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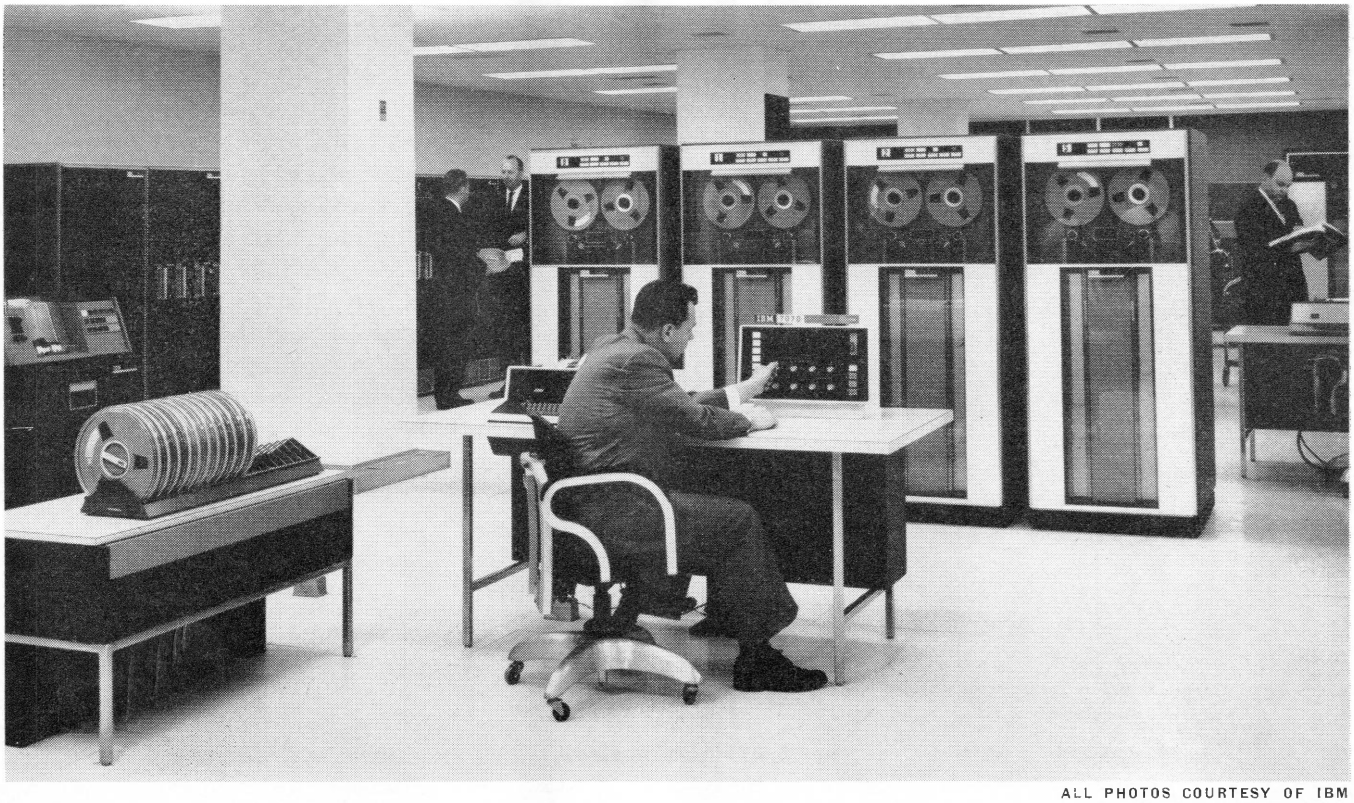

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THE EFFECT OF EDP ON INTERNAL CONTROL

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THE RAPIDITY with which electronic data processing is revolutionizing our "paper work" world is amazing, if not breathtaking. EDP has exposed the business community to an environment which is unique only unto the world of electronics and computers. In fact, the presence of an electronic computer has certainly affected the accountant's traditional paper work oriented methods. Perhaps this effect is best recognized by the change in appearance of many ledgers, journals, and source documents. But methods of implementing internal control, too, have been affected. For many years internal control has been identified with such characteristics as the division of duties, a network of authorization and approvals, arithmetical verifications, and lines of responsibility; however, with the ever-increasing centralization of data processing through the use of large-scale electronic computers, there has been a tendency to consolidate many of these functions.

