

# Audit Automation: Online Technology and Auditing\*

**Miklos A. Vasarhelyi, Ph.D.**

Automation in Information processing has substantially affected the auditing profession. Broader tools must now be developed and introduced to facilitate the audit process and make it more efficient. These tools include computers, management science, online technology, communication networks and microcomputers. Using them results in automation of such areas as document standardization, comparative analysis, engagement scheduling, and embedded audit routines.

The audit process will also change in terms of location, timing, access, procedure, and working papers. The six major steps of the audit process will be influenced by revised processes of contract preparation, client investigation, analytical review, personnel scheduling, ICQ utilization, internal control evaluation, source document retrieval, and other factors. Substantial investment and research on these issues is necessary. Their results (or lack thereof) will substantially shape the future corporate environment and the role of the auditor.

This three-part article presents technology in the audit process. Initially it examines the state-of-the-art and potential for automation in audit. Additionally, audit tools and tasks are introduced and interrelations explored. The second part analyzes the impact of automation on the audit process itself. Different steps of the audit process are examined vis-a-vis online auditing. The conclusion proposes a series of research and implementation priorities for audit researchers and practitioners.

## State-of-the-Art Auditing

The audit process is highly manual and labor intensive. Many procedures are ad-hoc based. Auditors often find themselves using manual methods to examine and comprehend highly technological accounting systems. This limitation is a natural consequence of using methods that survived experimental testing, legal testing and an environ-

*HEADNOTE: While there has been some application of recent advances in automation technology and of computers to auditing work, significantly greater use lies ahead. The author presents his views of the opportunities in this area, and of the research and experimentation needed.*

*Miklos A. Vasarhelyi, Ph.D., is Associate Professor and Director of the Center for Accounting Research, Graduate School of Business, Columbia University. He is the author of several books and articles on Accounting, Computer Related Topics and Research. He is also consultant to the FASB in its inflation accounting/pension database project.*

\* The research assistance of Ms. Janet Ahn and Katherine F. Rosen is appreciated. The comments of Professor Richard Savich (University of Southern California), and Mr. Louis Quakenbush (Marathon Oil) are gratefully acknowledged.

ment highly resistant to change. Computer audit techniques are often simply the computerization of manual audit methods, not reanalysis and redesign of the entire audit process. In a few instances, however, new methods (e.g., embedded audit routines) have been implemented.

Designers of accounting systems, on the other hand, have used technology extensively to improve the reporting function. A large portion of the major US organizations use databases to store accounting data. In 1982 accountants' concerns about the increasing use of databases caused the AICPA to set up a task force to examine its impact upon the audit process. Another major development is the advent of micro and minicomputers. Microcomputers decrease the role of general controls and instead emphasize application-specific controls. For example, unattended micros require an increased emphasis on physical security and less reliance on operator supervision. Finally, networks and communication links bring these two audit factors together into a more complex and exposure-rich environment.

### The Need for Audit Automation

Manual audit processes cannot function well within this increasingly complex environment. Recognizing this fact, the AICPA required (SAS No. 3) a preliminary review of computer usage and EDP control. This review assesses the impact of computerization of the auditing firm's systems and prescribes the necessary extent of review.

Cost escalation compounds the problems faced by auditors. The intrinsic profit margin of audit activities is probably decreasing due to the competitive environment in the profession.

---

*Auditors . . . find themselves using manual methods to examine . . . highly technological accounting systems.*

---

Finally, advanced information systems require auditors to integrate technology into the audit process. For example, automatic teller machines do not require the creation of a source document, to which auditors are accustomed. Auditors, therefore, tend to require the generation of an equivalent to capture data for audit trail purposes.

### Some Potential Automation Tools

After many of the major audit firms experimented with application-specific softwares, the development and use of generalized audit tools evolved. The integration of some audit sampling plans into these generalized softwares and the development of independent softwares for sampling purposes followed. Although not widespread in accounting

firms, these applications are commonly used in many corporations.

General descriptive statistics features are commonly part of these softwares. Typically these provide counts, means, standard deviations and strata of distinct population samples. Regression analysis is another improvement in the analytical review process. Deloitte Haskins & Sells has recently publicized its STAR package, which performs these functions. Operations Research/Management Science techniques exhibit potential for use in both the audit process and audit management. Dynamic programming, for example, was proposed for audit use in staff scheduling. Linear programming can determine the optimal level of engagement staffing.

