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# **The Impact of Technological Events and Trends on Audit Evidence in the Year 2000: Phase I\***

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## **Introduction**

This research project is an exploratory study that attempts to identify and analyze:

- (1) the most significant changes in information technology that will affect future audit evidence,
- (2) the impact of such changes upon auditing, and
- (3) the nature of audit evidence in the year 2000.

The success of items two and three is contingent upon results obtained in the first phase of the study, which is reported in this paper. Phase I is designed to identify not only the relevant future events and trends but also the likelihood that these events may occur at various points in time in the future. To accomplish this goal, the researchers have performed an extensive review of the technological literature, interviewed experts in auditing and various technical areas, and solicited expert opinions via a questionnaire. A Delphi study will also be conducted to elicit and analyze experts' predictions of important future information technology events and trends.

Using these data, phase II of the research will identify and analyze the effects of predicted technological events and trends on audit evidence and the audit process. Scenarios will be developed to extract potential new strategies for dealing with future audit evidence, audit technology, and auditor roles.

This paper is divided into six sections as follows:

1. Statement Of Problem And Need For Research
2. Review Of The Information Technology Literature
3. Research Issues And Proposed Methodology
4. Preliminary Findings Concerning Information Technology
5. Preliminary Findings Concerning Audit Evidence
6. A Tentative Scenario Of Future Audit Evidence

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## **Statement of the Problem and Need for the Research**

The basic problem addressed in this project is that changes affecting the nature and availability of audit evidence are occurring so rapidly that auditors have difficulty making practical plans to gradually adapt their auditing techniques and processes to deal effectively with future forms of audit evidence. Consequently, the auditing profession needs research that (1) identifies the most significant future events and trends expected to affect future audit evidence; (2) indicates when such events and trends are expected to occur; and (3) analyzes their impact on audit evidence, audit technology, and the role of auditors. For example, in planning future auditing techniques, auditors would likely give more attention to a particular new form of information processing if a consensus of experts indicates that it will be technologically and economically feasible by the year 2000 than if a consensus indicates that it will not be feasible or if no consensus exists.

The audit environment is greatly affected by technological change. The means by which information is captured, entered, retrieved, modified, and distributed has changed dramatically over the past 30 years. The state-of-the-art of computer auditing is clearly superior to that which existed at the beginning of this decade but probably not adequate for the highly sophisticated innovations in information technology that are likely to occur in the next 10 to 15 years.

The nature of auditing will undoubtedly continue to undergo substantial changes as the level of technology improves. Experts are forecasting continued improvement in the power and flexibility of computers and communication devices, while costs are expected to decrease over the next 15 years. A proliferation in the number of computers and terminals is expected over the next decade.

Numerous social, economic, and political factors are likely to be important to the future of audit evidence and auditing; consequently, they will be considered in the study. However, we have chosen to place less emphasis upon specific predictions of these factors because they seem to be inherently more difficult to predict reliably and somewhat less important to the future of audit evidence than changes in information technology.

Given the need for reliable predictions of future information technology and of other factors that will likely affect future audit evidence, our research is designed to address the following two basic research questions:

1. What will be the status of information processing technology in the year 2000?
2. How is the information processing environment in the year 2000 expected to impact the nature and adequacy of audit evidence?

The basic research approach for the first question includes: (1) a review of the literature concerning future information technology, (2) interviews with information technologists and auditors, (3) an open-ended questionnaire survey of information technologists and auditors, and (4) a Delphi study of information technologists to predict the likelihood of future technological events and trends.

The basic research approach for the second question includes: (1) discussions with a relatively small panel of auditors concerning the audit impact of predicted information technology changes, (2) preparation of narrative descriptions of likely audit impacts, and (3) a survey of a larger panel of auditors to test and validate the descriptions and scenarios.

## **Review of the Literature on Future Information Technology**

The first research step was a review of the literature concerning future information technology. The objective of this literature review was limited to identifying *potential* future information technology events and trends that may occur. At this stage of the research, it would be premature to make assertions about when these events or trends are likely to occur or even whether they are likely to occur. Potentially important events and trends that are identified at this stage will be included in the Delphi survey of information technology experts. Research inferences about the degree of consensus among experts will be based upon the Delphi study results.

The three major components of the literature review are: (1) computer hardware, (2) computer software, and (3) data communications and office automation. A brief overview of that literature is presented below.

### **Computer Hardware**

Computer hardware improvements continue to outpace software improvements. Computer processing has become much faster due to advances in integrated circuit technology. Computers are becoming smaller, more powerful, and less expensive which has led to a tremendous surge in end-user computing. AT&T (International Data Corp., 1985) estimates that available computer power is doubling each year. Just three years ago, Lewis M. Branscomb, a Vice President and chief scientist at IBM, estimated that computer power was increasing at a rate of 40 percent per year (Branscomb, 1982).

*Proliferation of Computers*—Where is this increased computer usage coming from? Of the three broad categories of computers—mainframes, minicomputers, and microcomputers—the growth has largely come from the microcomputer segment. In 1975, the market for microcomputers was virtually non-existent. The U.S. market for personal computers used in business or professional purposes has grown to \$11 billion, counting multi-user supermicros. The dollar volume of microcomputer sales is now nearly equal to the market (in dollar sales) for mainframes. By 1989, the market will be more like \$39 billion. The number of personal computers used for business or professional purposes in the U.S., either stand-alone or multi-user, will increase to 59 million in 1989 (IDC, 1986). The number of personal computers used for business or professional purposes was 7.5 million in 1984. The key trends causing the shift to personal computers are shift to hard disk storage, faster micros, multi-user systems, and higher resolution graphics.