For example, in processing sales on account, a computer system, by just one pass of the data, can record the sale and the receivable, modify the inventory file, compute the cost of the sale, test to see if the inventory needs to be replenished, type a purchase order if necessary, and prepare an invoice and shipping documents which relate to the original transaction. Since the computer has performed all of these operations without manual intervention, not only has there been no division of duties, no authorizations or approvals, nor any lines of responsibility, but the incredible accuracy of the computer has even eliminated the need

for arithmetical verifications. It seems fitting, therefore, that one examine more closely existing internal control methods in order to determine what real effect EDP has had upon them. The first portion of this paper will explore this. Thereafter, a discussion outlining "new methods of control" will follow. In addition to outlining a new control network for EDP, we will also attempt to show which of the traditional methods of implementing internal control are compatible with electronic data processing systems.

The American Institute of CPAs defines internal control in this manner:

"Internal control, in the broad sense, includes . . . controls which may be characterized as either accounting or administrative. . . .

"(a) Accounting controls comprise the plan of organization and all methods and procedures that are concerned mainly with, and relate directly to, the safeguarding of assets and the reliability of the financial records. . . .

"(b) Administrative controls comprise the plan of organization and all methods and procedures that are concerned mainly with operational efficiency and adherence to managerial policies. . . ."[1]

One can note that the above definition delineates between internal administrative control and internal accounting control (including internal check). The committee on auditing procedure resorted to this division of internal control in order to more clearly indicate the auditor's responsibility for the review of internal control. From a systems standpoint, however, the entire concept must be considered.

Internal administrative control is characterized by the organizational independence among departments and lines of delegated authority. The impact of EDP upon this group of controls has not been as far-reaching as in the case of internal accounting control and internal check. Nevertheless, some of the characteristics of internal administrative control are affected. The organizational independence which now exists between an operating department and accounting is undergoing an change in emphasis. Consider, for example, the following statement:

". . . I believe . . . the internal control function will have excellent results in the long run by focusing attention on the essential point of control (i.e., where the transaction takes place) and away from some of what we now consider controls which are established in accounting departments."[2]

The foregoing statement might be taken as a direct violation of the premise that no department should control the accounting records relating to its own operations, but this is not the case. What is implied is that the formal preparation of source data, for processing by the EDP system, will in the future become the responsibility of operating departments as data processing becomes more integrated and the desire for up-to-the-minute results increases (consider the widespread use of the data transmission devices which transmit data by wire from outlying district offices to the home office EDP unit). Thus, organizational independence will be vested, not in the separation of the operating department and the accounting department, but in the separation of the operating department and the processing unit or computer facility. Furthermore, lines of responsibilty are drawn within an organization to facilitate conformance with prescribed managerial policies. EDP, however, interferes with a management principle which recognizes that with the placement of responsibility must go the delegation of authority. In the past, lower level management has been free to interpret general managerial policies handed down from above in order to carry out the day-by-day operations of the business. With the conversion to EDP, these groups of managers tend to lose their authority to make decisions, as the computer is now being programed to execute these decisions for them.

Internal accounting control constitutes another element of the existing internal control network. The function of this group of controls is to check the accuracy and reliability of the accounting data. The characteristics of internal accounting controls permit them to be classified under one of three major subheadings—control total techniques, authorizations and approvals, and comparisons.

Control total techniques assure processing accuracy. The provisions made for the use of controlling accounts and the fundamental practice of batching are common examples of methods now being used to assure processing accuracy. Computer systems, however, afford a means for attaining unprecedented accuracy. The element of human error is no longer present when data are processed electronically. Although control totals might no longer be necessary to assure processing accuracy, they are still required to prove that there has been accurate transmission of data to and from the computer facility. Emphasis is being placed, therefore, not upon techniques to assure processing accuracy, but upon new techniques which make certain of transmission accuracy.

