The auditor's tool kit today includes the microchip (enlarged at right).

AUDIT TECHNOLOGY: A HERITAGE AND A PROMISE

BY ROBERT K. ELLIOTT AND PETER D. JACOBSON

AUDIT TECHNOLOGY' BRINGS TO MIND modern tools such as the microcomputer and multiple regression analysis. But audit technology has existed from the beginning of the profession, and a full history of its development would be voluminous indeed. In this article, our intention is more modest: to provide some perspectives on the development of audit technology, to identify themes and raise questions, and to assess where we stand now in terms of where we have come from and where we are going.

First, let us define "audit technology" as it will be used in these pages. It refers to the auditor's tool kit. A tool may be thought of as anything that enhances an individual's capacity to perform a task. Audit technology, then, consists of all the things designed to enhance the auditor's capacity to perform an audit task.

One typically thinks of tools as things that help people perform physical tasks—hammers and saws, for example. But tasks can be abstract, such as reaching a conclusion on the reliability of financial information, and the tools that enhance the auditor's capacity to perform such tasks can be abstract, too. Language and mathematics are abstract tools, as are basic auditing concepts, including audit objectives, and many of the procedures used in auditing. Audit sampling and the concept of relying on accounting controls to reduce substantive testing are tools in this category.

This article pertains only to the technology of the independent audit of financial statements. The independent audit of financial statements is a specific service within the generic category of attestation services—that is, the practitioner is engaged to express a conclusion about the reliability of a written assertion (the financial statements) that is the responsibility of another party (management). In recent years the range of assertions covered by attestation services has grown, and it is likely to increase in the future.

CPAs now provide reports on the reliability of descriptions of computer software, descriptions of systems of internal accounting control and investment performance statistics. The

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The immediate ancestor of the GAAS audit was the so-called balance-sheet audit. As it happens the oldest ancestor of today's GAAS audit developed for today's GAAS audit and its direct ancestors. As it happens the oldest ancestor of today's GAAS audit did not die out when the immediate predecessor of today's GAAS audit appeared on the scene. The first problem in gaining perspective on the evolution of audit technology is the changing concept of the audit of financial statements. We are interested in the technology of the GAAS audit (an audit in conformity with generally accepted auditing standards). We are therefore interested in the technology developed for today's GAAS audit and its direct ancestors. As it happens the oldest ancestor of today's GAAS audit did not die out when the immediate predecessor of today's GAAS audit appeared on the scene. The earliest form of audit in the modern era was the so-called detailed, or "complete," audit. In the typical detailed audit of 100 years ago the auditor would vouch all cash disbursements, check all footings and postings and check the ledger to the trial balance and the trial balance to the financial statements. The major portion of audit time was spent on footings and postings, and the most important aspect of the detailed audit was the search for defalcations. The ideal user of such an audit was the owner, who was interested in fraud in the transactions and postings; and the notion became clear that some amount of work less than the detailed audit could be sufficient to assure that the accounts were, in today's terms, materially correct.

The last point appears in Moyer's citation from a book of unofficial answers to questions from early CPA examinations. The question was, "In an audit where a detailed examination of the books is not stipulated or not practicable, what examination is essential to assure their general correctness?" We can translate "general" to "material." Moreover, the answer quoted by Moyer contains the concept of relying on controls to justify reduced testing: With respect to checking postings to individual customers' and creditors' accounts, "it is practica-
The audit tools recognized in 1917 in "Uniform Accounting" weren't expanded in the revision published in 1929, entitled "Verification of Financial Statements." The primary change was a more explicit recognition of the concept that reliance on controls justified reducing the extent to which procedures are applied: "In some cases the auditor may find it necessary to verify a substantial portion or all of the transactions recorded upon the books. In others, where the system of internal check is good, tests only may suffice."\(^7\)

The work was to include "incidentally, an examination of the accounting system for the purpose of ascertaining the effectiveness of the internal check."\(^8\) The word "incidentally" creates some ambiguity, which is highlighted by the absence of any guidance on how to evaluate the system of internal check.

Two reasons may explain the ambiguity:

The first is the distinction between a consideration of the system as part of determining what type of audit should be performed and a consideration of the system as part of the audit itself. Considering the system was not yet fully a part of the audit. In the 1934 edition of his auditing treatise, for example, Robert H. Montgomery puts the consideration of the system of internal check in a chapter entitled "Preparatory Considerations," which states:

"After his conference with the client and survey of the system of internal check the auditor is in a position to determine whether the needs of the client will be met most adequately by a balance sheet or detailed audit or by some partial examination, the nature and extent of which is to be governed by the purpose for which the report is to be used."\(^9\)

The second explanation for the ambiguous treatment of internal control is its dual function as the auditor's justification for sampling and as management's safeguard against irregularities. The auditor performing a balance-sheet audit, and thereby relinquishing responsibility for detecting immaterial defalcations, could say, and often did say, that the system of internal check provided management with an appropriate safeguard. That was the response of nine large accounting firms when representatives of the New York Stock Exchange (NYSE) inquired about the scope of the audit in 1933. Larger companies, they wrote, "rely on an adequate system of internal check to
Extensions of Auditing Procedures.