---

*Manual audit processes cannot function well within this increasingly complex environment.*

---

Office automation techniques or automatic document retrieval may help alleviate the problems of document organization storage and retrieval. Recent working papers can be stored in an orderly fashion, while older documents can be microfiched and magnetically encoded for later retrieval. These systems permit entire sets of working papers to be cross-tabulated and integrated into master catalogs of audit data, precedents, industry comparisons and auditor tendencies.

Databases and database retrieval may serve as tools for analytical review. Auditors are able to examine, division by division, historical ratios that may not have been available in manual or file systems. In addition, auditors may develop audit sub-schema more directly connected to the attestation process.

Furthermore, interactive (online) technology can be integrated into the audit process. The possibility of interactive audit program development, testing and implementation as well as potential online data queries may be valuable ancillary audit tools.

### Automation Tasks

*Preparation of Standardized Documents.* Word processors compatible with mass storage devices exhibit increasing potential in the preparation of semi-repetitive type documents. A substantial part of the documents is repeated or selected from a finite set of paragraphs. Such situations may occur in the preparation of audit bid proposals, engagement letters, contracts and confirmations.

*Comparative Analysis.* In the analytical review process, the need to compare the organization with other firms and its industry may arise. This analysis can be facilitated by using financial accounting databases (e.g., COMPUSTAT or

Value Line). The scope may then expand from linear to multiple regression. The same data can also be used with financial ratio calculation or in cluster analysis.

**Audit Scheduling Automation.** One key problem area in the managing of large audit practices remains the assignment of staff to engagements. Typically this problem has two dimensions: (1) a long-term assignment plan and, (2) a short-term engagement management plan. Intrinsic to this process is unplanned rescheduling, i.e. increasing or decreasing the size of the audit staff in a particular engagement, replacing a particular staff member due to illness, incompatibility or turnover. The long-term problem can be managed by firm policies coupled with linear programming. The optimal staff assignment can be made on a minicomputer using spread sheet software. The short-term engagement management plan can be devised using the query/update mode of the same data base.

**Internal Control Evaluation Automation.** The evaluation of internal control design and compliance is manually performed by a set of Internal Control Questionnaires (ICQs). The system is evaluated in terms of the importance of internal control procedures and their combinations. The combination of procedures may assume a large number of variations that are better evaluated by electronic data processing. Once the adequacy of the internal control system is determined, the issue of evaluating compliance arises. The assessment of compliance adequacy must be tied to the sampling process. This leads to the adoption of larger or smaller substantive samples.

**Audit Planning Automation.** Associated with the task of long- and short-term staff assignment is the evaluation of audit risk, analytical review, choice of audit effort assignment, timing of the audit and level of interim and year-end effort. Data processing integrates these processes into a homogeneous and court-defendable program. Once the prescribed steps are followed and documented through an interactive design of an audit plan, the plan follows the general firm guidelines limiting discrepancies in audit quality.

---

***One key problem area in . . . large audit practices remains the assignment of staff . . .***

---

**Self-Starting Audit Algorithms.** The audit of online systems poses a new range of problems to the auditor, including: (1) operations with system-generated (as opposed to user-generated) source documents, (2) transactions flowing through highly integrated systems, (3) data stored and accessed in multiple data storage media, and (4) multiple simultaneous access by users. These requirements may lead to substantially different audit procedures in the future, including passive devices that examine the flow of automated transactions and that are activated (self-started) by the event of a particular state-of-the-world—parameter of a

transaction, a random choice, or a systematic data collection heuristic. The adoption of such a technique requires substantial changes in existing softwares and/or the integration in the data flow of audit/monitoring devices—hardware, software or firmware.

The automation tasks are restricted by the limitations of the individual auditor as an information processor. The audit process is often too detailed and complex for assimilation by an individual auditor. In addition, the auditor must make a series of judgments concerning the adequacy of evidential matter that may exceed the auditor's human information processing capabilities.

### **Audit Process Change**

Inherent to the adoption of radically different technologies are modifications in the activity itself. We shall now examine some of the potential changes in the *process of audit* that may ensue from online auditing. Studies in the integration of technology into management processes clearly indicate that, unless processes are changed, the full benefit of automation is not realized.