Sound accounting control is also believed to be vested in a system of authorizations and approvals. The ability of the computer to make logical, comparative, "yes-no" decisions permits a set of predetermined criteria to be introduced into the stored program, thereby granting the computer the power of review. Input data can be accepted and processed, or rejected on the basis of these criteria. Since the present system of authorizations and approvals is nothing more than a review function—judgments be-

[1]Statements on Auditing Procedure No. 29: "Scope of the Independent Auditor's Review of Internal Control," American Institute of Certified Public Accountants, 1958, pp. 36-37.

[2]Arthur B. Toan, Jr., "The Auditor and EDP," *The Journal of Accountancy*, vol. 109 (June 1960), pp. 45-46.

Predetermined criteria in the program give computer the power of review

ing based upon predetermined criteria—it is apparent that the computer, through its stored program, is capable of performing such routine tasks as: granting credit, reordering stock, writing off delinquent accounts, issuing purchase orders, approving vendor invoices, and preparing checks. These are certainly not all of the duties which might be assumed by the computer, but they are sufficiently representative to indicate how the system of authorizations and approvals is now part of the computer's program.

Control by comparisons

The third classification of internal accounting control, which likewise attests to the accuracy and reliability of accounting data, is based upon comparisons. Comparisons take a variety of forms: time cards and clock cards are compared to prove the accuracy of the payroll; vendor's invoices and receiving reports are compared to authenticate the receipt of material; sales orders are compared with catalog prices to check quotations; and cash remittance advices are compared with accounts receivable to determine the accuracy of customer receipts. These, then, are a few examples of comparison techniques. The computer's ability to make logical comparative decisions of an "equal to," "less than," or "greater than" variety allows representative data to be fed into the computer with the result that the computer itself can make similar comparisons of data.

Internal check, another element of the present internal control system, represents the measures adopted to safeguard the assets. The division of duties (so that no one department, group, or individual authorizes a transaction, records it, and holds custody of the assets) is a well-established principle of sound internal control. The electronic data processing system, however, is designed to facilitate the consolidation of files and transactions. Payables, receivables, inventory records, credit information, salary and wage rates, and ledgers are all a part of the file system of the computer facility. Likewise, every transaction which makes use of or affects these files is processed through the computer. This mass consolidation of files and transactions certainly affects traditional internal control methods.

This, then, illustrates the effect of electronic data processing upon the existing internal control system. In almost every instance it has become apparent that many of the present methods of implementing internal control have been pre-empted by the computer facility. Manual techniques and decentralization have given way to electronic mechanization and consolidation. The internal control system which had been nurtured by management and accountants alike, for almost a decade, must now be re-evaluated, redesigned, and reinstituted in the terms set forth by the EDP environment. The rationale supporting such innovations has been well expressed by Arthur B. Toan, Jr.

"We should make a mistake if we thought of EDP as just a piece of equipment or technique for handling clerical and administrative work. It is also a potent psychological force in its own right which stimulates innovation and creates a degree of drive and receptivity which helps to turn ideas into realities. Those who work with EDP delight in challenging basic concepts of record-keeping, of organization and of management itself. . . .

"EDP specialists have, in short, a striving for accomplishment which is not unlike that of the truly professional accountant. . . ."[3]

How, then, might an internal control system be designed and wedded with the computer facility, when so many of the present methods of implementing internal control seem ineffective. EDP, however, has an answer, for it has in readiness a whole host of new methods—a few of which even represent new applications or modifications of some of the older and more familiar methods.