The number of terminals is also expected to increase dramatically throughout the 1980s and 1990s. International Data Corp. offered several projections in the April 15, 1985 issue of *Fortune* magazine.

1. In 1970, there were less than 200,000 remote terminals. In 1980, there were two million remote terminals, a ten-fold increase. By 1990, 100 million remote terminals will be in use.
2. There were 20 million digital keyboard devices in the U.S. workplace in 1984. By 1989, 80 million are expected to be in use.
3. Expected sales of Voice/Data terminals in 1987 are 250,000 units, a ten-fold increase over the actual number of units sold in 1983.

All of these projections point to a proliferation of computers and a business environment saturated with computers in the year 2000.

*Parallel Processing*—Machines like Japan's Teradata systems, part of their fifth generation project, have a high level of parallelism; that is, several microprocessors read different sections of the database at the same time. Present computers can read hundreds of transactions per second, but by 1990 some of the large banks will need a computer that can read thousands of transactions per second. With a computer that can read several records at a time, this desired tenfold increase in processing speed may be attainable.

## **Computer Software**

In an interview in *Computer Decisions* (Kull, 1984), James Martin, a noted writer, lecturer, and consultant on information technology, discussed a wide range of topics including programming, fourth and fifth generation languages, Database Management Systems (DBMSs), operating systems, spreadsheet packages, and expert systems. Since the issues raised by Martin are indicative of those raised in the literature on the future of computer software, they are discussed briefly below.

*Automation of Systems Analysis and Programming*—Martin believes the jobs of programmer and systems analyst will be automated. We are evidently heading in the direction of a "syntax-less" programming language. He favors replacing languages altogether with diagrams because no syntax is required. Fourth generation languages are much more English-like, but Martin does not feel that there are any top-rate languages yet. It is difficult to replace existing languages such as COBOL because companies have so much invested in them.

*End-User Programming*—Massive growth in end-user programming is predicted in the next ten years. For example, current end-users of spreadsheet software on a PC can use sophisticated financial-analysis tools to perform faster, more accurate, and more complex calculations than were performed previously by fulltime analysts on mainframe computer programs. Martin believes that spreadsheet graphics will move from two dimensions to three dimensions (with cubical structures) and that, eventually, four and more dimensions will be available.

The expected growth in end-user programming and decentralized computer processing raises auditability concerns. In his book, *EDP Auditing*, Weber states:

With the rapid growth in the use of minicomputers and microcomputers, the unavailability of generalized audit software that runs on these machines may be a problem confronted increasingly by the auditor.

Further, at least in some cases, it is unlikely generalized audit software vendors will make major attempts to increase the availability of their packages on new hardware/software configurations. Increased availability means increased maintenance costs, decreased efficiency, and a greater risk of the integrity of the software being compromised. (1982, p. 433)

*New Database Structures*—Continued rapid growth in database construction by professional programmers and end-users is predicted by several experts. Many experts believe that relational systems are far superior to CODASYL/hierarchical based systems, but there is a vast financial investment in the older systems. For example, Martin states: "By 1990, only a small percentage of major database systems will be relational" (Kull, 1984).

*Operating Systems*—A clear need exists for increased standardization of operating systems. The lack of program portability is inconvenient and expensive. Martin stated that in ten years we may standardize on an entirely different operating system, one without a UNIX pedigree. UNIX is weak in the human factors area and in machine performance. Furthermore, UNIX is research oriented and is ten years old.

*Expert Systems*—Many experts are predicting widespread applications of expert systems. Several companies such as Teknowledge, Intellicorp, and Xerox have developed "shells" for building expert systems that are sometimes described as expert system generators. Building expert systems, however, is very time consuming and requires a heavy investment of capital and human expertise. Illustrating the scarcity of human expertise necessary to build expert systems, Martin states: "By 1990, there probably won't be more than 5,000 professionals in the U.S. who can build an expert system, compared with the one million programmers we have presently" (Kull, 1984).

On the other hand, Technology Forecasts (Anonymous, 1984) states that artificial intelligence applications are seen propelling the AI market from its current annual level of \$250 million to at least \$11 billion by 1990. Expert Systems is one aspect of AI. Expert Systems will probably be the area of AI which has the greatest impact upon the business arena. Sales of expert systems reached \$216 million in 1985. Industry analysts project a \$3.5 billion market by 1990 (IDC, 1986).

In a personal interview, a Vice President from Information Builders (creators of Focus) stated that artificial intelligence in ten years will be where PCs are today. The development of AI knowledge-based systems will make software truly "user-friendly."

Anne Lampert, staffwriter for Computer Decisions (January, 1985) comments that expert systems are finally out of academe and into the business world. She commented on the expert systems presently in use and concluded her article by stating: "The expert system does not supplant human involvement in the problem-solving process. The system merely makes the problem-solving more efficient and accurate."

The auditing and accounting profession is making a substantial investment in expert systems evident by the attendance of 220 academics and practitioners at the 1986 USC Audit Judgment Symposium which focused on expert

systems. Expert systems have the potential to change both the way we account for economic and social events and the way we audit information systems and reports.

