THE ADAPTATION OF AUDITING STANDARDS
AND TECHNIQUES TO
ELECTRONIC DATA PROCESSING

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SYNOPSIS

Introduction

In less than twenty years, the computer has become the single most important means of processing basic accounting records. Unlike other influences on the auditor, the computer represented the alteration of technology, not the evolution of existing procedures.

The need exists to review the development of auditing standards and the more rapid growth of the computer with respect to accounting information. Where the development is going and what changes have occurred in response to this development are central questions which must be answered before possible alternatives for the future may be defined.

Development of Electronic Data Processing

Scientific computer development began in 1937. In 1954, the first business computers started to appear. Since 1965, installation of business computers has nearly doubled every three years. The business computer performs most accounting functions known today, and as a result of smaller, less costly models, it is involving the small business systems. In the future, unlimited, low cost storage will offer literally everyone the chance to have their own computer or computer terminal.

Review and Evaluation of Auditing Standards

The American Institute of Certified Public Accountants provides general standards which are a basis for auditing procedures. In the past, these procedures were the result of historical experience and pressures from users of financial statements.

Data processings' rapid growth during the last fifteen years has caused these general standards and procedures in use since 1933 to become obsolete.

The disclosures of large computer frauds of the past few years have increased pressures to consolidate the present standards and techniques and to evaluate their adequacy.

Large public accounting firms, corporations and banks, and educators have all contributed ideas and techniques needed to solve the problem.
Impact of Data Processing on Auditing Procedures

The computer caused an over-centralization of functions and reduced the visual records for accounting systems. New and unique EDP controls were not developed at a rate fast enough to compensate the loss of internal controls. Centralization and the great processing ability of the computer significantly increased the risk that a material error or fraud could occur; and today's computer technology now requires special training for those individuals auditing electronically prepared records.

To solve the centralization problems and to standardize the educational programs, an EDP auditing guide should be published by the AICPA.

Review of Internal Controls in Data Processing Systems

Data processing techniques require unique organizational, administrative, and processing controls to replace the internal controls that were lost when the manual accounting system was converted to the EDP system.

Use of the Computer as an Audit Tool

Program control, test decks, and observation of data processing are auditing techniques created to use the computer as an audit tool. The most successful and widely used technique has been the generalized computer auditing programs. These programs reduce the manual audit procedures and increase the auditor's independence from the system.

Conclusions and Implications for Future Computer Generations

Because the auditing standards and techniques have developed at a slower rate than the business data processing methods, internal controls have been weakened and the risk of large frauds increased. A computer audit guide including improved EDP controls and techniques for employing the computer as an audit tool is needed. The past growth of business computer systems and the projected growth of future systems will cause the problem to increase unless expedient action is taken to provide this required guidance.
INTRODUCTION

Purpose

The purpose of this research paper is to examine the development of electronic data processing (EDP) methods for business applications and to evaluate the changes to Generally Accepted Auditing Standards and procedures resulting from computer utilization.

Need for Research

The development of guidance for auditing electronic data processing has been fragmented and diversified as a result of the lack of a single authoritative source to coordinate the various groups involved. The large public accounting firms made independent appraisals and published directives for their staff members. Individuals in corporations and banks performed limited research to improve internal controls and to implement auditing techniques. Auditing courses offered by colleges and universities represent a third source. A definite need exists to review and evaluate all of these sources.

Approach

This paper is an attempt to:

1. Compare the history of the computer to the development of procedures to control and audit an EDP system.
2. Determine how auditing standards and procedures are affected by the introduction of the computer.
3. Evaluate the adequacy of present standards and procedures.
4. Present new EDP controls and auditing procedures.
Method and Scope

Published information describing the development of the computer, the evolution of auditing standards and techniques, and the possible effects of data processing procedures were researched. In addition, personal interviews and experiences that I encountered as an auditor for a large public accounting firm were incorporated into the paper.
DEVELOPMENT OF ELECTRONIC DATA PROCESSING

Evolution of the Computer

Many think of the computer as being the unique product of the twentieth century, but elements inherent in today's machines are centuries old. The abacus, developed about three thousand years ago, was the first digital counting machine. Since then, many other calculating machines were developed, including those by Pascal in 1642 and Leibniz in 1694. In 1882, Charles Babbage, a Lucasion Professor of Mathematics at the University of Cambridge, pioneered the idea of a large, general-purpose, automatic, calculating machine termed "analytical engine."¹

Babbage's machine consisted of a "store" in which numerical information could be recorded on a bank of counters, a "mill" in which numerical operations could be carried out on numbers taken from the store, and a unit to which he did not give a name, but which was similar to a "control" unit for controlling sequence of operations, the selection of numbers for the operation, and the disposition of the result.

Not unlike today's machines, Babbage proposed that control of the sequence of computing processes was to be carried out through a set of punch cards. Plungers passing through holes in the cards were to operate the mechanism for selecting the counters in the store. The numbers were transferred to the mill, the arithmetical operation performed on them, and the result transferred to the counter. Normally, the cards were processed in sequence, but they could be advanced or backed up according to the results of some criterion or set of criteria previously evaluated in the course of calculation. This led to the recognition of the repetitive nature of many extended calculations,

and the ideas of a recurring group of operations or cycles. Babbage's analytical engine, a mechanical, card-programmed machine, capable of making extended additions at the rate of about sixty per minute, multiplications of two fifty-digit numbers about one per minute, and division of a one hundred-digit number by one of the fifty digits in about one minute, was the seed of the computer revolution.  

In 1937, Professor Howard Aiken, in collaboration with the IBM Corporation, began constructing the Harvard Mark I Calculator, which was similar in principle and function to Babbage's conception of the "analytical engine," and was the first machine actually to be constructed and operated. With its extensive use of electrical components, it was structurally different from Babbage's mechanical design. Input was supplied to the machine in coded form by punched tapes or punched cards, and output produced by means of two electrical typewriters or on standard punch cards.

Mark I was soon superceded by Aiken's larger general-purpose electrical relay machine, the Mark II Calculator, constructed for the Naval Proving Group at Dahlgren, Virginia. Another machine, Eniac, developed at the Moore School of Electrical Engineering of the University of Pennsylvania for the Ballistic Research Laboratory at Aberdeen Proving Ground, operated by counting electrical pulses being routed by electrical gates.

This first fully electronic computer built by Dr. J.P. Eckert and Dr. J.W. Mauchly formed the basis for the Eckert and Mauchly Corporation, the first real business venture into computer technology. The company was absorbed in 1947 by what is now the Sperry-Rand Corporation, and together they built the first marketed computer, the UNIVAC I, during the years of 1947-1950.

\[2\text{Ibid.},\ p.\ 71.\]
For some reason, the IBM Corporation failed to follow-up its lead in development after helping Aiken to build his electro-mechanical computing machine. This may be attributed to the failure of the CPC, a prototype computer wider publicized by IBM in the late forties. The IBM 701 in 1953 was followed in November of 1954 by the very successful IBM 650 accounting machine which possessed a low cost two-thousand-word drum and magnetic tape storage, and a simple programming system. Over 1,500 models of the IBM 650 have been sold, by far the largest sale for any single machine until the advent of the IBM 1401 in 1959.

Two technological advances permitted the expansion of these first commercial machines from the limited Mark I. The first was introduction of magnetic tapes, which permitted more compact storage and faster input-output of business information. The second was the replacement of levers and electro-mechanical relays by electronic tubes and then by transistors. Transistors and other solid state techniques further reduced machine size, while increasing component reliability and processing speed.

During 1954, a number of insurance firms had begun installing UNIVAC I's to process their insurance accounting, and General Electric installed a UNIVAC I in its Kentucky headquarters. Intense sales promotion, primarily from IBM, soon made business installations common in the United States. By July 1, 1962, according to the best estimates available, approximately six thousand electronic computers were in business use. By the end of 1963, the six thousand figure had doubled, and by 1966, this figure approached twenty-two thousand installations.

American-dominated computer purchasing reached 39,500 by 1968, which constituted about sixty-five per cent of the world's

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4 Ibid., p. 3.
installations. The 1969 installations numbered fifty thousand with about sixteen thousand on order. Viewed numerically, the number of computers installed within the United States had doubled, and was expected to continue to double every three years.

