generally speaking, that with a computer there are fewer people who need to be involved in collusion in order to achieve a fraud, but the collaboration would need to be very close and very carefully planned. Almost certainly the falsification would have to apply, not to one or two items in a procedure, but to all in a given run. This would make the risk of detection very great.

My own view is that, in practice, the chance of using the computer fraudulently is negligible. Anyone seeking to defraud could more easily do this by falsifying the data. The computer program should provide checks on the consistency, but this could only be carried to a limited extent, and anyone wanting to defraud would probably find ways to get round such checks as there are.

In orthodox systems data sheets are scrutinized by other people while the job is being done, and so fraudulent entries are much more likely to be detected than later, when the data is being fed to a computer. For this reason the auditor of a computer system will be most concerned with the audit of the data.

Reconciliation Statements

It should be realized that a computer produces much more accurate results than does an orthodox office system, even when the work of the latter is checked. The number of errors an auditor is likely to find is, therefore, very much fewer. Apart from this the computer can be made to check itself to a much greater extent, with little or no extra cost, by having many more reconciliation statements.

Because these reconciliations are produced regularly day by day or week by week for each run of the computer, the auditor can examine the trend of each figure on them and, whenever a significant change is detected, the reason can be sought to see that it is fully justified. An examination of this sort can enable the auditor to find out if the work is accurate, and will bring to light any significant fraud.

Individual Checking

Although with the computer system there are no records of the procedure which the auditor can follow through and check, he can still carry out the procedure for himself in those cases where he wishes to make sure that the computer has obtained the right result. The auditor will, first of all, want to choose any items with abnormal results, but he also will want to pick out items at random, by some statistical sampling process, so as to be sure that an adequate check is being made. By this means he can satisfy himself that, in general, the correct procedure is being carried out and that there is no fraud of any magnitude being perpetrated.

Changing Circumstances

In all matters of accountancy and administration, the danger of inadequacies creeping in as circumstances change must always be present. This is equally true of computer programs. Up to the present this problem has not been met because everyone is strongly aware of the need to be informed of the circumstances and to take appropriate action. As programs settle down, however, and as changes in programs become more commonplace, this will no longer be the case. The auditor will fulfil a valuable function if he detects the need for bringing programs up to date. If he examines the specification when he starts the audit he will see if it has been modified since the last audit. If so, he can make sure that the modifications have been properly incorporated in the computer program. If any change in program has been made without a change of specification, this will quickly be detected by the random-sampling checks.

During the audit, care should be taken to see whether there are such changes in the nature of it to indicate a change in circumstances to justify a change in procedure, and therefore in the computer program.

Section 2: The External Auditor and Computers

By F. Clive de Paula

Introduction

At the outset, we should note a benefit that the computer should bring to the auditor, whether internal or external—namely, the greater likelihood of accuracy in the accounting process. Human clerks get tired and become more prone to error, whereas the computer can be expected to work longer hours with less likelihood of careless or slovenly work. Once the procedures have been laid down in the computer program, there is a greater probability of identical procedures being followed than there would be if a number of individual clerks were concerned. This greater probability of accuracy and of identical procedures means that a smaller test by the auditor is likely to prove the correctness of a greater volume of transactions.

Next, we must realize that the introduction of a computer does not in any way affect the value to the auditor of vouching original entries. The need for that vouching remains unchanged, and the method of doing it is unlikely to alter. In fact, the possibility of reducing the amount of routine "ticking" should enable the auditor to devote relatively longer to the more worthwhile task of vouching.

However, we cannot close our eyes to the fact that, from the auditor's point of view, the computer has a disadvantage in that it tends to eliminate people in the accounting process. As a result, fewer people are likely to control more aspects of processing a greater variety of transactions. This could mean that protection against collusion is decreased, and it is something which the auditor must watch carefully when considering the effect of the computer on the system of internal checks.

