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ABSTRACT

A review of the research has indicated that compact disc-read only memory (CD-ROM) technology is used most often by the home consumer, with educational use next and business use following. To assess how CD-ROM technology is used in the banking industry, bank auditors were surveyed. One hundred business systems and operational auditors in downtown Chicago (Illinois) were selected to participate in this study. Responses of 77 auditors confirmed that almost all felt that there is a need for CD-ROM technology. Seventy-eight percent use CD-ROM technology as a tool for referencing banking and financial information as well as technical information. Fifty-one percent think that CD-ROM saves them significant amounts of time, and they also comment that they are able to use CD-ROM with little or no training. Banks appear to be deeply involved in purchasing CD-ROM products, and the number of CD-ROMs in banks is increasing. (Contains 23 references.) (SLD)

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BANK AUDITORS ASSESSMENT OF THE USE OF CD-ROM TECHNOLOGY IN THE BANKING INDUSTRY

Michael W. Lightfoot

Paper has been the key medium for transmitting information. More paper documents are produced today than ever before. Sales of file cabinets is healthy, and all storage media such as microforms and data processing are experiencing growth. The need to handle, store and distribute information is overwhelming us. A key to personal and business success is the ability to make smart, informed decisions. Many banks today are considered service providers which means that people want the right information at the right time, in the right place, and at the best price. These criteria are what we use to judge the utility value of information (Bangasser 1988). The utility value of information has been enhanced by CD-ROM technology. What impact if any, has CD-ROM technology had on the business banking community? Do to its rapid growth, many people today are unaware of CD-ROM technology and how it is being applied to our everyday life.

There has been very little research in regards to the use of CD-ROM technology in banks. One study investigated the individual differences in the use of CD-ROM databases (Kamala, 1991). This study explored the effect of individual differences on performance of new users of CD-ROM database systems in academic libraries. There are also a number of marketing surveys available regarding CD-ROM hardware and software application purchases. These reports, however, do not capture the essence of how CD-ROM technology is employed in the banking industry.

Research findings for this study deals with a current and fast growing topic and adds to the state of knowledge CD-ROM and its use in business. In addition, this study provides insight into an area of technology which is unknown to most PC end-users. The findings is of value and interest to PC end-users, educators, application and systems programmers, computer science instructors, business managers, and the banking community.

Historical Perspective

Compact Discs Audio Disc System (CD) was first shown in 1980 and became commercially available in 1983. Initially the CD was introduced in 1983 as an optical medium for high quality playback of audio signals and to compete with analogue records for a share of the audio playback market. On of the

factors that contributed to the success of CD was the existence of a set of standards developed jointly by Phillips and Sony that allows any CD disc to be used on any CD player. The digital recording format for the CD was designed by Phillips and the error detection/correction system of the CD was jointly designed by Phillips and Sony. Because of the digital storage techniques employed by the CD, computer hardware manufactures, software suppliers, publishers, and database providers took a considerable interest in the potential of this new medium as a computer storage and retrieval medium (Hendley 1987).

In 1985, Phillips introduced the CD-ROM player which was in essence, a direct adaptation of the CD system for data processing applications. The CD-ROM and the CD are very similar, in that they use the same disc and laser scanning technology, and the same mastering and replication methods. However CD-ROMS use are primarily designed to store digital data whereas CDs are designed to store digital encoded audio information. The CD-ROM has a sophisticated built in error correction system designed to compensate for errors. These errors can arise from several sources to include errors arising from imperfections in material or those arising from production, damage arising from scratches or fingerprints, and dust and other particles on the disc surface.

The CD-ROM uses optical scanning technology to store massive amounts of information in a compact area. The use of lasers allows a CD-ROM to function as a high-density, compact, and portable computer storage or information retrieval device. The CD-ROM can be used in a stand-alone disc drive or a disc that is the same size as a floppy disk with a single computer interface. O'Connor (1985) stated that CD-ROM technology is *not* a replacement for any existing form of computer memory. It is best described as a low-cost high-capacity mass data distribution medium. He goes on to say that since CD-ROM is a permanent information storage medium, it is best thought of as low-cost *distribution* medium for large volume of programs and/or machine readable data which are not subject to frequent updating.