By 1975, it is estimated that the United States will have 140,000 computers in use and 2,230,000 people working with these systems.

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Growth of the Computer in Business

Initial development of the electronic computer at Harvard occurred almost entirely in response to the need for better ways of accumulating, calculating, and summarizing scientific, engineering, and statistical data. The use of the computer for scientific purposes often requires a relatively small amount of input, large computing capacity, and perhaps a simple statement as output. Business application characteristics were just the opposite. These rather different requirements for business information systems have promoted the development of specifically business-oriented computers from their scientific predecessors.

During the sixties, exploitation of the electronic computer gained an increased recognition by the business community resulting in rapid growth of business applications. Technology reduced physical size and increased internal data handling speeds to the point where input-output equipment became a limiting factor for the rapid processing of data. Business data processing normally requires high volume input and high volume output, with relatively little emphasis on the speed or logical capacity of the central processing unit. As a result of the demands of business firms, developments in peripheral equipment have occurred with accelerated speed since 1960. The central processing unit on the other hand, has remained relatively unchanged. Perhaps the single greatest inhibitor to the development of integrated data processing systems has been this functional imbalance of equipment installations.7

At the close of the sixties, the rapid growth of data processing was confined primarily to those consumers able to maintain a transaction level which would pay for the large capital investment and operating expenses required. During the last half of 1970, computer manufacturers introduced several innovations aimed at reducing transaction processing costs to exploit the small

7Boutell, op. cit., p. 4.
or medium business–user market.

The larger machines were made more efficient, making possible lower transaction cost for users with sufficient volume. In the small computer market, machines such as the IBM System 3 were designed for users with limited requirements and no previous computer experience. At the bottom of the list is a device introduced about ten years ago, the mini computer. The computer industry has developed hardware that attaches to these machines, causing them to behave like full-fledged computers, in that they can perform all the functions of a business computer. In a sense, many of these devices operate like accounting machines, e.g., NCR, Burroughs, etc..., but with a wider range of programming options.

Data entry and handling hardware have been greatly diversified to meet user requirements and to reduce data conversion costs. Data terminals and remote computers provide a wide variety of options for attaining economical processing of data.

The implications of these developments are a wider range of computer uses for all sizes of businesses, greater utilization of existing equipment, and greater portability of computers through communication lines and terminals.  

Advanced systems are already a reality in many areas. Mechanical bank tellers dispense cash to authorized card holders twenty-four hours a day, seven days a week. Rapid transit lines have turnstiles that read plastic badges and reduce the amount of trips remaining by altering the coded magnetic strip rather than punching holes in tickets. Robot bars dispense drinks in hotel rooms and automatically charge the proper room account. Diagnostic computers can be attached to a sensor plug in an automobile to quickly analyze mechanical problems. A retail store cashier can wave a wand past items on the counter and prepare a descriptive detailed list of the purchases, update the physical inventory, 

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and charge the customer's account.

During the 1970's, data processing appears to be advancing toward applications at all levels of uses: small, medium, and large. Decreased cost and data transmission techniques will usher in greater use of integrated or real-time systems that respond to each user inquiry.
During the computer revolution, business learned to utilize punched card equipment with a minimum amount of difficulty. The educational process for efficiently managing magnetic tape files was more difficult. Development of the techniques required to store and process data on disc files taxed the most skilled professionals within the data processing field. Based upon discussions with computer manufacturers, the "best," or "worst," depending on your vantage point, is yet to come. The next most significant event will be the production of unlimited, low cost internal storage. Unlimited internal storage will make available to the smallest users low cost remote terminal access and further integration of existing data basis. In spite of the awesome implications, it becomes more apparent that as the sophistication of the equipment grows, so does the time required to learn how to use it. Technological growth also tends to increase the total cost of the data processing facility, making cost justification of the benefits received more difficult.

Dr. Herb Grosh, editorial director of Computerworld, made reference to the inability to utilize the equipment's full potential already developed, during a meeting of the AICPA's computer services division in Chicago. Ten years ago he said, "We had computers that could run one job at a time, had limited memory, processed records at speeds of hundreds per minute, and operated at internal speeds measured in milliseconds. It took all morning to write payroll checks. Today, machines process many jobs at one time, memory sizes range into the millions, thousands of records are absorbed per minute, and speeds are measured in nanoseconds. It still takes all morning to write payroll checks!"  

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As a result of these factors, the technological growth may be slower when compared to prior years. On the other hand, the computer will be made available to literally everyone. Either alternative issues a serious challenge to those who would control or audit business systems.
Evolution of Generally Accepted Auditing Standards

The history of auditing theory is important to the analysis of the role of EDP in the sixties and seventies since future developments cannot be sanctioned directly by historical precedents, which were until recently the primary guidelines for the conduct of the examination of financial statements.

The General Standards and the attest functions are comparatively new, as is the accounting profession. Forces promoting their development began after 1933 when Congress established the Securities and Exchange Commission (SEC); and during the 1940's with the introduction of high income tax rates. The SEC in the United States promoted development through its required opinion by the independent public accountants on the financial statements of companies registered on the major stock exchanges. Although these legal demands guided and enforced auditing requirements, the demands of the business community appear to have preceded action by legislative and judicial bodies. Demands on the auditing profession have come from bankers, stockholders, labor unions, suppliers, and consumers; and the trend of auditing theory can be directly traced to the requirements of these various interest groups. In many instances, the result has been legislation to influence auditing standards and procedures.

Guidance for Generally Accepted Auditing Standards originates from the American Institute of Certified Public Accountants (AICPA or Institute), which was created to control the practices of the profession without statutory regulation. These Standards are directed toward the public accountant's examination of supporting documentation for the financial statements in order to express an opinion as to the fairness with which the statements represent
financial position and the results of operations. Financial position is in turn the summation of data, recorded in accordance with Generally Accepted Principles of Accounting, applied consistently in the preparation of the financial statements of the current period in relation to those of the preceding period. Responsibilities for assuring an acceptable level of data reliability, as put forth by the Institute, was implied by the adoption of sound accounting policies, the maintenance of an adequate and effective system of accounts, the safeguarding of assets, and the construction of a system of internal control to aid in the preparation of the statements of financial position.10

Review of Internal Controls

During the early 1900's, Robert H. Montgomery, in his Auditing Theory and Practice, strongly criticized accepted doctrines. He argued that three-fourths of the audit time was typically spent on detailed checking of the existent records; but that three-fourths of the defalcations actually occurred as a result of a failure to record income transactions.11 Ten years later, Montgomery suggested that the basis of deciding whether a detailed audit should be made, or whether a balance sheet examination would accomplish the desired end, depended to a considerable extent upon the existence of a satisfactory system of internal check.12

Prompted by the McKesson-Robbins case of 1933, the AICPA in 1939 issued a report adopted by the membership, "Extensions of Auditing Procedures." Confirmation of accounts receivable and the physical observation of inventories was covered extensively in this report without reference to the problem of internal control.


12Ibid., 1922, p. 258.
Finally, in 1949, the Committee on Auditing Procedures issued a special report entitled, *Internal Control*, which stated: "Subsequent examination cannot be regarded as a substitute for the exercise of proper controls in the actual handling of transactions."¹³

The Committee continued by defining the characteristics of internal control as: "The plan of organization and all the coordinate methods and measures adopted within a business to safeguard its assets, check the accuracy and reliability of its accounting data, promote operational efficiency, and encourage adherence to prescribed managerial policies."¹⁴

In October of 1958, the Auditing Bulletin No. 29, *Scope of the Independent Auditor's Review of Internal Control*, appeared with extensive material on internal control, and many decisions of auditing procedures had come to hinge more or less explicitly on the evaluation of the system of internal control. Finally, the Institute advanced the following formal pronouncement:

"In the ordinary examination, the selection of auditing procedures, their timing, and the determination of the extent to which they should be followed will depend largely upon the auditor's judgment of the adequacy and effectiveness of the internal controls. This judgment is arrived at as the result of his study and evaluation, (which may involve testing, observation, investigation, and inquiry,) of those internal controls which, in his opinion, influence the reliability of the financial records."¹⁵

From the pre-1900's to 1954, the review of internal control and the subsequent emphasis on audit procedures employed in the examination of accounts has matured to a prominent status in the conduct of an examination.

