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OPTICAL STORAGE TECHNOLOGY

by

Optical Storage Technology Subgroup
Automation Subcommittee
Field Information Management Users Group (FIMUG)

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User acceptance of optical storage technology has been slow because of problems pertaining to access time, transfer rates, and lack of industry standards. This technology, however, offers three distinct advantages over the present high-density magnetic media: greater storage density; less sensitivity to data corruption, contamination, or malicious alteration; and elimination of mechanical damage.

The most prevalent optical storage media are Compact Disc-Read Only Memory, Write Once Read Many, and Erasable Optical Discs. These media are described and evaluated according to their capabilities and limitations within each of the Information Management (IR) areas. The individual IR areas (namely, Library, Printing, Records Management, Visual, Scientific and Engineering, and Automation) are considered in relation to the current level of optical technology, and options for the US Army Corps of Engineers are presented.

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SUMMARY

The use of optical technology has not been as successful as the industry analysts (International Data Corporation, Gartner Group, etc.) predicted. The lack of user acceptance has been attributed to the time required to access and transfer the stored data and to the absence of a common industry standard.

To a great extent, the problems of standards have been overcome within the Compact Disc-Read Only Memory (CD-ROM) segment of the industry. Consequently, this area of the technology has received more interest from the users and has been the subject of more intense development efforts. These standards are the most advanced within the optical technology areas and have allowed the CD-ROM application developers to be vendor independent.

This situation does not hold true for the Write Once Read Many (WORM) or the Erasable Optical Disc (EOD) technology. The time required for a standards committee to develop a set of specifications (that all of the principals can agree on) is a lengthy process, resulting in proprietary standards being implemented by numerous vendors.

While the question of standards could be a pivotal issue, the use of optical storage technologies offers three distinct advantages over the present high-density magnetic media:

a. Significantly greater storage density. This is due to the precision with which a laser can be focused.

b. Less sensitivity to data corruption, contamination, or malicious alteration. This is achieved by use of light reflection. A transparent protective layer keeps dust and dirt from the focal spot on the disc, eliminating any chance of changing the reflected signal.

c. Elimination of mechanical damage. The magnetic medium requires a read/write head to be in close proximity to the rotating disk surface (an average of 0.25 μm). In contrast, the optical head comes no closer than 1 mm from the disc substrate.

Currently, development of optical technology hardware and application of this hardware towards business solutions are too dynamic for the US Army Corps of Engineers to make command-wide commitments. Prior to an enterprise-wide adoption of this technology, the Corps must perform a comprehensive evaluation and develop a sound implementation plan.

The utility of this concept spans the totality of Corps business. The areas of printing and publishing will realize operational economies and productivity increases. Libraries will gain independence from the use of on-line data base services and still provide timely information. Audio/visual offices will have an interactive medium in which they can

present the Corps to the public. Training of the Corps' workforce can be enhanced through use of the interactive features and can be available to the staff throughout the year. The automation offices within the Corps, as well as functional offices that have installed local area networks (LANs), will benefit from the large storage densities in the cyclic saving of user files and the portability of these files in the implementation of Continuity of Operation Plans (COOP).

A number of Corps offices have already taken the initiative in the optical areas and are presently investigating and installing this technology. The Corps must not inhibit this enthusiasm, but senior management direction is needed to prevent undisciplined evaluation and piecemeal adoption of this technology. The benefits from a coherent and planned implementation can be significant; conversely, the consequences from a piecemeal adoption could be severe.

The investigation and research performed in the compilation of this report resulted in the following general conclusions and recommendations. The rationale to support these findings is presented in the body and appendices of the text. Specific recommendations for Library, Printing, Records Management, Visual Information, Scientific and Engineering, and Automation are provided in the report.

Conclusions

General conclusions are as follow:

a. The use of optical storage technologies can offer the Corps significant economies and advantages in its daily operations.

b. The use of optical storage/retrieval technologies has the potential to impact on the current authorized staffing levels Corps-wide.

c. The applications to the COOP and offsite data storage, as well as the backup advantages for the many LANs, will be of added value to the Corps.

d. The legal storage and retention requirements imposed upon the Corps can be reduced to economical levels through the use of a high-capacity optical storage medium.

e. Printing and distribution costs incurred by many Corps offices can be reduced through the use of CD-ROM formats and distribution methods.

f. The volatility of the technology is of such a magnitude that the Corps should refrain from an undisciplined evaluation and piecemeal adoption of this technology.

Recommendations

The following recommendations are made:

a. Corps-wide equipment configuration standards should be developed in concert with the industry efforts.

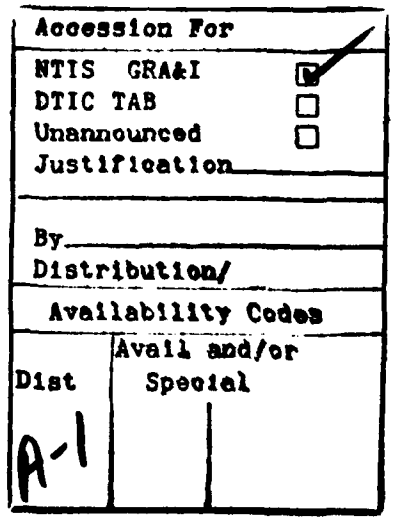
b. Corps senior management should continue support of limited test projects to investigate and define the criteria for Corps-wide adoption of this technology.

c. The Corps should establish a central management point within the Directorate of Information Management to manage all proposed, planned, and/or operational optical projects.

d. The Corps should establish special interest groups within the appropriate functional areas.

e. A comprehensive requirements analysis of the staffing impacts by functional area should be conducted.

f. The Information Technology Laboratory of the US Army Engineer Waterways Experiment Station should be tasked with the definition, investigation, and evaluation of the available optical technologies and their application within the Corps.



PREFACE

The Optical Storage Technology Subgroup was established by the Field Information Management Users Group (FIMUG) Automation Subcommittee, chaired by Dr. N. Radhakrishnan. The Optical Storage Technology Subgroup was tasked to produce an information paper that would define the technology, address the individual information management (IM) areas in relation to the current level of the technology, and present options for Corps management to consider in the area of this technology. The group met in September 1988. The group represented the Division, District, laboratory, separate Field Operating Activity (FOA), and Headquarters, US Army Corps of Engineers, IM offices.

The information contained in this report is based on research and the personal experience of the committee members. Additional information was gathered by visits to the IDC library, located in Tysons, VA; the US Department of Interior, Geological Survey, located in Reston, VA; and the OIS 88 Optical Technology Conference and Exposition, held in Washington, DC, September 1988.

This study was conducted under the general supervision of Dr. Radhakrishnan, Chief, Information Technology Laboratory, US Army Engineer Waterways Experiment Station (WES), who chairs the Automation Subcommitte. The report was prepared by the members of the Optical Storage Technology Subgroup, chaired by Mr. E. Dale Keenan, US Army Engineer Automation Support Activity.

The body of the report is structured by IM area and presents the findings in an abbreviated form. The individual area reports are presented as stand-alone subjects in Appendices B through G.

Optical Storage Technology Subgroup Members include the following:

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Kathryn Chaney (CELMV-IM-SO)
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COL Larry B. Fulton, EN, was Commander and Director of WES during the publication of this report. Dr. Robert W. Whalin was Technical Director.

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CONVERSION FACTORS, NON-SI TO SI (METRIC) UNITS OF MEASUREMENT

Non-SI units of measurement used in this report can be converted to SI (metric) units as follows:

Multiply	By	To Obtain
degrees (angle)	0.01745329	radians
inches	2.54	centimetres
pounds (mass)	0.4535924	kilograms
square feet	0.09290304	square metres

PART I: INTRODUCTION

1. The mass storage area is constantly experiencing innovation and growth. The introduction of optical/laser technologies is still being evaluated by the end user and industry. The ultimate viability of this storage medium has been questioned, and user acceptance is very slow. The problems of access times, transfer rates, and lack of industry standards are the major contributing factors to this lack of universal interest.

2. The purpose of this report is to identify the issues relating to optical storage technology and to introduce related technologies that are now in, or soon will enter, the marketplace, such as digital paper, Compact Disc-Interactive (CD-I), Video Disc-Interactive (VD-I), and floptical drives.

3. The optical oriented technologies most prevalent today are Compact Disc-Read Only Memory (CD-ROM), Write Once Read Many (WORM), and Erasable Optical Disc (EOD).

CD-ROM

4. The CD-ROM is oriented towards publishing, an alternative to on-line services or printed books. The major advantage of CD-ROM (and all optical storage devices) is its storage capacity. Applications that will return the most benefits using this technology have three characteristics:

a. The volume of material is substantial.

b. The information is targeted to a large number of people--the general public, a large customer base, or even a large number of employees.

c. The information is relatively stable.

5. The publishing segment of the information industry has embraced this storage vehicle, and the use of optical disc technology is now a reality in that portion of the information business world.

WORM

6. The WORM technology is appropriate for applications which are archival in nature, but which still require ready access to stored data. This is embodied in applications

where data should be preserved unaltered, i.e., where audit trails are essential or where historical data are important. The use of the WORM technology is also an excellent means of backup for the data center and the departmental user. The microcomputer drives are economical and readily available. The area of design and engineering drawings has significant storage requirements, as do the financial records within the Corps offices. Use of WORM technology offers the most reliable data backup and archival method now available. The data are protected against human error and hardware malfunction and provide a very durable storage media.