It is, naturally, still open to the auditor to take the original transactions on the one hand and the final accounts on the other, and to check that the former are correctly reflected in the latter. To do that is, after all, his prime responsibility. He can do it either by tracing a small sample of items through from start to finish, or by overall checks. By either method, it is of greater importance to him than ever that the numbering, coding, filing, and cross-referencing of the original documents should be done clearly and efficiently.

Nevertheless, there is a tendency for the introduction of a computer to cut out some of the separate steps in the accounting processes. Whilst this must tend to reduce the extent to which accounting is "fragmented," nevertheless for some time to come we are likely to be a long way from fully integrated "one step" accounting. However, if the auditor is to have reasonable facility to carry out test checks, he must ensure that the computer processes are divided up into sections of a reasonably small size, and that section totals are compiled and preserved for him. This will then enable him to check these section totals with the underlying detail, and carry a similar process of testing through the whole process. Clearly, if each section, for which such control totals are provided, is too enormous, it would make his work unnecessarily laborious—and therefore costly to the client.

Checking what the Program does

If, then, the auditor is to take an interest in the way in which the processes are broken down, it follows almost inevitably that he must take an interest in what is being done at the stage when the computer program is being written. Furthermore, if he is to take an intelligent interest in the programming, the more he understands about the computer and how it is programmed the better. This is not to suggest that it will necessarily be easy for him to learn something about the computer and its programming; but, on the other hand, it is not so impossibly difficult as to make it not worth trying.

If the auditor is to construct an intelligent audit program, it is suggested that he should study what is being done when the main framework of the program is being designed. He should study and agree the main outline of what is being programmed. Then, when the program is completed, he should study it in detail so that he knows exactly what it does—fundamentally, this is no different from the normal study he makes of any accounting procedure, whereby he evaluates the degree of internal check imposed, and decides what checking he needs to do. In particular he would want to know what checks are, and what are not, built into the program. He must also see that the program is arranged to produce the sub-totals and check figures that he will later need, which were referred to above.

"Master" copy of the Program

Having done this, it would seem sensible for him to "seal" the program—in other words, the program, as agreed, should become the only authorized program allowed to be used. To ensure this, the auditor might retain a "master" copy of the program in his own office. This would probably involve him in having copies of the program flow chart, as well as the detailed program sheets. He might also retain a copy of the set of punched cards on which the program is held for operational use, or the punched tape, or magnetic tape or whatever is used. It is conceivable that he might need charts of plug-boards, etc. How far he would need to go would depend on his own judgement of what is needed to enable him to check that the program has not subsequently been altered, and on the type of check which he later plans to impose.

Once the program has been finished, both the business concerned and the auditor have an interest in seeing that unauthorized alterations are not made to it. The necessary internal disciplines should be set up to ensure that alterations to the program are approved by all concerned before being incorporated into the routines. Likewise, when regular routines are being run, there should be strict control of what programs are being used, and when. Failing such control, it might prove difficult for the auditor to satisfy himself that in fact the program which he agreed and checked was really used in routine operation.

As part of the internal check, the programs should be stored in a program library, outside the control both of the machine operators and of the accounts department. Accurate records should be maintained of their issue and return, by whom, to whom, and when. Furthermore, there should be interlocking codes built into both the programs and the relevant records, identifying both the programs and the relevant data and brought-forward balances, preventing data and balances being processed except by the correct program.

Auditor's Test Runs

If, then, the auditor holds "master" copies of the authorized programs as referred to above, and if the individual "runs" are cut into convenient lengths, there is nothing to stop his carrying out a controlled test, using his own copy of the program and running the current data to see whether his "run" produces results identical with those previously produced by the client's staff. But, if he is to do such test runs, he must have a "starting point," in the form of any necessary brought-forward balances, or other basic data. Hence the importance of making sure that the appropriate intermediate and subsidiary totals will be available, which was referred to above. Furthermore, it may mean the auditor having to insist on the client retaining such things as the magnetic tapes containing the necessary detailed brought-forward balances, until he has made his audit tests or stated that he did not require them.