³⁴Ibid.
In 1963, the Generally Accepted Auditing Standards were codified by the Institute which included the second standard of field work: "There is to be a proper study and evaluation of the existing internal controls as a basis for reliance thereon, and for the determination of the resultant extent of the tests to which auditing procedures are to be restricted."16

Characteristics of a System of Internal Control

The characteristics of a satisfactory system of internal control were summarized as including:

1. "A plan of organization which provides appropriate segregation of functional responsibilities.
2. Personnel of a quality commensurate with responsibilities.
3. A system of authorization and record procedures adequate to provide reasonable accounting control over assets, liabilities, revenues, and expenses.
4. Sound practices to be followed in performance of duties and functions of each of the organizational departments."17

These characteristics of internal control are predominantly a part of the accounting system in the public accounting practice, although the Institute makes the distinction that these controls may be administrative controls as well as accounting controls. Individual classification depends upon the particular organization. A review of the previously mentioned characteristics is as follows:

Fundamentally, the plan of organization should establish clear lines of authority, reporting, and action. With the assignment of responsibility normally goes the custodial function and the requirement to separate the operating, accounting, and internal auditing functions from this custodial function. The duality of accounting requires that records exist separately from the activity they seek to control. Assignment of responsibilities should be delineated in organizational charts or manuals with a continuity of operations.

17 Ibid., p. 16.
The Institute observed with respect to these controls that "the independent auditor is primarily concerned with the accounting controls. Accounting controls generally bear directly and importantly on the reliability of financial records and require evaluation by the auditor. Administrative controls ordinarily relate only indirectly to the financial records, and these would not require evaluation."\textsuperscript{18}

Auditing standards have developed slowly since the early 1900's in reaction to changes from the surrounding financial world. Because the standards are general, and therefore flexible, they have not directly motivated the profession to use specific auditing techniques. The techniques evolved due to the interaction within the public accounting profession over a number of years. Following the traditional path, the Institute revised Auditing Standards and Procedures: Statement on Auditing Procedure No. 33 in 1972 with the publication of the "Codification of Auditing Standards and Procedures." This document represented the first formal attempt to define auditing standards within a data processing environment.

**Codification of EDP Auditing Standards**

With the publication of the "Codification of Auditing Standards and Procedures," the Institute recognized the special problems resulting from the increased use of computers and from the integration of data into a management-information system.\textsuperscript{19} The statement specifically addressed two of the auditing standards, one General Standard and one Standard of Field Work.

The First General Standard stipulated that "the examination is to be performed by a person or persons having adequate technical training and proficiency as an auditor."\textsuperscript{20}

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\textsuperscript{18} Ibid., p. 32.

\textsuperscript{19} Auditing Standards and Procedures: Statements on Auditing Procedure No. 1, issued by the Committee on Auditing Procedures, AICPA, New York, 1972, Foreward.

\textsuperscript{20} Ibid., p. 7.
implications of the Field Standard as to the review of internal controls, it is a necessary requirement that the auditor attain a certain proficiency with respect to data processing techniques.

Members of the Institute's Auditing EDP Systems Committee attempted to define technical proficiency for auditing computer processed records in relation to the standards of training and the review of internal control. The Committee concluded that because it is impractical to train and continually update each staff accountant to a very high level of expertise in computer auditing, three different proficiency levels for persons assigned to the audit are appropriate....the general audit staff member, the computer audit specialist, and the data processing professional. The computer audit specialist is an auditor with special training in data processing beyond that required for the general audit staff member. This does not absolve the general staff member of technical competence. The Committee felt all personnel should understand basic computer concepts, including the functions of the central processing unit and peripheral equipment, basic programming and systems flow charting, and data handling procedures. Further effects of EDP internal controls, including a comprehension of systems documentation techniques, knowledge of the use of generalized computer auditing software, and an understanding of concepts of file processing were outlined. Lastly, the Committee required that the general audit staff member know when to request assistance from a computer audit specialist.

A computer audit specialist is an auditor with training in complex EDP techniques, who from time to time will be called upon to assist other members of the audit staff. He is a link between the auditor and the data processing manager.

A data processing professional is a person specially trained

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in many aspects of the field, usually a management consultant who would be called in to solve problems of highly technical nature.

The thrust is that there exists a need to be trained in the specialized area of data processing in order to carry out the review of internal control. This proposal for technical proficiency is advanced, but not strictly codified in the auditing standards. Under Basic Concepts, Paragraph 320.33., the assertion is made that tests of the Internal Control Procedures may be influenced by the method of data processing used.²² By the revision of these standards, the Institute appears to have addressed the problem EDP has brought to the profession.

To insure the standard is maintained, the Institute provides the examination for acceptance as a Certified Public Accountant. A survey of the more recent examinations has demonstrated data processing questions of greater sophistication since their introduction in the late 1960's.

Development of Generally Accepted Auditing Standards during the last sixty years has for the most part been a result of political or legal action, either actual or implied. Greater influence by the SEC in the development of Generally Accepted Accounting Principles has made the connection more visible due to the close relationship of the financial statement presentation and auditing techniques. History also seems to indicate a high correlation between disasters like the McKesson-Robbins case and significant changes in the Standards.

Published views questioning the adequacy of those Standards was, and still is, rare, due to the difficulty in challenging such general principles and the consensus among many practitioners that the basic guidance presented remains applicable. The

Generally Accepted Auditing Standards' reliance on the review of the system of internal control and the performance of the review by a technically competent person remain the foundation upon which auditing procedures and techniques are founded. Recent problems have occurred which seem to question if the Standards have performed the function of adequately controlling business assets.

Data Processing Frauds

An increasing number of data-processing-encouraged frauds directly related to data processing indicate that internal controls were not adequate or were not properly instituted. A few of these cases follow:

Between 1951 and 1959, a member of Walston and Company, a New York brokerage firm, electronically siphoned $250,000.00 in company funds for his personal use. Inspite of the disclosure, the brokerage officers were not able to explain how the theft was perpetuated until the culprit demonstrated his technique. Primarily, his superior knowledge of the system and early Sunday morning keypunching were the keys used to access the company's funds.

The brokerage of Carlise and Jacquelin experienced a similar embezzlement amounting to $81,120.00 when its data processing manager instructed the computer to write checks to fictitious persons and then send them to his home address.

Recently, National City Bank of Minneapolis discovered that the employee who programmed the computerized check handling system in 1965, embezzled $1,357.00 over a period of one year. He programmed the computer to completely disregard his personal checks any time his account had insufficient funds to cover them. The computer allowed each of his bad checks to clear the bank and did not debit the employee's account for the overdrafts. The scheme was discovered only by accident, when a computer breakdown forced manual processing of some checks. One of the embezzler's bad checks was returned for insufficient funds. When bank officials confronted him, the employee readily disclosed his scheme.23

In another of the fewer than one hundred crimes on record, Hugh Jeffrey Ward obtained the code for a rival firm's program, and extracted data from the firm's on-line computer. This data was to be used to compete against the owner of the data. Settlement of this case established the precedent that a computer's knowledge qualifies as a trade secret.24

The problem was greatly magnified by the Equitable Funding Disaster, which, in addition to the alteration of data bases and the preparation of duplicate but altered reports, introduced the concept of simulation. A group of top executives and data processing personnel programmed a model of the company's operations on a small computer to determine various inputs required to create a desired level of revenues. False input data introduced to the company's main computer altered operating reports to present a favorable business performance. No assets were physically taken in this case. However, as a result of large scale falsification of records and reports by the machine, some two billion face amount of non-existent life insurance was sold to reinsurers.25

In a recent case involving the chief teller of the Union Dime Savings Bank of New York, the amount was not known for certain, but officials have estimated the loss at approximately $1,500,000.00 How the theft occurred is also not known by officials at this time as the person accused did not have direct access to the computer. It appears that the money was transferred from legitimate accounts to fraudulent accounts, and then withdrawn. At quarterly interest payment times, the money was somehow briefly redeposited so as to make the account balances correct.26

Bonn B. Parker of Stanford Research Institute for the past several years has been engaged in the research and investigation of computer-related crimes. He has built up a file of some one hundred and fifty cases reported in the public press, and has investigated over fifty of those cases by direct contact with at least one party concerned. From Parker's research, it is noted

that cases of computer fraud and embezzlement reported in the public press should be treated with caution, as it is often found to be unreliable. He does conclude, however, that computer-based fraud and embezzlement have occurred, and in most instances, the cases have been serious, amounting to the loss of tens or hundreds of thousands of dollars. A second point emerging from his research is that the embezzler generally is not deterred by the threat of punishment, and sometimes not even by quite sophisticated controls. The controls might serve as a challenge more than a deterrent.27

**Increased Need for Audit Guidelines**

The disclosure of the Equitable Funding Case, much like the McKesson-Robbins Case, was the straw that broke the camel's back. The realities of what could be accomplished with EDP were exposed in a dramatic way, creating shock waves throughout the SEC, IRS, AICPA, and other entities concerned with the presentation of financial statements.