7. The WORM technology is also a fast-access alternative to microfiche, microfilm, and paper file systems, all of which are suitable for storing text and images. The large storage capacities of the optical devices offer many advantages to the user, but the continued lack of format standards and the propagation of proprietary interface and cartridge designs have resulted in a slow user acceptance of the technology. However, the International Business Machines (IBM) 3363 WORM drive has the capability of becoming a de facto standard. The capacity of the IBM drive is one of the lowest (200 megabytes (MB)) on the market but may force other manufacturers to produce compatible drives. If the IBM standard is adopted, it must be remembered that the majority of the drives already in the market have higher capacities and the lack of standards for these larger capacity units will persist indefinitely.

EOD

8. The EOD will be an alternative to magnetic disks for applications where data can be stored and subsequently replaced. Two characteristics of this medium--high capacity and slow data transfer rates--determine which applications are suitable.

9. High storage capacity makes the erasable disc useful for storing images. Applications which utilize this characteristic are the creation and subsequent editing of images, desktop publishing, Computer-Aided Design and Drafting (CADD), and Computer Assisted Engineering. Other applications include workstation computing, document processing, on-line data storage and retrieval, and data backup for all sizes of computers.

10. The relatively slow transfer rate makes this technology more suitable for personal computers (PCs) and workstations than for minicomputers and mainframes. However, the use of EOD is viable for host and minicomputer backup applications, but the relative costs of the cartridges and the need for extended storage make this alternative less desirable. The vendors are working very ambitiously in this area, and the transfer rate will be competitive with the existing WORM devices by mid-1989. The lack of direct physical contact or any accidental contact with the recording surface offers data integrity to the user on a level that has not been available in the past. The loss of data due to magnetic tape damage, the crash of a recording head, or magnetic contamination will no longer be a problem.

Related Technologies

11. It is possible that some of the concerns, expressed previously, can be mitigated by even newer developments in the optical storage field. An English firm, ICI Electronics,

has introduced a "flexible" optical medium. The company has dubbed this new medium "digital paper."

12. Digital paper is film-oriented, with the transfer of the data being accomplished by laser technology. The medium is currently a write-once technology, and the economics of the medium are such that the developer considers digital paper a disposable medium rather than reusable. The initial costs are expected to be a half-cent per megabyte. The low cost, high storage density, and faster transfer rate will make this a very desirable and competitive option. The initial hardware devices will cost about $200,000 per device and will be oriented towards the mini/mainframe market. The initial use will most likely be as a backup medium. Development is also being undertaken by the Iomega Corp. through its wholly owned subsidiary, Bernoulli Optical Systems Corp., for the use of this technology in the Bernoulli-type storage devices. The project is well underway, and Iomega anticipates delivery of evaluation units by the end of 1989.

13. The use of flexible film-based concepts has also stimulated the development of a drive by an American firm (Insite Peripherals). This new drive is based on the 3.5-in.[1] floppy and is referred to as a "floptical" drive. This technology utilizes both the laser and magnetic recording technologies to achieve very high recording densities, as well as transfer rates above those of the standard floppy drives in use today. The recording is done with magnetic tracks, and the laser technology is used for the encoding of the servo tracks. This use of laser encoding will allow for track density of 1,250 tracks per inch. The magnetic data storage and the increased rotational speed allowed by the laser encoding give the drive a data transfer rate of 1.6 megabits, over twice that of the current magnetic floppy drive units. This development offers an erasable technology with the high density capabilities of the laser and data error rates comparable to those of the standard magnetic floppy units. The economies of this type of drive are also significant: the developer anticipates original equipment manufacturer (OEM) unit prices below $300 and cartridge costs below $10 per unit.

14. Additionally, the original technology continues to evolve with the VD-I and the CD-I techniques, which promise additional options and economies. As the present recording techniques are more fully developed, the unique properties of light as a storage medium continue to surface in the national laboratories and industrial research projects. The most notable is the use of Raman light. This technology, Surface Enhanced Raman Optical Data Storage (SERODS), is estimated to increase capacity on optical discs by more than a thousandfold. The development time is projected at 5 years.

Legal Issues Related to Optical Media

15. Attention has recently been given to whether information stored on optical discs will be accepted in cases where legal evidence is required. If optical disc technology is not accepted, applications for the technology and for digital document management systems will be severely limited. This subject is currently being addressed on two fronts.

16. The National Archives and Records Administration (NARA) and the General Services Administration (GSA) have drafted a rule (see Appendix L) to assist Federal

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1 A table of factors for converting non-SI units of measurement to SI units is presented on page vii.

agencies in the selection, management, and maintenance of electronic records. The draft also defines the criteria computerized data must follow to be admitted as evidence in court cases. The adoption of this rule will establish mandatory operating procedures when maintaining electronic records. The establishment of a standard and auditable procedure for the storage and maintenance of these records will ensure that all of the Government's records are admissible in Federal courts. The Office of Management and Budget is presently reviewing the proposal and has the option of including it in the Federal Information Resources Management Regulations.

17. The Internal Revenue Service is currently using optical storage for the retention of submitted tax forms and supporting information. The system is being used in parallel with the more conventional document storage methods, and it is felt that the acceptability of this storage system will not be decided until a legal precedent is set during a tax litigation action.

18. The admissibility of electronic records has been established through the Federal Rules of Evidence. The use of electronic records can and should be used in court cases, but there is still a serious mistrust of information that is not on paper.

Bridges to Traditional Storage Technologies

19. Millions of documents are currently housed on traditional storage technologies such as computer output microfilm and microfiche. Users of large storage systems who are interested in implementing optical systems require bridges from the traditional technology to the Digital Document Storage and Retrieval (DDSAR) systems so that they are able to access older documents. Eastman Kodak offers the multimedia KIMS system, and Bell and Howell has also promised compatibility with its older micrographics systems and future DDSAR systems.

Data Security

20. The issue of data security is a two-part question. The actual integrity of the data is significantly enhanced through use of this technology. The destruction of the data due to mechanical failure (i.e., stretching of a magnetic tape or a head crash on a magnetic disk platter) is not an issue in an optical environment. The possibility of data erasure and/or corruption by magnetic contamination is also removed, as is the possibility of an employee accidentally, or by design, altering or destroying the data.

21. However, the large capacity of data storage coupled with the small size of the media presents the possibility of someone's walking off with complete data sets. The use of this storage media will require that the user increase the physical and procedural security of the storage area.

Storage Considerations

22. Optical disc technology attempts to provide an answer to problems associated with hard-copy storage. However, some users are afraid to dispose of the original copies of documents once stored on optical disc. This is due to early problems with disc performance and original 10-year guarantee limits from the media vendors. In these cases, continued storage of documents will be needed, thereby reducing the benefits that could be derived from the use of the optical storage technology.

23. The media life has been experiencing steady improvements and now is being advertised at 15 years plus for the majority of the optical media, with the SONY Corporation advertising a 100-year data guarantee.

24. The optical market is growing and evolving at a rate that places the prospective user in a quandary when attempting to decide the best format choice for the organization's needs. The lack of standards for the storage and retrieval of data is one issue; the differing media sizes and capabilities are another. The discs come in 3.5-, 5.25-, 12-, and 14-in. sizes. In addition to the size differences, the optical medium itself has many major differences and recording means.

25. The use of the standard rigid optical disc, that is a disc constructed of a polycarbonate substrate with a sensitive layer for data recording, offers a high degree of data integrity; the flexible film technology offers increased storage density and significant economies in the purchase of the media, while the newer optical/magnetic transfer technologies have the appeal of erasability.

26. The size of the disc also presents many choices; a 14-in. disc can hold up to 6.8 gigabytes (GB) of information; the 12-in. disc is only capable of storing up to 3.6 GB; and the 5.25-in. disc offers only 800 MB of data storage. These storage figures are for the standard rigid optical disc and are not at all representative of the newer film-oriented cartridges. The difference can be clearly shown by the comparison of the 5.25-in. discs: the film-oriented disc is capable of storing 1 GB of information, and the rigid optical cartridge can store only 800 MB. The flexible cartridge, therefore, has a storage capacity 124 times that of the rigid cartridge.

Standards Issues

27. The use of optical storage devices is improving information access and increasing productivity while reducing storage costs and fixed operating costs. The optical technology field is just now starting to mature and define the standards that will be needed to propagate this medium. The area of standards is a major problem for the industry. The use of the technology as an information distribution medium is the most advanced to date, yet the very name "Compact Disc-Read Only Memory" is referred to as "CD-ROM," "CD ROM," and "CDROM." The industry cannot even settle upon a common spelling for the acronym "CD-ROM," much less for the format and storage standards necessary for the widespread adoption of the optical technologies.

28. The CD-ROM area of the industry has made progress in the formatting standards. The WORM and the EOD segments of the industry are still using proprietary methods of formatting, data generation, and retrieval. These problems are further magnified by the use of many differing cartridge styles. The use of this medium for publishing large data

bases and distributing these files is a reality. However, the competing physical cartridge/disc styles detract from the viability of the technology.