### ***Types of Information Input***

The sophistication of computer input is also expected to improve throughout the next 15 years. Papageorgiou (1983) predicted by the mid 1980s computers would be able to optically scan hand-printed information. David Terrie, manager of International Data Corp.'s office automation services, says: "The machine will adjust to the user instead of the user to the machine." Terrie also believes that computers will be accepting unstructured voice input before the turn of the century (Pilla, 1982). Other respected individuals in this field are not as certain of this prediction as Mr. Terrie. In that same article, AT&T stated that voice recognition will not have a major impact upon non-routine decision making before the year 2000. Brian Blackmarr, a principal with the management consulting firm of Lifson, Hermann and Blackmarr in Dallas, Texas, believes it would take a major breakthrough to make it work well.

The Naisbitt Group assisted the Colorado CPAs on an auditing futures project. They concluded: "By 1990, a document will not only include text, but also data, image, and voice" (Colorado Society of Certified Public Accountants, 1984). Forecasters may not agree on the year, but they do agree that these changes are coming. Computers with voice recognition capabilities could substantially impact the nature of auditing. Detailed audit testing and flowcharting are almost completely document oriented. The profession needs to prepare for the changing nature of audit evidence in a paperless society.

### ***Data Communications and Office Automation***

Improvements in the data communications industry will also have a substantial effect upon the audit environment. Technological innovations such as communication satellites and fiber optics have increased data transmission speeds dramatically. Papageorgiou states that with this improved speed and reliability the electronic desk is expected to become standard equipment. An electronic desk is defined differently by various technologists. Papageorgiou believes that it is comprised of a large display screen, a keyboard, a pointing device, a local processor, a local file, a storage unit, a local printer, and a link to the rest of the system. Computerized Private Branch Exchange (PBX) technology allows electronic mail, voice, and word processing to communicate with one another.

In addition, video teleconferencing, telecommuting, and picturephone are all expected to make revivals now that the technology has improved. Electronic mail is already being used, but it will become far more pervasive. Electronic communication between organizations will also expand significantly according to Omar Sawy of University of Southern California's Center for Futures Research. Some companies have installed terminals connected to their mainframe computer at customer plants to facilitate inventory ordering (McFarlan, 1984).

The main function of the mainframe will be to handle anything that people want to share, according to several experts. The micro-to-mainframe links will

have to get better. We need standards for data representation so a user can easily download information from the mainframe. Eventually users will not know whether they are using data on the PC or the mainframe, especially if they have a Local Area Network (LAN).

International Resource Development, Inc. estimates the office automation market to be \$36 billion by 1990. Much of this money will go toward networking (Pilla, 1982). In addition, multifunction terminals will come of age. A multifunction terminal can do jobs such as word processing, electronic mail, electronic filing and data processing from one workstation. Gerald Maskovsky, Vice President of MIS for Home Insurance Co., believes that the biggest challenge ahead of us is not technological, rather it lies in changing the operational and organizational patterns of organizations. "Everything is designed around a physical piece of paper and now that paper will disappear and drastically change the system" (Pilla, 1982).

LANs which allow individual users to pursue tasks independently from separate PCs while calling on shared resources, such as hard disks, high speed printers, and shared data bases, are expected to increase substantially in the next several years. According to Future Computing, a market research firm specializing in the personal computer marketplace, shipments of personal computer LANs will increase to 166,000 in 1988 from 10,000 in 1983 (Guttman, 1985, p. 43).

The PC has helped to decentralize the information processing within a company. Tim Sammons, director of a computer consulting firm, says that: "Control and centralization of information processing are compelling reasons to get a LAN. I think we'll see some companies go back to a centralized operational structure. Others will centralize locally so a given manager will be able to review the work done by his or her staff" (Luhn, 1985, p. 79).

Many experts predict that the networks and PCs that we know today will soon be obsolete. For example, Sammons predicts:

The future lies in very high-speed networks that integrate voice and data and blur the distinctions between the telephone and the computer. The whole notion of stand-alone vanishes. That's why I think broadband, fiber-optic-based networks are the future. You'll have a machine that delivers your morning newspaper, the Sears catalog, shopping services, and more (Luhn, 1985, p. 80).

Videotex, the generic label applied to home information retrieval systems, is growing significantly. Management Horizons Inc. predicts that 20 percent of all U.S. retail sales will be done via videotex by 1990. More than eight million U.S. homes are predicted to use videotex by 1990 (Anonymous, *Business Week*, 1981). Transaction processing in financial services appears to be the trigger application (of videotex) that the public would be willing to pay for. However, Edward J. Atorino, a securities analyst for Smith Barney, describes some of the current limitations: "Videotex is providing a service which has too many alternatives that are cheaper and easier. It requires the consumer to perform, to go through too much effort, to get the services" (Granelli, 1986).

Various communication channel options are available. Big users like Seattle-based Boeing Co. are building their own corporate phone networks instead of leasing from the telephone company. Demand is soaring for transmission lines



that carry huge quantities of digital voice and data over one line, such as the so-called T-1 transmission lines. Companies also can continue to ship smaller quantities over separate lines, or send information between buildings with microwaves and their own transmitting and receiving dishes (Simpson, 1986).

Fiber optics is growing at about 25 percent a year, and that growth is expected to accelerate (Barrons, 1985). Fiber's favorable characteristics include a digital nature, small size, light weight and low heat, wide capacity, and immunity to electromagnetic interference and eavesdroppers. The telephone companies, especially the long-distance carriers, buy roughly 80 percent of what is produced. Fiber optics has approximately 20 times the bandwidth (capacity) of coaxial cable. However, a worry to the fiber-optic industry is the lack of standards for components.

