1958

Electronic data processing -- Programming for the internal auditor

Virgil F. Blank

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By Virgil F. Blank
Partner, San Francisco Office

Presented before the San Francisco Chapter of The Institute of Internal Auditors — February 1958

Our principal concern these past few years with respect to electronic data-processing systems has been with the problems of shifting from the planning stage to the developing and using stage. Where we formerly struggled to learn all about electronic equipment and its capabilities, we are now attempting to utilize this knowledge in our particular accounting and management applications.

Tonight we shall assume that everyone here has a working knowledge of computer systems. Accordingly, we shall confine the theme of our remarks to the technical problems confronting the internal auditor as a result of the development and application of electronic data-processing systems in business.

When we speak of programming for the internal auditor, we are using the term *programming* in its broad sense. We are selecting the control phase of the electronic data-processing problem in order to concentrate our attention on those matters that should be of particular interest to—and the particular responsibility of—the internal auditor. We are going to focus attention on the auditors' contributions to the programming effort.

As we examine our subject more closely we find one factor which aids in pin-pointing the areas requiring study. This factor is the retention of all of our traditional auditing methods and standards. Electronic data processing challenges us only in the matter of modification of our customary auditing techniques. These techniques, therefore, must be shaped to fit the electronic system in such a way that there will be no question as to the validity of the tests or the degree of verification obtained.

In most of the present installations the electronic system embraces a relatively small segment of the total work area for which the internal auditor is normally responsible. It is in this small segment of work that there must be a reshaping of techniques. In this part of his work the auditor will have to change his approach and alter his auditing procedures to meet the requirements of electronic accounting methods.

In carrying out the internal audit responsibilities for the work within the electronic system, it is only necessary to clarify that which

may safely not be done and that which must be done. The extent to which auditing procedures may safely not be done is dependent upon the degree of internal control—which might be termed *automatic auditing.* On the other hand, the work that must be done is dependent upon the existence of an audit trail to permit its accomplishment. Accordingly, we may divide our consideration of a program for audit into two major segments: (1) internal control and (2) audit trail. We shall see however, that there is even an interrelationship between these two segments since we are usually willing to sacrifice an audit trail if we are able to gain better internal control. This is especially true with respect to mechanized accounting procedures.

INTERNAL CONTROL

As we turn our attention to those controls that should be present within the electronic system, let us first consider the basic, or foundation, control for the entire electronic data-processing function. This is the external manual control that establishes the quantities and balances for which the mechanical system is responsible. Usually these amounts are established in the aggregate from adding machine tapes or from totals developed in preliminary operations during the data-gathering phase of the work.

This manual control function is best located in the proximity of the machine room so that all documents to be processed can be logged along with pertinent dates and amounts connected with them. This record is the means for controlling all balances of accounting significance, especially those balances rejected by the electronic system because of failure of a record to pass one or more of the many internal validity tests. This manual control is also the checkpoint for determining that the output data of the electronic system is in balance with predetermined totals.

From this description it must be apparent to you that this manual control is the same type as the one used for a conventional punched-card tabulating department, except that a few embellishments have been added to accommodate some additional complexities peculiar to electronic data processing. It must also be apparent to the internal auditor that the manual control can be his reference point in evaluating the functioning of the processing controls within the system.

INPUT CONTROL

Once a satisfactory manual control has been established, all audit efforts within the electronic data-processing system can be directed

towards maintenance of absolute accuracy within the system. This philosophy presupposes that input data, as recorded by the manual control, is accurate.

The first problem of audit significance facing the data-processing center usually is the transcription of raw data into a language readable by the mechanical equipment. Frequently there is a dual step in this phase in order to obtain highest possible standards of accuracy. First, tabulating cards are punched. Then these cards are verified before conversion to magnetic tape. This dual step presently offers economic advantages that may eventually be nullified through the development of reliable point-of-transaction recorders, character sensing devices, or lower cost magnetic tape typewriter-verifier combination units.