The AIA's obligation to evaluate the system of internal controls to determine the scope of work necessary to reach a conclusion on the correctness of the financial statements and evaluating those controls to provide assurance that the company's system protects it from fraud.

Later in the stock-exchange correspondence, the NYSE expressed its desire to have "auditors assume a definite responsibility for satisfying themselves that the system of internal check provides adequate safeguards and should protect the company against any defalcation of major importance." The Institute's special committee on co-operation with stock exchanges said in its reply that the duty to evaluate controls was already recognized in "Verification of Financial Statements," and it added a statement that both absolved the auditor from the responsibility to search for all defalcations and linked the absolution to the responsibility for evaluating controls: "if in any case a defalcation should occur and escape detection, the accountants can not be expected to accept any financial responsibility, but only to accept such blame as may attach to a possible error of judgment on their part with respect to their review of the methods and extent of the internal check and control."

Not surprisingly, the obligation to review the system of internal check was sharpened in the revision of "Verification of Financial Statements," published in 1896. The auditor was instructed to consider the system of internal check in determining the nature and extent of the examination, and there was, for the first time, some rudimentary guidance on evaluating the system. Although no equivalent of the compliance test was recommended, the document cited several circumstances justifying reliance. These circumstances varied from periodic reconciliation of cash accounts and corresponding bank accounts by employees independent of the cashier's department, to an accounts receivable arrangement marked by good segregation of duties, to the general notion of notes receivable being "controlled by a satisfactory internal check.

As a consequence of the McKesson & Robbins case, the Institute in 1939 issued Extensions of Auditing Procedures, which made the obligation to evaluate the system of internal control an integral and obligatory part of the audit. The scope paragraph of the standard report was required to include the statement that the auditors had "reviewed the system of internal control." The occasion for adopting the new requirement, the widely publicized McKesson fraud, implied that one possible purpose for the obligation was to provide some assurance that the company had some protection against defalcations. The implication was encouraged by a paragraph in Extensions which allowed a reader to conclude that the auditor was in some way relying on the internal control system to do what the auditor wouldn't do—attempt to discover all cases of fraud.

Frank G. Short of Barrow, Wade, Guthrie & Co. was one such reader, and he explained his position in the Journal of Accountancy. Influenced by his belief that auditors hadn't been giving internal controls much attention, he reasoned that the new requirement was in part adopted "with a view to forcing an extension of our present methods." To him, the statement that the auditor reviewed the system could only mean that "we have reviewed the system of internal control with a view to determining its adequacy (a) in revealing fraud, if it exists, and (b) in revealing those errors which are not discovered by balance-sheet auditing methods. In other words, we are returning in part to the viewpoint, if not the methods, of the detailed auditor."

Such views affect one's perspective on the adoption of the new requirement. It was almost as if the profession was trying to establish by implication a quid pro quo—relief from the obligation to detect all fraud in return for some kind of vague assurance on internal controls. In 1987 the larger issue is the continued struggle to establish as the exclusive audit objective the opinion on the material correctness of the financial statements. To achieve this, the discovery of immaterial defalcations would have to become incidental to the audit rather than an ancillary objective.

Extensions of Auditing Procedures is most famous for mandating observation of physical inventory taking and confirmation of receivables. But neither represented new audit technology. From the standpoint of audit technology the important fact was that the procedures had been mandated. An element of structure had been added to the audit process, and the way was open for additional ele-
The AIA's Extensions (1939) became the first of a series of SAPs. The events that led to the issuance of Extensions were also important because they showed that the Securities and Exchange Commission could influence the development of audit technology. The SEC began hearings on the McKesson & Robbins case on January 5, 1939, and the scope of the hearings included the adequacy of auditing principles and practices. The hearings ended on April 25 after recording 4,587 pages of testimony covering, among other things, auditing inventories and accounts receivable. Ten days later the Institute's council adopted Extensions, substantially the same document approved by the membership at the next annual meeting (September 18, 1939), more than a year before the SEC issued the accounting series release (ASR) with its conclusions on the hearings. The swiftness with which the Institute prepared Extensions permitted the SEC to endorse its guidance in ASR no. 19, but the SEC's actions had nevertheless contributed to the adoption of the new requirements.

The securities acts also contributed to a crystallization of the concept of materiality. Warren Reininga has shown that surrogates for the concept had already appeared in "Uniform Accounting" and "Verification of Financial Statements" but concluded that growing use of the term had its origins in the Securities Act of 1933 and in auditors' experience in meeting the legal requirements of SEC practice. He cites as an example the definition by Spencer Gordon, the Institute's legal counsel, in 1933: "A material fact is a fact the untrue statement or omission of which would be likely to affect the conduct of a reasonable man with reference to the acquisition, holding or disposal of the security in question." According to Gordon, this definition was derived from the 1933 securities act and a chapter on fraud and misrepresentation from the American Law Institute's Restatement of the Law of Contracts. We can assume that when the SEC in 1940 stated that the information in the McKesson & Robbins financial statements was "materially false and misleading," most readers understood the SEC's use of the term.