The CD-ROM has reliability, permanency, and durability. Currently, CD-ROM has the highest reliability of any present-day magnetic or optical storage. Because of the digital storage techniques used, CD-ROM can be used to retrieve all types of digitally encoded data to include text, sound, photographs, and motion pictures. A single disc has a storage capacity of up to 600 megabytes (million bytes), or 15 billion bits of computer data, the equivalent of:

- 800 eight-inch floppy disks.
- 200 books, each containing 1000 pages.

- 10 computer magnetic tapes.
- 1,500 5.75-inch floppy disks.
- 500 3.50-inch floppy disks.
- 275,000 pages of text.

There are however some limitations with CD-ROM systems as described by Roth (1986). Two of which is the relatively slow access times and data transfer rates. The average CD-ROM has a typical access time of two seconds and a slow computer-drive data transfer rate of about 1.25 mbits per second. This is relatively slow compared to other storage devices.

A CD-ROM disc needs a drive to function. Unlike the CD audio player, the CD-ROM drive cannot stand alone to perform; it has to be connected to a computer. Since CD-ROM is a computer peripheral (operates only in conjunction with a computer), its abilities are in part a function of the host computer. In practice as outlined by Elshami (1990), CD-ROM is designed according to the capabilities of the computer. For example, if the computer is capable of displaying graphics, CD-ROM can be designed to do the same. In addition, CD-ROM can be interfaced with all existing and future computer systems. Because of this relationship between CD-ROM and computers, any computer advances will have a positive impact on CD-ROM. This dependency on the host computer is reflected in the design of the CD-ROM drive. Drives can be standalone or can be fitted into the personal computer. The concept of CD-ROM is still applied, meaning that the medium is not recordable. Data has to be stored on the disc only by a manufacturer that is usually the publisher of the CD-ROM.

CD-ROM discs cannot be played on musical CD players. Like CD audio, a CD-ROM cannot be copied, erased, or altered, a feature that will protect software developers against unauthorized or illegal copying.

How CD-ROM Technology Works

As Gall (1986) explained data are stored on the disc as a spiral track of microscopic pits, Machine-readable information is stored on the disc as a series of pits (data) and lands (no data) that spiral from the center of the disc to its outer edge. When inserted into a CD-ROM drive or CD player, these microscopic pits appear as bumps from beneath the disc and scatter the light from the laser beam. Lands, the areas between the pits, reflect the light from the laser.

Intermittent bursts of light are deflected onto light-detector laser diodes through light polarization techniques that convert the light into electronic signals and decode them as on-off binary bits-ones and zeros. Combinations of ones and zeros are grouped in 14-bit long strings that, by matching

them against data tables which are stored in permanent memory chips in the CD-ROM drive, decoded into eight-bit data symbols. CD-ROM drives read the information contained on the disc by focusing low-powered laser beams on the microscopic pits. An optical unit measures the pits reflectively, and the drive's semiconductor translates that reflectivity back into a binary signal that can be read by the computer.

In order to appreciate a CD-ROMS disc compactness, consider that the disc's entire spiral data track is almost three miles long, and each individual data track is 1.2 micrometers, which is one sixth the width of a human hair. These tracks are separated by 1.6 microns. Each separated microscopic pit is about 0.5 micrometers wide by 2 micrometers long and has a depth of 0.1 micrometers.

CD-ROM Mastering and Replication

The process of CD-ROM mastering and replication involves the customer supplying the manufacturer, such as 3M, with a one-half-inch, data tape which 3M transfers to a rigid disc. During this stage of CD-ROM mastering, the manufacture adds file information to CD-ROM World Standard specifications. The customer's premaster data tape is processed in order to split the information into blocks of 2K bytes to which synchronization patterns, headers (address and mode indicator), and error detection and correction codes are added in order to form CD-ROM sectors.

The glass master disc is coated with photoresist. Digital information from the customer's premaster tape is recorded on a glass master disc as a series of microscopic pits and flat areas spiraling from the center to the edge of the disc. These microscopic pits are created by a modulated laser which exposes the photoresist coating on the glass master.