### ***Limitations of the Existing Literature***

Despite the fact that a wide variety of sources have been examined, there are some weaknesses in the literature. The most notable weakness is the limited time-span of the forecasts. Nearly all of the experts confine themselves to a five-to-ten year time horizon. Only the most recently published articles dared to venture into the 1990s. John C. Papageorgiou, the author of the article "Decision Making in the Year 2000," states at the outset of his article that "[f]orecasting is almost impossible nowadays" (Papageorgiou, 1983, p. 77). This statement is particularly appropriate for the forecasting of technology. However, forecasters can offer projections that can give guidance to the auditing profession for the 1990s and beyond.

The preliminary review of the published literature shows that auditors need more *current* forecasts. *Science* magazine devoted an entire issue to all aspects of the computer world in February of 1982. The issue was extremely insightful, but the articles were written over four years ago and there have been many major changes in computer and communication technology since that time. Given the lag between collecting data and publishing a report, most forecasts are several years old. In addition, none of the reviewed studies specifically addressed the implications for business and auditing.

### **Research Issues And Proposed Methodology**

Research Question No. 1 is: What will be the status of information processing technology in the year 2000? The first three of the four research steps for Question No. 1 which are listed below have already been performed.

1. A review of the technological literature to identify the probable status of information processing technology in the year 2000.
2. Interviews with a sample of EDP audit specialists and directors of internal audit.
3. A survey of a sample of information technologists, internal auditors, and external auditors using an open-ended questionnaire to validate the findings of the literature review and to identify other potential changes.
4. A Delphi study of technologists to ascertain the likelihood of future technological events and trends.

To address the first research question, a number of methodologies for “futures research” were considered. Fowles (1978) gives a detailed discussion of ten related approaches in the *Handbook of Futures Research*. Sackman and Citrenbaum (1972) list and rank order 26 “futures-creating” methods. The methods that were given the most serious consideration for this study were: Delphi technique, cross impact analysis, scenarios, simulation gaming, simulation modeling, technology assessment, technology forecasting, and brainstorming.

The most appropriate methods to identify possible future technological events and trends seem to be review of appropriate literature and interviews with experts, particularly those in research environments where future implementations of technology are already on the drawing boards. The most appropriate methods to assess the likelihoods of future events and trends seem to be Delphi and Cross-impact analysis. The literature in the area of futures forecasting leans strongly toward using the Delphi method. The Delphi method has been used successfully in several past forecasts of information technology. The Delphi method is a highly cost-beneficial technique for obtaining the opinions of leading experts in a given field. However, the Delphi approach has been criticized because it does not take into account interdependencies of events/trends. Cross-impact analysis does incorporate interdependencies. However, a recent Delphi study by Eschenbach and Geistauts (1985) did incorporate interactions through a scenario approach in the final round of the Delphi.

The Delphi Method was suggested as an appropriate research tool for forecasting technological changes affecting auditing in a recent article by Garsombke and Cerrulo (1984, p. 6), as follows:

Since there is little reason to believe the rate of technological innovations will decrease, the auditor is faced with the problem previously described (i.e., how should auditing adapt to changing technology). We believe the auditor's best response to the challenge is to try to predict future changes, rather than simply react to changes as they occur. . . .

The primary goal of any research project designed to address the problem outlined above should be to predict the future direction of change in certain relevant computer technologies, to the extent the change may affect auditors. We suggest using a technological forecasting tool, such as the Delphi Method, which enables one to determine the consensus of views of the future held by experts. Our expectation is that knowing experts' views, auditors will be able to better prepare for changes that are foreseen.

Research Question No. 2 is: How is the information processing environment in the year 2000 expected to impact the nature and adequacy of audit evidence? The research steps to be performed for Question No. 2 include:

5. Preliminary discussions with a selected small number of auditors to identify the likely effects.
6. Documentation of the proposed likely effects in a narrative or questionnaire format.
7. Validation of the documented effects by surveying a larger number of practicing auditors and obtaining their responses.

## 8. Analysis of the responses.

### **Preliminary Findings Concerning Information Technology**

#### ***Nature of the Open-Ended Questionnaire Survey***

As recommended in the literature on the Delphi technique, we sent open-ended questionnaires to small groups of experts prior to the preparation of the actual Delphi questionnaire. This procedure was designed to help ensure that the questionnaire would be as complete as possible. We used two sets of open-ended questionnaires because we believed that it was important to obtain information from both technologists and auditors. We performed a more extensive open-ended preliminary survey with auditors because there was very little literature available that referred to the future of auditing. Some of the comments made by auditors did, in fact, influence the questions included in our Delphi instrument for technologists. A copy of the questions included in our Delphi questionnaire is included in Appendix A at the end of the paper.

Open-ended questionnaires were developed at this phase of the project to obtain an unbiased list of responses from our expert respondents. One of the primary concerns of questionnaire surveys is that the wording of the questions may bias the respondent. Using an open-ended questionnaire format at the initial "event identification phase" is favored by most futures researchers.

The questionnaire and methodology for this milestone phase of the study were reviewed by consultants from the USC Center for Futures Research, who made several important suggestions. For example, due to their suggestions, the questionnaire was divided into two sections. The first part of the questionnaire asked respondents to identify the five most important changes/events/trends (within their area of expertise) that they believed would occur by the year 2000. The questionnaire for the auditing and accounting groups was modified slightly. It asked respondents to indicate those changes that would have the most impact upon the nature of audit evidence.

