system suitable?
(4) Were the input and output and storage adequate?
(5) Was the speed of the computer adequate?

Mr Bailey's own company were mainly interested in a computer for recosting, valuation, automatic calculation of paid-up values and surrender values, and the production of visual records (all in connexion with pension business), and were investigating the possibilities of using a medium-sized magnetic tape computer. They were led to think in terms of a computer because of the volume of calculation at each renewal date for group business; the premium billing was not just a repetitive operation. It did not look as though they could employ that size of computer for more than half a day a week and they could not use the remaining four and a half days on the rest of their life business. Computer time on such a machine would be rented at from £30 to £50 an hour, but it would cost £400 an hour if the machine were bought and only used to one-tenth of its capacity.

Mr B. T. Ramm described three large-scale American applications of a computer.

Policy issue. The first application, which had not yet been put into operation, was designed to handle 3000 proposals daily, to prepare from those the policies themselves and to up-date the premium billing and alphabetical name and address magnetic tape files, together with actuarial and other records. In order to save time work proceeded without waiting for underwriting decisions, all proposals being processed as if the policy would be issued in exactly the form applied for. On underwriting about 20 % of the applications were rejected or altered and the amendments were fed in on a magnetic tape at quite a late stage in the processing. Although the computer carried out a certain amount of editing of the proposal form it did not go so far as to underwrite non-medical cases automatically although there was no reason why that should not be done.

It was hoped that when it was finally installed the procedure described would cut the time of issue of a new policy down from two days to one as well as introduce economies in costs. In practice, however, the processing time in an application such as that could eventually be found to be of the order of four times the original estimate.

Premium billing and accounting. A basic policy file comprising 300 reels of magnetic tape was a starting point for a system designed to carry out the following procedures for premium billing and accounting for $3\frac{1}{2}$ million ordinary life policies:

(1) Maintenance of the tape record file.
(2) Calculation of bonuses, loan interest, etc.
(3) Production of statements and accounting records.
(4) Calculation of commission payments.
(5) Accounting for bonus and premium payments.
(6) As a by-product, notification of transactions to other departments.

The statement produced for the policyholder included the premium due, the bonus, the reduction in premium if, following American practice, the bonus was used for that purpose, and any interest due on a policy loan. In addition, a card was prepared for the use of the local office, mark-sensed, and returned to show payments received and any changes made in the policy. That 'stub' then formed the basis of the accounting procedure and any amendments to the basic magnetic tape record file. The accounting procedure also initiated overdue action when no 'stub' was received back.

Where possible, information was fed into the system entirely automatically, or otherwise from a single reference to the original documents.

Actuarial work. Three actuarial tasks were mentioned as having been carried out on large- or medium-scale computers. The first was the preparation of basic functions for a new mortality table. It took three hours to produce the whole of the table after two programmers had taken fourteen hours to prepare the programme; the same programme was, however, used for each of the twelve mortality tables constructed. The second task was the calculation of year-end reserves. That took eight man-months to programme and enabled the actuary to produce more accurate and earlier results and it was calculated to save $200,000 per annum in costs. (That seemed high since it was equivalent to the work of 500 clerks for a month, if each was paid at the rate of $400 per month, but it must be assumed that the figure of $200,000 was accurate.) The third task was the calculation of sets of single premiums for joint and survivor annuities. It was calculated that the cost of that, including the preparation of the programme, was $1500, whereas to do the same work by means of desk calculators would have cost $7500. In connexion with that programme the machine's instructions were prepared by automatic programming using an interpretative routine. As in other fields, methods needed to be changed when converting to computers, usually towards a greater degree of calculation from first principles, e.g. using a life table and discount functions rather than commutation columns.

It appeared that actuarial work took rather a back place in the computer organization; the actuarial department could use it so long as there was spare capacity, but had no permanent stake in its running hours. Two of the actuarial tasks described—the calculation of mortality functions and annuity premiums—were of the non-recurring type which could well be done on a service basis. The third—the regular actuarial valuation—seemed generally to be fairly low on the list of priorities of work to be taken over by the computer. For example, a flow chart of the issue procedure showed that, of the three files it maintained, the actuarial one alone was still kept on punched cards.