The need exists for an extension of the general audit guidelines throughout the publications of specific internal control procedures and audit procedures for data processing. Traditional standards developed by the Institute appear to remain applicable. As a result of the rapid development of business EDP applications, the normal evolutionary processes of finding techniques through actual practice have not provided sufficient guidance to cope with increasing frauds and problems. A single authoritative body should bring the numerous essays, articles, and editorials together to form a combined audit guide. The rate of technological change, in spite of possible slowing, continues to move forward, and the longer the delay in the preparation of this audit guide, the more difficult it will be.

Recently, the Institute created a computer services division,

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27Ibid., p. 2.
recognizing for the first time the need for positive guidance in
the data processing field. Perhaps this will be the vehicle for starting the needed improvements.

The way in which EDP affects the auditor, the general standards, and auditing techniques should be the first step in determining the EDP Auditing Guidelines needed.

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IMPACT OF DATA PROCESSING ON AUDITING PROCEDURES

Alteration of the Internal Control Function

Generally Accepted Auditing Standards rely significantly on the evaluation of the system of internal controls and other related accounting procedures. Data processing has during its relatively short life altered the structure of the accounting system and the internal control procedures. When the IBM 650 accounting machine was introduced, it replaced a small segment of the traditional accounting system such as the maintenance of accounts receivable balances. Journals and source documents were converted to a card deck to be manipulated through use of wired circuit boards. Input was comparable to output with the audit trail easily followed from punched card creation to master data file updating. There were essentially three steps to this system of data handling progression: data origination-conversion; the actual processing; and the recording of the transaction in the final account.

A second phase began with the storage of files on magnetic tape and the subsequent expansion of internal storage to permit more sophisticated program processing techniques. Data files became larger and more integrated. At first, source data was keypunched on cards for loading on magnetic tapes. Later, data was punched directly onto the tapes. Today, optical scanners read source documents onto magnetic tape, further shortening the chain of personnel handling transactions. In spite of these innovations, the computer remained a batch processor of transactions. Payroll, customer billing, and other accounting data handling functions which allowed the sequential processing of a high volume of transactions against a sorted master file were the primeutilizations of the EDP system.
A third phase began with the introduction of large random access drum and disc files. Data files were further consolidated and many different programs run against the larger integrated data bases. Software developments allowed increased utilization of larger, lower cost, random access bulk storage; faster machine operation speeds; and increased program options available to the systems designer. Innovations eliminated many traditional accounting records and absorbed successive levels of personnel into the data processing center. Most systems are today within this third phase, although the United States Government and other large users have entered the fourth phase, on-line-real-time operations.

In this last phase or generation of computers, a large random access data base has been coupled to a myriad of peripheral input-output devices and a program capable of accessing the data upon request. The constantly updated data base signaled the end of pure batch processing techniques, and introduced real-time data processing.

The progression from early card systems to fully integrated systems shortened the audit trail as an increased number of documents were prepared by the computer. At first, only customer invoices were printed, but soon the daily sales journal and, finally, the general ledger were absorbed within the data processing group. For a time, both the manual and the EDP systems existed within a parallel processing mode, eventually abandoning the manual system.

The centralization of functions reduced the number of transaction handlers, all but eliminating the redundancy factor of a manual system. Errors which may have been caught by a snoopy employee were lost within the magnetically stored files once converted to machine sensible media. Loss of visual inspection eliminated a valuable review procedure.
Also, once converted, the storage of magnetic records and their alterations leave little evidence of the occurrence of errors, accidental or intentional. With fewer individuals involved, the need for collusion to effect a fraud was greatly reduced, if not eliminated. The doctrines of separation of responsibilities and dual accounting were weakened as a result of the unique alterations in the system of internal controls. The potential for loss through reduced fraud prevention and detection techniques was considerably increased.

Unfortunately, the computer programmers, operators, system designers, and EDP managers were not trained in accounting and internal control techniques. When the old controls were disposed of, new ones were not erected in their place. Often during the early phases of conversion to EDP, the primary objectives were result-oriented.

Accounting personnel contributed to the problem by ignoring the developments or even by fighting progress. Eventually the machine prevailed, and usually those who challenged it did not. Indecisiveness during the growth period, or the lack of positive action to become involved in the problem of EDP controls served to increase the problem. With the weakening of management's internal controls came new problems for the auditor.

**Increased Risk as to Errors and Fraud**

Auditing procedures and techniques are significantly altered when the amount of control over transactions declines, as in the problem brought about by data processing. The auditor's opinion as to the fairness of the presentation of financial statements is weighted by judgment as to the materiality of possible errors and the related risks involved. The consolidation of data and less separation of duties clearly presents increased risk, and as the cases of fraud already uncovered demonstrate, the amount of the potential fraud may be very significant. Another implication of
indiscretions disclosed to date is that one individual having access to a high transaction level procedure quickly makes unimportant amounts quite significant.

Unfortunately, high transaction accounts have been the areas where EDP has made its inroads by providing a lower processing cost for each transaction. Customer billing, payroll preparation, purchase orders, production control, and check preparation are only a few of the applications in this category.

Traditional auditing techniques analyze ending account balances, emphasizing the balance sheet. Transactions as mentioned above, for the most part, flow through the income statement. Testing is often analytical review as to reasons for changes in amounts from period to period supported by testing of compliance with internal control procedures. The latter is performed by statistical techniques to economically test the transaction and provide a basis for quantitative evaluation of the results. Increasing both the potential amount of loss and risk related to the reporting of primary financial indicators, especially the income amount, would appear to imply a greater emphasis of auditing techniques on the income statement. To do this, the auditor must expand the audit scope and increase the audit time.

Requirements for EDP Education

Eventually new control techniques began to appear as a result of attempts by data processing users to regain some of the controls lost through conversion to EDP. To a greater degree, the new procedures were performed by the machine as program controls, or were concerned with the movement of data between the accounting department and the data processing center. The auditor was required to obtain an expertise in EDP procedures and control techniques in order to evaluate the new system. A 1965 survey by Wayne Boutell showed that thirty-nine per cent of staff auditors had neither a
general understanding of how a computer function, nor the ability to read and interpret documentation. Colleges and universities began offering computer programming and general systems organization courses during this period. As a result, an increasing number of junior auditors have become familiar with data processing techniques. Auditing courses have given the computer only generalized coverage.

The 1957 edition of Montgomery's Auditing Theory and Practice offers the following conclusion in the section on "Machine Bookkeeping":

"Although the mechanics of auditing have to be adapted to machine bookkeeping, the fundamental purpose of auditing remains the same. Difficulties may arise in preserving a trail that can be audited; and the auditor will be forced to use his ingenuity in following information from the ultimate results back to the original data. Internal accounting control will probably be affected, but it may not be weakened, if proper division of duties is maintained. In fact, it may be strengthened since the mathematical accuracy of electronic machines is infinitely greater than that of human beings."30

This approach might be referred to as the "Audit Trail Review," and was one of the first approaches to the problem with only a brief reference to the role of internal control.