Internal control by EDP

Felix Kaufman speaks of the automation of internal control via EDP and notes that the "electronic data processing system's powerful checking abilities make it a center of control."[4] He furthermore seems to lend support to a premise that control is now a part of the computer facility when making introductory remarks relative to the effect of EDP upon internal control:

"Systems employed to date, using manual and semiautomatic means for processing, have not achieved . . . internal control goals. Their controls are, in a sense, a separate procedural system, even though superimposed on regular operating procedures. The effectiveness of these controls depends primarily on the continuous vigilance of people, whereas in electronic data processing the means to integrate the procedural system and the control thereof is present."[5]

EDP takes no exception to the American Institute's broad definition of internal control. Only the present methods of implementing internal control are being affected. Since emphasis has been placed exclusively upon the computer facility, it seems logical that these new methods might be characterized by

[3] *Ibid.*, p. 43.

[4] Kaufman, Felix, *Electronic Data Processing and Auditing*, The Ronald Press Company, New York, 1961, p. 146.

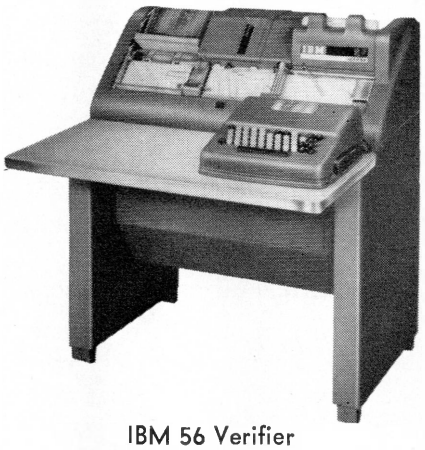
[5] *Ibid.*, p. 123.

the three elements present in any EDP control system—input controls, processing controls, and output controls.

Source data will naturally continue to be generated from the operating departments. Input controls, however, not only ensure that all valid data are being processed, but afford the computer a means for summary checking processing accuracy. The control methods introduced here are not new; they are merely adapted to fit a computer-oriented data processing system.

Batching with a control total. Under batch accounting methods source documents are accumulated into batches which constitute economic processing groups. Control totals customarily represent dollar amounts; but if the input is not expressed in dollars, or as in the case of a random access facility where input need not be sorted into any logical transaction group or sequence, use of some other control total is desirable. These other control totals (commonly referred to as "hash" totals) represent insignificant totals of some data field which is common to all documents in the batch. Common examples of such data fields are quantities, item codes, and account numbers.

Serial numbered forms. This practice is certainly not new, but is included because of the computer's ability to control serial numbers. Serial numbers of certain documents which constitute input (such as requisitions, vouchers, and receipts, as opposed to invoices and checks) might be introduced along with account codes, quantities, etc., and stored within the computer. At periodic intervals the serial numbers of those documents which had not as yet passed through the data processing unit could be determined by the computer for review and follow-up. This would assure that all data are being processed through the computer facility.



IBM 56 Verifier

Digit verification devices. Peripheral devices are available which ensure the accuracy and validity of all input data. Although many digit verification devices are not associated electronically with the EDP system, this equipment is just as much a part of the system as is the electronic computer and its components. For example, International Business Machines' 56 Verifier is one type of digit verification device. This machine checks and verifies card-punching. The operator, using the original source documents and the punched cards, rekeys the data into the keyboard of the Verifier. The machine compares what has been punched and what is rekeyed; any difference will cause the keyboard to lock. Another digit verification device is National Cash Register's Check Digit Verifier. This machine is designed to test the validity of an account number before it is recorded into tape or cards by means of a programed mathematical formula. Thus, the presence of any one, or a combination, of these or similar devices contributes to the effectiveness of input controls.

Processing controls comprise by far the largest and most comprehensive group of new methods of controls offered by EDP. Not only is unprecedented accuracy and reliability attained in processing accounting data, but the impersonal nature of the computer permits transactions and file records to remain independent and assures that prescribed managerial policies will be carried out with a high degree of consistency. Processing controls are made up of checks built into the system by the manufacturer and checks capable of being incorporated into the computer's program. The first group to be discussed relates to the "built-in" features, or what are sometimes referred to as "hardware" controls.