The second section of the questionnaire asked the experts to indicate two "less likely, but still possible," events. Prior experience of futures researchers has indicated that the responses from most experts are similar (identifying the more obvious events) unless respondents are asked to consider "the unexpected" or potential surprises. In many cases, these unexpected events or plausible surprises do in fact occur over a long time horizon such as 15 years.

*Type of Technical Experts Surveyed*—We surveyed 30 technologists using mailed questionnaires and in-person interviews. Our sample included experts in the areas of artificial intelligence/expert systems, applications software, database systems, data communications, computer hardware, and office automation, including information technology researchers at Bell Labs. In addition, we interviewed experts who made presentations on various emerging information technologies at a computer conference in Los Angeles.

We interviewed two experts in organizational structure and behavior. This area is important to the present study because future organizational structures are expected to have a significant impact on future information flows and audit evidence.

The preliminary findings relating to changes in information technology are divided into the following sections:

- a) Office Automation and Transaction Automation
- b) Data Communications
- c) Computer Hardware
- d) Computer Software.

### ***Office Automation and Transaction Automation***

*Electronic (Paperless) Transactions and Records*—The computerization of the business office paperwork and accounting records could be the most significant concern of the auditors whom we surveyed in our open-ended questionnaire. Some of them expressed difficulty in auditing electronic funds transfers at present. The potential lack of an audit trail from a paperless business office could have the greatest impact on auditing of any of the changes being predicted. Already, some companies are ordering inventory from computer to computer with no purchase order involved. Electronic checking and home banking have been explored in a number of areas. Most of the auditors we surveyed responded that a paperless or near-paperless business office would occur by the year 2000. Many believed that the change would occur first in the large (Fortune 500) companies.

*Voice Recognition Input*—Voice input of data before the year 2000 is predicted by some of the technological experts. It is being used in some cases by inventory counters at present. Questions are included in the survey concerning the expected usage level and reliability level of various input mediums including voice, keyboard, and optical scanning devices.

### ***Data Communications***

*Data Sharing*—Data sharing appears to be a primary goal in business today. Local area networks and multiuser systems seem to be dominating the hi-tech spotlight at present. Most experts agree that there is a tradeoff between data sharing and data security. A truly secure network has not been designed to date. Loss of data integrity is one issue that is exacerbated in the networking/multiuser environment. The physical design of the network can impact the security of the information system. There are presently three common types of LAN designs—star, token ring, and bus. A technical discussion will not be addressed at this time, but the star is considered to be the most secure design followed by the token ring, and then the bus. IBM has adopted the token ring design so it is expected that this design will dominate in the future. A question concerning LAN design is included in our Delphi instrument.

*Communication Channel Options*—Another very important communications issue is the selection of a communication channel. Using the channel already in existence, the telephone system, is certainly one option. Telephone wire (technically, twisted-pair wire) is slower and slightly less reliable than other wire/cable options. Coaxial cable is faster and more secure than twisted-pair; however, fiber optic cable is much faster and even more reliable yet. A major disadvantage of fiber optic cable (concerning networks) is that the wire

cannot be spliced to add a new node. T-1 lines are massive (1.5 megahertz) communications channels that are extremely popular with large companies. Wireless communication can be achieved via either microwave or satellite. Microwave is usually considered a local communication option. Inclement weather and static discharge can affect the reliability of the signal. Weather does not usually affect satellite communication. Questions concerning local and long-distance communication channels are included in the questionnaire.

*Data Security*—The security of data travelling over communication channels is a major concern. Data encryption is one possible solution. A question concerning encryption of confidential data is included in the instrument.

*Communication Among Computers*—Another important issue is the level of communication among computers. Will microcomputers, minicomputers, and mainframes be able to communicate with one another? Will computers made by different manufacturers be able to communicate with one another? Many companies have a variety of computers within the departments of their company. Although some departments may desire to share certain data, often they cannot. Data sharing may improve efficiency and effectiveness, but it could result in an exposure to data security risks.

## **Computer Hardware**

*Proliferation of Computers*—Our preliminary findings indicate that there will be a proliferation of computers, especially microcomputers. The computers will be faster, more powerful, smaller in size, and less expensive. In other words, the trend of the early 1980s is expected to continue. These findings do not raise many *new* audit concerns; however, they do intensify our existing concerns. The problems of unauthorized data access, program access, and hardware access are certainly not going to go away and certainly could get worse. Separation of duties, one of the cornerstones of effective internal control, is becoming less and less attainable. Hardware failure and lack of adequate hardware backup will become increasing concerns as we become more dependent upon computers. Vastly improved processing speeds are likely to result from parallel processing and other innovations.

*Backup Storage*—A number of questions arise concerning the types of primary and backup storage mechanisms for accounting data and the location of the backup data (stored off-site/on-site). Some experts have predicted that microcomputer storage will be measured in terms of gigabytes (billions of bytes) in the very near future. Storage and backup of data on microcomputers with this much information will be critical. Microcomputer users are generally not as conscientious in backing up data, which could be a major data security risk. The trend is clearly toward a decentralized computing environment. One concern is that in this type of environment there might be a lack of standard operating procedures at some locations (e.g., backing up data daily).