The 1940s

The 1940s weren't notable for developments in audit technology. The hiatus created by World War II makes the period seem otherwise relatively uneventful, even though the 10 generally accepted auditing standards were adopted in 1947-48. However, regarding audit technology, the documents adopting the standards are notable in two respects.

First, the commentary on the second standard of fieldwork, which requires a study and evaluation of internal control, stated that the auditor who evaluated controls had to obtain "a reasonable degree of assurance that the procedures actually are in use and are operating as planned." It wasn't enough to obtain "knowledge of the procedures and methods in use and an understanding of their function and limitations." The distinction implied that testing had to be performed, adding another structural element to the audit.

The second notable feature of the commentary on the standards was its recognition of the concept that the audit should be planned and performed with regard for the risk of material error. Materiality and "relative risk," we are told, are pertinent to both the standards of fieldwork and the standards of reporting. "There should be stronger grounds [that is, more convincing evidence] to sustain the auditor's informed opinion in respect to those items which are relatively more important and in respect of those in which the possibilities of material error are greater." In discussing how "degree of risk" bears on planning, the passage cites as an example related-party transactions: "Arm's-length transactions with outside parties are usually subjected to less detailed scrutiny than those relating to intercompany transactions or those with the officers and employees, where the same degree of disinterested dealing cannot be assumed." Today this consideration, degree of potential bias, would be categorized as part of inherent risk—the risk that material errors might occur absent internal control.
The relationship of internal control to audit risk and thereby to planning was explicit: "The effect of internal check and control on the scope of an examination is the outstanding example of the influence on auditing procedures of a greater or lesser risk of error." The controls minimize the risks of errors and irregularities; therefore, "the more adequate and effective the system, the smaller the risk and the less extensive the detailed examination and testing required."

STATISTICAL SAMPLING AND THE NEW APPROACH TO AUDIT TECHNOLOGY

The idea of applying statistical sampling techniques to auditing took hold in the 1950s. In 1956 the AICPA created the committee on statistical sampling, and a year later Herbert Arkin, writing in the New York Certified Public Accountant, reported that the past few years had seen "a veritable explosion of literature and discussion" on the subject. Today statistical audit sampling is an accepted audit tool, and statistical sampling questions routinely appear on the CPA examination; however, progress toward this end was in fact evolutionary rather than dramatic. This was partly because of the work that had to be done to express audit objectives in terms to which statistical techniques could be applied and partly because of the difficulty of combining statistical and subjective evaluations of audit evidence in forming overall conclusions. Such work was necessary in order to have statistical audit sampling become an accepted and widely used audit tool, and it contributed significantly to clarifying basic concepts of audit testing and audit risk. The work helped define the distinction between compliance and substantive tests, and it helped define the audit risk model later refined in Statement on Auditing Standards (SAS) no. 47 (1983). Both concepts appeared in the 1964 report of the AICPA committee on statistical sampling and were incorporated into SAP no. 54 (1972).

The evolutionary adoption of statistical audit sampling is also explained by the opposition of people who assumed that audit sampling using statistical methods would necessarily damage the profession by curtailing auditor judgment. We'll have more to say later about the role of this professional syndrome, but for now let us focus on the implications for audit technology as a whole of the successful steps to adapt statistical sampling to auditing.

A new source of audit tools had been tapped and a new approach to audit technology established. In the past audit tools had been developed from the wisdom of experienced auditors. On this occasion techniques from another discipline, a branch of mathematics, had been borrowed and adapted to audit sampling. The research performed to refine the application of statistical sampling to auditing was in this sense unprecedented, but it was to be the first of similar events. The subsequent development of new audit tools was to owe more and more to research based on techniques from other disciplines.

One example occurred during the period when statistical audit sampling was becoming established. In 1966 R. M. Skinner and R. J. Anderson of the Canadian firm Clarkson Gordon & Co. published Analytical Auditing, which explained a systems-based approach to the audit using flowcharting techniques to analyze the system of internal controls and obtain a more explicit linkage between evaluations of controls and related substantive tests. The book stimulated many firms to study and adopt systems-oriented auditing methods, and flowcharting is now a commonplace auditing tool. Its development owes much to the field of systems analysis. As Anderson wrote in an earlier article on analytical auditing: "General systems of...charting are well described in a number of books on systems and procedures. Some minor modifications of these are needed, however, to adapt the technique specifically to audit needs."

The application of techniques borrowed from other disciplines to develop new audit tools—that is, applied research—was soon supplemented by basic research on auditing using techniques from the behavioral and mathematical sciences. For years auditing research had been the much neglected sibling of accounting research. By the mid-1970s this changed as researchers discovered that new approaches, such as those in the branch of psychology called human information processing, could yield useful findings. Research employing these techniques has added to our understanding of the auditor's decision-making process, has made it possible to evaluate the auditor's approach to types of audit decisions and has pointed the way to new audit tools that can improve the auditor's decision making.
DETECTING FINANCIAL STATEMENT FRAUD
SAS no. 16 (1977) clarified the auditor's responsibility to detect fraud. It made the obligation explicit and limited to material financial statement fraud. Under SAS no. 16 the auditor is responsible for planning the audit to search for material fraud as well as errors "within the inherent limitations of the audit process." Further, the SAS states that "an independent auditor's standard report implicitly indicates his belief that the financial statements...are not materially misstated as a result of...[fraud]."