Parity check. The most universal of all machine circuitry controls is the parity check. This particular check verifies each binary-coded character (a character being a letter of the alphabet, a number, or perhaps a special symbol, each of which is represented by a certain combination of zeros and ones). By adding another bit (a zero or one) to the binary code value when characters are being converted to machine-code by some input medium, a condition is created whereby every character is made up of an even or odd number of ones. Computers designed to recognize an even parity count, for example, would process information containing only an even number of ones. The computer, therefore, is designed to check this situation continuously at every point where information is transferred in its system. Any addition or loss of a bit, thereby distorting the character, will cause the machine to stop or correct itself by switching to an alternate program.

Duplicate circuitry. Some computers duplicate the more essential circuitry of their main arithmetic

unit. In this way calculations are carried out twice to insure accuracy.

Dual arithmetic. In this case the computer does not possess dual circuits, but automatically performs every computation twice using the same circuitry. The results are then compared. A few systems are capable of performing the second calculation with the complements of the true figures.

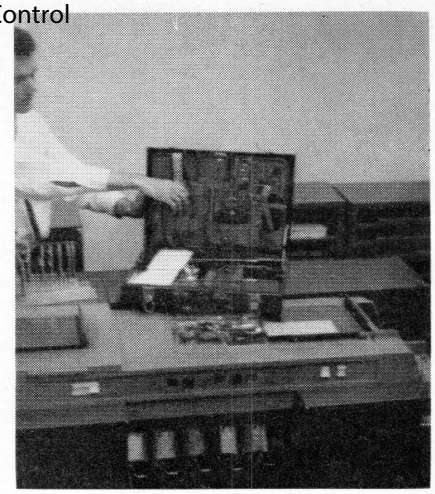
Echo check. This method is often incorporated into the system at points where information is transferred. Here a feedback mechanism echoes a character back from the point of transmission to its source. For example, when information is to be transferred from the computer to magnetic tape, the recording device senses what has been received and a signal is echoed back to the computer from the tape unit. This signal is then compared for accuracy.

Dual heads. This is another method similar to echo checking but is used in checking the transmission of recorded information. A reading device senses recorded information and transmits it instantly back to the source for comparison. Dual heads represent a much more effective check than the echo check, since recorded information is checked, not just the electronic impulse.

Overflow check and sign check. The overflow control is designed to indicate whenever an arithmetic function causes the data to overflow the capacity of a counter or accumulator in the computer's arithmetic unit. This prevents the loss of significant digits during computation. The sign control will indicate whenever an arithmetic function is performed on an amount which does not carry a positive or negative designation.

Tape ring. When information is being written on reels of magnetic tape old information is automatically erased. To assure that master files might not inadvertently be used on an output unit, a plastic ring is removed from the reverse side of the tape reel. Without this plastic ring no information can be written on the tape.

Preventive maintenance. Although this control method is not a part of the system per se, it is included under this section of "hardware" controls because it does



Maintenance: one hour a day

make use of some of the technical aspects of computer design. Normally a schedule is followed which allows a crew of engineers to devote at least one hour each day to preventive maintenance. Test problems are fed into the computer which check all of its components. A "high-low" voltage test is applied whereby the computer is tested to detect marginal functioning of its circuitry.

These, then, represent the mechanical controls which have been built into the electronic computer's system by the manufacturer. A second group of processing controls, however, represent checks capable of being incorporated into the computer by means of coded instructions and control panel wiring. These so-called "programed" controls are much more sophisticated than many of the "hardware" controls previously discussed. They will now be examined in greater detail.

Record count. A record consists of a group of characters which are normally considered together as a unit, such as the combination of numbers which make up a particular transaction or an account balance. The computer might be programed to count the number of records it processes, and later this result can be compared with a predetermined total. Record counts are generally made a part of the information on every tape reel. Thus, file data can be transferred from

Coded instructions to computer can strengthen controls

one tape to another without fear of loss of records.

Sequence check. This program control permits master records to be checked for ascending sequence while being read for processing. Master records, for example, might be identified consecutively by customer number or account code. This control method assures that a file is processed in its proper sequential order.