It was not possible to operate expensive installations at a profit without con-

siderable reduction in staff numbers. No great difficulty seemed to have been experienced on that account, largely because the staff made redundant had been those with the highest rate of turnover, who had been often the hardest to get. The most difficult person to fit into the new scheme was the senior clerk with many years service, doing little more than a routine job but valued for his accuracy and reliability. With that one exception, the changes were usually welcomed by the staff, and in general their morale was improved, particularly since there was usually a large amount of up-grading.

Mr A. Duval referred to applications of computers in small and medium-sized American companies, some of which would, however, be very large companies in Europe.

An office not large enough to justify the installation of a large-scale computer had the choice of installing a smaller computer or entering into some kind of time-hiring or sharing arrangement.

One company had installed a stored programme punched card computer for issuing policies. Five and a half hours were needed to issue 400 policies a day, the computer checking that the proposal conformed with legislative and company requirements, checking the correctness of the premium, printing the policy and listing out the reference numbers of the policy rider forms to be inserted in the policy, and calculating the commissions and preparing the punched card for inclusion in the head office file which was used for valuation and renewals. (That task was not so simple as it might appear, however; there were premium rates for ten different levels of substandard mortality and some 2000 different policy rider forms.) The original estimate of computer time was two and a half hours. The computer had replaced seventeen staff and a number of typewriters and desk calculating machines and was therefore just about paying for itself. The office had not recovered the planning costs, which amounted to ten man-years, excluding the replanning of policy-forms and management decisions. On the other hand, there was still some time available on the computer. The use of a computer had speeded up the policy-issuing somewhat; previously it had taken an average of 2·3 days, now it took 1 day in every case, but that had only been achieved by working the computer installation each evening from 4.30 to 11.30 p.m. It had also been possible under the previous procedure to issue the policy in an urgent case on the same day as the proposal was received, whereas that was not practicable with a computer system.

The limited internal storage of the machine made seven or eight passages of the data through the machine necessary. To guard against complete breakdown of the machine the company came to a reciprocal arrangement with a neighbouring oil company using a similar computer.

In order to obtain the scope and versatility of a large-scale computer some offices had entered into sharing arrangements. A separate body with its own staff had been set up to run the computer system, and a great deal of planning, programming and even form-designing had been carried out in common between the companies although they were highly competitive in other respects. That had the advantage of using the best brains and encouraging cross-fertilization of ideas between men with different company backgrounds.

Other offices either hired time on a computer or bought a computer with the intention of hiring out time on it to other users.

Some offices intending to use a large-scale computer installed medium-sized computers first as an intermediate stage to enable the office to change records

and routines, and to give the staff some experience in methods analysis and programming, but that meant two disruptions of office organization.

Almost every office which had actually installed a computer seemed to have discovered that it had substantially underestimated the planning costs, computer costs, and computer processing time, but every office was confident that the installation of a computer had been advantageous and would be of greater advantage in future.

Magnetic tape was accepted without question in the American offices as a reliable and thoroughly satisfactory form of record for processing purposes. There was still some reluctance to rely on magnetic tape as a primary record and practically all offices introducing tape systems proposed to maintain at least one card record for each policy.

Few applications seemed to have been made of computers to premium accounting in fire, accident or industrial life assurance, although those would all seem likely to be more profitable applications of a computer than any in ordinary life assurance.

If a large computer was to be installed the work involved in planning, departmental reorganization, and conversion of records was very great indeed, all of which would prove very difficult for the small office.

In the United Kingdom it might well be that composite offices would have an advantage in that they could use the computer for general business as well as for life business, and the industrial/ordinary offices might have an advantage, not in that they did industrial business, but in that the renewals were all sent to and the premiums collected through full-time agents, which enabled them to ensure that the data were submitted to head office in a form suitable for the computer system.