Holmes' 1962 edition of Basic Accounting Principles answered the question of how auditing procedures changed when EDP was used by saying:

"The principles of auditing remain unchanged under any accounting system, but the application of recognized audit procedures is changed. With punched card and electronic applications in operation, the auditing follows the pattern of a thorough examination of internal control and programming, followed by tests to determine that the internal controls and programming

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29Boutell, op. cit., p. 164-169.
30Montgomery, op. cit., p. 78.
are being followed and that the results are correct. As the application of electronic analysis increases, auditing will become more and more an analysis of internal control and programming, followed by tests of the programming."31

Holmes introduced the element of "Program Review." Meigs' Principles of Auditing, 1962, adds examination of controls operating outside of the processing center. Stettler's Auditing Principles, 1950, advises planning in controls, but gives no further guidance. Peloubet and Heaton's Integrated Auditing, 1958, describes the necessity for the auditor to understand machine controls and proof totals in the conduct of the audit. The authors' emphasis was placed on retention of the "Audit Trail," until evolution demanded that the "audit trail" be reduced in order to more efficiently utilize the timesaving features of the computer. Attention was then directed toward program control under an implied postulate that he who controls the program, controls the output.

Auditing textbooks of the 1970's have displayed various approaches to the teaching of EDP auditing techniques. Holmes' fourth edition of Basic Auditing Principles devoted one page to organizational controls within the EDP system. Meigs and Larsen's Principles of Auditing covers all areas of EDP auditing.34

Interviews with recent college graduates entering the public accounting profession confirm my supposition that many current

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curricula provide for skills in programming and systems operation with little emphasis on the teaching of computer auditing techniques.

Concludingly, the auditor must be more technically educated to competently review the new EDP control techniques....To accomplish this seems to require the integration of EDP and auditing courses for those just entering the auditing field. More inclusive EDP training for new personnel would serve to improve the general level of knowledge from the bottom level of the organization to the top level.

Practitioners have many sources of information available from the manufacturers' publications to specialized courses. All of these educational sources provide a portion of the required knowledge, but none fulfill the need for an authoritative guide to the implementation and review of EDP controls and audit methods.

Guidance Required for the Auditor

The fundamental requirement to increase the technical knowledge of auditors was adopted by the Institute and recognized by most practitioners and educators. A more active program by the Institute would speed the learning process.

Reduced internal controls and increased audit workloads are more urgent problems requiring the attention of management, educators, and practitioners. Probably the most urgent of these problems to be solved is the decentralization of function to improve the internal controls, and the formalization of policies and procedures related to data processing. Next, unique EDP internal controls which make greater use of the computer should be implemented. Once designed and operational, these functions will help to reduce the probability of risk. It is doubtful, however, that risk with respect to the processing of large transaction income statement accounts will be reduced sufficiently to preclude greater audit emphasis.
Extending the auditor's scope to the income statement does not necessarily mean increased audit time. Once internal controls are improved, the computer may be used as a tool to assist the auditor in the conduct of the audit. Thus, good EDP internal controls and the means of using the computer as an audit tool provide the foundation for auditing an EDP function.
REVIEW OF INTERNAL CONTROLS IN
THE DATA PROCESSING SYSTEM

Organizational Controls

Increased centralization as a result of EDP and changes in the basic organizational structure require special emphasis on the plan of organization. As previously discussed, the principle of separation of duties grows in importance within an EDP audit. Functions are created giving rise to new possibilities for a weak system of controls.

The EDP group should be functionally independent in its dealing with the departments it services. Whether the EDP department should report to the chief financial officer or directly to the chief corporate officer has been debated. Either alternative is acceptable provided no one can conspire to manage the information flow from the department.

Within the EDP department, functions not compatible must be separated. The data processing unit should be organized in such a way that duties relating to the handling of source documents and related input media, the operation of machines, and the programming and systems analyses are assigned to separate individuals or sections.

Programmers and Operators:

The separation of programmers and console operators usually presents no problem in the initial stages of system development of a program since the two groups report to separate supervisors. Once the program is operational, the programmers should not be permitted to run the console. Most facilities have adopted a general rule of permitting only the computer operators to run the machine even during the programming debugging phase.

Close consideration should be given to the position of the console operator. The person in this position usually develops considerable skill in programming as a result of his participation
in program testing.

**Input-Output Clerks:**

Source documents should be handled only by control clerks, keypunch operators, and others who are directly involved in transcribing the source data to cards, magnetic tape, or other input media. These employees should have no duties related to the operation of the EDP equipment, and conversely, the operators should not be permitted or required to handle the source documents.

In larger installations, a control clerk is used to check the receipt of source documents or input media to control totals and to monitor the disposition of output documents. This function is also not compatible with programming or machine operation.

**Librarian:**

The librarian function controls storage of the master files normally stored on magnetic tape. Only the librarian should have access to tape files, and all issues to operating personnel should be made on a formal requisition basis or under an approved schedule for repetitive runs. Requisitions should be signed and dated to provide a clear record of the processing history of the tape. The physical security of the library is usually a large fireproof safe or vault with access limited to the librarian. To further improve controls, the librarian should be instructed to issue tapes to operational personnel only.

For all of the positions mentioned above, a determination of the educational and experience requirements should be performed prior to hiring new personnel. The need for individuals of high quality and integrity cannot be over emphasized. Rotation of shifts and duties has been found to be a valuable technique for preventing any one person from becoming too familiar with the processing procedures.

Larger data processing facilities have established good
organizational control functions as a means to expedite the day to day operations. The introductions of small computers, e.g., IBM System 3, has created serious problems in that one or two individuals perform all of the functions just described. To improve controls, the input-output function should be removed from the data processing department and placed under the control of the financial officer. Extensive controls should be instituted and enforced to insure that all processing is performed as planned.

Administrative Controls

Administrative controls encompass the activities of programming the computer, documentation of procedures, and program testing. Although current trends emphasize documentation, these controls have been the most neglected during the early years of data processing development.

To insure the continuity of operation and the capability for review of programming and run problems, a summary-to-detail program file should be maintained by the systems personnel. The following should be included:

1. A program specification summary.
2. General system flow charts.
3. Supplemental narratives and decision tables (as required.)
4. Block diagrams of computer logic.
5. Record descriptions—input, output, and storage areas.
6. Program listings of coding and program checks.
7. Detailed operating instructions.35

Again, operational personnel should not have access to these files, and a copy of the detailed operating instructions should be provided for their use in running the program.

Processing Controls

There are four stages to data processing: data acquisition,

data transmission, data processing, and data utilization.

Data acquisition, or input, is the conversion of data from source documents into the processing media of punched cards, paper tape, or magnetic tape. Conversion may be manual as in punched cards, automatic as in optical readers, or as a by-product of another operation, as a bookkeeping machine. Data could also be introduced directly into the central processing unit via an on-line typewriter. Following acquisition, data is transmitted either physically or electronically by converting the data to electrical or electronic signals and transmitting the information over the telephone, radio, or microwave networks. A reader and transmitter accepts data from cards or tapes and converts the data to code for transmissions on a carrier wave. Receivers then decode the data and convert it back to hard media, although this step can be avoided in real-time systems, when impulses act directly upon the data base.

The data processing stage consists of input editing, arranging, processing, and output editing. As the data is read in, records are reviewed to test the quantity and quality of incoming data prior to processing, or at critical points during the processing where unacceptable data could cause serious consequences.

Sorting normally follows the edit functions to align incoming data files to the master stored records, thereby reducing processing time. The data is then processed by the program, and the output is arranged and often edited prior to transfer to another media.

The fourth and final stage in the data flow, data utilization, is the use of the final results, including the actions prompted by output documents.

**Input-Output Controls:**

In most data processing facilities, the Input-Output (I/O) clerk or station acts as the input-output control. All data is
channeled through this point and scheduled for processing. A requisite for accurate processing is the receipt of valid data before it has had the opportunity to effect the existing data base. Batch control techniques are employed in conjunction with the I/O control point. Two independently derived totals, usually the dollar field, are prepared by the data originator and the computer program. An adding machine tape, a count of data cards, or other such totals are prepared prior to submission for processing. The input-output control clerk compares the totals to determine that the processing has been as planned. Systems with complete general ledgers stored on data processing, use self-balancing batch totals to insure the proper updating of the master files.

When batch techniques are not used, a system of receipts and authorizations are employed to acknowledge processing and to show the accumulated control total. This method is less desirable due to the greater possibility of human error.