---

***The audit process is often too . . . complex for assimilation by an individual auditor.***

---

**Physical Location of the Auditor.** The auditor, particularly in an EDP audit situation, will not be performing work at the client's EDP site, but at the site of the client system (e.g. accounting), where source documents or their equivalents can be directly accessed. This will substantially increase auditor visibility and accountability as well as decrease communications and transportation delays.

**Time Required to Access Data.** Auditors will be able to use random number generators when choosing the source documents to be examined and record the result of this access immediately. These results can be entered into a spread sheet working paper and algorithms can be run on the desirability and location of the additional sample. Online auditing and recording allows for the subsampling of different populations, and potentially, identifies sources of systematic discrepancies. An optical scanning device that reads source documents can substantially reduce information recording and examination time. Voice recognition devices may further improve and speed up this process.

**Audit Timing Issues.** Currently, audits are planned at discrete time intervals and usually at announced dates. This results mainly from the problems of scheduling and logistics, causing limited, if any, deterrent value. If client source documents are kept in computer-readable code, discrete availability of time by auditors, such as a day, may be used for unannounced audits at the compliance and substantive levels.

*Treatment of Working Papers.* Working papers currently follow general firm guidelines but vary substantially from office to office, engagement to engagement and year to year. These discrepancies increase the difficulties in peer review, staff integration and recall of events in a particular situation.

Online technology will likely imply standardized working paper formatting and substantially increased indexing. Additionally, word processing softwares will be used for preparation and spelling checks as well as for standardized footnote comments; arithmetical and mathematical aids will ease footing and subtotaling tasks.

It is somewhat more difficult to assess changes in working paper techniques per se. However, a trend toward more voluminous documentation is expected. This would imply more extensive support of evidential matter and additional supporting schedules.

Cross-indexing (tying) of numbers in schedules will be substantially aided by computer-based search procedures that can uncover relationships without considerable page flipping, colored pencils and various symbols. Of course, current technology also allows for multicolored displays and symbols but, most likely, the complexity and cost of these media will not compensate for their advantages.

*Technological Dependence.* Auditors depend on client computer availability for part of their audit work; however, they are mainly self-reliant and use manual methods. The evolution towards more advanced forms of audit will be dependent on: (1) audit aid access, (2) communication lines, (3) database access and, above all, (4) technical competence.

The latter item may cause substantial change in the process or in the careers of auditors. Studies indicate that EDP auditors are on average more experienced and more highly trained than their traditional counterparts. This finding can be supported by the argument that EDP training and experience is harder to come by and EDP auditors take longer to be proficient and useful in engagements. To enable firms to groom proficient, technologically aided auditors, current career paths must be adjusted. Furthermore, alterations to the curricula for college accounting training would be required.

## Technologically Aided Auditing and the Audit Process

We shall examine the audit process vis-a-vis automation considering its main elements:

- Engagement Definition.
- Engagement Planning.
- Internal Control Evaluation.
- Compliance Testing.
- Substantive Testing.
- Attestation.

### Engagement Definition

#### A. Contract Preparation

Large law firms engaging in repetitive types of contract preparation have set up contract clause databases in word processors. The actual contract preparation usually entails

paragraph selection, but seldom are paragraphs actually rewritten. The same concept can be extended to audit contracts, engagement letters and other engagement definition documents.

#### B. Client Investigation—analytical review, database queries

A substantial number of databases are currently available for the examination of financial statements (e.g., NAARS), stock prices (e.g., CRSP), legal precedents and rulings (e.g., LEXIS) and other issues. These can be used for analytical review both in a time-series mode as well as in cross-sectional inter- and intra-industry analysis. Database availability results in a wider scope of analytical reviews.

### Engagement Planning

#### A. Analytical Review

The same questions raised in client investigation are the basis for a more in-depth year-to-year analysis of a particular auditee.

#### B. Risk Assessment

A series of different methodologies have been proposed for the assessment of audit risk. Automation would permit the usage of simulation, "what if . . ." models and sensitivity analysis in risk assessment.

---

*Online technology will likely imply standardized working paper formatting and . . . increased indexing.*

---

#### C. Planning Matrix (worksheet software use)

Worksheet software (e.g., Visicalc) may be used to plan and schedule the engagement. In addition, these plans may be incorporated into actual budgets and serve as audit control mechanisms.