29. While the High-Sierra Group logical format resolved many of the standard incompatibility problems and provided for the use of CD-ROM discs between different manufacturers' drives, it did not address the problem of physically interfacing the CD-ROM drives with the Disk Operating System (DOS) software. Microsoft attempted to assist the industry by the development of a standard device driver set for CD-ROM drives. These drivers are usually packaged with the drives by the manufacturers. This standard set of drivers makes it possible to purchase any CD-ROM drive and successfully connect it to any DOS-based machine.

Costs

30. The economics of this medium are impressive. The current optical storage costs per megabyte are approximately:

Media Type	Storage Density	Approx. Cost per Megabyte	Estimated Storage Life, years
Rigid Optical Disc*			
5.25-in.	800 MB	$1.20	30
12-in.	2.6 GB	$125.00	30
14-in	3.1 GB	$161.20	30
Flexible Optical Disc*			
3.5-in	200 MB	$1.50	15
5.25-in.	1.0 GB	$1.50	15
12-in.	1.0 TB	$0.09	15
Rigid Magnetic Disk			
5.25-in	20 MB	$12.50	10
3.5-in.	20 MB	$13.75	10
3380 unit	7560 MB	$15.21	10

* The optical disc costs were calculated as if the unit were fixed and not a removable medium. In fact, a majority of the optical devices are oriented towards removable media. Calculation of the costs with this base assumption shows the megabyte cost per drive unit and not an actual cost per megabyte of storage.

31. The costs associated with the optical hardware are very appealing and will continue to decline as the industry attracts more users and vendors. The current price structure is as low as $900 for microcomputer compatible drives, to subsystems in excess of $1,000,000 for the mini/mainframe market.

32. The cost of optical storage media is economical and will continue to decrease in price as the technology becomes more prevalent within the user environment. A recent survey of the use of CD-ROM by industry was just published by Dataware Technologies. This study addressed the costs associated with differing storage media (see Figure 1).

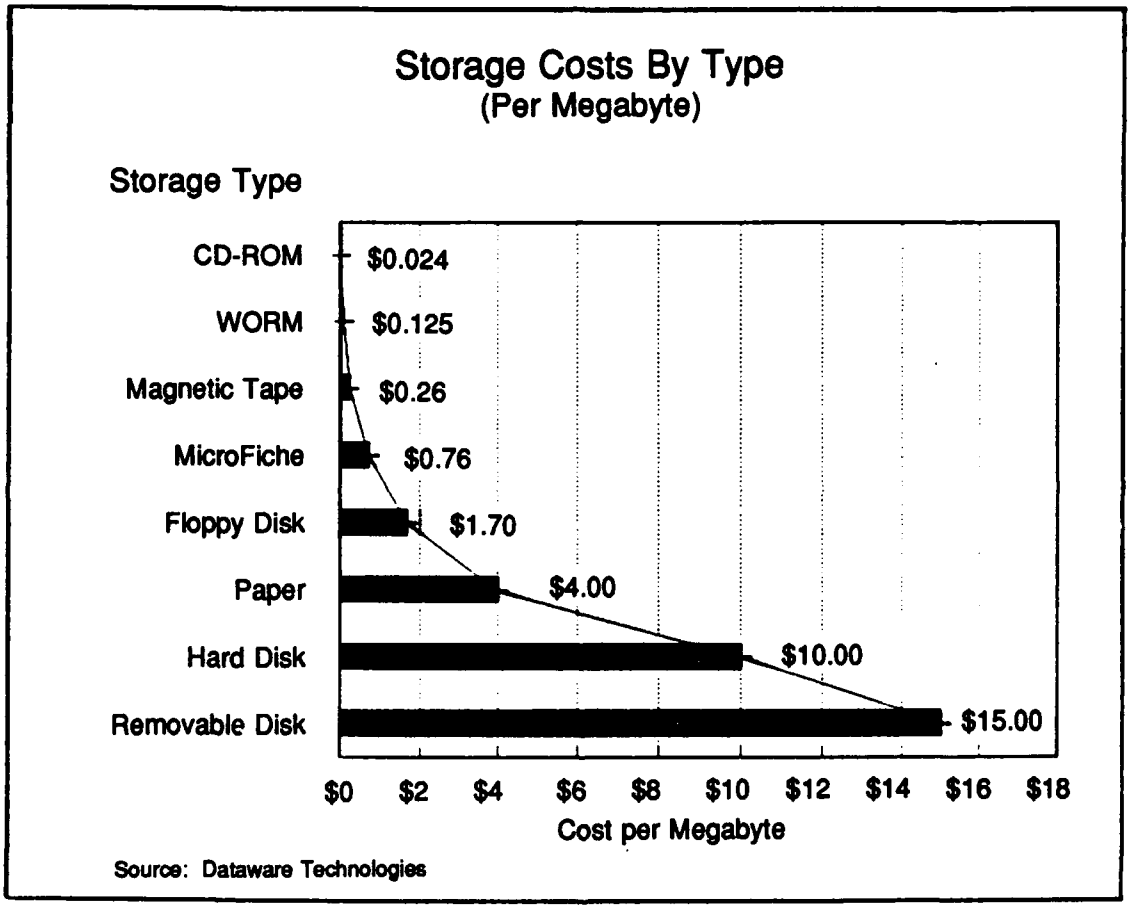

Figure 1. Storage costs

PART II: LIBRARY

Current Environment

33. Within the US Army Corps of Engineers, there are currently 50 libraries whose role is to provide information support services within the Information Management (IM) area. These libraries range in size from one person to more than a dozen staff members and collections of a few thousand to half a million items. They form a network that provides resource sharing and bibliographic control to the publications of the Corps. They are linked both through the Online Computer Library Center (OCLC) and through the Corps' LS2000 data base. Because each library is a separate holding location on LS2000, each library in the system can access its own holdings on-line, as well as the entire Corps data base. Libraries are connected to the Corps' LS2000 computer, located at the Office, Chief of Engineers (OCE) Library, either through dial-up phone lines or dedicated lines contracted annually through OCLC.

34. The majority of optical product activities within Corps libraries has centered primarily around replacing commercial on-line data bases with their CD-ROM counterpart, such as Dialog On Disk and Search CD450. Also, some hard-copy reference materials, such as *Books In Print* and *Microsoft Bookshelf*, as well as personnel manuals and construction specifications have been purchased in CD-ROM form.

35. CD-ROM versions of card catalogs, referred to as public access catalogs (or PACs), are not as widespread in the general library community as other CD-ROM applications. A number of integrated library systems offer CD-ROM versions of their on-line data base for backup and dissemination to remote sites. In addition, vendors are available through contract to produce CD-ROM versions of a library's holdings direct from OCLC input.

36. Optical products other than CD-ROM, such as WORM, have not been developed as much in the library market, and there is little literature related to this technology as it applies to libraries. By far, the majority of optical products in the library have been developed around CD-ROM data bases by outside sources, so the library often has little choice but to purchase the hardware and software required by the company that sells the CD-ROM product.

Requirements/Objectives

37. There are as yet no clear-cut rules or formulas to determine cost savings associated with CD-ROM in the library. In fact, a number of librarians contend that

CD-ROM is a costly alternative to on-line searching, since current subscription charges for CD-ROM data bases are so high. Although telecommunication charges are expected to increase, little cost savings will be realized if the volume of searching is not high enough to offset the cost of procuring the necessary hardware and software to search a CD-ROM data base and the cost of the subscription price of each service.

38. Perhaps a major issue that needs to be resolved by libraries replacing on-line searching with CD-ROM is how to charge for CD-ROM searching. This issue has not really been addressed by the library community. Some libraries currently bill on-line searches back to the customer, depending on the length of the search. This lends itself fairly easily to a library being able to keep up with what charges are involved and which customers should be billed. However, CD-ROM versions of the on-line data base are paid for on a subscription basis, and there is no built-in mechanism to monitor the length of the searches on the system. In fact, most libraries have been offering the searches free in order to attract customers to CD-ROM. There is also some evidence that users are reluctant to pay the same cost for a CD-ROM search as an on-line search. Yet, the subscription cost for most CD-ROM data bases is currently high, and unless libraries that charge for on-line searches can determine how to charge customers for CD-ROM use, it will result in a loss of revenue for these libraries.

Alternatives

Advantages

39. CD-ROM is not dependent on telecommunication links as are on-line data bases. This means that not only can telecommunication charges be avoided or reduced, but also the data base is more accessible and there is less likely to be downtime associated with a CD-ROM service. Remote sites are less tied to the on-line system, thereby resulting in reduced system load and faster response time by the on-line system.

40. CD-ROM cannot be altered or corrupted as on-line data bases. Once mastered, the data are secure and cannot be changed or deleted by users.

41. CD-ROM discs, once mastered, are relatively inexpensive to duplicate and can be distributed to remote branches or sites for a nominal cost.

42. Space can be saved by converting materials to CD-ROM. Some libraries with integrated library systems have already closed their card catalogs because the data are available on-line. In such instances, CD-ROM can provide valuable backup to an on-line system and enable users to access a data base even when the host system is down.

43. The CD-ROM product can offer more index points and provide more effective retrieval of material, depending on the software employed.