Limit check or reasonableness tests. Predetermined limits (gross pay, the amount of an invoice, or the amount of a purchase order) can be established as a part of the computer's program. When processed data exceed these predetermined limits, the machine can be instructed to stop and special handling techniques can be designated by the on-line printer.

Proof figures. A proof figure can be used to check an important series of multiplications. An arbitrary figure, larger than any multiplier, is selected. Each multiplicand is multiplied once by its true multiplier and then again by the difference between the multiplier and the proof figure. Upon completion of a series of multiplications, the total of the products resulting from both multiplications is compared with the product of the total of the multiplicands and the proof figure. They should be equal.

Reverse arithmetic. This is another method which might be used to insure that a multiplication has been made correctly. A calculation of x times y equals z might be checked by multiplying y times x and substracting z to determine that the result is zero.

Cross footing balance checks. Cross footings have long been used by accountants in checking the accuracy of individual postings. For example, by vertically adding the net amount of invoices and discounts allowable, the totals, when cross footed, should equal the total gross amount of the invoices. The computer, however, can be programed to perform this function.

Identification comparison. This method permits comparisons to be made of common items. By programing a compare instruction invoice, amounts can be compared with predetermined credit limits to facilitate limit checks. All in all, identification comparison enables data fields to be machine-checked against one another in order to prove the accuracy of matching, coding, balancing, and file record selection.

Tape labels. A tape label is a part of the records on each reel of magnetic tape. Certain identifying information can be written on the tape in the form of a lead record. Desirable types of information which might be made a part of the tape label are: nature of the information on the tape, processing directions, frequency of use, earliest date the reel might be used as a new output tape (frequently referred to as the "purge" date), control totals (record count, for example), and name of the individual responsible for the tape. The computer can then be programed to read this information before processing the tape.

Blank transmission test. The computer system might be programed to monitor data fields at transfer points for blank or zero positions. The blank transmission test might be used to detect the loss of data and to prevent the destruction of existing records in file storage.

Alteration test. Failure to update a file may be sensed by comparing the contents of the file before and after each posting. This test is similar to identification comparison.

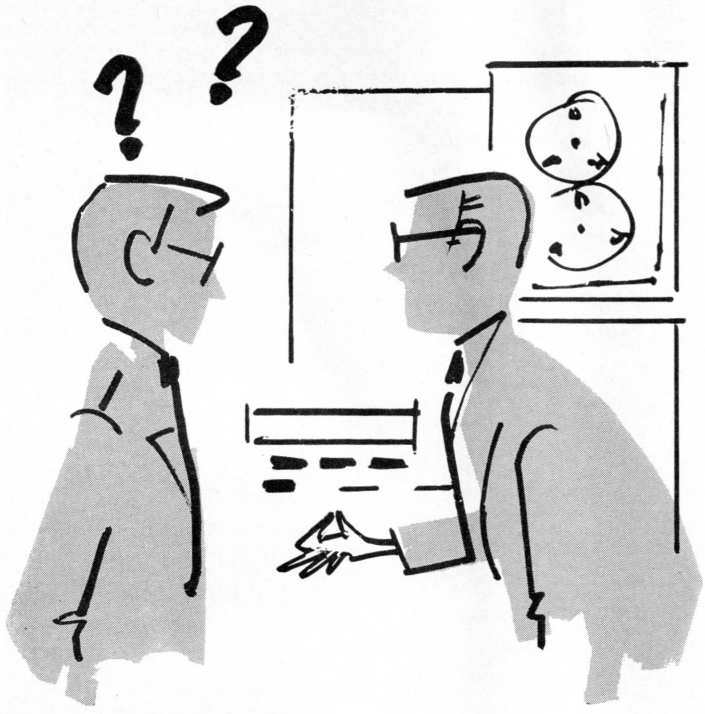
Checkpoint or "rollback" and restart procedures. These methods permit the computer to continue processing from the last checkpoint, rather than from the beginning of a run, in case of an error or an interruption in the program. Checkpoints are predetermined in the program and at certain intervals input-output records, as well as the contents of certain storage areas, are recorded internally in the computer. At the same time, if desired, accuracy of processing up to the checkpoint can also be established. In the event of an error, restart procedures permit the program to revert back to the last checkpoint and resume processing.