These responsibilities are limited by caveats that give meaning to the words "the inherent limitations of the audit process." To be cost-effective, audits are performed on a sampling basis; it's very difficult to identify unrecorded transactions, cleverly designed acts of forgery or collusion, and management override of accounting controls; and it's reasonable for the auditor to assume, unless there are indications to the contrary, that management's representations are not false. These caveats are realistic. To omit them would constitute a
The “red flag” approach represents a significant advance in audit technology. The red flag approach has its limitations. Red flags do not indicate the presence of fraud; rather, they are conditions believed to be commonly present in events of fraud and therefore suggest that concern may be warranted. But the same conditions may occur where there is no fraud. For instance, insufficient working capital or credit to continue operations may predispose some managements to misstate financial statements. To an honest business person the same conditions would simply be a harsh fact of business life. However, even with these limitations the red flag approach represents a significant advance in audit technology because the recommended audit procedures were designed with the sole objective of increasing the discovery of material financial statement fraud without regard for immaterial defalcations. Moreover, the red flag approach added to the structure of the audit process. Although the specific red flags cited in SAS no. 16 are presented as examples, the auditor is required to “consider whether there are circumstances that might predispose management to misstate financial statements.”

The clarification of auditors’ responsibilities for fraud detection and the development of the red flag approach took place under a number of similar influences:

- Litigation against accountants and SEC enforcement activities had increased, and there were fears that auditors’ liability was becoming a threat to the profession’s viability.
- The press and congressmen were denouncing improper payments by corporations in a campaign that did not cease until passage of the Foreign Corrupt Practices Act in December 1977 and that included the cry “Where were the auditors?”
- The subcommittees of Congressman John Moss and Senator Lee Metcalf issued publications that were highly critical of accountants, influenced by the improper payments issue and, in all too many instances, blatantly misinformed and misleading.

In these circumstances, it isn’t surprising that a statement clarifying the auditor’s responsibilities for detecting fraud was issued. What may surprise some is that in the hot-house atmosphere of the mid-1970s, the standard setters withstood the pressure to make auditors responsible for detecting items immaterial to the financial statements, such as most improper payments, and managed to advance audit technology through the red flag approach. They refused to roll back the evolution from the detailed to the balance-sheet audit to the modern GAAS audit. And we now know, since the Foreign Corrupt Practices Act has silenced the issue, that the standard setters would have acted unnecessarily had they extended auditors’ responsibilities to include the detection of immaterial improper payments to overseas officials.
THE AUDIT RISK MODEL

A refined and fully stated version of an audit risk model was adopted by 1983. The model was applied to audit sampling (SAS no. 39) and to the audit as a whole (SAS no. 47).

The model can be summarily stated:

\[ AR = IR \times CR \times DR \]

- **AR** equals audit risk—the risk that an auditor may issue an unqualified opinion on materially misstated financial statements.
- **IR** equals inherent risk—the risk that, in the absence of internal accounting controls, a material error will occur in the accounting process.
- **CR** equals control risk—the risk that a material error that does occur, and is not detected or corrected by the system of internal accounting control, is not detected by the substantive audit tests performed.
- **DR** equals detection risk—the risk that a material error that does occur, and is not detected or corrected by the system of internal accounting control, is not detected by substantive tests performed.

The auditor following this model decides on an appropriate level of audit risk, obtains evidence with respect to inherent and control risks and determines the level of detection risk consistent with attaining the selected level of audit risk. The resulting level of detection risk determines the intensity of substantive audit procedures necessary to meet the audit objective (a low level demanding extensive procedures and conversely). The risks on the right side of the equation are reciprocal. For example, the more evidence obtained indicating that control risk is less than the maximum, the higher the level of detection risk that is compatible with the selected level of audit risk and the less evidence need be obtained from substantive tests.

The audit risk model is applicable to planning the audit, selecting procedures for account balances and classes of transactions, and evaluating audit findings. It provides conceptual unity for the audit process. For example, many of the red flags for fraud detection are subsumed by the concept of inherent risk. SAS no. 47 makes this explicit by citing two red flags as examples of inherent risk factors and referring the reader to the relevant passage from SAS no. 16, which presents the red flag approach. In addition, the model allows that evidence from substantive tests alone can reduce audit risk to an acceptable level—in other words, that the auditor performing a test-basis audit can obtain evidence sufficient to support an opinion without obtaining evidence on control risk (that is, relying on accounting controls). The model thus complements SAP no. 54 and SAS no. 43, which interpreted the requirement to evaluate internal accounting controls in a way that is compatible with obtaining solely from substantive test procedures evidence sufficient to support an opinion on the financial statements.

EDP

The evolution of electronic data processing has had an enormous effect on how the auditor does his or her work. It has necessitated new audit tools to access and test computerized data, and it has made possible still other tools for more efficient and consistent audits.