*Data Access*—Preventing unauthorized access to data is a critical internal control issue. Password systems have evidenced vulnerability to unauthorized employees and outside hackers in recent years. Technology for biological

“passwords” such as fingerprints and voiceprints has already been developed. A question concerning the nature of access control mechanisms in the future is included in the Delphi instrument.

## ***Computer Software***

*Resistance to Change*—In spite of the predicted proliferation of new programs, change is not easily achieved in the software arena. Such resistance has been encountered with COBOL programming language and hierarchical database management system software. Supposedly “better” languages and database designs have been introduced. However, due to the level of investment in terms of money and trained manpower, it is difficult to replace “adequate” software. We are beginning to witness similar occurrences at the microcomputer level. DOS is the most widely accepted operating system software (for business purposes). Perhaps UNIX has some better features, but to invest the additional manpower and money, the improvements will have to be substantial. In application, software, DBASE III is certainly vastly superior to DBASE II, yet many individuals continue to use DBASE II. Will any new spreadsheet software be able to replace Lotus 1-2-3 (on a large scale)?

The benefits of new software must be substantial for a company to reinvest the money and training needed to make a change. Artificial intelligence based or natural language based software offers those potential benefits. Questions regarding the likelihood of these occurrences are included in our questionnaire.

*Natural Language Programming and Expert Systems*—Natural language programming and expert systems could have substantial audit implications if they become feasible on a large scale. Program review by the EDP auditor would become more simplified, but unauthorized tampering with programs written in natural language (or close to natural language) could become a greater problem.

## **Preliminary Findings Concerning Audit Evidence**

### ***The Open-Ended Questionnaire and Expert Auditors Surveyed***

Prior to formally surveying expert technologists, an open-ended questionnaire was sent to various experts in accounting. This questionnaire was used to obtain a list of the concerns of the professional accountant as input for the eventual survey of technologists.

The (non-random) sample of accounting professionals surveyed included ten directors of internal audit of Fortune 500 companies, 20 partners of large CPA firms, and ten controllers of Fortune 500 companies. The questionnaire simply asked the respondent to list the five trends/changes/events that would have the greatest impact upon auditing which he/she expected would occur within the next 15 years.

### ***Overview of Predicted Trends***

The comments obtained centered on approximately ten different categories. The following is a list of those categories:

DESCRIPTION	NUMBER OF COMMENTS (N = 20)
1. Trend toward a paperless society with a reduced audit trail.	19
2. Increased governmental intervention in auditing.	10
3. There will be an increased number of business failures and audit failures. Auditors will be more responsible for predicting these failures. Increased litigation concerns for external auditing firms.	7
4. The financial reporting package will place a greater emphasis on forecasts over historical reports.	6
5. Increased prominence of internal control reporting.	6
6. Changes in financial reporting and information required (e.g., disaggregated data replacing financial statements, current value based reporting).	6
7. Expert Systems used in auditing.	5
8. Increased competitive pressures among external auditing firms.	3
9. Increased trend toward a world economy.	3
10. Trend toward a "Decision Support System" environment.	3

The three categories receiving the most responses—(1) paperless society, (2) governmental intervention, and (3) business/audit failures—are not unrelated. As the computerized accounting environment becomes more complex, auditing becomes more difficult. As auditing complexity increases, the likelihood of audit failures increases. And if audit failures occur, government intervention becomes more likely.

There are also several legal, regulatory/governmental, macroeconomic, and reporting issues that are of much concern. However, the primary focus of comments was with the impact of changing technology upon audit evidence and internal accounting controls. Therefore, the thrust of our research will be directed toward that area.

### ***Potential Future Effects on Types of Audit Evidence***

The following section informally discusses some suggested possible effects of potential information technology changes on future audit evidence. Information technology changes will likely have a significant effect on all seven basic types of audit evidence: physical examination, observation, confirmation, vouching or documentation, inquiries of client, tests of mechanical accuracy, and analytical tests.

***Physical Examination***—The most common types of physical examination are inventory observation and examination of securities. One possible change in this area is that inventory taking could be done "on-line" with voice input or laptop computers. Actually, this may help to improve auditing because a physical inventory listing could be available at the time of observation.

Physical examination of marketable securities could undergo significant change if the physical piece of paper, the certificate, is eliminated. Obviously, other audit procedures will have to be performed to establish validity and perhaps value as well.

*Confirmation*—Two of the respondents in our open-ended audit questionnaire stated that the reliability of confirmations would decrease in the future. Outside confirmations are one of the strongest forms of audit evidence at present. It would conceivably take significantly more audit effort to establish the validity of the asset or liability presently being confirmed. Further, despite additional audit effort, it is unlikely that the evidence gathered internally would be nearly as persuasive as the external confirmation.

*Vouching/Documentation*—It seems obvious that auditing in a world without cancelled checks (or even checks), invoices, purchase orders, time cards, etc. would be much different than it is today. Several partners from large accounting firms surveyed in our open-ended questionnaire argue that continuous controls monitoring, auditing at the time of occurrence of the transaction, will become essential. With a reduced audit trail, strong internal controls become more essential. A greater understanding of the computer, accounting controls, and management control systems will be required of the auditor.

*Inquiries of the Client*—Client inquiries are considered a relatively weak form of evidence that must be substantiated if possible. Substantiation can be difficult even now. In a more electronic environment, the situation may even worsen.