44. Labor costs can be lowered with the use of CD-ROM, since filing tasks can be reduced or eliminated in some cases.

Disadvantages

45. Because of the cost of mastering CD-ROMs, there is a problem with keeping them up-to-date. Some vendors have reduced this problem by developing transparent

interfaces between hard disks and CD-ROM discs, so that the hard disk can be updated more frequently, but there is still some amount of delay involved. Erasable, or rewritable optical discs, may alleviate some of these types of problems, but none of the vendors supplying public access catalogs are using this type of technology yet.

46. CD-ROM products are not easily networked, and although there is energetic activity in this area, it has not been adopted so far by any of the vendors supplying the library CD-ROM market. This means users are reduced to searching only on stand-alone machines, and users could experience delays and lines of other searchers waiting to use the same machine.

47. Materials have to be converted to machine-readable form for mastering into CD-ROM. This could mean additional costs involved in converting these materials.

Recommendations

48. Since the CD-ROM market is in a high state of flux, it is premature to establish agency-wide configurations in the library area. Each manufacturer has its own set of requirements, and libraries seeking to replace on-line data bases with CD-ROM are limited to those choices. On the other hand, the issue of cost of CD-ROM versus on-line data bases is significant and should be examined before purchasing CD-ROM and evaluated on a regular basis thereafter. Likewise, the question of charging for CD-ROM searching should be addressed in order to assess the impact on the library's budget.

49. Libraries involved in producing CD-ROM versions of their card catalogs have a larger set of choices available, and consequently face a larger problem with standardization if they intend to distribute these data to other libraries. In cases where the library intends to distribute its catalog to remote sites or branches, the library should determine before contracting with a vendor what hardware and software requirements must be met by each remote site to read the CD-ROM product. Since a number of libraries have obtained external Hitachi and Philips CD-ROM drives through OCLC, libraries intending to mass distribute their CD-ROM catalogs should explore the possibility of producing a CD-ROM disc that can be read by these machines.

50. Libraries intending to convert full text materials to CD-ROM or other types of optical discs have the largest set of options, and the largest problem with standardization. They also face copyright issues that should be resolved before pursuing such a project.

51. Although there has been little networking of CD-ROM devices in libraries, this area needs to be considered by libraries planning CD-ROM applications, since networking may require specific formats to be used.

52. A task force, or special interest group, should be established to research and recommend library-related CD-ROM applications within the Corps.

PART III: PRINTING

Current Environment

53. The decreasing costs associated with CD-ROM production makes this information storage and retrieval technology practical and feasible for the Corps to consider in pursuing its printing, reproduction, and publishing responsibility. The applications offered by CD-ROM for distributing the mounds of Corps information are of particular interest to project managers, design engineers, draftsmen, legal technicians, engineering staff, analysis, writers, editors, accounting personnel as well as contractor and construction workers. In the long term, a considerable cost savings could be realized through reduced use of printed paper materials, publication warehouse storage space, distribution efforts, and postage expenses. The small size but large storage capacity of a CD-ROM disc are features that support these savings.

54. Now that PCs give Corps personnel, and their customers, the power to process electronically stored data, it makes sense for the Corps to begin publishing and distributing documents in electronic form. CD-ROM offers users of IBM PCs and compatibles with laser printers and a CD player interface to access Corps data bases to search, retrieve, examine, cross-reference, and print specified information in whole or part.

55. CD-ROM is an appropriate medium for data used by every Corps Division and District office and laboratory. It allows engineers, office staff, analysts, and general purpose users to find information easier through keyword searches than through the traditional paper documentation review. An entire series of publications, project data, maps, drawings or a combination of these products can be included on one CD-ROM disc.

56. Corps use of CD-ROM technology is likely to build slowly. The newness of the technology and the high initial cost of embarking on a CD-ROM project mean that applications must be chosen carefully. For example, a Beta test involving publishing engineer manuals, engineer technical letters, and engineer regulations is currently underway. The data are being converted from the current paper form to electronic machine-readable configuration through the use of optical Character Recognition and Raster Scanning methods. Several locations are being provided software and CD players to participate in the evaluation process.

57. Printing personnel were chosen to work with Corps engineers and the manufacturers/developers of the test CD to provide expertise in format. Each screen of the scanned paper document contains complete textual material, associated pictures, and drawings in-place as they appear on the original. Less than 0.01-percent error rate is expected from the scanning process.

58. Obviously, the Corps wants the most cost-effective and efficient system available to meet its requirements. CD-ROM appears to be this system. However, the Corps' reluctance to print on this medium is due largely to the small number of offices and customers that have CD players. Few Corps offices and customers have players because very little Corps information is available on CDs.

59. The dominant cost of compact discs is preparing the data and cutting the initial master disc, approximately $10,000. However, each master disc can generate thousands of discs that cost about $10 each.

60. The Corps operates 18 field printing plants and 12 duplicating facilities, each supplying millions of pages of printed materials for various projects and programs. In addition to these in-house facilities, procurement from the Government Printing Office totals in the tens of millions of printed items.

61. There are over 850 ENG forms and in excess of 1,205 publications written, stocked, and distributed for various programs. Current storage of these materials requires 12,000 sq ft of warehouse space. Updating, editing, proofing, and redistribution of forms and publications involve numerous Corps personnel. As the demands for reducing costs within the Federal Government continue, many current document management practices will be altered to take advantage of cost-saving improvements in maintenance and distribution functions. CD-ROM will be used as a complementary technology to supplement paper documents while helping reduce the costs of maintaining large storage areas (file cabinets and warehouse space).

Summary

62. The power of the personal computer (with laser printer and CD player) is entering another area, publishing, to increase productivity, offer cost savings, and improve products. CD-ROM is a major step in the evolution of human productivity tools that will assist in the effort to reduce the quantity of publications and printed materials while providing needed information for customers.

63. With the CD-ROM, the Corps can take advantage of an evolving technology that will drive the future publications process in which a document, once written and approved, can be electronically stored and distributed. It will increase productivity and shape the way business is conducted. Compact disc mass storage technologies will be the Corps' publications warehouse of the future. Compact discs assure enormous benefits for the Corps in meeting a customer's requirement. Although not the paperless office notion of a few years back, it is an exciting advancement in publishing to make printed materials more readily accessible and available.

PART IV: RECORDS MANAGEMENT

Current Environment

64. The majority of the Corps' records are manually maintained in filing cabinets and records holding areas (RHA). However, with the proliferation of microcomputers, local area networks (LANs), and increased access to mainframes in the Corps, many records are currently being processed by computers.

Installed Systems and Procedures

65. Records are currently maintained under the Modern Army Recordkeeping System (MARKS), which replaced The Army Functional Files System (TAFFS) on 1 January 1987. The MARKS is governed by AR 25-400-2, which prescribes procedures for managing both records in hard copy and machine readable records (MRR). It provides guidance to ensure permanent preservation of archival information in machine readable form. The medium on which MRR are most often recorded is erasable, reusable, and conducive to rapid manipulation of data. Hard-copy records are manually stored in filing cabinets or in standard record storage boxes in an RHA.

66. The conversion of documents or information to microforms includes microfiche, microfilm, and aperture cards. Approved micrographics projects are designated by Microform Document or Information System (MICRODIS) numbers. There are many Corps-wide MICRODIS projects approved for such information as:

MICRODIS # 3053 - Hydrological and Hydraulic Data Files
3054 - Civil Works Project Files
3055 - Civil Works and Military Construction Drawings and Construction Contract Files (35-mm ApertureCards)
3058 - Standard Construction/Engineering Drawings (35-mm and 105-mm system)
3059 - Geological and Soil Data Files
3060 - Civil Works Project Operations and Maintenance
3061 - Basic Topographic Data Files
3062 - Realty Historical Files (Maps)(35-mm Aperture Cards
3063 - Realty Historical Files (Documents)

3064 - Permit Files (16-mm Reel System)
3065 - Operation Reports and Log Files
4017 - Permit Files (16-mm Cartridge System)
4099 - Corps Library Documents and Reference Material
4100 - Catalog Leases from Showcase Corp. or Information Handling Service

There are a few microform automated retrieval systems installed throughout the Corps, but many systems are simply storage systems with no automated retrieval capability.

Summary

67. The main objective of Records Management in the Corps is to provide modern, efficient, and systematic management of all records to ensure that commanders and managers at all echelons have the information they need to accomplish their mission. The life cycle management of this information must be accomplished in a manner which will ensure that the information is available to managers in a usable format and that it is properly maintained, stored, retrieved, and preserved. Specific disposition standards are established under MARKS for all records regardless of format or media. Records are subject to these dispositions, which prescribe the cut off, retention period, transfer to the RHA, retirement to the Federal Records Center (FRC), or destruction.

68. CD-ROM and other optical disc technology certainly seems to offer possibilities for reducing costs of storing records while providing compact mass storage, fast retrieval, and a higher level of security. However, some questions are yet to be answered before applications of optical disc technology are employed to any appreciable extent in the Records Management area.

Alternatives

69. Alternatives in Records Management include the following:

a. Maintain hard-copy records manually and continue doing business the way it has always been done. (The advantages and disadvantages are discussed in paragraphs 70 and 71).

b. Convert records to microforms using computer-assisted retrieval (CAR) systems for easier, faster retrieval. (The advantages and disadvantages are discussed in paragraphs 70 and 71.)

c. Employ optical disc technology in maintaining and storing records.