It was quite possible that a computer system would not be justified in an industrial life office for the maintenance of the industrial policy record and for dealing with the changes in that record. Where a most profitable application for the computer might arise in industrial assurance, if suitable equipment could be constructed—and, so far as he knew, that had not yet been done, though a good deal of research was going on—was in the industrial premium accounting. At present the premiums were accounted for by the agents, who summarized them and submitted them to the district office, which might check the agents' summaries and further summarize them before remitting to head office. The amount of work involved was probably two or three hours a week per agent, and in his own office, with some 7000 agents, probably the equivalent of two or three girls at each local office, a total of 400–500 girls. That could all be saved if a suitable system of recording premium payments mechanically in a form which could be handled by a computer could be devised.

Mr A. C. Baker devoted his remarks to the fundamental question of file maintenance using a magnetic tape computer.

File order. It was clear that there were considerable differences amongst large-scale magnetic tape computer users about the order in which the basic policy records were filed, as well as about the data stored in them. In those cases where valuation data were stored with renewal data in the same policy record—an approach which appeared to be generally approved even though not used by all companies—the file order was determined by premium billing considerations. Where premiums were billed monthly from and collected directly by head office, the file was kept in policy number order; if the billing procedure was spread over

the month, e.g. dealing with two consecutive days at a time, the file was kept in policy number order within pairs of days. Another company, which collected premiums through branches and billed six days' collections at a time, filed the main record in a 'Branch/six-day period/policy number' order. From those illustrations it was apparent that the policy reference might well be much longer and more complex than was customary under a punched card system; that, however, was of little consequence from a machine point of view since a computer could sort or trace a reference number of, say, ten to fifteen characters as easily and quickly as it could one of five or six characters.

Frequency of up-dating. In whatever order the magnetic tape main file was stored the up-dating procedure involved passing the whole file through the computer—a process which might take an hour or more for each 100,000 policies, depending largely on the amount of data recorded for each policy. For a very large company that procedure was so lengthy that it was not practicable, even if thought desirable, to maintain the files continuously up to date, and weekly, fortnightly, or monthly up-dating was carried out.

One large company was, however, up-dating its files daily and claimed that the advantages obtained over a less frequent up-dating cycle more than compensated for the additional computer time absorbed; such advantages included the use of the computer for the calculation of surrender and loan values and the settlement of claims.

Policy history. Three forms of historical policy record used in conjunction with computer systems were as follows:

(a) visible cards written up manually although the original entries might be prepared by the computer,

(b) periodical tabulations prepared by the computer from the data in the main record, and

(c) loose-leaf copies of the data on the main computer record, printed when the data were first recorded and again after each alteration in the data.

Sorting. Magnetic tape sorting time was largely independent of the number of characters in the sorting field and whether they were alphabetic or numeric, whereas the time required for a card sort was proportional to the number of decimal digits in the sorting field, each letter ranking as two decimal digits for that purpose. Although the computer sorting time, based on a sorting field of ten to fifteen characters, had always been very small by comparison with the time required for a similar-sized sort on a punched card sorter (some 2%–5%), the cost of doing the work on the computer was only recently falling below the cost of doing it on the card sorter.

Record alteration procedure. Before alterations could be introduced to the computer to change the data on the main files one of two procedures was used as follows:

(a) Punch the new data on cards, sort them to the main file order on a card sorter and then transcribe the data on to magnetic tape *via* a card-to-tape converter or the computer itself. Under that method it was customary to apply a computer check on the accuracy of the punched cards sort.

(b) Punch the new data on cards or record them as a by-product of a typing operation on paper or magnetic tape and feed that initial record on the computer for transcription on to magnetic tape. The data on the magnetic tape were then sorted by the computer to the main file order.

Method (*b*) was coming into greater use than method (*a*), and, while computer sorting programmes were fairly complex, they were generally provided by the computer manufacturer, so that actuaries need not be unduly concerned about the detailed techniques used.