*Mechanical Accuracy*—In one respect, the mathematical accuracy of virtually all tab runs, spreadsheets, invoices, etc. should improve. However, client prepared electronic spreadsheets, for example, might be an area of concern. Electronic spreadsheets “look” correct, but the assumptions underlying the spreadsheets must be audited. At present, this is a very difficult procedure and audit judgment problems concerning spreadsheets are just emerging. Perhaps the software will improve in that regard.

*Analytical Tests*—It seems possible that we will be placing more reliance upon analytical review procedures as “hard” evidence becomes less available. More creative uses of analytical procedures may have to be developed to meet the need for audit evidence.

*Observation*—Observation is generally considered one of the weakest forms of audit evidence. However, observation of computer environment and general computer and office procedures may give added information of the strength of a client’s internal controls.

*Summary of Preliminary Findings about Audit Evidence*—Three of the currently strongest forms of evidence—physical examination, confirmation, and vouching—could possibly all deteriorate in reliability and persuasiveness. It is unknown at this time whether other forms of evidence, or other types of audit procedures, can compensate for these potential losses.



This potential deterioration of evidence is occurring at a time when the complexity of business transactions (especially financial) and accounting rules is increasing. At the same time, Congress and other regulatory bodies are applying increased pressure for improved auditing.

## **A Tentative Scenario of Future Audit Evidence**

The following tentative scenario of future information processing and audit evidence is offered merely as an attempt to provide a stimulus for discussion at the Symposium. In the final research report, such a scenario will be based upon more extensive empirical evidence from the Delphi study information technology experts and the survey of audit experts. In this tentative scenario we distinguish “highly likely events and trends” from “important contingencies,” which are not highly likely but which would be important if they occur.

### ***Highly Likely Events and Trends***

Based upon the research to date, some of the highly likely events and trends that are expected to have an important impact on the future of audit evidence and auditing are:

1. Vastly increased computer power, reduced cost, and miniaturized size.
2. Commonplace usage of small, highly portable, powerful computers that telecommunicate without a hard physical connection or coupling to a network.
3. Commonplace usage of voice data entry and image processing and ultra high-speed printers.
4. Vastly increased practical use of expert systems for a wide variety of audit tasks.
5. Commonplace usage of imbedded audit monitors to flag items of audit interest on a continuous basis.
6. Vastly increased computer and information processing sophistication by management and employees.

### ***Important Contingencies***

Events and trends that are not highly likely to occur but that would have a significant impact on future auditing if they occurred are regarded as important contingencies. Some of the important contingencies that are suggested in the research to date are:

1. Uncertainties about the *specific type(s)* of (a) computer hardware, (b) software, or (c) networks that will prevail.
2. The degree of assurance that can be delivered by future systems with respect to (a) information security, (b) guaranteed privacy, or (c) backup reliability. Technological advances will greatly enhance both the sophistication of security measures and the tools available for overcoming those security measures.
3. The prevalence of expert systems and the specific arena or role of individual human judgment in auditing. Individual human judgment is likely to be used interactively with expert systems.
4. The extent of legal liability of auditors—both external and internal. The presently exploding liability costs may continue to rise or may

- be controlled by various legislative, legal, social, or economic remedies.
5. The level of governmental regulation or intervention into the auditing and/or business environment. This could be affected by any major failures related to business enterprises, audits, or databases.
  6. The degree of public acceptance of (or disillusionment toward) pressures for higher and higher levels of computer and technological sophistication.
  7. The prevalence of the "electronic cottage" or working at home and telecommuting.

## Conclusion

In summary, this paper reports on Phase I of a research project that attempts to identify and analyze the most significant information technology changes and other factors that are likely to have a major impact on audit evidence, the audit process, and the role of auditing in the next 10 to 15 years. The literature review, interviews, and open-ended questionnaires used in this phase of the research tentatively identified numerous events and trends that, if they occur, will have a significant impact on the future of audit evidence. In the remaining phase of the research, a Delphi survey will be used to measure and analyze more rigorously the predictions of a panel of information technology experts. The audit implications of these predictions will then be further tested through use of another panel of auditing experts.

In concluding this paper, we are requesting that Kansas Auditing Symposium participants—in addition to critiquing the paper in any way they deem appropriate—also provide feedback concerning (1) specific factors likely to affect future audit evidence that may have been omitted from our discussion and (2) the most likely scenario of audit evidence and the audit process in the year 2000.

## Appendix A

### Questions Included in the Delphi Survey

#### *Estimation of Trends*

#### **Data Communications**

1. What percentage of microcomputers and terminals will be able to communicate with any mainframe or minicomputer *made by the same manufacturer* (in the following years)?
2. What percentage of microcomputers and terminals will be able to communicate with *any* mainframe or minicomputer?
3. What percentage of microcomputers used for BUSINESS purposes will be used. . . ?

- a) As stand-alone devices
  - b) As part of a Local Area Network or a Wide Area Network
4. What percentage of *local* data communication will be transmitted over the following channels? (Use whatever your definition of LOCAL is.)
    - a) Twisted-pair wire
    - b) Coaxial cable
    - c) Fiber optic cable
    - d) Microwave
    - e) "T-1" type lines
    - f) Other
  5. What percentage of *long-distance* (i.e., NON-LOCAL) data communication will be transmitted over the following channels?
    - a) Twisted-pair wire
    - b) Coaxial cable
    - c) Fiber optic cable
    - d) Microwave
    - e) "T-1" type lines
    - f) Satellite
    - g) Other
  6. What percentage of local area networks will utilize the following architectures?
    - a) Star design
    - b) Token Ring design
    - c) Bus design
    - d) Other
  7. Certain data are considered confidential. What percentage of the data which *you* consider confidential will be encrypted when transmitted over communication channels?