**Programmed Controls:**

Programmed controls may include a great variety of methods to improve data reliability, but the greater the number of control methods used, the longer the processing time. A trade-off must be selected to maximize control and data reliability and to minimize processing time and cost. A rule of thumb has been to select controls based upon cost versus the possible exposure to loss.

The editing of input for invalid data is the most common control method to increase data quality. Either a special input-editing program is prepared, or the edit is added to the existing processing program. Control totals are a by-product of such a program with the primary objective being to clean up the data before problems occur. Some examples of edit tests follow:

1. Valid character tests: A field is tested to determine that alphameric, numeric, zeroes, blanks, or other validating characters are there. Checking for
alphabetic characters in a numeric customer account number field would help reduce the possibility of future processing of a customer master file.

2. Field size test: The number of digits in a field are counted for predetermined field size.

3. Sign tests: The fields are tested for plus or minus signs, or debits or credits in an accounting function.

4. Check digits: These are digits, usually not data used, to determine transposition errors in input fields.

5. Missing data tests: All fields requiring data are checked to insure data is there.

6. Authorization tests: A code, department number, or other character is tested to a program-stored table which will allow only a valid code to initiate the transaction.

7. Consistency tests: A correlation of several conditions to determine data correctness.

8. Limit tests: Programmed criteria, e.g., all checks over one thousand dollars, employees over age seventy-five years or less than fifteen years, time cards with eighty hours or more, are printed out as an exception for follow-up action.

9. Sequence tests: Checks for prenumbered documents to insure all input has been received. A serial number may be keypunched into the input document to institute this control feature. A programmed edit or routine feature would then print out the missing numbers.

10. Per cent-Error tests: Processing is halted if the number of errors encountered exceeds a predetermined per cent.

Errors resulting from the edit function are printed in an error listing for follow-up correction and resubmission by the user. For those errors representing a failure to comply with internal control procedures, the error listing should be referred to a supervisor for further investigation. A control file may be necessary for records rejected. Each record is held in the suspense file until properly corrected, thereby insuring a proper follow-up action.
Operational Controls:

Operational controls are procedural methods to reduce errors during the program running. The system of documentation outlined under administrative controls would be available and used by the computer operator. Input file descriptions, set-up instructions as to the equipment required, computer-switch settings, halt procedures, and "end-of-job" actions are some of the information required by the operator to insure the proper running of the program.

External and internal labels prevent processing of the wrong data file with a computer program. External labels are attached to the tape reel or disc to show the operator the data prepared, the retention period, file name, reel number, and file number. Internal labels are usually the first, or header, records and the last, or trailer, records of the tape or disc file. Programmed controls print out this information on the console typewriter for identification purposes prior to running. Routines are also added to the computer program that will reject invalid data file labels.

Boundary protection is primarily required in the use of disc files and must be programmed. When several files or tables are stored on the same disc module or pack, all programs which read or write on the disc should provide boundary protection. Also, additional programmed controls should be established to limit read and write instructions to those discs which contain required information, or on which information should be written.

File Maintenance Controls:

As a master file is processed to create a new, updated file, an additional copy of the new master file is prepared and retained. This serves as a back-up to be used in reconstructing the master file should subsequent events destroy the data base. Library control over these files is essential to data security, for they may provide the basis for the creation of erroneous data bases.
Physical security is essential not only to prevent the interruption of essential business functions, but to prevent individuals from using the equipment for personal purposes. Without controlled access to the machines, the doctrine of separation of duties can become fictitious during the night.

The general listing of control techniques presented are a few of the many variations found in practice today. Analysis of the frauds uncovered demonstrate the increased need for EDP controls, and for auditors familiar with the application of the control techniques.

The computer can be an embezzler's tool where sloppy controls and laxity exist, but the computer can also be a powerful countermeasure in the hands of trained auditors. Procedures are executed with precise accuracy over all transactions, which was not possible prior to data processing. If the proper controls are instituted and supported by management, data reliability and security are significantly improved. When faced with the possibility of frauds exceeding millions of dollars due to the unique power of data processing, management is justifiably more interested in controlling the computer. Adoption of a system of EDP control techniques is essential to the control of resources. Without them, as in the traditional accounting system, an infinite number of EDP auditors could not function in their capacity of testing the underlying documentation of the business transactions.
USE OF THE COMPUTER AS AN
AUDITING TOOL

Development

Even with the extensive use of computers, it should be recognized that the purpose of the external auditor has not changed, and the attest function remains the same. The auditor still renders an opinion on the fairness of presentation of the financial statements. Financial statements are generated by a system, and the auditor must know, evaluate, and test this system to be satisfied that data was accumulated properly. To the extent the system is EDP integrated, the auditor must understand and test the system based upon his review of the EDP internal controls in being. This testing requires greater use of procedures which involve the computer directly.

The publication of EDP auditing techniques has been confined for the most part to internal documents used by the major public accounting firms. During the sixties, the auditing philosophies of these firms followed two approaches. The first approach advocated the application of traditional accounting techniques. The other attempted to use the technological advance of the computer as a means of improving present auditing techniques. Between these two extremes were many firms who engaged in varying degrees of innovation toward EDP techniques. Progress was slow because of large experimental and developmental costs, the lack of trained auditors with extensive computer backgrounds, and the inability to decide the impact of EDP. In addition, clients were often reluctant to go along with the interruption of busy EDP schedules for experimentation, and many computer users had not yet grown to sufficiently large systems whereby the economies of computer auditing were the greatest.

Evaluation of the progress is difficult even today, as firms do not appear willing to discuss untried techniques or failures.
The increased frequency of EDP articles in the *Journal of Accountancy* enforce this supposition, and their increased sophistication of the subject points to the advancement of EDP techniques as applied to the accounting profession.

**Program Control, Test Decks, and Observation of Processing**

One of the first techniques proposed was "Program Control." This technique contemplated obtaining and controlling copies of the program and requesting that the data be run while using the auditor's copy. An EDP specialist would review the program, and the auditor would then satisfy himself that the program would perform as designed if run uninterrupted.

A second method utilized a simulator program or test deck to be run on the client's computer, using the regular operating programs. Results are compared to predetermined solutions, again testing the client's programs.

The third technique required the auditor to test the processing of data by observing the client's personnel on an unannounced basis.

The first two methods had only limited applications for an auditor. Program control techniques require the auditor to maintain a set of updated programs under his control. With the innumerable changes that are made to programs because of changing business conditions and new equipment, it is evident that an auditor would have to work constantly with his client's data processing personnel to maintain useful programs. In addition, the auditor would have to be satisfied with the original program to preclude the possible perpetuation of existing program malfunctions, intentional or otherwise. It is also apparent that the auditor would have to be an EDP expert, or that experienced programmers would have to become a part of the audit team if this work were to be performed properly.
Simulator programs may be useful in testing procedures and the system of internal control. However, the preparation of test data and the annual updating to provide for new operating developments would require considerable time and study of the program.

The third method, observation of actual processing, can be a practical aid to the auditor in his review of procedures and internal accounting controls. Check tests for evaluation of procedures and controls should assist in directing efforts for this technique.

All three techniques emphasize program testing or control, and prove to be impractical because of the time involved and the level of EDP expertise required. Only test decks have continued to provide limited usefulness.

To employ a test deck, the auditor must have an in-depth understanding of how a computer works. This is contradictory to the position that the audit is not designed to uncover fraud. A computer during processing is capable of only a few operations. These operations include arithmetical computations such as the modification of data, the transfer of control statements which move to a different part of the program sequence often contingent upon a condition, and the input-output instructions. A computer program, once assembled from word instructions into the numerical codes of a machine-language program, is loaded into the "black box." Data is subsequently loaded into the box, either all at once, or in small increments if the data volume is very large. Input-output statements handle this portion of the processing. Within the circuitry of the computer is a counter or address register, which, once the program is loaded, takes control. Programmed instructions are of a fixed length and stacked one after the other into the core storage, much like sentences on the page of a book. Once the program is loaded, the counter is set at the address of the first instruction to be executed. Upon completion of the instruction,
the counter is increased to the address of the next instruction. This process is repeated until an end of program instruction shuts off the operation and transfers the control to a "monitor" program inherent in all computers. If the instruction directs an arithmetical operation, the specified data is operated upon. If the instruction specifies a transfer of control, a "Go To Statement," the address in the register is increased or decreased causing the computer to branch to that instruction address.