Advantages

70. The advantages of using optical storage include:

a. Great savings in space can be realized resulting in a reduction in fixed operating costs. A CD-ROM disc is capable of storing as much as

270,000 pages of records
1,500 diskettes
18,000 pages of computer graphics
72 boxes of records (RHA)

b. Optical discs are resistant to damage and offer increased security to the integrity of the data.

c. Access time is slower than magnetic media on hard disks, but faster than floppy disks.

d. Mailing costs, an element of variable operating costs, are minimal.

e. High resolution (compared with microforms).

f. Optical recording provides a level of data security not possible with rewritable storage devices. Data on optical discs cannot be covertly altered. This is very important for archival purposes.

g. Data on optical discs are much less susceptible to mechanical drive failures.

h. Optical discs can easily augment, rather than replace, magnetic disk storage.

Disadvantages

71. Disadvantages of optical disc storage include the following:

a. Most people are more comfortable with hard-copy records since they are familiar with the filing system.

b. File clerks are trained, and Records Management procedures are easily applied to hard-copy records.

c. Standards are in place for hard-copy records (file folders, cabinets, storage areas, labeling procedures, etc.).

d. The technology is new, and there are imprecise standards set at this time.

e. At this date, optical disc drives are not media-compatible and have no interchange capability.

f. The cost of equipment, or contracting mastering, is high, though expected to come down in the future.

g. The legal aspect of the acceptance of optical disc images in courts of law has not been resolved.

h. The NARA has not given approval for optical storage media to be used as archival (permanent) storage. NARA is currently studying the benefits/drawbacks of paper, film, and optical disc storage.

Recommendations

72. Because the optical disc technology is untested, not standardized, incompatible, and expensive at this moment, no particular application can be recommended for use in the Records Management function. However, it is recommend that Corps Records Management personnel keep abreast of the developments in the optical disc technology because it is predicted to be the medium preferred over microforms and some forms of magnetic media in the very near future. With over 60 vendors now producing CD-ROM products, and the eminent possibility that many vendors will not survive the eventual "shakeout," it is risky at this point to invest in any significant amount of optical disc products. Areas which are of prime importance are:

a. The establishment of firm standards governing the entire range of the optical disc industry.

b. NARA's decision on optical disc storage for archival purposes.

c. Determinations by the courts of the legality of information which is entered from optical disc storage.

d. The development of WORM technology which will be user friendly, compatible (effective in an LAN environment), and reasonably priced.

73. Conversion of microform media to optical disc is touted by several vendors as being simple and inexpensive. With this in mind, a good position to take at this time is to continue to use the media of microfiche/film and watch for the above developments in the optical disc industry. The office of the near future should have a typical configuration which would include a scanner, several integrated workstations, an optical disc storage unit, and a laser printer. Records will be created, distributed, and stored using optical disc and PCs integrated on a network.

PART V: VISUAL

Current Environment

Environment

74. Visual Information (VI) environment includes still photography, graphic illustration (manual and electronic), motion pictures, television (video), exhibitory, audio (sound), and the combination of these media and equipment. The VI environment involves production, presentation, duplication, and distribution of VI products. This environment stocks, stores, lends, and maintains VI products, equipment, and systems.

Applications

75. The following list is only a sampling of applications in the VI area that would be enhanced by using CD-ROM technology:

a. Slide presentation.

b. Computer graphics and animation.

c. Technical training courseware.

d. Video and motion picture production.

e. Kiosk presentation.

f. Duplication and distribution of VI products.

Requirement/objectives

76. Because of the nature of VI work, that of using a host of media, it is anticipated that CD-ROM technology will eventually augment VI/Graphics day-to-day production.

77. See Appendix E for procedures and training.

Cost saving

78. At the present, no studies have been undertaken to compare the cost of doing business within the VI area using CD-ROM technology. However, it is firmly believed that

CD-ROM technology will never in itself totally replace the VI/Graphics media currently being used. It is firmly believed by specialists in the field of VI/Graphics that CD-ROM technology will be an enhancement to an area already capable of using multiple media when producing products. Presently, there does not appear to be any substantial cost saving within the VI area; however, CD-ROM offers itself as an additional tool to be used in production of VI/Graphics tasks. The cost to do it via CD-ROM versus conventional ways will probably be the driving force until CD-ROM technology becomes less expensive.

79. The price of printed discs ranges from several hundred to several thousand dollars. Microsoft's *Bookshelf* costs $300, and free information, like Government statistics, reprinted on CD-ROM platters is comparably priced around $300. A typical CD-ROM player retails in the $800 to $1,000 range. Networking has helped bring down that cost, much as it did with expensive laser printers.

80. At this stage, videodisc technology will not reduce the cost of using this medium for storage of graphic drawing. However, it does provide a way to print a copy of an original document filed away without the need to physically locate that document by printing a copy from a stored image on video disc.

Conversion

81. The cost of conversion still appears to be high for capturing existing work into a CD-ROM system for storage, retrieval, and/or distribution. However the majority of industry is still a bit concerned with converting to a particular type of CD-ROM medium (3.5-, 5.25-, 12-, or 14-in. disc format) that may become obsolete within a couple of years. The CD-ROM market is still rapidly developing, with newer types of storage media being announced frequently. Further research is required in this area.

Redundancy

82. See paragraphs 109 through 121 for advantages and disadvantages.

Manpower

83. The use of CD-ROM technology is not expected to increase or decrease current manpower levels within VI offices. The use of optical storage/retrieval technologies has the potential to impact on the current authorized staffing levels. This area deserves a comprehensive requirements analysis to define its impact.

Storage

84. Users should be cautioned about the tremendous difference in capabilities in vendor offerings. The IBM optical drive provides 200 MB, whereas drives from ISI, Maxtor, and other companies provide more than 800 MB.

85. Optical discs will augment rather than replace magnetic disk storage. Some of the relatively permanent and less frequently accessed data now will migrate to optical disc. The low media cost-per-megabyte and 10-year shelf life of optical storage, together

with direct access to facilitate retrieval, will draw archival data to optical disc. (Also see paragraphs 109 and 121 for advantages and disadvantages.)

Alternatives

86. Visual Information/Graphics offices should consider how these new technologies may assist/augment day-to-day operation. It is firmly believed that eventually most of the alternatives discussed in the following paragraphs will be at least examined very closely by VI/Graphics offices.

No change in current operation

87. The VI/Graphics offices will be able to continue to function generally without much difficulty. Also see paragraphs 109 and 121 for advantages and disadvantages of using CD-ROM technology.

CD-ROM

88. Compact Disc-Read Only Memory is a publishing medium, an alternative to printed books. Paradoxically, the technology is stable and mature, even though it has scarcely emerged in the marketplace because standards which govern the coding of text, data, and images have already been adopted.

WORM technology

89. Write-Once, Read-Many is more appropriate for capturing transactions. This medium is used in large, multimedia (text, image, voice, and data) data base applications typically archival in nature, but still requiring ready access to stored data.

Optical subsystems

90. Subsystems emulate current storage devices such as magnetic disks or tape, alleviating potential problems with the operating system and driver interfaces which do not recognize optical discs. Optical subsystems include the optical drive, cable connection to the host, bus adapter, controller, and firmware. Subsystems range in price from $2,000 to $40,000, depending upon capacity.

CD-I

91. Compact Disc-Interactive technology is an extension of two existing optical disc technologies: compact audio discs, used by the recording industry, and CD-ROM discs, which let computer users store data bases of text in a read-only form. A standard CD-I configuration includes a CD-I player, a television, and stereo speakers. CD-I is effective

for assembling special material and could serve as a larger capacity for clip art and sound tracks.

DVI technology

92. Digital Video Interactive (DVI) is essentially two technologies. One is a compression technique (of up to 100 to 1) that allows over 1 hr of full-screen, full-motion video with eight-channel, interleaved audio to be stored on a single CD.

93. The second technology deals with decompressing and displaying the information from the CD. DVI uses a proprietary, very large-scale integration chip set to perform the decompression and display processing that result in real-time video. The chip set comes on three AT-compatible boards: a video board, an audio board, and a utility board. The boards should initially sell in the $5,000 range when they are released this fall, but will probably drop to under $3,000 by the middle of 1989.

Turnkey systems

94. Scores of systems integrators now offer turnkey optical systems which can be based on PCs, departmental systems, or mainframes. Turnkey systems include all of the optical components described in the following paragraphs as well as any computer hardware. Costs for a turnkey system range from $35,000 to $2 million+ for custom systems.

95. There are three sizes of turnkey systems:

a. Small-scale PCs. $30 to 100 K; 3.5-, 5.25-, 8-in. form factor; 1 to 10 MB/sec data transfer rate, 1 GB/platter; 4,000 to 100,000 pages; LaserData, TAB Products Chorus Data.

b. Medium-scale computers. $100 to $500 K; 8- and 12-in. form factor; 5 to 10-MB/sec data transfer rate, 1 to 4 GB/platter; 100 K to 1 million pages; FileNet Kodak Wang.

c. Large-scale mainframe. $500 K to $2 million+; 12- and 14-in. form factor; 24 MB/sec data transfer rate, 4+ GB/platter; JUKEBOX libraries; Kodak Plexus, Access, Integrated Automation, and Alpharel.