### ***Office Automation and Transaction Automation***

8. What percentage of payments will be conducted electronically by the following entities?
  - a) Large (Fortune 500) corporations
  - b) Medium-size companies
  - c) Small businesses
  - d) Individuals (consumers)
9. What percentage of invoicing and billing will be done electronically by the following entities?
  - a) Large (Fortune 500) corporations
  - b) Medium-size companies
  - c) Small businesses
11. What percentage of business-related transaction data will be input using the following mechanisms?
  - a) Keyboard
  - b) Voice
  - c) Communication channels
  - d) External data sources (e.g., from another company's computer)
  - e) Optical scanning device
  - f) Other

12. What percentage of business office employees in America will telecommute? (The employee does not have to work all five days of the week at home. His/her schedule might call for working at home every other day, for example.)
13. What percentage of business and accounting data will be backed up on the following devices?
  - a) Magnetic Tape
  - b) Floppy Disk
  - c) Hard Disk
  - d) Laser Disk
  - e) Tape Streamer
  - f) Other
14. What percentage of companies will store back-up data at off-site premises?
15. What percentage of back-up business data will be stored on "Read Only" devices?

### ***Hardware, Software, Other***

16. What percentage of databases do you expect to utilize the following designs?
  - a) Hierarchical
  - b) Relational
  - c) Network
  - d) Other
17. What percentage of user identification/authentication schemes for gaining access to hardware or files will use the following?
  - a) Personal characteristics (e.g., fingerprint, voiceprint)
  - b) Possessed objects (e.g., card, key)
  - c) Remembered information (passwords)
  - d) Dialog (typed or spoken)
  - e) Other
18. What percentage of business application software for the mainframe will be programmed using the following categories of languages?
  - a) Higher level languages (e.g., COBOL, FORTRAN, etc.)
  - b) Fourth generation languages
  - c) Fifth generation languages (i.e., natural language based)
  - d) Other
19. What level of reliability will voice input of data achieve?
20. What percentage of each category of computers listed below will have parallel processing capabilities?
  - a) Mainframes
  - b) Minicomputers
  - c) Microcomputers

**WHAT IS/ARE THE PRIMARY SOURCE(S) OF YOUR KNOWLEDGE FOR RESPONDING TO THE QUESTIONS IN THIS SECTION OF THE SURVEY? (Please rank them if your knowledge comes from more than one source.)**

\_\_\_\_\_ First-hand; personal involvement in the area related to these trends.  
 \_\_\_\_\_ Professional literature.

- \_\_\_\_\_ Oral communication; information from knowledgeable persons whose opinions you respect.  
 \_\_\_\_\_ Popular literature.

**RATE YOUR LEVEL OF EXPERTISE ON THESE TRENDS (0 TO 10)**  
 (0 = No Expertise; 10 = Very highly qualified)

### ***Estimation of Events***

Specify probability of occurrence for the following (0–100%)

1. **SOFTWARE:** Sophisticated software is developed capable of creating computer programs that solve complex analytic problems specified by a user who has only minimal computer literacy. The software system identifies the inputs needed, elicits these inputs from the user and writes the program.
2. **AI:** Breakthroughs in the so-called fifth generation computers result in the development of a complete artificial intelligence capability. These units speak several languages, and respond to oral questions in a wide variety of subject areas.
3. **HARDWARE:** Microcomputer storage capacity is measured in gigabytes (billions of bytes).
4. **OFFICE AUTOMATION:** Office automation reaches a level in which elimination of all paper-work from repetitive tasks is feasible for the following items:
  - a) Payroll time-cards
  - b) Accounts payable vouchers
  - c) Expense reports
  - d) Purchase requisitions
  - e) Purchase orders
  - f) Invoices
  - g) Job Sheets (for production)

## **Appendix B**

### **Sample Page from Delphi Questionnaire**

#### ***Estimation of Trends***

##### ***Data Communications***

1. What percentage of microcomputers and terminals will be able to communicate with any mainframe or minicomputer *made by the same manufacturer* (in the following years)?

BY:	1990	1995	2000	NQ
	_____ %	_____ %	_____ %	_____

2. What percentage of microcomputers and terminals will be able to communicate with *any* mainframe or minicomputer?

BY:	1990	1995	2000	NQ
	_____ %	_____ %	_____ %	_____

3. What percentage of microcomputers used for BUSINESS purposes will be used. . . . ?

BY:	1990	1995	2000	NQ
As stand-alone devices	_____ %	_____ %	_____ %	_____
As part of a Local Area Network, or a Wide Area Network	_____ %	_____ %	_____ %	_____

4. What percentage of local data communication will be transmitted over the following channels? (Use whatever your definition of LOCAL is.)

BY:	1990	1995	2000	NQ
Twisted-pair wire	_____ %	_____ %	_____ %	_____
Coaxial cable	_____ %	_____ %	_____ %	_____
Fiber optic cable	_____ %	_____ %	_____ %	_____
Microwave	_____ %	_____ %	_____ %	_____
"T-1" type lines	_____ %	_____ %	_____ %	_____
Other _____	_____ %	_____ %	_____ %	_____

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