#### D. Personnel Scheduling

Linear programming techniques can improve short-term personnel usage management. The use of online reservation systems enhanced the art of resource utilization management. Stochastic techniques may be used for personnel "overbooking" and task completion estimation.

#### E. Multi-Year Engagement Planning

Multi-Year models can be used in personnel scheduling to improve audit management and decrease multi-year risk. The yearly choice of areas to be audited should be part of this risk minimization process.

### Internal Control Evaluation

#### A. Computerized ICQs

Internal controls are complex and interlinked. The automation of ICQ's may provide a basis for "tailored" ICQs based on industry, company size and error experience.

### *B. Automated Flowcharting*

ICQ flowcharts may describe document flow and control points. These may be examined to evaluate system integrity.

### *C. Critical Control Combinations Analysis*

The preceding two steps can be overlapped on an "optimal set" or a critical set of controls.

### *D. Audit Trail Sampling*

SAS 3 requires a preliminary review of EDP based systems that identifies document flows. Tagging and tracking techniques may serve to automate this process.

## **Compliance Testing**

### *A. Multiple Sampling Plans*

Computationally complex sampling plans become menial computation tasks when used with state-of-the-art data processing. They can be directly linked to both the internal control compliance testing and the substantive sample selection processes.

### *B. "Over the Shoulder" Supervision of Compliance*

Most interactive systems of today provide the option of an operator or someone with high priority to visibly or invisibly link with another terminal and observe the user/system interaction being performed. This feature can be used for the audit of the alertness of users in interactive systems as well as their compliance to internal control rules.

## **Substantive testing**

### *A. Preparation of Confirmations*

The combination of word processing, client files and sampling plans will generate economies in the audit. This traditional computer usage step still can be substantially perfected to gather further evidential matter with cost benefits.

### *B. Random Number Generation*

Techniques such as the adoption of multiple sampling methods, revised sampling schedules and verifiable sample plans may make extensive use of computers. This will expand the scope of audits and at the same time help document audit costs and increase audit reliability.

### *C. Source Document Retrieval Automation*

Modern storage technologies may lead to a substantially increased level of source document storage in data processable media. Software can be designed to retrieve automatically on a sample basis, within a sampling plan, part of this data. This software may also be used to generate tables with document availability, content, location and update data.

## **Attestation**

### *A. Evaluation of Audit Evidence (integration algorithms)*

Expert systems may be used to supplement audit judgment. Knowledge bases and policy-based heuristics can help in judgment and to force/remind the consideration of particular issues.

### *B. Issuance of Opinions*

Dictionaries of types of opinions, caveats, qualifications, restrictions of scope, etc. may be used to decrease the expense of creating new wording on an ad hoc basis or of searching for similar precedents and established disclosure wordings.

### *C. Issuance of Management Letters*

The same technique described in item (B) may be used in management letters.

These changes in the audit process lead to a series of educational and cost benefit implications. These needs include: increased hands-on skills, mixed backgrounds in accounting and computer science, substantially improved technological backgrounds, increased hardware requirements and costs, simple and multiple-purpose languages.

## **Conclusions**

The audit process encompasses: (1) economic events, (2) captured economic evidence, (3) an accounting system structure, (4) the activity of search for evidence, (5) audit personnel, (6) audit agents and, (7) a set of statutory requirements.

These seven elements are affected by automation and open multiple roads of research inquiry:

In automated systems economic events are captured differently and with a substantially lower level of error. Direct generation of source records poses a wide set of research questions, such as level of detail frequency, reliability, centralization/decentralization, and level of editing.

Data capture generates issues regarding frequency of collection, selection, aggregation, log records, frequency, database centralization and acceptable error rates.

Structure questions of automated accounting systems relate to the substantially changed environment and control requirement of a computerized system. Controls, tags, accounting records, control combinations and structure documentation pose major challenges to practitioners and researchers.

The search for evidence activity now may be extended to the search through entire populations for algebraic validity and discretionary transactions. It also requires the search for discrepancies of every nature and a major increase of exposure due to systematic processing and increased distance between the auditor and data.