Erasable optical disc

96. Erasable optical discs will be an alternative to magnetic disks for applications where data can be stored and subsequently replaced. Two characteristics of this medium-high capacity and slow data transfer rates--determine which applications are suitable. High storage capacity makes erasable discs useful for storing images. Applications which utilize this characteristic are the creation and subsequent editing of images and desktop publishing.

Videodisc

97. While the videodisc is not a new technology, more Federal agencies are turning to this medium because of its ability to integrate audio, video, and graphics to provide high-quality training applications that can be mass-produced.

Assumptions

98. In the short term, poor performance characteristics of CD-ROM drives are not likely to improve significantly because these shortcomings do not seriously impact applications appropriate for this medium.

99. Twelve-inch WORM drives have inferior reliability compared with other drives. When these drives were first designed, WORM technology was used for backup, and reliability was not very important. This characteristic will improve in time.

100. The 3.5-in. erasable systems have a slow access rate and low capacity compared with 5.25-in. erasable drives. Current 3.5-in. systems are really prototypes and will improve in their performance characteristics.

101. Most printed CD-ROM platters currently available are compilations of information which a buyer compares with on-line services or paper alternatives.

102. Vertical applications characterized by valuable and stable data will initially drive the CD-ROM market. Medical and legal applications have these characteristics. Financial and economic data, sold as subscriptions with periodic updates, are now the most common application.

103. Industry applications will flourish once users have invested in drives. References like an encyclopedia, a dictionary, a thesaurus, and Bartlett's quotations could be very useful on CD-ROM, even though these applications are not now sufficiently compelling to motivate the purchase of a drive.

104. The performance of CD-ROM applications depends to a great extent on the effectiveness of the retrieval software. Search engines that support selection on Boolean operators, menu-driven selection, recognition of synonyms, and associative inquiries will be critical to the success of CD-ROM applications.

105. A wave of erasable 5.25-in. magneto-optic disc-drive systems is about to hit the market, with a variety of companies announcing products that come close to Winchester drives on performance and beat them on capacity.

106. Also appearing are 3.5-in. erasable disc drives and a new class of erasable compact discs. Format standards should be set by the American National Standards Institute (ANSI) for 5.25-in. nonerasable disc drives this year and eventually should be expanded to include erasable discs as well.

107. Industry analysts expected 149,000 WORM and 103,000 CD-ROM shipments in 1988. Unit shipments in both categories should double each year thereafter through 1991. By comparison, the number of 5.25-in. erasable drives shipped should grow from a few thousand drives shipped in 1988 to about 76,000 units in 1991, with most of the growth taking place in 1990 and 1991.

108. Multimedia files are used most often as central, departmental, and work-group files. Multimedia files are especially well suited for active documents--media retrieved

on a continuous basis. Ironically, filing needs have come full circle. Computers themselves generate paper (albeit sometimes in a different format) that must be stored. Nevertheless, as documents evolve, there is no survival-of-the-fittest rule to kill off the previous generation of media. Every new kind of electronic device creates a new medium, but it never obsoletes the old one. Instead, there is a proliferation of media. Paper is not enough. Microfilm and microfiche are not enough. There are also computer discs and computer tapes in all shapes and sizes. So CD-ROM technologies will augment most, if not all, of the current storage media used today.

Advantages

109. The optical disc provides a shared storage resource; thus the data can be retrieved by multiple users. Data migrated to optical storage remain on-line and preserved in computer processing format, reaping a benefit in error reduction because manual handling of microfiche is eliminated, as is the possibility of lost or misplaced media.

110. Optical discs can store whole pages of text and charts together. Optical disc drives also have greater data densities than magnetic storage: A 12-in. optical platter can hold 1 GB (1-billion characters) of information, which allows a greater amount of data to be stored in a smaller space.

111. The CD-ROM diskettes are reliable and stable. Shelf life, depending on the underlying substrate, can be 30 years.

112. The major potential advantages of erasable optical disc systems are capacity and durability. Other potential advantages include economy, random access, and removable media.

113. CD-ROM provides a means of distributing 600-million characters of data--equivalent to 175,000 pages of ASCII text, plus indices--to any end user with a microcomputer and a $700 drive.

114. Whereas today's average PC random-memory is about 1 MB or less, CD-ROM can expand ROM available on PCs to more than half a gigabyte. With the ROM supplement, applications once unheard of become a strong possibility.

115. Optical disc drives are not direct replacements for magnetic tape or disk drives and cannot be effectively evaluated on the traditional criteria of speed and seek time. Magnetic tape provides low-cost storage on removable media, but data cannot be directly accessed. Winchester disc drives provide direct access, but the media are not removable and the cost per megabyte is high compared with tape. Optical storage offers the combined advantages of direct access and removable media at an on-line cost per megabyte competitive with Winchester drives and a media cost per megabyte competitive with tape.

116. Optical storage media provide a level of data security not possible with rewritable storage devices. Data on an optical disc cannot be covertly altered because any attempt to do so will destroy the data itself.

117. CD-ROMs are used primarily for archival purposes or as a way of distributing data bases and software.

118. Multimedia files solve a problem that has been exacerbated by today's office technology: What does one do with records that will not fit into filing systems designed

for letter-size paper? The problem is not a new one. Most accounting departments work with a range of document sizes. In fact, depending on how loosely the term "media" is defined, the potential for unusual storage requirements is almost unlimited. Any department that depends on media other than letter- or legal-size paper will probably be a user of multimedia files. Today and into the future, that will include almost every department.

119. A single CD-ROM disc is capable of storing up to 650 MB of data. That is as much data as can be stored on 1,500 floppy disks. CD-ROMs can be used to store any kind of information in digital form: data, text, graphics, audio, and video. Additionally, a CD-ROM enables users to easily search and access information from workstations and provides an inexpensive method to reproduce, update, and distribute information.

120. The technology works best when applications require at least 20 to 40 MB of storage. When the amount of information to be stored is less than 10 MB, it is not necessary to switch from floppy disks or diskettes to CD-ROM technology.

Disadvantages

121. Disadvantages of optical discs are as follows:

a. Due to the lack of industry standards, discs are not interchangeable and must be used with the appropriate drive. Approximately 15 companies manufacture optical discs.

b. The use of optical discs requires large initial investment of time and money.

c. Optical discs have slower retrieval times than magnetic media.

d. Optical discs are effective only as a publishing or archival medium until erasable versions are available.

e. Even with a lower price, traditional CD-ROM is less flexible for storage and backup concerns because it is a read-only medium.

f. The CD-ROMs cannot be easily updated hourly or weekly, although material that needs to be updated monthly or quarterly can be updated economically.

g. Applications are an obstacle, as well as a lack of interchangeability among drives.

h. Hard disks traditionally have seek times that are at least twice as fast as those of optical discs.

Standards

122. No two optical disc drives available today are media compatible. Media interchange standards are being developed to overcome these concerns. The most advanced standards activity is directed at the 5.25-in. optical disc, with coordinated projects being conducted by the ANSI, the International Standard Organization (ISO), the Japanese Institute Of Standards, and the European Computer Manufacturers Association. The 5.25-in. optical standard will dovetail with a 5.25-in. EOD standard, thus enabling multifunction drives to handle both write once and erasable media.

123. There are four sets of CD-ROM standards. The first is the physical layout of the disc, or how the tracks are engraved. Interpretation of the data, a second standard, describes how to read the digital information from the 660-MB physical disc. The third standard is the High Sierra Format, which imposes a restructuring of the disc, creating discrete files and directories. Instead of a long, 660-MB disc, it is broken down into files. The standards for physical layout, data interpretation, and file formats have all been established. The fourth standard, which involves the CD-ROM playback device, is still emerging. The playback device can be hooked up to an IBM PC or compatible, and Apple Computer Inc. has a CD-ROM for the Macintosh. This is the area where standards are least set.

Recommendations

124. The following recommendations are made:

a. Increase participation within the Special Interest Group on CD-ROM Applications and Technology (SIGCAT) Federal User Group.

b. Establish functional groups to address CD-ROM applications and usages within each Corps information discipline.

c. Establish a center point (point of contact (POC) or office) within the Corps to funnel all proposed, planned, and/or operational CD-ROM projects. The POC/office would act as a clearing house and source of research for offices that plan on establishing CD-ROM applications.

d. Because of the nature of VI/Graphics offices, recommend and proceed with ideas, and propose plans and projects provided these undertakings are local in scope. However, it is too soon to be contemplating a CD-ROM system that would be deployed Corps-wide. The CD-ROM technologies are changing at such a rapid pace that it is better to wait until the market settles within the VI/Graphic area.

PART VI: SCIENTIFIC AND ENGINEERING

Current Environment

125. Scientific and Engineering (S&E) oriented systems are traditionally resident on all tiers of the Corps' automation architecture. Design analysis is supported by the Corps' engineering program library and commercial software available on mainframe and microcomputer systems. Graphics are supported by the Graphics Compatibility System (GCS) subroutine library. Computer-Aided Design and Drafting (CADD) is resident on dedicated minis and networked microcomputers or workstations, generally provided by the Intergraph Corporation.

Installed data storage and distribution systems

126. Large data base applications exist in the S&E area related to construction specifications, CADD, hydrology, earthquake records, soil borings, hydrographic surveys, mapping, coastal processes, project management, technical publications, and computer program libraries.