The story begins in the 1960s with recognition of the impact that computers were having on clients' data processing and the prospect of a rapid increase in both the use of computers and the comprehensiveness of their effects on clients' accounting systems. The Institute took its first step to perform research and provide educational assistance in 1965, when it signed a contract with Systems Development Corporation to act as a consultant. A year later it appointed a special auditing EDP task force under the chairmanship of Gordon B. Davis. The efforts of the task force led to the publication of *Auditing & EDP*, a book providing guidance on auditing in an EDP environment, which was also the report of the task force. The preface calls the guidance “the views of the members of the task force based upon their experienced judgment,” rather than auditing standards. However, in 1972, SAP no. 54 referred practitioners to the book's chapter on evaluating internal control, and many of the ideas in SAS no. 3, *The Effect of EDP on the Auditor’s Study and Evaluation of Internal Control*, had appeared earlier in *Auditing & EDP*.

EDP changed the audit environment facing an increasing proportion of practitioners in a number of now well-recognized ways. For example, accounting controls were built into computer programs; accounting data and records were stored in machine-readable form; input documents might not exist because information was entered directly into the system; certain computer files might exist only...
The development of computerized audit techniques sparked much literature in the 1970s. Progress in developing concepts for evaluating programmed controls was slower than progress in applying the power of the computer to audit tasks. One basic concept is still not clear—the circumstances under which tests of certain “EDP general controls” are necessary to support reliance on programmed controls. The EDP general controls in question are access, systems-development and program-change controls.

The successive official statements on controls in an EDP environment (SAS no. 3 in 1974; the 1977 audit and accounting guide on the same subject; and SAS no. 48, which superseded SAS no. 3 in 1984) acknowledge in various passages the importance of the three EDP general controls and their close relationship to application controls. SAS no. 48, in fact, describes the relationship between some general controls and application controls as “interdependence.” However, it does not require test evidence of access, systems-development and program-change controls in order to rely on related application controls, even though the concept of interdependence implies reliance on either all the interdependent elements or none of them.

Interdependence implies, in other words, that an application control cannot be considered reliable unless there is assurance that programs and program changes are properly developed and that the programmed application control is not subject to unauthorized changes. The full implication of the guidance is somewhat masked by the term “general controls,” which is often used to refer to items such as the plan of organization and operation of the EDP activity. It’s true that access, systems-development and program-change controls usually affect many, if not all, application controls, and in this sense they are “general.” However, their effect is not general. It is sufficiently particular to create interdependence and to defeat, if they are inadequate, the case for reliance on specific application controls.

Such issues are becoming increasingly important. With the growth of integrated, real-time systems and the remarkable reliability of computer processing, evaluating controls will become essential to cost-effective auditing. Computers, of course, occasionally malfunction, but a properly programmed system under normal conditions processes data without the fatigue and variable attention that plague even the most devoted human data processor. In these circumstances, focusing on control risk is essential to the efficiency of the audit.

Turning now to the development of computer-assisted audit techniques, the pace was so rapid that by the early 1970s articles appeared on how to select the appropriate software package. By 1975 Keith O. Dorricott could write: “It used to be that auditors of computerized accounting systems had difficulty in carrying out their audits because they did not have the appropriate tools at their disposal. Today, there are still many auditors bemused by computers—not because there are no tools, but because there are so many of them.”

The basic problem was how to use the computer to access and test clients’ data files, application programs and programmed controls. An early technique was to use test data (test decks). In applying this technique, the auditor processed previously tested data through the client’s computer and compared the independently calculated results to the results produced by the client’s computer. The procedure provides evidence with respect to the client’s program and programmed controls. Auditors could also write, or have written for them, programs that accessed and tested computerized data, but generalized audit software was soon available and provided a simpler approach. This software consists of a computer program or series of programs designed to perform data processing functions useful to the auditor, such as reading and comparing computer files, selecting and reporting desired information, and performing calculations.
Audit software not only solves the problem of accessing and testing client data, but it also makes more efficient the performance of various audit techniques that had been performed manually. For example, it can prepare accounts receivable confirmation requests, perform analytical review procedures, and select and evaluate statistical samples. The increased use of statistical sampling owes much to the computer because it relieved the auditor of cumbersome manual procedures once necessary for statistical audit sampling.

The availability of portable microcomputers that can be taken to the site of the audit has made possible new audit efficiencies, new audit tools and new opportunities to reduce the variability of auditors' performance. The efficiencies are derived from automating portions of the audit process. Many firms have already been employing microcomputers, using software they have developed or acquired from vendors. The range of tasks that can be automated is extremely broad, including producing and updating workpapers, preparing flowcharts, facilitating engagement management through telecommunications and accessing databases to research authoritative literature or perform analytical review procedures.

These and other audit applications are described in the AICPA's study, Auditors' Use of Microcomputers, the publication of which is evidence that the use of the microcomputer as an audit tool has come of age. Further progress in using microcomputers at the audit site seems inevitable, and it is not hard to imagine their eventual use in all phases of the audit.

The use of microcomputers to automate the audit process should add structure to the audit at the firm level and thereby reduce the variability of audits. Many elements of the audit process cannot be computerized unless they are given additional structure, and computerization allows controls to be built in that ensure adherence to prescribed procedures. To take a simple example, a structured flowcharting syntax is a prerequisite to building a computerized flowcharting system, and the computerized version can contain controls that prevent violations of the syntax.

