Character Recognition and Document Handling in Banks

By R. Hindle

The automation of bank accounting processes cannot go very far unless based on the assumption that automatic document handling equipment will be provided. Moreover, the specification of the required document-handling machines is exacting because of the basic principle of bank accounting—that it is an "open" system operating with vouchers, cheques, credit vouchers and so on, which are produced, in the main, outside the control of the banks where they are to be processed.

The Banking System

The need for economic accounting systems is more pressing in banks than in many other organizations because by far the greater part of staff time and equipment costs are absorbed in this accounting effort. On the other hand, a bank's profit is not derived from the charges for the accounting service, which costs them so much, but from the funds that they hold and can therefore invest. Accounting operations mean that money is moving, but profits come from money that is static. The banks hope to attract more of the public to use their services, but such extension must be largely in the groups who will provide a lower order of static balances compared with the turnover on their accounts, making economy of accounting processes even more necessary.

Another peculiarity of the banking system is that a large proportion of vouchers enter the banking system at some office other than that where the account is kept, and consequently they must pass from hand to hand through the clearing system until they arrive at the office where they are to be accounted for. In the course of their progress, they are likely to suffer mutilation and contamination, but nevertheless they must be readable when they reach their destination.

The British system of clearing is simple. All items to be cleared from all branches of all banks throughout the country are routed to London (except for a small proportion of items which are exchanged on a local basis, but the area covered by these local clearings and exchanges is severely limited), where the clearing departments of the banks exchange the packets. Each bank, now having cheques drawn only on its own offices, distributes these to its branches and carries out the accounting functions of settling with other banks and charging to its own branches. In these clearing departments, therefore, are accumulations of large numbers of items (a single bank may deal with up to a million in a day), and they would appear to be particularly suited to automation. The daily cycle is to list cheques in the order of receipt in order to prove to the other banks' lists, then to sort out into packets according to the branches on which the cheques are drawn. It is customary then to microfilm the cheques. The branch packets have to be listed; sometimes this is done in the clearing department but often under present circumstances the operation is left to branches. Finally, there is a reconciliation between the incoming lists and the branch lists.

Document Sorters

The banks, it appears, have provided the major motivating force for the design of paper-document sorters. Perhaps it has been easier for other commercial houses to adopt for their systems the longer established document sorting techniques—the familiar punched-card equipment. The earliest demonstrations in this country date back to 1953 and were given by our own punched-card firms—BTM and Powers; the speeds of sorting were approximately 150 per minute. More intensive and more fruitful work was carried out in the U.S.A., where the Bank of America commissioned the Stanford Research Institute to develop an electronic banking system. The experimental sorter developed for this system was bulky but effective. However, a sorter developed by Pitney Bowes and now being offered by the National Cash Register Company Limited was adopted by that bank for its accounting installations. Its speed of sorting is 750 items per minute. IBM also have developed and are now offering a cheque sorter with a maximum speed of 950 items a minute. The Burroughs version now available (not their first model) is capable of sorting up to 1,560 items per minute. Two other sorters are available in the U.S.A., one is being developed by BULL in Paris, and there are two projects under development in this country.

The knowledgeable systems analysts will look carefully into quoted speeds of sorting. The Pitney Bowes method is to pass cheques at a synchronized repetition speed, and consequently the speed quoted is attainable under practical conditions. Other manufacturers work with a constant gap between cheques, hence the speed of sorting depends on the length of the cheques.

The figure of real interest is, of course, the speed with which the complete sort can be attained and there has to be taken into account many other factors such as the number of rejects or jams (and the extent of the lost sorting time arising therefrom), the sorting technique that can be applied to the machine, and so on.

Sorting Techniques

The digital sorting method (i.e. that used in punched-card systems) is suitable where the number of digits in the key is relatively small, where substantially all variants of the key are present in the material to be sorted, and where the batches from the sorter do not vary too widely. At the other extreme, where the key has a large number of digits and where only a small proportion of possible variants are present, the digital method is wasteful and a programmable-sort technique might be worth while. In this case an electronic controller is programmed to sort on the whole key; on each pass it will select only one variant of the whole key for each pocket. In this case there is no particular justification for ten pockets. One of the American sorter versions can be made to provide 16 pockets for this purpose.