However, it must be recognized that to retain such magnetic tapes of balances for any length of time might involve the client in building up a very large stock of tapes, which are expensive. The auditor must therefore be reasonable, and should if necessary be prepared to test frequently and quite soon after the event. As soon as he has either done his test, or stated that he is not going to do one, he can authorize the re-use of the relevant magnetic tapes, and the erasure of the details on them.

Correcting Errors

The next important point is the control of procedures for correcting errors that arise. In his review of all procedures, whether computers are used or not, one of the points to which the auditor must always give close attention is how errors are corrected. To protect the client against the danger of fraud being perpetrated under the guise of the correction of error, a strict routine must be laid down for the correcting procedure. In particular, the routine should so far as possible require the co-operation of two or more people; it should be covered by full documentation; and it should be strictly followed and enforced. If the auditor attends frequently enough (as it was envisaged earlier that he might), then he might even authorize correcting entries before they are made.

Attending more frequently

The points made above suggest that the auditor may have to envisage a change in the timing of his work. When he was dealing with ledgers written up by quill pens in bound leather and parchment ledgers, he could attend five or six months after the event to carry out his checks. Such delay did not matter with records nearly all of which were of a permanent nature. Now that the processing is being done with paper tapes, punched cards, and magnetic tapes and films, some stages of the processing are getting on to media which are of only a semi-permanent form. This may well mean that the auditor will have to attend more frequently during the actual year, to carry out such tasks as the following.

(*a*) Do test runs and authorize the re-use of magnetic tapes of brought-forward balances and other data, referred to above.
(*b*) Authorize correcting entries, referred to above.
(*c*) Spot check that the correct use is being made of program, tapes, etc., and that the program actually being used is identical with the "master" program that he holds.
(*d*) Spot check the library records of the programs and magnetic tapes, etc., that are "out" being used.
(*e*) Spot check the computer log which records who controls the machine, when it is in use, and what they are doing (referred to below).

Basically, this is no different from the similar visits he makes to carry out spot checks of cash balances. In other words, the auditor may have to get into the habit of attending at his client's office now to check what is being done, rather than turning up afterwards to check what has already been done.

Programming to "print out" Corrections

When discussing above the correcting of errors, it was implied that the correction should be the subject of a special routine, and that normally no errors should ever be corrected "on the spot." With a computer, however, that procedure might not always be possible, because certain errors, until corrected, would cause a hold-up in a long data-processing procedure. In such circumstances, it might be desirable for a routine to be written into the original program providing for a "print out" of details of any corrections that are made in the course of a run—for example, by printing out the original record, or figure, with details of where it came from, together with details of the corrected record, or figure, with details of where it went to.

A Monitor of the Control Console

This consideration leads on to the whole problem of settings on the control console. However much the auditor might check and agree the original program, and the interlocking controls between program and data and brought-forward balances, he has no positive proof that the program was in fact used throughout the whole of a given run—other than the spot checks that he may make, referred to above. The console could have been used to interrupt the program and insert other instructions at some stage of the proceedings. Admittedly, this irregularity is far from easy to carry through, but it is not impossible; and it must be remembered that most of the really spectacular frauds have required a vast amount of patient ingenuity, which the perpetrator has considered to be well rewarded by the fruits of his labours. It would therefore seem desirable for there to be built into the computer an automatic procedure for printing out all console settings on which the computer acts. From the audit point of view there would thus be a check that unauthorized procedures had not been inserted via the console. This would be an equally valuable check when program testing, and when trying to find out why a given program went wrong. It might be equally valuable from the operating point of view, when making a quick check as to why a given "run" has gone wrong. If the "print out" of the console monitor were available to the operating staff, then a separate tape, or print out, would have to be in a locked bin, to which, preferably, it should only be possible to gain access by the use of two keys held by two separate people. A console monitor of this sort should not be difficult to arrange, and one computer manufacturer has already included some such device in one of his machines.