Where the punched cards are used as the data entry means, the cards may be subjected to verification at comparatively low cost in the same manner as in the strictly punched-card system. The internal auditor should also know about another more powerful control device available from International Business Machines Corporation at relatively low rental cost. This is the Type 101 statistical sorter. This machine will arrange punched cards into selected groups, summarize amounts from desired fields of the cards, and count the number of card records. Since these functions are performed at the rate of 450 cards a minute, this equipment is a better match for the high-speed electronic machines than the tabulators with their top speed of 150 cards a minute. These features make this equipment ideal for processing punched cards before transcription to magnetic tape, balancing them to previously determined group totals, establishing record counts for subsequent proof to tape counts, and providing a printed record of these control numbers for use in the manual control function.

Where an electronic system provides for data entry verification of this type, the internal auditor can limit his tests of this phase to a review of the procedures to ascertain that they conform to the plan and to an examination of the controls to acquire an impression of the levels of accuracy being maintained.

Once cards are determined to reflect accurately the input data, they may be placed in a card reader for transcription to magnetic tape or for entry directly into the system. At this stage, the card reader can be equipped with a record counter and this count can be checked to the count previously established on the Type 101 sorter or other device. In the process of transcribing to tapes it is desirable to enter on the tape file the balance of the card group as well as

the record count. This permits a balancing to these amounts during the entry of the tape data into the central processor. This control feature completes the continuous chain of proof from the manual control to the internal hardware of the computer system.

In some EDP systems there is a direct entry from the source record to magnetic tape. Verification in this instance is accomplished by reprocessing this tape through a tape verifier which provides for repetition of the entry process by a second operator. This is similar to the punching and verifying process used for punched cards. By the entry of a control amount as a final record on the tape, the central processor can balance the tape amounts on the first pass of that tape through the equipment. As far as controls are concerned, the principal difference between this direct entry method and the one previously described is that in this latter method the initial mechanical proof takes place within the central processor. In the former method, the initial proof is accomplished "off line" on auxiliary equipment.

Although much has been said about the random entry of miscellaneous individual documents into the electronic system, it appears that batching, or grouping, the documents affords the only practicable means of establishing input control. Methods using random document entry must rely on a more detailed human scrutiny of the output documents for verification.

PROCESSING CONTROL

If you have been satisfied that adequate internal controls have been incorporated into the input procedures, the next concern must be for the safeguards provided for the processing within the electronic equipment. It is in this area of study that the internal auditor must use his accumulated knowledge of machine characteristics, programming techniques, and processing logic. Assurance of adequate control rests upon a maximum understanding of the automatic checking features built into the circuitry of the equipment; upon an understanding of the various routines available to the programmer for detecting data loss or distortion; and upon an understanding and analysis of the logic on which the procedure design is based.

Because of the variety of electronic systems now available and the diversity of problems applied to the systems, perhaps it would be advisable to confine our present consideration to a few of the typical processing controls. Generally, processing controls may be thought of in three categories:

- Mechanical controls provided by the manufacturer of the equipment for detection of system abnormalities.

- Controls incorporated into the processing routines by the programmers for checking validity of data and agreement of balances with predetermined totals.
- Controls existing as part of the system logic for verification of amounts developed within the system and for assuring compliance with planned operation of an internally stored program.

MECHANICAL CONTROLS

There have been built into most of the electronic processing equipment many ingenious controls for detecting malfunction of certain devices or for detecting transient difficulties arising from dust or intermittent component failure. Some of these controls are actuated during planned maintenance by service engineers; others depend upon the setting of switches by the console operator; and still others are energized as a result of the internally stored program.

The internal auditor should not feel that he has any general responsibility with respect to the mechanical checks. These are in the nature of test runs during which operating power in the equipment is reduced to marginal thresholds so as to induce failure of any components that might be approaching a critical functioning point. The manufacturers have specified routines for these maintenance tests and it is sufficient that the auditor ascertain that scheduled maintenance is being performed at prescribed intervals.