Audit and client personnel may change substantially, as may interaction patterns. Behavioral factors will differ, reflecting many of the psychological defenses that people present in the presence of computers.

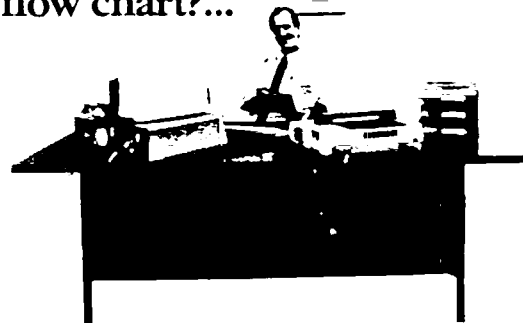
Finally, statutes, and particularly audit standards, must evolve to adapt to different exposures, cost-benefit tradeoffs, alternative audit tools, etc. In addition, technology will undoubtedly have an effect on reporting requirements by facilitating desegregation, disclosure and information preparation through media.

This article examines the introduction of automation to the audit process. It raises questions to challenge researchers and practitioners in the search for better quality auditing. □

#### BIBLIOGRAPHY

- Adams, D.L. and Mullarkey, J.F. "A Survey of Audit Software." *The Journal of Accounting*, September 1972.
- AICPA. "The Effects of EDP on the Auditor's Study and Evaluation of Internal Control," *Statement of Auditing Standards No. 3*, New York, December 1973.
- AICPA. "Tentative Draft of the Committee on Database Audit." Walter D. Pugh Chairman, NY, 1982.
- Argyris, C. "Management Information Systems the Dialogue to Rationally and Emotionality," *Management Science*, February 1971.
- Balachandran, K.R. and Steuer, R.E. "An Interactive Model for the CPA Firm Audit Staff Planning Problem with Multiple Objectives," *The Accounting Review*, January 1982.
- Deloitte, Haskins & Sells *AUDITSCOPE Manual*, 1978.
- Ernst & Whinney. *Audit Sampling*, Cleveland, 1974.
- Ernst & Whinney. *Sigma Users Guide*, Cleveland, 1976.
- IIA, "Conference on EDP Audit," *Proceedings*, New York, February 1983.
- Messier, W.F. and Hansen, J.V. "Decision Support for EDP—Auditing," Working Paper, School of Business Administration, University of Florida, 1982.
- Messier, W.F. and Hansen, J.V. "Expert Systems for Decision Support in EDP Auditing," *International Journal of Computer and Information Sciences*, Vol. II, No. 5.
- Stringer, K.W. "A Statistical Technique for Analytical Review" *Proceedings of the Conference on Statistical Methodology in Auditing at the Graduate School of Business at the University of Chicago*, 1975.
- Summers, E.L. "The Audit Staff Assignment Problem: A Linear Programming Analysis," *Accounting Review*, July 1972, 443-453.
- Vasarhelyi, M.A., and Pabst, C.A. Practices, Standards Involvement, and the Usage of the Computer in EDP Audit: A Survey", *The EDP Auditor*, Summer, 1981.
- Vasarhelyi, M.A., Pabst, C.A and Daley, I. "Organizational and Career Aspects of the EDP Audit Function: A Survey", *The EDP Auditor*, Spring, 1981.
- Will, H.J. "Computer Based Auditing," *Canadian Chartered Accountant*, March 1972 (Part 1).

Want to see  
us make you a  
flow chart?...



Want to see  
it again?



Now you can gain control over your project by quickly and skillfully charting the flow of your resources. In a matter of minutes, you can generate and print presentation quality flow or organizational charts with Flow Charting."

You can generate a wide variety of symbols and sizes. You can also print them vertically or horizontally on standard or wide pages. Even better, you can generate special shapes to suit your needs and then save them on disk for future reference.

Flow Charting's powerful editing capabilities let you add, delete, and reorganize your data any way you want it. Again in minutes, you have a revised chart.

Flow Charting runs on the IBM® PC XT/AT and compatibles with graphics capabilities.

See your local dealer or order directly by mail. Only \$167. Also available on Apple's 340 Lassenpark Circle, San Jose, CA 95136; (408) 629-5044.

IBM is a registered trademark of International Business Machines.  
APPLE is a registered trademark of Apple Computers.

**PATTON & PATTON**