CD-ROM discs are replicated from the glass master disc. Using a galvanic process, a glass disc master surface is transferred onto a nickel shell (father). Using the same processing, a number of positives (mother) are produced from the negative father. From each mother, a number of stampers (sons) are created and used for subsequent replication using injection molding techniques. These replicas are covered with a reflective aluminum coating that enables the CD-ROM drive to read the information with a low-powered laser beam. A protective lacquer coating is added over the reflective coat that protects the disc against minor scratches, dust, and fingerprints.

The final CD-ROM replica is tested and evaluated for quality control, labelled, and packaged in a jewel plastic

box. Automated quality control is performed using a laser scanning, and the other properties of each CD-ROM disc are also checked.

Advantages and Disadvantages of CD-ROM

Bangasser (1988) stated that information users really don't care how or where information is stored or how it gets to them as long as a single, easily performed request gives them what they want. He goes on to explain that CD-ROM advantages are many: high-density storage capacity; readability; user-friendliness; interactivity; low-cost replication for high volume; economy of distribution; local distribution of archival information; ability to free storage space on mainframe computers; inexpensive hardware; virtual indestructibility of discs; substantial space savings; data integrity; ease of database maintenance; and access and local control through a personal computer. In addition, CD-ROM is normally not subject to metering and information can be downloaded at very high rates compared to dial up lines. Equipment can be moved from one location to another at will and can be used without authorization by many different users. CD-ROM can combine text and images; offers unlimited end user searching; provides powerful search capabilities; enables search terms to be indexed and indexes to be structured and combined in many different ways for faster retrieval. The most attractive advantage a CD-ROM system is its simplicity and ease of use.

CD-ROM disadvantages include: data access can be slow and inefficient compared to magnetic media and online information retrieval; lack of currency-most CD-ROM databases are not updated as frequently as online databases; relatively high data preparation cost; and lack of reliable data about the archival (shelf) life of optical disk media.

Although CD-ROMS can store enormous amounts of data, getting to it is rapidly is another story. Miller (1991) outlines two reasons why CD-ROM drives are slower than hard disks. First, a CD-ROM's sectors are arranged in a continuous spiral track. This spiral track is ideal for reading large blocks of sequential data, such as music. Using the spiral track allows CD-ROM makers to take advantage of the equipment and infrastructure developed for mastering, pressing, and playing audio CDs. But it makes for slower random access times than hard disk whose sectors can be located faster because they are always found on a given track at a fixed distance from the center.

The other reason lies in the way sectors are arranged along the tracks. Hard disks use a constant angular velocity (CAV) encoding scheme, in which the disk spins at a constant

rate of speed and each sector occupies the area subtended by a fixed angle. Sectors are placed at maximum density along the inside track of the disk; going outward, however, the sectors must spread to cover the increasing track circumference, leading to "wasted" space between them and within them.

To make use of this space CD-ROM disc use constant linear velocity (CLV) encoding scheme in which the length of a sector is constant regardless of whether it's located on the inside or the outside of the disc. This means that the rotation speed of the disk must vary inversely with the radius; the motor must slow down to read sectors toward the outside of the disc and speed it up to read sectors toward the inside of the disc. Doing this requires a more complicated drive mechanism that can overcome the inertia of the disc when accelerating and the momentum when decelerating, which slows the drive's random access times. But this coding scheme allows data to be packed at maximum density over the entire disc.

CD-ROM Applications/Products

Since 1984, when the Library Corporation announced the first library CD-ROM-based information system, an increasing number of PC based systems or applications/products have been introduced. These systems have integrated the CD-ROM to store digital information in a wide variety of information environments. Examples of CD-ROM applications/products include:

- Library cataloging and ordering.
- Reference tools.
- Database publishing and distribution.
- Software distribution and documentation publishing.
- Instruction and service manuals.
- Distribution of in-house training and publications.
- Distribution of specialized information.
- Motor vehicle navigation system.
- Alternative to online newspaper service.
- Map storage and retrieval system.
- Marketing and educational presentations.
- Storage and distribution of graphic databases.
- On-demand printing.
- CAD/CAM/CAE.