The auditor is also concerned with control over the use made of the computer and reference has been made earlier to the need for the auditor to check who used the computer and for what. As part of his check on the system of internal control, he should check the normal computer-room log, which should show who was in charge of the machine; what program was being used; what data was being processed; what standing data was being amended; and when. In addition, it would be useful if the automatic console monitor, referred to above, were to record the details from the identification codes on each program, pack of cards, tape, etc. It could record such information as, for example, when the machine was switched on and off; the identity number of the program tape in use; the identity number of the current data tape, or pack of punched cards; the identity number of the tape, or pack of cards, of standing data or brought-forward balances; the identity number of the tape, or cards, carried forward, or other output data.

As part of the internal check, there should be control of the use of the computer out of office hours. Both during normal office hours, and at other times, there should always be two people on duty to sign, and countersign, the normal hand-written log. It has also been suggested that the automatic console monitor might be linked to the H.T. clock and might be arranged to switch off the main electricity supply outside normal office hours, so that misuse of the machine cannot take place when nobody is about.

Conclusion

Many of the points raised above are put as suggestions about which the auditor must think. As yet the experience gained of auditing computer-controlled clerical processes is very small. The technicalities involved are so complex that the auditor is liable to be mesmerized by the problem of *how* the computer does it—rather than concentrating on *what* it is doing. Furthermore, the auditor has responsibilities in connection with the accuracy of accounts both from what might be described as the mathematical point of view, and also from the point of view of fraud. However, there is a tendency for attention to get concentrated on the mathematical side of accuracy, to the exclusion of the problem of fraud. It may, therefore, be thought that the above paragraphs pay too much attention to the problem of fraud. No apology is made for this. The auditor can afford to ignore the problem of fraud only at his own peril—the peril of an action for negligence. All that it is being suggested here is that he should give careful thought to all the above points. If, after careful consideration of all the circumstances of the case with which he is dealing, he decides to ignore certain points, then at least he is taking a calculated risk with his eyes open.

Book Review

Programming Programme for the BESM Computer, by A. P. Ershov. Translated from the Russian by M. Nadler. Edited by J. P. Cleave, 158 pp. Pergamon Press, 1959.

This book is an account of the algebraic language translator developed for the BESM computer at the Computation Centre of the Academy of Sciences, Moscow. It is the first book published in any language on the subject of automatic programming. The work described in the book was completed in early 1956.

BESM is a 3-address code machine employing floating-point arithmetic. It has a ferrite core store of 1,024 (39 bits) and a diode "fixed" store of 384 words for standard subroutines. There is also a magnetic drum consisting of 5 sections each of 1,024 words, and 4 magnetic-tape units. The input unit is a photoelectric tape reader (2-hole tape), and for output there is a directly-coupled tape printer and an off-line photo-printing equipment operating from magnetic tape. An instruction word provides for up to 64 operations (6 bits) with 3 addresses each of 11 bits. There are no "B" digits and address modification is done by a separate operation, "addition of instructions." There are 2 controls: a main control and a "subroutine" control. A number word consists of an exponent (6 bits) and a mantissa (33 bits). There is no fixed-point arithmetic, but one of the function digits allows the user to inhibit normalization. The "magnetic" instructions provide for the transfer of an arbitrary set of consecutive words between the ferrite store and the drum or tape, and vice versa. The access time of the core memory is 6 μ sec, and the speed of the machine is between 8 and 10 thousand operations per second. There are 34 operations in the instruction code, which is very easy to learn.

The development of automatic programming in Moscow appears to have been influenced by two principal factors. The first of these was the early lack of alpha-numeric input facilities: all information is read in (and can be put out) in hexadecimal form, and there are built-in instructions to do this. Consequently, before a program can be put on the machine it has to be "coded," and to judge from the account of this procedure (chapter 2) it would appear to be rather a severe bottleneck to using the machine. Apparently, however, there is plenty of semi-skilled labour for such routine tasks, and as a result programmers proper are not restricted to using "keyboard" symbols in the source language, or a "one-dimensional" format. Instead, the "operational" notation of Liapunov has been adopted; this has been the other influencing factor. In this notation a calculation

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