Some of the mechanical types of controls with which the auditor should be acquainted are either entirely automatic within the system or are caused to function by the internally stored program. These are such controls as the following:

- Instruction check. This control detects errors or miss-reads in the instruction programmed to cause the machine to function in a precise manner.
- Machine check. This control detects an error in any character during its transfer within the system. Usually a second device is used to control the detection of character errors during a reading or writing function in the system.
- Record check. This control indicates when the punched data or printed data output does not agree with the data transmitted to the output device.
- Overflow check. This control is designed to become operative whenever an arithmetic function causes the data to overflow the capacity of a counter or accumulator. This prevents loss

of significant digits through unanticipated use of abnormally large amounts during a particular process.

- Sign check. This control is used as an indicator whenever an arithmetical function calls for an operation on an amount that does not carry a designation as to whether it is positive or negative.

Since some of these controls are subject to selection and used by the console operator, the auditor may wish to ascertain the manner in which the controls are being employed. A study of action taken as a result of the activation of each control would provide a measure of the frequency and type of errors in the system. Accordingly, the general level of accuracy and care in processing would be revealed.

PROGRAMMED CONTROLS

Perhaps the most challenging controls are those which may be designed by the programmer as part of the processing routine for checking validity of data. Fortunately, the machine companies have available certain library tapes that accomplish some of the desired controls.

One of these is a preliminary checking routine designed for use at the start of a tape-processing job. This routine checks all tape units for proper positioning of each tape to be processed and includes procedures for setting all internal machine areas to blanks or zeros prior to starting the main processing program.

In addition to stock routines such as this, there are programming routines originated by the person responsible for insertion of controls in the stored program. The internal auditor should expect to find such programmed controls as the following:

- Tape-label check. In this routine the first record is checked to ascertain that it is a tape label. Within the label the job and run numbers are verified and usage data is inspected. The date written is inspected to check that the current tape is mounted on the unit.
- Check point. Before the processing starts this routine usually provides for a test of all arithmetical functions to be performed during the particular process. Then a series of check points are established at which the settings of all accumulators and contents of all storage areas are recorded on a tape. This routine provides for a return to the most recent check point and re-establishing the settings associated with that checkpoint. This may be necessary if subsequent

error conditions or component failures require a restart of the processing.

- Error routines. Whenever a "compare" instruction is executed in the processing of data there is a program for analysis of any resulting "error" or "impossible" condition.
- Balancing routines. The programmer usually has a complete repertoire of balancing routines so that an appropriate one may be selected for each varying circumstance. Where posting to tape records has occurred, provision is usually made for a cross-footing operation similar to that used by a bookkeeper. This is simply a verification that prior balance plus current transactions equal current balance. Where it is desired to check that pure descriptive matter has been read into the machine correctly, hash totals are used. These are totals of serial numbers, order numbers, etc., that have no meaning other than for detection of transcription errors. Record counts, previously mentioned, are generally used on every tape and appear as part of the final record on each reel. Record counts should be printed out and reconciled where there are multiple output reels in a processing run. Where upper and lower limits are known for sets of results, these are stored in the equipment and utilized as a checking device. In addition to some of these unique routines, there is usually provision for storing pre-determined balances on each job tape and proving to these balances internally during the various processing cycles. It is customary to print out only those records that do not balance so that clerical time will not be required to check totals already checked by the electronic system.
- Sequence check. Much of the processing within an electronic system uses records in numerical sequence. A sequence checking routine, therefore, usually precedes a processing routine so as to ferret out records that might be out of sequence, in error, or invalid.

Knowledge of control techniques such as these should enable an internal auditor to assist in the development of the maximum protection within a data-processing system. His background is usually quite valuable to the programmer since he has been trained to be aware of the desirability for internal controls. The internal auditor is usually systematic in his approach to a problem and, in electronics, this often uncovers many control possibilities not apparent to the electronics technician.

Logic controls are those related to the methods selected within the electronic system for verification of portions of the routine not readily subject to outside checking. These controls are also used to gain maximum assurance that the machines are functioning in exact compliance with the internally stored instructions by which the routine is being guided.