LOOKING AHEAD

One way to view the future influence of the computer on the audit is to project the curve of progress already under way. Many future improvements seem to fit this model of continuous progress. Computer-assisted telecommunications, for example, should continue to increase the speed and efficiency of data transmission for audit purposes, of queries and responses among audit personnel, and of instructions from engagement management to other members of the audit team. The same kinds of efficiencies will affect every aspect of managing the practice—hiring, training and assigning personnel; evaluating prospective clients; desk-top printing of brochures for clients; and planning the firm's capital needs, which will grow because new hardware and software needs will make the profession more capital-intensive. Similarly, access to computerized databases, which once was limited to the National Automated Accounting Retrieval System (NAARS), will continue to expand, enhancing capacities for research and analytical review.

The accelerated continuous progress described above will be accompanied by changes that create discontinuities—that is, future improvements sufficiently different from what preceded to seem unprecedented. These changes are harder to discern but could have a greater influence on practice. They are best illustrated by examples. Three such examples are new capabilities (1) to examine segregation of duties in large, complex organizations, (2) to influence audit programming by feedback and (3) to improve the consistency of auditors' judgments by expert systems.

Segregation of duties is a long-recognized internal control. When some duties are combined by being within the responsibilities of a single individual, that individual is in a position to perpetrate and conceal an irregularity. In large organizations the numbers of persons and duties are large, and the number of possible combinations enormous; therefore, the number of potentially incompatible duties is enormous. With paper and pencil alone, a thorough analysis would be extraordinarily difficult. But, in time, thorough analyses will become relatively routine because of the computer. It will be able to sort the huge number of potentially incompatible duties with a speed that can make the analysis cost-effective.

The use of computerized feedback to improve audit programming will be possible because audit working papers will become a computerized database. Research on the relat-
tionship between procedures applied and results obtained, which is now laborious and time-consuming, would be easily available through the computer for use in subsequent audit programming. The auditor would be able to know which procedures formerly performed on the engagement, or similar engagements, were most effective in detecting errors and to correlate previously identified areas of high audit risk with areas where the highest proportion of errors actually occurred. The same kind of data would be available by industry and by account balance or transaction type. The result should be a solid gain in the effectiveness of audit programming.

The third example of how the computer will affect future audit technology—the computerized decision aids called "expert systems"—is the most clearly unprecedented of the three examples. It is also the prospect with the most ramifications for the audit process. In an expert system an expert's reasoning is simulated. The program captures the expert's identification of the factors that should influence the decision and the way in which evaluations of the factors are combined to reach a decision. The system also contains a knowledge base of information the expert uses in judging the factors. Expert systems can be developed for all sorts of audit decisions—for example, evaluating the collectibility of loans, determining reserves for inventory obsolescence, analyzing inherent risk for specific accounts, evaluating the propriety of using particular accounting principles and developing programs of substantive audit procedures.

From the perspective of the user sitting before the computer screen, a typical expert system is primarily a series of questions. The questions request factual information and judgments, and in responding the user enters step by step the same factors considered by the expert in making the decision. Factors extraneous to the decision are excluded because questions on such matters aren't asked. However, all factors that would be considered by the expert are the subject of questions. At the end of the questioning session, the computerized model combines the user's input to produce the final decision.

The factors that make the increased development and adoption of expert systems likely are the availability of powerful, relatively inexpensive microcomputers; findings from behavioral research on auditors' decision-making; advances in the field of artificial intelligence; economic incentives; and the prospect of reducing the variability of auditors' judgments. Expert systems address a growing economic need: to make available at many locations the expertise of individuals whose time is already committed. The high degree of specialization that is characteristic of modern auditing is likely to increase. Because of differences in assignments and training, some auditors gain more detailed knowledge of specific industries and audit environments than others. They also gain more experience in making various complex audit judgments characteristic of their areas of specialization.

As our economy becomes more complex, the demand for different types of specialists will mount, and individual specialists will be more pressed to serve their firms' needs. Expert systems can relieve these demands by making the specialist's knowledge available to less experienced auditors, who, aided by the power of the computer, should perform their judgment tasks more efficiently.

The growth of expert systems should also be stimulated by the fact that they can reduce the variability of auditors' judgments. This potential for improved audit quality through computerized expert systems comes at a time when there is renewed demand for such improvements. Incentives to improve audit quality include abundant litigation alleging audit failures, congressional hearings that have served as a pulpit for critics of the auditor's performance and press coverage of both that highlights every negative accusation. All of these reinforce the obligation to improve audit quality imposed by membership in a profession whose work affects the public interest. And they come at a time when audit research by the academic community is providing more and more insight into the auditor's decision-making process, steadily making technological progress more attainable.

Although the incentives cited above are likely to accelerate the development, adoption and benefits of expert systems, the increasing role of expert systems will also bring a behavioral problem: how to ensure that auditors fully exercise their judgment rather than treat expert systems as mechanical. This is a new variation of the old professional syndrome which criticizes structured elements in the au-
One result of the guidance on sampling was an increase in required judgments. This misguided supposition inhibited the growth of statistical audit sampling and other structured audit tools. In short, it has been a significant barrier to technical progress.