For the banks' clearing operation the key is the branch number—four digits only. A large proportion of possible variants are in use. The sizes of the batches for the different branches vary widely, however, and the banks have attempted to provide for more economical sorting by arranging for the larger branch batches to be taken off the machines during earlier passes, by using offsort facilities built into the available machines. Three techniques are available on different machines.

(1) Manual setting of the code number to be offsorted.
(2) Zero kill whereby if a zero appears in the column being sorted the reader checks digits to the left and if all these are zero the item passes to the offsort pocket, otherwise they go into the normal "O" pocket.
(3) Override. If certain digits appear in the "override" position these cause the sorter to ignore the digit in the position being sorted to pass the item to the offsort pocket.

A single size of cheque is impracticable. However, all the sorters referred to will handle a range of sizes intermixed, the range embracing the limits declared by the banks, i.e. maximum 8 in. $\times$ 4 in. down to a minimum of 6 in. $\times$ 3 in.

Problems arise concerning the kind of paper to be used for vouchers intended to be sorted automatically, and research bodies in this country and the U.S.A. are co-operating with the London Clearing Banks in their search for a suitable medium.

Automatic Reading

Automatic sorters must be able to read for themselves and consequently automatic reading techniques have been fully explored. In the early days of research, miniholes and fluorescent-ink spots, as automatic reading codes, were considered, but were rejected. It was felt very strongly that human beings must be able to control the machine functions, and therefore the code should be in the form of arabic characters equally understandable by the machine and by the human operator controlling it.

In the U.S.A., the Stanford Research Institute, in the ERMA project previously referred to, had produced an answer. A comparatively simple reading technique for numerals only had been evolved, using arabic characters somewhat distorted from the normal in order to accentuate differences between characters when read automatically, but which numerals nevertheless were still recognizable by human readers. The problem of contamination by rubber stamp impression or writing ink was overcome by using an ink with a magnetizable content to print the characters. Immediately prior to reading, the characters passed under a magnetizing head, and the characters were read by magnetic effect, which could be detected through the contaminating marks which might obscure the characters visually. This method was adopted by the American Bankers' Association and was developed by the machine manufacturers into what is now known as the E13B system, eventually to be accepted as the *common machine language* by the American banks.

In this country, the banks also examined alternative propositions. Optical systems were studied but were thought unacceptable, because of the problem of contamination. The development by E.M.I. of the FRED system was encouraged, and later the BULL method of reading was also given an opportunity of proving itself. However, taking into account economic as well as technical considerations, the London Clearing Banks decided that for their purposes (and the same arguments would not necessarily apply to those in different circumstances), the American E13B character form was the best available. Consequently, in 1960, E13B was accepted as the common machine language for English banks.

Code Line

All three character forms mentioned are the same size, i.e. $\frac{1}{8}$ in. high and 8 to the inch, and already it had been decided that the code characters should appear on a single line, nominally $\frac{1}{4}$ in. from the bottom of the cheque to match the position decided on by the Americans. After all, it was expected that the same machines would be used. The necessary changes in cheque lay-out (comparatively minor except in the case of some special cheques) are well under way already, and other accounting forms are being redesigned on similar lines.

It is practicable for matter other than the code line to be printed in magnetic ink, if so desired, but the stipulation is that any such magnetic ink must be outside a band $\frac{5}{8}$ in. wide along the bottom of the cheque—playing for safety, where possible banks are trying to clear all printed matter from this $\frac{5}{8}$ in. band. The permitted vertical tolerance of the code line is specified as $\pm\frac{1}{16}$ in., but this is governed largely by the risk of paper edge damage. In fact, the reading head searches over a $\frac{1}{2}$ in. band (the other $\frac{1}{8}$ in. is a safety margin). In the case of IBM equipment there is normally a search limit

feature, which requires characters within a block to be aligned to closer limits with the lead-in symbol.

Five items of information are to appear in code on the code line, these being from right to left (the order in which the machines read):

the amount,
a transaction code to identify for the purpose of automatic accounting the kind of entry being read,
an "on us" field,* which, in the case of a cheque, will be occupied by the account number,
the bank and branch code number,
and a second "on us" field, which, on a cheque, will be occupied by the serial number.