These applications/products capitalize on the CD-ROM'S ability to store very large amounts of data and its ability to accurately deliver data to the point-of-use in a timely manner and reliable fashion. Roth (1986) predicated that CD-ROM will represent a new method of increasing the availability of tutorial diskettes, printed documentation and instructions for not only one particular microcomputer but several computer systems. He said that instructional delivery systems will use

CD-ROM to store and distribute videodisc courseware programs, and documentation as a more efficient and cost-effective method. According to Elshami (1990) as the number of CD-ROM products and services increases, product assessment will be greatly needed. No matter what type of information is stored on the disc, be it bibliographic, data, archived, graphics, or full text, such information has no value unless it can be easily and quickly accessed, retrieved, and utilized. CD-ROM applications/products can be evaluated according to many criteria, such as user interface, searching capabilities, response time, output and post processing, display capabilities, system requirements, technical support, documentation and ease of learning.

CD-ROM Users

Ambron and Hooper (1986) pointed out that the greatest use of CD-ROM technology will come from developers, educators, and information providers using CD-ROM as interactive multimedia tool. As discovered by Fisher (1988), one group of potential CD-ROM users has lagged behind. This group is the MIS (Management Information Systems) or organizations of large corporations. Fisher, U.S. Sales Manager for Phillips and Du Pont Optical (PDO) decided to find out how this group of potential users felt about CD-ROM technology. His survey team contacted more than 200 members of MIS senior management at large industrial companies, service organizations, and financial institutions. The questions asked provided some surprising answers, revealing that a large percentage of MIS managers were taking CD-ROM very seriously.

Two thirds of the managers surveyed said they were happy with the technologies they are currently using for information distribution. On-third of the group was considering the use of CD-ROM, but less than 5 percent currently using CD-ROM. One thing was clear according to Fisher: All managers in the survey group agreed that they had one common enemy, PAPER-more specifically, the cost of handling, storing, and distributing paper. Nearly 50% of those surveyed wanted to reduce the storage and distribution cost of paper.

Fisher's survey also asked the MIS managers what benefits they expected to derive from using CD-ROM in addition to lower distribution cost. Other reasons included the ability to have archival information available locally, the ability to deliver images and text together and the ability to free the mainframe storage capacity by reducing the need for online systems. Nearly 50 percent of the people surveyed said they were unfamiliar with CD-ROM and were unable to evaluate possible applications for CD-ROM and were reluctant to try any new technology. Other objections to CD-ROM included the perception that CD-ROM was too slow for their needs compared

to online systems and is too expensive a technology.

Many of the barriers to using CD-ROM indicated by MIS managers are being lowered. Cost are continuing to drop for developing applications, and speed of accessing data continues to be reduced. Software vendors are developing newer business applications and providing the corporate world with a better understanding of how CD-ROM applications will fit their business needs. According to Hoffmann (1989), more than half of the fortune 500 companies are formally reviewing or have initiated a CD-ROM project.

Another survey was conducted by Microsoft (International Conference on CD-ROM, 1988). By surveying the conference attendees, Microsoft obtained a profile of CD-ROM industry participants. A questionnaire was included in the program materials for the conference. Of the 1200 conference attendees, 939 people completed surveys for a total response of 78 percent. There were a total of twenty questions ranging from participants involvement in the CD-ROM industry to business and consumer purchases of CD-ROM products and what publications are read. The survey did not, however, determine which business or industries use CD-ROM. For example, one of the questions in the survey asked "Is your company involved with CD-ROM?." Eighty percent said yes, while 20% said no which gives no indication as to what business the 80% were involved.