Error routine. After a programed check signifies an error in reading or writing (for example, the tape file may be out of sequence, or the disk file might not be properly updated through execution of the alteration test), a programed error routine should cause the operation to be preformed once again. If there is still an indication of an error, certain predetermined formal procedures should be made available to the operator outlining what action is to be taken.

These, then, represent some of the more common checks which can be made an integral part of the computer's stored program. In a sense, these "programed" processing controls are optional, but, if there is to be sound internal control, they should be made an inherent part of every computer program. The accountant must be as equally familiar with each of these programing control features as he is with existing control applications, for, in many cases, these new methods of control have superseded their manual counterparts.

Output controls

Output controls accentuate the role of the computer facility as a center of control. Insofar as input controls insure that all data are being processed, output controls assure that the results are reliable and that no unauthorized alterations have been made to transactions and records while in the custody of the electronic data processing unit. Output controls promote operational efficiency within the computer facility over records, programs, processed data, and machine operations.



The machine operator's knowledge of detailed programs should be sufficient to enable him to perform his job effectively

Comparison of control totals. In reality, the most basic of all output controls is the comparison of batch control totals, after processing, with those which accompanied the source data to the computer facility. It will be recalled that the nature of these control totals were discussed under input controls.

Separation of duties. This is certainly an old method, but in new guise. Within the computer facility there should be at least four separate and distinct groups of individuals—the planners (system specialists and programers), the machine operators, a group responsible for output controls, and a record librarian. In this way no one group has direct and complete access to the record-keeping system. For example, the planners, who are intimately familiar with the stored program and the entire EDP system, should have no contact with the day-to-day operations. On the other hand, the machine operator's knowledge of detailed programs and the historical records should be sufficient enough to enable him to perform his job as an operator effectively; too much knowledge can lead to intentional or unintentional manipulation of data, but too little knowledge might reduce the efficency of the entire data processing unit. Responsibility for output controls might be identified with the internal audit function or could be assigned to a separate group of individuals organizationally responsible to the data processing unit. The presence of a record librarian assures that programs, as well as historical records, will be adequately controlled. By assigning one individual—one who has no relationship whatsoever with any of the other data processing activities—the responsibility for the custody of all file information, only authorized changes can be introduced into computer programs or historical records.

Control by exception. The output control group would make comparisons of control totals; they would also be responsible for investigating persistent errors, amounts which exceed predetermined limits, and any differences between file records and physical inventory counts or account confirmations. Summaries might also be prepared comparing current data with historical data to note any other significant changes.

Information retention program. Programs, transaction data, and records must be meticulously controlled. Master tapes which contain computer programs are usually duplicated, with one copy retained in a locked storage area. A formal system of authorizations might be instituted for making any program changes. File records might be periodically read out of the machine, so that, in the event of losing some portion of the file data through operator error, an opportunity remains available for reconstructing the file records. A policy must also be set relative to the retention of transaction data since tape reels are expensive and they can be used over and over again.

Systematic sampling. Tests might also be made, by the control group, of selected individual items being processed. Individual transactions can be traced from the originating department, through the computer facility, to the records stored internally by the computer. Such tests would assure that transactions are being processed both accurately and in accordance with prescribed policies and procedures.

Numerical accountability. This practice is again an old one. Although invoices, checks, and all preprinted forms are presently controlled by numerical sequence, numerical accountability might be extended to all types of output—preprinted forms or otherwise, and including data generated by the on-line printer. For example, a program can be designed to print out instructions or data to the operator. If numerical control is exercised over this type of print-out too, reasonable control can be assured over machine operators, as well as

all the various forms of output data.