127. Mainframe and minicomputer distribution is through dedicated telecommunications lines or dial-up modems for online data and through paper reports or magnetic tapes for static data. Hydrologic data from Watstore and National Weather Service computers are accessed by on-line and interactive systems. Construction specifications are distributed through the Specbase and National Institute of Building Sciences (NIBS) Construction Criteria Base by on-line access to Control Data Corporation (CDC) mainframes. Technical publications such as technical reports and computer program documentation are generally distributed by mailing paper documents. CADD applications using Intergraph software based on Digital Equipment Corporation minicomputers utilize an LAN to effect the transfer of drawing files between the host minicomputer and workstations in a specific site. The distribution of other mainframe/minicomputer-based data is primarily by magnetic tape media, customized for each vendor's specialized format requirement. This includes the Corps and Hydrologic Engineering Center (HEC) program libraries, GCS, earthquake accelerometer data, and Beach Profile Analysis System data distribution procedures.

128. Microcomputers have expedited the transfer of data through the use of on-line file transfers between the microcomputer and mainframe/minicomputer and the mailing

of floppy diskettes between sites. The use of micro-based LANs or micro-to-micro file transfers has seen limited application for data distribution. The NIBS Construction Criteria Base is distributed on floppy disks or on a CD-ROM disc. A large fraction of the Corps, HEC, and GCS libraries have been adapted for the microcomputer environment and are distributed by floppy disks periodically. The Coastal Engineering Research Center and Construction Engineering Research Laboratory also distribute program libraries via floppy disk mailings.

Disadvantages

129. The primary deficiencies in current S&E data storage and distribution systems are considered to be the cumbersome and expensive characteristics of magnetic tape preparation and mailing; expense and time intensive characteristics of on-line data transfer; and system administration aspects related to data currency, security, and integrity for widely distributed magnetic media.

Advantages

130. On-line access to data bases provides the most efficient storage medium in high-capacity magnetic disk drives, and the facilities for system administration of mainframe systems are superior to other systems. The floppy disk medium is the most inexpensive for smaller distributions of data. The Corps currently has hardware installed to support the magnetic tape distribution systems.

Summary

131. The Corps must apply new technology, as appropriate, to ensure that the highest professional standards are maintained in the area of S&E data. Economy and data integrity are issues that are directly affected by IM policy. Internal and external customer support, cost effectiveness, reduction of duplication, compatibility, timeliness, quality control, and system administration are all affected by the media used for storage, access, and distribution of S&E data. The Corps must strive to ensure that IM policy is dynamic in nature and reflects state-of-the-art technologies.

Alternatives

132. It is assumed that the Corps' requirement for data storage and distribution systems will continue to increase geometrically for the near term. Also, it is assumed technological advances in data storage, retrieval, and communications systems for S&E data will increase capacities and reduce unit costs geometrically. Thirdly, data storage and distribution will become critical benchmarks in systems design as processing and software considerations become a smaller fraction of the associated direct costs of system development and operation.

Available systems

133. Continued use of the currently employed or standard systems and procedures for storage and distribution of S&E data must be considered for each application area. The applications considered having high potential for benefiting from optical storage technology are those which exhibit largely static data, large data bases (100 MB), and wide distribution. Applications which do not meet these criteria would have a higher unit cost for distribution than current systems and would experience system degradation when time sensitive data are involved.

Commercial systems

134. Commercially available, "off-the-shelf" applications and systems are viable for consideration for many S&E applications. Labor and hardware intensive applications, such as those requiring replication of optical discs, large-scale or frequent distributions, or high throughput data bases, would appear to have the highest potential. Additionally, products for external customers would benefit from the versatility and conformance to industry standard data formats afforded by commercial systems. Conversely, for transient data requiring intensive in-house management, commercial systems would tend to be cumbersome and expensive to operate.

Application/system development

135. The development of data storage or distribution systems would normally be reserved for applications where sufficient uniqueness exists or performance requirements are such that the additional expense, implementation time, and the loss of transportability is justifiable.

Recommendations

136. The consideration of CD-ROM and optical storage technologies for the storage and distribution of digital data is strongly recommended. It is obvious that optical storage is cost effective in many applications. The adoption of ISO standards for CD-ROM makes this technology especially stable for the near term. Commercially available data bases on CD-ROM provide potential for immediate performance increases over current systems. It is also obvious that the mechanisms for defining ongoing functional requirements for S&E applications (special interest groups, steering committees, etc.) must address the CD-ROM and optical storage technologies. Distribution of program libraries and archival of S&E data should be addressed in the Automation functional area.

Short term

137. The Field Information Management Users Group (FIMUG) should continue research on optical storage technology by establishing a mechanism which can review S&E data storage and distribution requirements. The initial activity of this mechanism would be to adopt a standard CD-ROM reader and configuration which would afford the Corps S&E community maximum exposure to currently available data bases, c.g., Specbase and

US Geological Survey terrain data. Secondly, a comprehensive review of current Corps products distributed in digital form should be made. Thirdly, a comprehensive review of current data base applications should be made.

Long term

138. The previously established mechanism would continue to compile functional requirements on an ongoing basis. Additionally, a review of optical and other storage and distribution technologies should be made. The defined applications would be analyzed and compiled into a prioritized list for transition to alternative storage technologies. Concentration of effort should be directed at distribution applications with data base applications being coordinated with the Automation subcommittee of FIMUG.

PART VII: AUTOMATION

Current Environment

139. Automation in the Corps of Engineers is effected using various computer architectures, all of which support data transfer and storage functionality.

140. Mainframe systems primarily support on-line access to data bases and reporting facilities. Typically, the Corps develops mainframe systems on its own Honeywell DPS8 computers or the TSP contractor's Control Data Corporation series of computers.

141. Minicomputer systems are primarily used for specialized applications at the District level and as front end processors to the mainframe systems. Harris minicomputers are used for financial, office automation, water control, and data base applications as well as remote job entry applications. Recently, Sperry and Harris Unix based minicomputers have been acquired for stand-alone office automation applications.

142. Microcomputers are used in all areas of automation and have found broad acceptance by the Corps. Applications are typically stand alone, using off-the-shelf software for data base, word processing, and spreadsheet applications. The most popular microcomputer is the standard Zenith ZX-248; however, Apple microcomputers have a large installed base.

Installed data storage and distribution systems

143. Mainframe systems use high-capacity magnetic disk drives for providing on-line access to data base files and program libraries. Specialized data base applications may use removable magnetic disk packs. Distribution of data is primarily in the form of reports transmitted via paper, remote job entry synchronous data communications to minicomputers, or microfiche. Distribution of program libraries is traditionally via magnetic tapes. Archival and backup of on-line data are by magnetic tape library facilities. Some systems have been developed that transfer data using microcomputers connected through asynchronous communications devices.

144. Minicomputers have magnetic disk drives with less storage capacity than mainframes. Data distribution capabilities, however, exceed those of the mainframes in the areas of interfacing, networking, and integration. Generally, minicomputers lend themselves to acting as servers to shared resources, as central nodes in distributed applications, and as remote job entry facilities. Archival, backup, and program library functions are performed with systems analogous to mainframes.

145. Microcomputers in the Corps have primarily operated in a stand-alone mode with floppy and fixed disk drives associated with each station. The primary application for microcomputers has traditionally been word processing, with data distribution via paper documents, mailing floppy disks, or file transfer using telecommunications through dial-up modems.

Disadvantages

146. The cumbersome, expensive, and volatile nature of magnetic tape and paper media for distribution of data are the primary deficiencies in current mainframe and minicomputer systems. Conformance to standards is deficient for magnetic tapes making their portability between mainframes and between minicomputers restricted.

147. The capacity of microcomputer magnetic disks is inadequate for many data base applications. The limited capacity of archival and backup systems for microcomputers discourages proper system administration procedures from being performed.

Advantages

148. Magnetic disk drives are cost effective and exhibit high throughput which appears unrivaled for on-line data storage and access. For limited quantities of data, high-speed, reliable communication links provide reasonable data transfer rates for both asynchronous and synchronous devices. The communication networks of the Corps provide extensive horizontal and vertical data distribution functionality.

Requirements summary

149. The Corps must apply new technology, as appropriate, to ensure that its automated systems are efficient, reliable, and effective in supporting the functional areas of Information Management and its production systems. Economy and data integrity are issues that are directly affected by IM policy. Internal and external customer support, cost effectiveness, reduction of duplication effort, compatibility, timeliness, quality control, and system administration are all affected by the media used for storage, access, and distribution of digital data. The Corps must strive to ensure that IM policy is dynamic in nature and reflects state-of-the-art technologies.

Alternatives

150. It is assumed that the Corps' requirement for data storage and distribution systems will continue to increase geometrically for the near term. Also, it is assumed technological advances in data storage, retrieval, and communications systems for digital data will increase capacities and reduce unit costs geometrically. Thirdly, data storage and distribution will become critical benchmarks in systems design as processing and software considerations become a smaller fraction of the associated direct costs of system development and operation.

Available systems

151. Continued use of the currently employed or standard systems and procedures for storage and distribution of digital data must be considered for each application area. The applications considered having high potential for benefiting from optical storage technology are those which exhibit largely static data, large data bases (100 MB), and wide distribution. Applications which do not meet these criteria would have a higher unit cost for distribution than current systems and would experience system degradation when time sensitive data are involved.