Webster (1988) described the CD-ROM market as maturing as the cost of CD-ROMS decreased and applications increased. He recommended that CD-ROM should be considered as a publishing and data distribution product and noted based on his survey, that fortune 1000 companies were increasingly distributing data on CD-ROM for captive customer bases or internal use. Keough (1988) predicted that the Corporate use of CD-ROM storage would probably build slowly because of the newness of the technology and the cost of investing in a CD-ROM project. He explained that some companies were working on CD-ROM pilot projects to offer more efficient and expanded services to customers. In particular American Airlines used CD-ROM to support images in its computerized reservation system and Federal Express uses CD-ROM to store audio data for training users on its package routing and tracking system.

The CD-ROM market has split into three sectors: business, education, and home consumers according to Schwartz (1993). CD-ROMS backers projected its chief market would be for archival storage of information by libraries and business. But the big demand has turned out to be in interactive multimedia for the home consumer. The Market research firm Disk/Trend Inc (1993) predicted that sales of CD-ROM drives will reach 6.2 million in 1995, up from 2.3 million in 1992.

Falling prices and consumer applications are fueling the CD-ROM's ascent to mass-market status.

Summary

Based on this research, it appears that the greatest use of CD-ROM technology is the individual user in the home consumer market. Educational use of CD-ROM technology is second while business use is last. Business use of CD-ROM technology however, is growing at a rapid pace as new business application software is being developed and CD-ROM drives are becoming faster and less expensive. Over the last few years, there has bee a substantial increase in the number of people using CD-ROM for business applications. Because of the CD-ROM capacity, many developers and other business are keying in on the technology to deliver information.

Therefore, the purpose of the study was to assess how CD-ROM technology is used in the banking industry.

Procedures

Population and Sample

The population for this study included six Chicago loop banks. There are a total of forty one banks located in the Chicago Loop. The desired sample size is fifteen percent and the available sample resulted in six major banks selected for the study. From the six banks selected, the population of auditors is 335 with a desired random sample size of thirty percent which resulted in 100 business systems and operational auditors being selected.

A self developed CD-ROM survey was distributed through the mail with a cover letter explaining the purpose of the study and containing instructions for completing the survey. The survey consisted of eighteen questions which the answers were designed to assess CD-ROM usage in the banks included in the population. Open-ended comments requested for respondents to qualify or otherwise expand the scope of their answers. The survey was pilot tested on five auditors at the First National Bank of Chicago who were not included in the study to evaluate its validity and reliability.

The bank auditors included in the study were requested to choose answers that best reflected their knowledge and their auditees knowledge of CD-ROM usage in the various business areas they audit. They were also asked to distribute surveys to CD-ROM business managers and business analysts in areas where they were not familiar.

Use of CD-ROM technology in the banking industry was

determined by the results on the CD-ROM usage inventory. The responses were tabulated in terms of percentage of total responses to each questions. The Chi Square test was employed to determine the statistical significance of the responses at the .05 level of confidence.

Findings

Of the 100 surveys distributed, 77 were returned with completed answers and tabulated in terms of the type of bank business areas and applications using CD-ROM and the type of CD-ROM applications/products being used. Whenever possible informal interviews were conducted with bank auditors. The bank auditors were asked to answer the questions based on their experience in their respective banks. The data were tabulated in terms of percentage of users using CD-ROM.

From the population sampled the study revealed that CD-ROM technology is being used in banks in a variety of business areas. Seventy-eight percent of the respondents use CD-ROM technology as a tool for referencing banking and financial information as well as technical information. The majority (57%) of CD-ROM users in banks are in the auditing and data processing areas while 13% work in the consumer banking.

Various business applications such as commercial and consumer banking employ the use of CD-ROM technology to reference banking libraries and other financial data. The audit areas of these banks use CD-ROM technology to retrieve audit procedures and polices and bank regulations. The data processing function use CD-ROM to access software and documentation for software installation which is being distributed by software vendors. Several areas are using CD-ROM to retrieve instruction and service manuals and use CD-ROM for training, marketing, and educational purposes.

Almost all of the respondents felt that there was a need for CD-ROM technology at their job. Fifty-one percent of the respondents indicated that over half of their time is being saved as a result of CD-ROM technology. They also indicated that they were able to use CD-ROM with little or no training. Based on this study banks appear to be deeply involved in purchasing CD-ROM products and the number of CD-ROMS in banks are increasing.

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