The supposition is the opposite of the truth. The addition of structure to the audit process adds to the number of required judgments. For example, the guidance on audit sampling adopted in 1981 not only added structure to the audit process but also added to the number of judgments required of the auditor. Consider the judgments the new guidance required the auditor to make in order to select a sample for a substantive test of details: whether sampling is appropriate, the effect on the appropriate sample size of both the degree of reliance on internal accounting control and the evidence from related substantive tests, the level of audit risk (risk of incorrect acceptance), the tolerable monetary error consistent with materially correct financial statements, the relationship of the test to the audit objective, and the characteristics of the items in the population to be sampled (stratifying the sample may be more efficient). Thus, the consequence of the authoritative guidance on sampling, which increased the structure of the audit, was an increase in required judgments.

Expert systems would similarly require additional auditor judgments. The auditor would have to make a judgment on each of the factors considered by an expert, which would presumably be greater than those considered by a less experienced auditor. It's true that the model would combine the input judgments to reach a final decision, but there would still be a net increase in required judgments. Moreover, expert systems can, and for audit purposes should, make the expert's rationale available to the user auditor in order to permit that auditor to evaluate the system's judgment and, if necessary, to override it. In such situations the required judgments the expert system adds to the auditor's decision-making need not be netted against any decision made solely by the computerized model. The auditor would be

Themes in the Development of Audit Technology: Concepts and Procedures

Audit objectives. The evolution of audit objectives over the past 100 years has guided the development of the audit tools necessary to accomplish the objectives. The primary objective of the detailed audit, which dates back to the 19th century, was the search for defalcations; the primary objective of the balance-sheet audit, which was becoming established at the turn of the century, was to provide assurance that the balance sheet and statement of profit and loss were appropriately set forth. The objective of today's GAAS audit is to provide an opinion on the material correctness of the financial statements. The auditor's current responsibility for detecting fraud is explicit, but limited to a single type of fraud—deliberate, material misstatements of financial statements.

The detailed audit in its purest form involved checking all footings and postings and vouching all cash disbursements, whereas the balance-sheet audit relied on the concept that a conclusion could be reached on the material correctness of the financial statements by verifying fewer than all transactions and entries (audit sampling).

The evolution from the detailed audit to the balance-sheet audit was influenced by market forces—chiefly by the increasing size and complexity of business enterprises, which made the detailed audit very costly, and by a change in the types of users of audit reports. Owners with effective control over employees, who were naturally interested in defalcations, became less important as users than creditors, potential shareholders and shareholders who had no effective control over management. The new class of users was interested in the company's earning power and debt-paying ability and not in defalcations immaterial to the statements.

Rationale for test basis. The concept that a test-basis audit (audit sampling) could be justified by reliance on the system of controls dates back to the early years of this century and was acknowledged in official AICPA pronouncements in 1917 and 1929. In 1939 the auditor was obligated to review the system of controls on every audit; in 1947 the concept of testing controls appeared in authoritative literature. However, by the 1950s, when work had begun to apply statistical sampling to auditing, it was becoming appreciated that statistical theory justified sampling
in the absence of evidence of the reliability of controls. But it wasn't until 1972 that official literature said controls didn't have to be tested unless they were to be relied on.

Ironically, official recognition of a test-basis audit with no reliance on controls came about just as the spread of advanced EDP systems was making the evaluation of controls more and more important to a cost-effective audit. When the financial statements are produced by a state-of-the-art, integrated, real-time accounting system, a fully substantive audit is usually more difficult and costly than one in which controls are tested and relied on.

External influences. External forces have had a major influence on the development of audit technology. Market forces were primarily responsible for the development of the balance-sheet audit, and the FTC and Federal Reserve Board took the initiative that led the Institute to issue the earliest auditing standards in 1917. The securities acts and the requirements of SEC practice led to a crystallization of the current concept of materiality in the 1930s. The courts, the SEC, the press and congressional activities have influenced other developments in audit technology—for example, the requirements for confirmation of receivables and observation of physical inventory taking, the development of the "red flag" approach to detecting financial statement fraud and the clarification of auditors' responsibilities for fraud detection.

Increasing structure. As the AICPA added to the requirements applicable to all audits, it added structure to the audit process. These elements of structure (for example, the requirement for confirmation of receivables) reduce the variability of audits, adding consistency to the meaning of unqualified opinions and providing users with a more uniform product. However, such requirements have added to, rather than subtracted from, the total number of judgments required in a GAAS audit, partly because the auditor must make judgments about implementing the requirements (for example, how many locations at which to observe inventory taking) and also because the requirements often mandate judgments (for example, to consider audit risk and materiality in planning the audit, whether there are circumstances that might predispose management to misstate statements and the effect of evidence from related substantive tests on a substantive test sample).

Sources of audit technology. Starting in the 1950s, when productive work began to apply statistical sampling to auditing, a major change took place in the sources of audit technology. Up to that time the primary source of new audit tools was the wisdom of experienced auditors. The work to apply statistical sampling to auditing was different because it borrowed concepts from another field—in this case, a branch of mathematics.