The serial number and the bank and branch number are known to the cheque printer and he will put them on when he prints the cheque. Quite likely, transaction codes will often be printed at this stage. He can also print the account number in cases of cheques printed specially for customers. In other cases, cheques will have to be printed with the account number at the branch issuing them. Much thought has been given to the possibility of using an addressing machine of a special type for this purpose, but there is grave doubt about the ability of this method to print to the exacting standards required for E13B printing. Centralized methods, using the lithographic process, are more in favour at present for the "personalizing" process (the name of the customer is printed as well as his account number), but there are also some type-set machines specially developed for the purpose.

Machines are available also to enter amounts on documents in E13B characters. It is not the intention to ask customers to do this; at some point within the bank accounting system, the amounts as written by the customers will have to be read and manually converted into E13B characters on the code line. Suitable equipment is already available, which combines adding and, in some cases, analysis facilities with the E13B amount encoding. These machines can also apply a transaction code, adjacent to the amount on the code line. The adding function is used to prove the amounts as encoded.

Ideally, all branches of all clearing banks would be equipped with amount encoders. They would then encode amounts on all cheques passing through their hands, whether drawn on their own or on other banks. From that moment onwards processing could be automatic. Though this situation might arise in the future, in the early stages different banks will move with differing speeds and those who first need E13B amounts will have to apply them in their own offices. Where this will be done depends on the systems approach. It would be reasonable to use these machines in the clearing department, to be used on first listing cheques as received from other banks, so permitting automatic processing from that point onwards. On the other hand, if first emphasis is on an automated customer-accounting system, there would be no point in encoding cheques on branches not to be included in this automated system, and, consequently, encoding would be carried out at a later stage.

One of the problems, presented by the "open" system of accounting, is the length of time that it will take to ensure that a reasonable proportion of cheques in the pipeline via customers are encoded with data in E13B characters; it is generally believed that two years must elapse before a new form of cheque can be in general circulation. However, a number of banks have now at least an experimental sorter on order, and it can be expected that by the autumn of 1961 there will be in operation exercises in the automatic reading and sorting of cheques, which will be of convincing dimensions.

* i.e. a field for use by individual banks which has no inter-bank significance.

Summary of Discussion

The Chairman, Mr. A. Geary (*Head of Mathematics Department, Northampton College*) in opening the session, had said that the speakers for this last session were from organizations rather different from those represented in general in the Conference. Mr. Hindle, the first speaker, represented Martins Bank on the Electronics Sub-Committee of the Committee of London Clearing Bankers; he was one of the three members of the Working Party.

Mr. H. W. Emery (*Ministry of Agriculture, Fisheries and Food*) asked whether the speaker had given consideration to the Postmaster-General's payable orders in this résumé.

Mr. Hindle replied that he ought to have said that a great deal of co-operation had been received from the user bodies and he had talked to the representatives responsible for these problems who saw eye to eye with the banks in the sort of things that were now wanted. Indeed, in talking to them one got the impression that they were co-operative and would fit in with the framework of new bank systems. He did not know of any specific problems which arose which did not permit them to fit in and he hoped that they would go the way mapped out by the banks.

Mr. G. H. Perkins (*Mullard Equipment Ltd.*) said that he gathered that the problems of automated sorting, and the attendant problems of which they had heard that afternoon, were largely created by the banks themselves in concentrating documents for statistical and accounting analysis. Had the banks investigated the alternative of what was virtually simultaneous sorting by day-to-day transmission over some means such as Telex? What were the relevant economics? No doubt, the information required by the accounting, etc., authorities might be derived from the same transmission.

Mr. Hindle replied that the banks would like to do away with all these bits of paper. They would not have to bother with bits of paper if only customers could initiate entries via some telecommunication system; these entries could be passed on via a data telephone exchange, untouched by hand. It seemed to be a fairly satisfactory method of doing it in the long run, but meanwhile the problem was to handle pieces of paper and interpret the data thereon at each point.

The next stage would be to say "All right, let us have an interpretation at one point only, and let us then transmit data rather than transport paper," but the problem was the passage of the customers' authority for the transactions: a difficulty when the instruction went through to other places was to make sure it was an effective entry. A clearing department could see that the amounts of transactions and identity of customer passed to destination, but this must be authenticated and the only way to do that was by signature. The problem was to pass the information with the signature. They had been told by scientists that they could analyse a signature into an electronic pattern. This being so, and if it could be proved, there was a way of transmitting accounting data by a telephone circuit, but, of course, this was something which would have to be developed and brought down to reasonable economic proportions.