Programmed control transfer statements will be performed on a condition automatically, or may be controlled by switches on the console of the computer. These switches will cause a jump to different locations within the program contingent upon the setting. A primary objective of test decks is to trip these branch instructions in a technique called "error checking." Programmers should be able to recognize many common, illegal, or improper transactions; e.g., invalid codes, items exceeding limit checks, arithmetic runover, etc.... Error checking thus tests the system's ability to detect non-compliance with management's prescribed procedures and methods. Assurance is provided by the fact that if one transaction of a given type passes a test, then all transactions containing the identical test characteristics will, if the appropriate control features are functioning, pass the same test. Accordingly, the volume of test transactions of a given type is important.

In testing the system's compliance with prescribed methods and procedures, test decks may be designed both for particular transaction-handling features and for general system features.

Representative tests of transaction-handling features would be:

1. The effect of missing transactions, such as an employee's checking in on a job without having previously clocked in for the day.
2. The handling of erroneous transaction, (either deliberate or accidental), as charging time or
materials to improper accounts.

3. The handling of illogical conditions, as inventory issues that exceed on-hand quantities, or payroll deductions that exceed an employee's gross pay.

4. Validation checks performed by the computer to see if the checks catch credit limits that are too high, or a credit limit change that is too large, or missing fields of information in input transactions.

Tests of general system features would include batch control procedures, validation check procedures, machines and operational control procedures, and other features described in this paper.

Designing a test deck begins with a review of the systems flow charts or logic charts in an attempt to locate where the dummy transaction should be injected in order to accomplish the desired objective. For practical considerations, the client's data should be used to introduce data representative of the actual system augmented by erroneous transactions designed by the auditor.

The following procedural steps are required to utilize the error checking method:

1. Review the logic and determine the program points to be tested, thereby reaffirming the audit objectives.
2. Set computer switches according to procedural instructions and record the setting as part of the run data.
3. Process the test deck and record the handling of unusual transactions during processing.
4. Examine output for validity.
5. Evaluate the results, and if necessary make successive runs using different console settings or transactions.

One of the primary limitations in the early techniques was the level of EDP knowledge required to determine the type of testing and data to be used. In addition, numerous program changes in the early days of a data processing system necessitated extensive updating each year, thereby offering little time savings in the subsequent year's applications. Finally, determination of the
specific audit objective was difficult, or the test could be more economically applied using conventional techniques.

As the data processing systems matured, and the program changes decreased, the test deck increased in value as a tool of the internal auditor for the detailed tests of compliance with internal and adherence to management procedures. The lack of EDP education on the part of accounting personnel has suppressed the use of test decks. As the more technically trained accountants move into the profession, this gap should be bridged with the possible increase of test deck applications.36

**Special Purpose Computer Auditing Programs**

While the test deck can be a valuable technique, its application is primarily confined to the review of internal control. Use of specialized computer auditing programs expands the auditor's review of internal control, provides a technique for gathering evidential matter, and permits utilization of the time efficiencies available by auditing through the computer. Peripheral operations and special studies are added as bonuses.

The specialized programs were designed for individual client's equipment, data storage media, and data format. Programming required expertise and considerable cost in program "debugging" time. Once a program was developed, however, it could be re-used and improved in subsequent years after minor alterations. The limitations of these highly specialized programs centered around their inflexibility to be applied on EDP systems other than the one for which it was designed. Common applications of these programs were in seven major areas:

1. Testing extensions and footings: Simple summations and computations are performed to independently verify that master files equal control accounts or

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to establish arithmetical integrity of the figures. The auditor no longer had to rely on samples of data, for now it was possible to recheck all of the data in order to verify company totals.

2. Summarizing data and performing analyses useful to the auditor: Aging of accounts receivable, preparation of annual usage requirements of parts and inventory, listing all credit balances in accounts receivable and all debit balances in accounts payable are only a few of the many applications in this area.

3. Examining records for quality: Limit checks and listing of customer file records might be examined to determine the number of records in which there is no credit limit specified. A listing such as this merely transforms magnetic records to visible hard copy for subsequent review by traditional auditing techniques.

4. Selecting and printing of confirmations: Based upon quantifiable selection criteria, the computer can select and print out the confirmation requests. One firm has progressed to a multipart form which prepares a first request, a mailing envelope, a return envelope, a control copy, and a second request. Returned confirmation may then be analyzed by similar programs.

5. Selecting and printing audit samples: Selection of samples by multiple criteria is probably one of the most powerful applications of the computer to auditing. Samples are then used for confirmations, price tests of inventory items, etc....

6. Comparing audit data with company records: Inventory counts can be compared to the physical inventory records; cash receipts may be traced to accounts receivable records; and inventory costs may be compared to the cost data master file.

7. Specialized audit programs do not have to be written by the auditor. Often programs written by the client, or programs written by or under the supervision of the auditor may be employed. The most recent application is the generalized audit program.37

Recognizing that many audit functions do not change from client to client, attempts were made to develop one program compatible with different systems.

During the past eight years, generalized computer audit systems have been developed by private companies and by professional accountants. (See Table I for an historical summary.) One of the earlier programs, the Auditape of Haskins and Sells, CPA's, has been in active use since 1965. Discussion of this auditing system best describes its possible uses. The Auditape system was designed to be used "by persons having no specialized knowledge of computers or programming languages, and having only a nominal amount of simple instruction; and on a wide variety of records, interchangable without any need for preparation or special programs for each type of application to be processed."^38

Auditape is a system composed of subroutines that are capable of accomplishing the seven functions listed for specialized computer auditing programs. The program is on magnetic tape, or disc pack, and requires mounting on the client's system. Parameter cards are read by the computer, thereby telling Auditape which routines are to be used, and interfacing the client's data forecasts with those of the Auditape system.

Interfacing includes adapting the generalized audit program to the client's system regardless of the storage devices, input-output hardware, and other system characteristics. This program has been written for IBM, Control Data, and Honeywell machine language. For other equipment, commercial translator routines are available.

Similar to any computer system, the Auditape has a monitor

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routine for loading and controlling the rest of the program, thus assuming control of the client's computer. Next comes the Edit Routine which includes the Subtotal-Subroutine and Include-Exclude Subroutine. Also a Print-Punch Routine, Summarize Routine, Mathematical Routine, and an Audit Sample Routine. An auditor may by keying his parameter cards, instruct the system to use the application required for the review he is conducting.

Once the system is mounted on the client's computer, the Edit Routine begins extracting designated fields of information from the client's records and rewriting them on scratch tape. Simultaneously, the routine is maintaining totals of the data handled, and will include or exclude items with given characteristics, if so directed. A total dollar amount of items handled, e.g., accounts receivable, for a comparison the control account is one possible product. Another is the establishment of an accounts payable or purchase cutoff. All of the extracted data may then be saved for subsequent routines, or printed or punched by that routine for an independent review of the items as well as the gathering of audit evidence.

For recomputation of inventories, footings, etc..., the Mathematical Routine could next process the data tape. Finally, the most powerful routine is the Audit Sample Routine. Unlike predecessor statistical sampling plans, the computer's great processing ability provides for a more extensive sampling technique. And unlike previous plans, once the reliability levels are read in on parameter cards, the auditor may not have second thoughts and "loosen up" as is the temptation with manual-table sampling plans.

A recent summary of an Auditape accounts receivable application published in the Journal of Accountancy follows:

"Examine the content of individual accounts; stratify the dollar values of the accounts; resummarize the account totals; select, as well as identify, the
audit sample; and prepare accounts receivable confirmation notices."

The study concluded:

"As it is abundantly clear from the broad outline of this case study, the client's record-keeping techniques were in the 'dark ages' of computer approaches, and yet we were able to apply the computer to auditing the accounts in a much shorter time than would have been required for a manual audit."39

The following table is relevant to and representative of EDP auditing with Auditape.