In the 1960s systems approaches
Sophisticated computer capabilities may radically change the audit. Even the hypothetical real-time financial statements could be made obsolete because of the capabilities of the computer and telecommunications. Users may one day be able to create their own financial reports by accessing company databases. Each user or set of users (for example, an investment firm) would have software to access companies' databases, to retrieve the desired data, to manipulate it in some number of ways and to report it in the format or formats of the user's choosing. In such a world, there would probably be a lively competition for users' dollars among software vendors advertising the advantages of their products, and sophisticated users would probably have an array of reporting capabilities.

Such a world would also change the audit radically. The audit could not include an evaluation of the preparation and presentation of financial statements because the user would be preparing the financial reports. The "reporting entity" might have defined responsibilities for the arrangement of its database, and there could be questions of appropriate classification and measurement at the point of original entry of data to the system. Nevertheless, the primary, and perhaps the exclusive, focus for an auditor providing assurance to third-party users of the database would be control risk assessment. Without adequate controls over entry to and processing in the database, the third-party user's software could not provide reliable reports.

Should such events, or similar events, come to pass, they would bring full circle the auditor's relationship to clients' internal accounting controls. The auditor, who was once told that no test-basis, substantive audit could be performed unless it was justified by a satisfactory system of internal accounting controls, who then became emancipated from that notion because statistical theory justified a test-
basis, substantive audit and who saw the evaluation of controls assume increasing importance in the efficient audit of modern EDP accounting systems, would be wedded to the evaluation of accounting controls more than ever before in the history of the profession.

CONCLUSION
Audit technology has reached the stage of self-sustaining growth. The conceptual infrastructure is in place. The resources devoted by practitioners to research and development appear to be regular and substantial, and they are augmented by the vigorous activities of academic researchers. The financial incentives for new technology are obvious, and the computer has supplied the means to multiply the power, increase the efficiency and reduce the variability of individual auditors' performance. There seems little doubt that there will be substantial progress in the near future. Our confidence in this progress is part of the heritage left to us by prior practitioners and at the same time a measure of the promise the future holds for the profession.

The next generation of audit tools will owe much to the computer.
Focus has been on meeting the needs of external users of government financial statements. In 1985 the GASB issued a report that identified three primary user groups: citizens, legislative and oversight bodies, and investors and creditors. The GASB's work was undertaken with the understanding that its emphasis on user needs would bring about substantial changes in the way information is presented in government financial statements.

The GASB's due process on major projects includes research on issues to determine the project's scope, appointment of a task force, discussion memorandum for public comment, public hearing, exposure draft of tentative conclusions for public comment and, finally, issuance of a statement of governmental accounting standards. During all stages of the projects the issues are deliberated at board meetings open to public observation. The GASB staff also issues technical bulletins to provide timely guidance on matters of limited scope.

Seven statements of governmental accounting standards have been issued to date. The board has also made considerable efforts to formulate a conceptual foundation for governmental accounting but no concepts statements have been adopted at this time.

The GASB is composed of five members. The current terms of all members of the original board run until December 31, 1989.

Audit technology has reached a stage of self-sustaining growth.

**MEMBERS OF THE GASB—1987**

James F. Antonio, Chairman
W. Gary Harmer
Philip L. Defliese
Elmer B. Staats
Martin Ives, Vice-Chairman


"SAP no. 29 (New York: AICPA, 1958), par. 6, and SAP no. 54, par. 52 (New York: AICPA, 1972).


"SAP no. 54, par. 51.

"SAS no. 43 (New York: AICPA, 1982), par. 51.

"SAS no. 16 (New York: AICPA, 1977), par. 5.

"Ibid., pars. 6, 8 and 10. SAS no. 6, Related Party Transactions (New York: AICPA, 1975), included the red flag approach. Three of the red flags cited here are from paragraph 11 of that statement.

"SAS no. 16, pars. 9 and 10.


"See also SAS no. 17 (New York: AICPA, 1977), which provides guidance for the auditor "when client acts that appear to him to be illegal come to his attention during an examination of financial statements."

"The equation in the appendix of SAS no. 39 (New York: AICPA, 1985) divides detection risk into two components (analytical-review risk and test-of-details risk) and conservatively assumes that inherent risk is the maximum (one)—that is, that material error absent internal control would be certain. IR is therefore not represented in the equation in paragraph 4 of the appendix, as is explained in footnote 2 of the appendix.


"Gordon B. Davis, Auditing & EDP (New York: AICPA, 1968), and SAP no. 54, footnote to par. 33.

"SAS no. 3 (New York: AICPA, 1974), pars. 7 and 29; The Auditor's Study and Evaluation of Internal Control in EDP Systems, audit and accounting guide (New York: AICPA, 1977), pp. 36 and 42 (compliance tests are presented for each general control described, and the concept of reliance on general controls is mentioned, for example, on pp. 22, 27 and 28); SAS no. 48 (New York: AICPA, 1984), pars. 57 and 58.


"Auditors' Use of Microcomputers, auditing procedure study (New York: AICPA, 1986).

"SAS no. 39, pars. 15-22. These citations by no means exhaust the number of judgments the SAS requires of the auditor in performing audit sampling.

"SAS no. 47, par. 25.