An example of this type of control would be the one used when processing depends upon reference to a table of rates or prices for completion of an arithmetical routine. Since this table is contained within the computer and reference thereto is being made at electronic speed, a logical check of this activity should be made periodically by the computer in order to detect either a transient or permanent component failure in that portion of the circuitry.

One method of achieving a reasonably reliable control is to store quantity units of known magnitude as a lead record and, if desired, as a trailer record to a section of data requiring rating or pricing. After these test units have been processed in a "table look-up" routine, the resulting extended amounts are compared with a predetermined extension—also stored as part of the test record. This procedure should afford adequate control for this type of internal-processing problem. A programmed print-out of instances of error detection would supply the auditor with a means of investigating the action taken for each type of error.

Another logic control similar to this one would be used where it is desired to verify a multiplication, division, or series of mathematical functions. There are various approaches to this control routine but all depend upon a second computation. Usually in a multiplication the multiplier and multiplicand are reversed on the second pass. In a division, the proof often is made by multiplying the quotient by the divisor and comparing the product with the original dividend. In a series of mathematical functions there is usually a subtraction of amounts previously added so as to achieve the effect of a reversal of previously used factors. Where this control results in discovery of an error, there is a provision for the equipment to try the calculation a few more times. This repetition is quite rapid and usually results in obtaining a correct solution without any apparent delay in the processing routine.

Other types of logic controls are tailored to fit the particular processing requirement and depend principally on the ingenuity of the programmer or codes. The objective of each of these controls is always

to build into the system logic enough safeguards so that even the decisions programmed into the equipment are subjected to mechanical scrutiny often enough to give assurance of reliability.

These various types of processing controls—mechanical, programmed, and logic—should be understood by the internal auditor. He should be in a position to judge whether a given system has incorporated into it all of the possible controls that were available to the programmer. He should also be in a position to judge whether there is a tendency to overcontrol the system to an extent that operating efficiency is being sacrificed.

OUTPUT CONTROL

Upon the termination of the processing routines, the output reports and documents begin to flow from the electronic system. Output may be transferred directly onto a printer, but usually the requirements for speed demand that the system expel the output data in some form of machine language such as punched cards, paper tape, or magnetic tape. This creates control problems similar to those of the input stage inasmuch as a translation or transcription process must take place before the edited document is ready for human use.

In the conversion of data from machine language to printed format there are the same hazards of lost records, incorrect amounts, invalid characters, misinterpretations, and similar items needing control measures for their detection. The use of record counts, control totals, or hash totals as part of the output record permits the use of the Type 101 statistical sorter as a proving device for any punched-card output. For printed output the record counts and accounting control amounts permit balancing to the manual controls.

Where the output is in the form of punched cards containing printing, such as checks or customer bills, there is a need for additional output control to ascertain that the punched data agrees with the printed data on a card. This is an operational problem since present equipment does not permit simultaneous punching and printing on a tabulating card. Careful handling and frequent visual checking seem to be the only controls available until character sensing devices reach a commercial stage. When these machines become available, there will not be a need for the punched holes in the output documents. Punched-card output documents are usually intended for reentry into the electronic system at some future time. The use of character-sensing devices will eliminate a control problem not previously subject to mechanical aid.

The subject matter to this point has been related to some of the internal-control features being used in present electronic data-processing systems. These are the controls that must be considered and evaluated by the internal auditor in determining how much detailed checking and verification may be eliminated from his program. The auditor will probably find many auditing processes have been utilized within the electronic system because of the nature of this equipment. The machine-room operators have had to rely on a maximum of internal controls in order to make the equipment function with an acceptable level of reliability. Accordingly, there is usually a large amount of automatic auditing included in every computer program.

AUDIT TRAIL

When the internal auditor is faced with the problem of revising some of his audit programs to accommodate a new electronic system, he is ordinarily concerned with the apparent disappearance of an audit trail. A discontinuance of familiar records and forms makes the electronic system baffling. The existence of controls in a new format requires evaluation. The imposing electronic hardware and records on magnetic tape do not seem to offer the auditor any place to get a foothold from which he can start a new audit trail.