Rather closer was the duty of transmitting rather more locally as between the receiving position and the accounting position. It was the accounting problem for a branch some distance away from the central posting system and much attention had been given to daily transmission methods. One bank in particular was well advanced in planning to make use of this sort of circuit for the transmission of data. Some experiments had been made to see whether information could be passed by telecommunication means from London to Liverpool with not very encouraging results at this stage, and the bank would not be justified in moving to this field until one could see that it would work out with a sufficient degree of accuracy; they had not investigated the cost. The method of transmitting over the telex circuit, and the exercise he was speaking of was over the telex circuit, was too slow in view of the amount of data which had to pass and the bank was more interested in the higher speed transmission systems which would pass over a telephonic circuit. They were interested only as a possibility, but it was not near enough for it to be incorporated into the system. His bank believed in trying things before costing them. One could often be discouraged by cost before even trying something. They would experiment and when it was known whether it would work it would be costed. Until that was done he could not give any comparative costs.

Mr. W. E. Norman (*IBM*) thanked Mr. Hindle for his description of progress in telecommunications. Regarding devices which were available for transmission, one could use the IBM Magnetic Tape Transmission Terminal for transmission of data recorded on magnetic tape over any distance, on a private speech line, by special arrangement with the G.P.O. One could also transmit, at the same speed, 150 characters per second, from one IBM 1401 computer to another 1401 computer; also a magnetic-tape unit could transmit to a computer and vice versa; so there were four possible tape unit and computer links. The G.P.O. had given approval for the use of these units over a private speech line of Tariff D or Tariff E quality.

Mr. Hindle said that the point he wanted to make was that in banking one must move the signature with the entry and that data transmission at the present time could only be as between the branch and the accounting centre. Generally speaking, the use of such circuits depended on geographical considerations. The first computer was only just being installed for the bank and the branches affected were immediately adjacent. Long distance transmission had not become a necessity yet. When the lines of communication lengthened the banks would be sufficiently advanced in their techniques to make use of what was available. As between the point of collection of the cheque and the point of payment one had to move the signature, not only the data, and that was why the more highly developed systems were difficult to bring to a bank.

Mr. G. S. Dorey (*United Glass*), said that speaking at a much more mundane level, cheques now 6 inches long, which is to be adopted as a minimum size, have to be folded to fit into a standard-size envelope. Were the banks going to issue envelopes to fit the cheques, or run the risk of all these folded cheques jamming the machine?

Mr. Hindle replied that it was better for the banks to go to the manufacturers and say they must handle folded cheques; they must devise machines for the purpose. They could not expect cheques not to be folded and had no intention of saying folded cheques could not be accepted, but in practice by the time the cheque got to the clearing department it had been opened and handled and put in a packet with a lot more cheques; the packets had been compressed in passage through the Post Office and had gone through to the clearing department in a pretty flattened state. It was too early to say that the creases would have no effect, running a test would show if it was a difficult problem. If it was, it would be cheaper to throw the computers away rather than buy customers' envelopes for their cheques.

Mr. J. M. Dunsdon (*Price Waterhouse and Co.*) had two questions he wished to put. Had the bank set a target date on which this system was to be brought into operation, and, secondly, would the banks consider getting rid of the old type of cheque? His wife drew a cheque once every six months and at that rate a cheque book lasted a long time. He would think many such cheques would remain in existence; would the bank withdraw them or handle them as they came along?

Mr. Hindle replied that at the moment they were in the experimental state and no target date was in mind; the date when banks would put these methods into operation would vary from bank to bank, but sooner or later something in the nature of an ultimatum would be issued and the bank would say that as from such and such a date they would prefer that customers use the cheques of the new type, but that date was not yet. With regard to the wife who drew one cheque every six months, he felt she was using the wrong cheque book. His wife drew as many cheques as he did himself, but the important thing about the ladies was that they must be in the fashion.

The Chairman said that Mr. Hindle was the Manager for Organization Research and Development at the Head Office of Martins Bank; the Conference was specially indebted to him for coming from Liverpool to give this most informative address. The members thanked him very much indeed.

Mr. Hindle, in thanking the members, asked them to co-operate with the banks and get rid of their old cheque books as quickly as possible.