Safeguards. Much effort had been applied to procedures for detecting and correcting errors. Those safeguards all cost money either by way of extra checking circuits built into the hardware of the computer system and/or by way of checking procedures in the programmes, which not merely complicated them but probably also had the effect of slowing down the computer operating speed.

A stricter control was applied to data being fed to the computer than was normally applied in, say, a punched card installation; those controls were not merely applied externally to the computer but also within it; for example, the computer checked new policy codes, premiums, valuation factors, etc., for consistency and reasonableness and also ensured that tapes fed to it for processing were in the correct sequence.

It was also usually arranged that every few minutes (at intervals varying from 2 to 45 min. for different companies) all the data stored in the computer at the time were recorded on magnetic tape so that, if the computer broke down within the next few minutes it was possible after the fault had been rectified to restart the procedure at the check point and so carry on from the last known correct position.

Other safeguards were applied to the magnetic tapes themselves; for example, duplicate programme tapes were kept and those were checked periodically to ensure continued reliability. A 'generation' system was generally applied to main file tapes; under that system the old main file and amendment tapes from which the current main file was produced might be stored away from the computer system until a new main file had been correctly produced from the current main file and the latest amendment tapes. A further check used was the periodical printing of the tape records.

Questions were asked and comments made by **Mr W. Perks, Mr D. R. Spackman, Mr C. A. Poyser, Mr J. M. Beattie, Mr W. V. Webb, Mr P. V. Ellis, Mr G. A. Brown, Mr N. S. Graham, Mr K. J. Britt, Mr J. Bacon, Mr G. W. Pingstone, Mr R. E. Beard, Mr J. Plymen** and **Mr R. L. Michaelson.**

Mr K. A. Usherwood, in closing the discussion, paid a tribute to the willingness of their North American friends in the United States and Canada to give not only for the benefit of the visitors, but for the benefit of each other, the case histories both of their achievements and of the hitches and mistakes which had inevitably occurred in those achievements. He was left with the impression that for any office and any organization, the size of the computer which should be contemplated must be governed by what he might describe as the major foreseeable operation. In other words, it was most unlikely that any planners would succeed in foreseeing all the things for which the computer could be used until one was actually installed, and they would have to be content with planning enough to make a computer worth while.

The object in the course of the installation of the computer had surely to be to get the computer earning its keep at the earliest possible moment. He did not believe that it was possible to plan the installation of a computer so that from the day after the engineers handed it over it could be occupied fully, even if the day

when the engineers were going to hand it over was known. So far economy had been the main object of computer installation rather than the extension of operations for research and analysis.

The problem of whether to rent or to purchase a computer was one which had come under his personal notice in other ways. The point had been put to him that the manufacturer was bound to charge obsolescence costs in his rental in any case, so that if a computer was rented the obsolescence costs were bound to be paid at a fixed rate, whereas if one were purchased the owners could decide for themselves when to replace it.

A further point was the problem of transfer of operations from the old system to the new. There were various methods of transfer. One company was proposing to transfer one geographical area of its operations at a time, while others were actually transferring function by function. The function-by-function approach looked simpler and smoother, but it had been pointed out that the geographical approach at least had the merit that the customer, whether policyholder, independent agent, or field staff or broker, had only to learn one new system, whereas if one function were changed at a time the procedure would be constantly altering stage by stage.

Difficulty might arise with the more senior people to whom reference had been made, who, after spending a considerable period at the same sort of job month after month and year after year, might not take kindly to change of occupation. Those staff problems did not, in his view, provide a reason for declining to adopt the most efficient methods, whatever they might be; but the staff considerations which he had outlined did seem to him to indicate the need for careful planning and for the determination to create the right climate of opinion, in which changes could be graciously applied and suitably accepted.

Like some speakers, he had felt that in some respects the proceedings that night might be thought to be somewhat non-actuarial. On further thought, however, it seemed that developments of the kind in question, which of course affected many professions and occupations in addition to their own, were actuarial, since they had a great bearing on the record systems of the offices or other organizations for which actuaries worked.