For this reason I should like to outline an approach to this problem that should permit the internal auditor to discover the electronic audit trail. As a matter of fact, it should also permit him to assist in the construction of the trail.

The internal auditor should participate in the electronic data-processing program as early as possible. It has been found most desirable to include an internal auditor on the electronic systems team. As a minimum program, the auditor should be present at a weekly, or periodic, coordination meeting of the systems staff. His participation during the system design stage would have two objectives. He can make valuable suggestions as to controls that should be included in the new system. He will become familiar with the new system design as it is being formulated and, accordingly, will be in an excellent position to plan audit strategy based on this knowledge.

If the auditor has had continuous exposure to the electronic system during its development and observes its operation during test, he should have opportunity to compile and inaugurate an adequate audit program. Without this background, the auditor would not be in a position to carry out his responsibilities to management.

Where it has not been possible for the internal auditor to participate in the electronic development program, he may still acquire a working knowledge of the new system after its design or installation. To do this it will be necessary to have the assistance of a system analyst who is thoroughly familiar with all phases of the electronic system.

Because of the complexities of electronic data processing, the internal auditor should compile an analysis of the system for use as reference material. This analysis should be designed to fulfill the needs of the audit staff on a continuing basis. For this reason, it should be compiled in a methodical and thorough manner. A design for this analysis has been developed which has been found to supply all needed data.

As most applications to electronic data processing are too involved to process as a single pass through the equipment, these applications are generally divided into segments. Each segment may be a complete or partial processing of a group of data. These segments are termed *runs*. For clarity, it is best to divide the system analysis into these natural *run* groupings.

Each *run* analysis should contain the following:

- A list of inputs with a short description of their natures and a designation of the source of the input data—(whether or not it is the output of a prior run).
- A list of outputs with a short description of their natures and a designation of the next use of these data.
- A complete description of the processing that takes place during the run. This should recite all features of the processing and list all exceptions considered in the process. It should also include a description of the various tape records.
- Logic charts and tape record layouts.
- External controls directly related to the run data.
- Copies of manual control forms.
- Internal controls of the system. This should include descriptions of mechanical, program, and logic controls and the action taken upon activation of a control check.
- Formulas for control balancing.
- Comments of auditor regarding effectiveness of controls.
- Copy of all output documents.

In order to prepare this *run* analysis, it is necessary to study the logic charts prepared by the systems group. It is generally not necessary to review the more detailed process charts and it is never

necessary to study the machine coding of the program. Frequently, the systems group will prepare a book describing each run and containing the various tests made of input and output data in the run. This book, supplemented by discussions with a systems analyst, usually supplies sufficient information to accomplish the auditor's review.

After completing the review, the comments in the analysis regarding controls should be summarized. This summary, together with copies of output documents, should be used to devise an audit program. If this study results in a need for some by-product of the various runs such as more detailed print-out or edited data for confirmation of balances, the auditor should discuss this with the analysts. It is ordinarily possible to satisfy all special audit requirements without adding materially to any of the established computer programs.

Upon the completion of the review of the electronic system and the design of the new audit program, you will probably conclude that there is an excellent audit trail in this new processing method. Some of this trail may disappear momentarily into the equipment but you will have assurance that the mechanical audit taking place therein is probably more thorough than any you would perform. You will find, therefore, that auditing the new integrated system should be simpler than auditing the many departmentalizations of data under the old system. You will be able safely to transfer some of your former audit responsibilities to the electronic data processor.

To arrive at these conclusions, you must be possessed of sufficient training in computers to resolve in your own mind the degree of reliability you may impute to the electronic equipment. Every internal auditor must acquire some knowledge of electronic equipment if he is to retain his stature in the field of auditing.

During the past few years, there has been a significant broadening of the rôle of the internal auditor as an instrument of business management. There will be a continuation of this trend as the auditor assumes his place as a vital part of the electronic data-processing program.