<table>
<thead>
<tr>
<th>Manual Approach</th>
<th>Computer Approach</th>
</tr>
</thead>
<tbody>
<tr>
<td><strong>Audit Staff Time</strong></td>
<td><strong>Audit and Computer Staff Time</strong></td>
</tr>
<tr>
<td><strong>Preliminary Investigation and Discussion</strong></td>
<td>4</td>
</tr>
<tr>
<td><strong>Footing Accounts Receivable File and Audit of File Contents</strong></td>
<td>35</td>
</tr>
<tr>
<td><strong>Selecting Confirmation Sample and Preparing List</strong></td>
<td>28</td>
</tr>
<tr>
<td><strong>Preparing Confirmations, Stuffing and Mailing</strong></td>
<td>31</td>
</tr>
<tr>
<td><strong>Accumulating and Appraising Sample Results</strong></td>
<td>43</td>
</tr>
<tr>
<td><strong>TOTAL</strong></td>
<td>141</td>
</tr>
</tbody>
</table>

A generalized computer auditing program, in conclusion, provides all the options of a specialized program without the extended programming time. It may be used by a non-EDP educated auditor with more than significant time-saving, and as shown by

the chart, causes a shift from clerical tasks to professional review. The professional accountant must therefore develop an intensive program to evaluate the internal controls associated with all aspects of data processing. Test decks are available to check the execution and design of specific programs. For applications where there are minimal program changes, dual processing with the aid of a specifically designed program may be employed to test the processing of data. The most versatile and practical data processing technique is the generalized computer auditing system as described in the Auditape case study.

GCAPS, (Generalized Computer Auditing Programs), allow the auditor independence with respect to the data processing system. Due to the wide range of possible applications, these tools should be an essential part of the auditor's procedures.

Conclusions and Implications for Future Computer Generations

Since its introduction, the computer has produced major changes in the accounting systems, the accounting records, and the manner in which business functions are generally performed. Research by the large public accounting firms, individuals in business, and educators created many new techniques and procedures for controlling the computer and for employing the computer as an audit tool. To date, these techniques and procedures have not been successfully brought together, resulting in fragmented and diversified internal controls and auditing standards throughout business systems.

This lack of consolidation of control and the increased risk of potential large frauds indicate that current auditing standards set forth by the present authoritative sources are not sufficient. The rapid rate of technological changes brought about by the growth of business computers has not allowed the historical concept of the gradual evolution of guidance to happen. The increased number of computer frauds serves to attract the attention of
regulatory agencies and other interested groups to the growing problem, while also creating needs for urgent and specific action.

The AICPA should advance the Generally Accepted Auditing Principles at a rate comparable to the development of EDP. Because the Institute has published many audit guides for various industries, the preparation of an EDP audit guide seems to be an appropriate solution to correct this deficiency. Such a guide could present unique internal control features and establish procedures for the review of internal controls within the EDP system. Also needed are detailed computer auditing methods and sources for technical guidance to assist all auditors and management regardless of the size of the EDP installation. As the computer gains wider application due to the increased use of small and mini computers, this guidance would be even more essential for controlling and auditing the system.

If the Institute fails to provide the necessary guidance, another agency may take over this function. Frauds disclosed will exert more and more pressure to solve the problem. Individuals with expertise in EDP controls echo the belief that the Equitable Funding and the Union Dime Savings Bank cases are only a sample of what could happen. An enterprising individual with the knowledge and desire could relieve an unsuspecting corporation or bank of many millions of dollars and possibly never be caught.

Auditing techniques and internal control features discussed in this paper represent a starting point for what should actually be considered. They were developed for use on a third generation computer, which processed data in easily controlled "batches." Unlimited internal storage, larger central processing units, and "on-line" terminals will present an entirely new set of problems to be solved.

An "on-line" system consists of a central processing unit capable of interacting with many devices connected directly to the
control unit. With the "batch" processing system described in this paper, a group of similar transactions were run simultaneously, and control techniques insured the batch was processed as management desired. Master files of data were maintained for each application on either magnetic tape or disc storage. This unlimited, low cost internal storage implies that the files could be stored in the central processing unit’s storage area and be continually updated. The addition of numerous input terminals, using present techniques, would make the task of obtaining data cutoffs and data control almost impossible.

Finding future methods of controlling and auditing such a system would require both time and a very sophisticated level of technical expertise, not presently found in the auditing area. The following implications produced by the research of this paper could be an appropriate beginning.

First, the internal control procedures presented for batch processing should be strictly enforced with greater emphasis on the internal programmed controls in order to check data entering the system and to monitor personnel using the system. Limit tests, both as to size and number of transactions would automatically be displayed as an item for audit explanation.

Second, terminal and communication security should be developed and rigidly enforced.

Third, functions should be decentralized within and without the data processing group and controls to further the separation of duties developed.

Fourth, methods, as a dedicated tape drive continually recording information, to extract data on an unannounced basis during the hours of system operation should be developed. An independent auditing group would then reconcile the output as to final records and then test the system.

Fifth, the independent auditor would have to gain an even greater knowledge of EDP and take a more active role in client control. This could require spending more time with the client and installing a computer terminal in the auditor's office to further facilitate testing during the year.
The developments for today and for the future clearly call for immediate, precise, and dynamic audit guidelines for electronic data processing systems. Because the AICPA is the primarily organized body for producing these guidelines, it should direct the program. Technology may appear to be slowing, but it is obviously not relenting in its progressive attack on the auditing field. A major disaster may never occur before auditing's evolutionary standards "catch up" with this progress. However, the chances are great that without the implementation of updated and consolidated controls and EDP standards and procedures, an awesome, record-breaking fraud may soon be uncovered.
APPENDIX A

GLOSSARY OF SELECTED EDP TERMS

address. A name, label, or number identifying a location in storage.

audit trail. Documentation or other evidence created to facilitate tracing source documents to machine-produced output, and vice versa.

batch. A group of transactions processed in sequence as one lot.

central processing unit (CPU, main frame). The component of a computer system which contains the main storage, arithmetic, and control units.


control group. Persons who control and review all data processed by the computer and all computer output before its distribution.

control total. A total of one information field for all the records of a batch, as the total sales dollars for a batch of sales invoices.

disk. A random access storage device consisting of a circular metal plate with magnetic material on both sides.

external label. An identifying label affixed to the outside of a file holder, as a magnetic tape file.

generalized audit programs. Computer programs developed by CPA firms for the purpose of auditing.

hard copy. Computer output in printed form, as printed listings, reports, and summaries.

hardware. Physical equipment and devices comprising an electronic data processing system.

header label. A machine-readable record at the beginning of a file which identifies the file.

library. A collection of magnetic tape files and records.

master file. A file of relatively permanent data or information which is generally updated periodically.

nanosecond. One billionth of a second \((10^{-9} \text{ seconds})\).

off-line. Pertaining to peripheral devices or equipment which are not in direct communication with the central processing unit of the computer.

on-line. Pertaining to peripheral devices or equipment which are in direct communication with the central processing unit of the computer.

operator. The person who manipulates computer controls, places information media into input devices, removes output, and performs related functions.

peripheral equipment. Components of an electronic data processing system other than the central processing unit.

random access. Pertaining to a storage technique in which the time required to gain access to data is not significantly affected by the location of the data in storage. A disc is a random access device.

real-time processing. Data processing of a transaction performed concurrently with the occurrence of the transaction, providing output immediately useful.

routine. A set of sequence instructions that causes a computer to perform a particular process.

software. Programs and routines, including assemblers and compilers, furnished by a computer manufacturer to facilitate the operation of a computer.

solid state components. Transistors, diodes, and other electronic components which control or convey electrons within solid materials.

systems analyst. The person who examines a business activity to determine what must be accomplished and how it is to be accomplished.

test deck. A set of dummy records and transactions developed to test the adequacy of a computer program or system.
## GENERALIZED COMPUTER AUDIT PACKAGES

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<th>YEAR</th>
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<td>AUDITRONIC-16</td>
<td>Ernst &amp; Ernst (U.S.)</td>
<td>1961</td>
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<td>AUDITAPE</td>
<td>Deloitte, Haskins &amp; Sells (U.S., Canada)</td>
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<td>PROBE</td>
<td>Computer Resources Corp. (U.S.)</td>
<td>1971</td>
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