Separate runs. The ability of the computer facility to consolidate so many functions might require in some instances that the same data be run through the computer more than once. For example, McCullough[6] illustrates this by inferring that there might be three inventory runs: a run to produce accounting totals; a run to produce data for storekeepers; and still another run to provide information to purchasing. Separate runs, therefore, represent an effort to establish continuity and agreement among successive related computer runs since control totals can be established during each run and later compared.

In fact, there is another advantage to separate runs other than that of control—this being processing efficiency. Many computers are programed to perform a number of functions by passing the data through the machine only once. The time saved by this single run, as opposed to separate runs, is not so significant when compared with the problems which could arise in the event of a data-transmission error or an error in processing. Not only are these types of errors difficult to localize during a single run, but also a great many file records are affected. Hence, separate runs might even be a more efficient way of processing data.

Control over console intervention. The likelihood of console intervention is a problem common to all computer facilities. Programed controls are unable to prevent the operator's ability to interrupt processing and manually introduce information into the computer through the console. Likewise, even if the stored program does possess an instruction to print out all information introduced via the console, the machine operator still has the opportunity to suppress the print-out. Perhaps this entire situation has been magnified beyond reality. It seems improbable that the machine operator could manipulate the records successfully when his knowledge of the detailed program is limited (if there is adequate separation of programing and machine operator responsibilities), and when there is such a large number of complex file records requiring alteration. Research on this subject, however, revealed only one reference in the literature (cited by the same author in two separate articles)[7] to a defalcation which was actually attributed to the unauthorized manipulation of a computer program. Nevertheless, if there is proper separation of duties (with the operator accounting for processing time as is customary in most computer installations), if there is rotation of operators, and if numerical accountability is exercised over all types of print-out, chances for intervention will be minimized.

EDP has certainly provoked a number of new ideas with respect to internal control methodology. The talk of automation of internal control cannot be scoffed at, and the growing importance of the role of the computer facility as a center of control is gaining momentum. When accountants are instructed to review the system of internal control, they cannot afford to overlook the computer facility. They must recognize that it is now an integral part of the internal control system.

In a manual, as well as in an electronic data processing system, data must be introduced into the system (input), processed, and the resultant information (output) communicated to management and other interested parties. Thus, a sound functional internal control system is equally important in either system. However, traditional methods of implementing internal control are affected in the presence of EDP. The foregoing discussion illustrates that: (1) Traditional methods of implementing internal control need only be adapted in the input-output phases of an EDP system; and (2) separation of duties, authorizations, approvals, manual comparisons, recomputations, and the like, are either unnecessary or should be extremely modified in the processing phase of an EDP system.

Summary

In support of conclusion (1) it has been shown how batch control totals, serial numbered forms, and digit verification methods all can be used effectively when data are introduced into the electronic system. Similarly, separation of duties, comparison of results, and numerical accountabilities are equally important, but especially in the output phase of an EDP system. Evidence has been offered as well in support of conclusion (2). It was emphasized how an electronic computer can perform so many processing steps without manual intervention. Thus, the need to superimpose control steps during processing operations becomes less important in order to ensure accurate processing due to the mental and moral frailties of the individuals in the system. It was shown that many controls have been built into or programed into an electronic computer by manufacturers and programers alike in order to continually test the accuracy of the processing unit. Emphasis has shifted, then, from controls which test employee integrity to those which test machine accuracy.

Accountants today must be aware of the characteristics of internal control which have changed or which have experienced a change in emphasis due to the advent of EDP. Accounting systems can neither be designed nor audited properly unless the real effect of EDP upon internal control is thoroughly understood.

[6]Thomas E. McCullough, "The Auditor Uses the Computer," *The Internal Auditor,* vol. XVI (December 1959), p. 35.

[7]William L. MacDonald, "The Auditor and the Computer," *The Canadian Chartered Accountant,* vol. LXXXI (September 1962), p. 256, and "Audits and Audit Trails—Part 1," *Data Processing, Proceedings of the 1961 International Conference of the National Machine Accountants Association,* vol. IV, National Machine Accountants Association, Toronto, 1961, p. 149.