Commercial systems

152. Commercially available, "off-the-shelf" applications and systems are developing in the areas of microcomputer CD-ROM readers and WORM systems. Labor and hardware intensive applications, such as those requiring replication of optical discs, large-scale or frequent distributions, or high throughput data bases, would appear to have the highest potential for migrating from traditional storage and distribution technologies to optical storage technology. Additionally, products for external customers would benefit from the versatility and conformance to industry standard data formats afforded by commercial systems. Conversely, for transient data requiring intensive in-house management, commercial systems would tend to be cumbersome and expensive to operate.

Application/system development

153. The development of data storage or distribution systems would normally be reserved for applications where sufficient uniqueness exists or performance requirements are such that the additional expense, implementation time, and loss of transportability is justifiable.

Recommendations

154. The consideration of CD-ROM and optical storage technologies for the storage and distribution of data is strongly recommended. It is obvious that optical storage is cost effective in many applications. The adoption of ISO standards for CD-ROM makes this technology especially stable for the near term. Commercially available data bases on CD-ROM provide potential for immediate performance increases over current systems. It is also obvious that the mechanisms for defining ongoing functional requirements for automation applications (special interest groups, steering committees, etc.) must address the CD-ROM and optical storage technologies.

Short term

155. The FIMUG should continue research on optical storage technology by establishing a mechanism which can review digital data storage and distribution requirements. The initial activity of this mechanism would be to adopt a standard CD-ROM reader and configuration that would interface with the current microcomputer architecture which would afford maximum exposure to currently available data bases from Government and

commercial sources. Secondly, a comprehensive review of current Corps products distributed in digital form should be made. This includes distribution of program libraries and CADD products, for examples. Thirdly, the migration of archival and backup systems for micro, mini, and mainframe computers to WORM technology should be analyzed. Lastly, a comprehensive review of current data base applications should be made.

Long term

156. The previously established mechanism would continue to compile functional requirements on an ongoing basis. Additionally, a review of optical and other storage and distribution technologies should be made. The defined applications would be analyzed and compiled into a prioritized list for transition to alternative storage technologies. Concentration of effort should be directed at distribution applications with archival, backup, and data base applications being coordinated with the Automation subcommittee of FIMUG.

PART VIII: SUMMARY

157. The optical storage technologies are a significant advancement within the area of electronic data storage. The promise of this technology is great, and the future of the medium will be as dynamic as the entry of the microcomputer was to the data processing environment. Unfortunately, the lack of standards and the competition between the vendors have resulted in a very restrained acceptance by the users. The lack of a positive user reaction is directly attributable to the lack of standards as well as the performance deficiencies of increased access times and reduced transfer rates.

158. The CD-ROM segment of the industry is receiving increasing interest and use. The development of standards is the most advanced within the optical areas. However, the user is still presented with significant problems. The implementation of a logical data format has allowed the CD-ROM to be vendor independent; i.e., the CD-ROM can be read by many different drives. Unfortunately, the industry cannot agree on a common cartridge format, and while the data are drive independent, the physical disc cartridge is not.

159. The optical storage/retrieval technologies can offer the Corps significant economies and advantages in its daily operations. The applications to the COOP and off-site data storage, as well as the backup advantages for the many LANs will be of great value to the Corps.

160. Additionally, the Corps can take advantage of an evolving technology that will drive the future publications process in which a document, once written and approved, can be electronically stored and distributed. It will increase productivity and shape the way business is conducted. Compact disc mass storage technologies will be the Corps' publications warehouse of the future. Compact discs assure enormous benefits for the Corps in meeting a customer's requirements. Although not a paperless office concept, it is an exciting advancement in publishing that will make printed materials more readily accessible and available.

161. Currently, the optical market is too dynamic for the Corps to make agency-wide commitments to the technology. A number of Corps offices have taken the initiative in the optical area and are installing and investigating this technology. The Corps cannot allow the undisciplined evaluation and piecemeal adoption of this technology. The benefits can be too great, and the consequences too severe.

PART IX: RECOMMENDATIONS

Short Term

162. Short-term recommendations are as follow:

a. Establish a central contact point within the Directorate of Information Management (DIM) to manage all proposed, planned, and/or operational optical technology projects. *This central contact point would act as a clearing house and source of research for offices that plan on establishing optical applications.*

b. Task the Information Technology Laboratory, located at the US Army Engineer Waterways Experiment Station, with the definition, investigation, and evaluation of the many options and paths open to the Corps for the use of the optical technologies.

c. Refrain from an agency-wide commitment to equipment and/or related software prior to a stabilized standards program within the optical market.

d. Encourage those libraries intending to use CD-ROM technology for the mass distribution of their catalogs to produce an optical product that is compatible with the external Hitachi and Philips CD-ROM drives obtained through the OCLC.

e. Establish a task force, or special interest group, to immediately research and recommend CD-ROM applications within the Corps library and publications areas. *This group should also serve as an information clearing house and be available to lend assistance and to provide advice during individual organizational procurements and/or the development of the CD-ROM products.*

f. Increase participation within the SIGCAT Federal User Group.

g. Establish functional groups to address CD-ROM applications and usages within each information discipline within the Corps.

Long Term

163. Long-term recommendations include the following:

a. Address and resolve the policies and procedures necessary for customer billback when using CD-ROM data base searching within the Corps' library structure. This subject must be addressed and resolved in order to mitigate the impact on a library's budget.

b. Develop and issue budgetary guidance to the IM community for the proper preparation and submission of hardware and software requirements into the PRIP and the ARMPMIS budget cycles. This guidance will be based upon the research and recommendations developed by the Information Technology Laboratory.

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APPENDIX A: GLOSSARY

Access Time	A term that can be used to describe several types of activity: (a) the amount of time it takes to get an instruction or a unit of data from computer memory to the processing unit of a computer, or (b) the amount of time it takes to get a unit of data from a direct access storage device to computer memory.
Address	Either a specific location in computer memory, a specific location on a direct access storage device, or a relative location.
ANSI (American National Standards Institute)	An organization composed of representatives from many various special interest groups such as the Society of American Mechanical Engineers (SAME), Underwriters Laboratories (UL), etc., which determines standards for manufacturing designs, practices, and procedures.
Applications Software	Programs designed to perform a user-specific task. Examples of applications software include word processing and full-text search and retrieval.
ASCII (American Standard Code for Information Interchange)	The binary transmission code used by most teletypewriters and display terminals. A code established by the American Standards Association in an attempt to standardize data representation in order to achieve compatibility among all data processing systems. Used in computers and communications systems in which each character number or special character is defined in eight bits.
Bit	Abbreviation for binary digit. A bit is the smallest unit of information recognized by a computer.
Block Error Correction	During CD-ROM premastering, data recovery methods are applied to a physical block of data (2,048 bytes) to ensure the recovery of all user data.

Buffer	A temporary storage device that is used to compensate for a difference in data flow rates or in time of data flow events when transmitting data from one device to another.
Bug	(a) An error in a computer program. (b) A malfunctioning piece of hardware.
Burst Error	Errors are detected in consecutive data bits which are often the result of CD-ROM disc surface scratches, fingerprints, and other physical irritants.
Burst Mode	A method of writing or reading data that does not permit an interrupt to occur.
Bus	An internal path used to transfer information to different components within a hardware system.
Byte	A sequence of eight adjacent binary digits (bits) that are operated upon as a unit and are the smallest addressable unit in a computer. The most common byte is eight bits long. A byte has 256 different possible combinations of eight binary digits.
Capacity	Method of describing the number of bits/bytes that can be recorded onto an optical (or magnetic) storage media.
CAR	Computer assisted retrieval.
Characters Per Second (CPS)	A unit of measure equal to the number of characters that can be transferred from one device to another in 1 sec.
Compact Disc-Read Only Memory (CD-ROM)	Optical storage medium that uses an optical media to store large amounts of data. The discs can hold up to 660 MB of information. This equates to more than 1,800 360-K floppy diskettes. The technology is well suited to publishing and large information distribution requirements.
Compound Document	A document composed of multiple media formats, text, data, and images. Images can include signatures, pictures, drawings, forms, and charts.
Compression	The reduction or gain of a signal with respect to the reduction or gain at another level of the same signal. (See Data Compression.)
Computer Assisted Instruction (CAI)	A training program which is resident on a computer system and which provides instruction in the form of work examples for the student to follow.

Computer-Input Microfilm (CIM)	The process of reading data contained on microfilm by a scanning device and transforming these data into a form suitable for computer use.
Computer-Output Microfilm (COM)	Microfilms containing data produced by a recorder from computer-generated electrical signals.
Configuration	The components, either software or hardware, or a combination of both, which make up a system.
Content Search	The ability of a system to search through stored data to match a specified group of characters.
Conversion	Procedure by which a program recording on one format is transferred to another form, e.g. paper to microform, microform to electronic information.
CPU (Central Processing Unit)	The part of the computer that controls the interpretation andexecution of processing instructions.
Data base	(a) A collection of digitally stored data records. (b) A collection of data elements within records within files that have relationships with other records within other files.
Data Compression	(a) A technique that saves storage space by eliminating gaps, empty fields, redundancy, or unnecessary data, to shorten the length of records or blocks. (b) Provides for the transmission of fewer data bits than originally required within information loss. The receiving location without the reverse operation to convert it to the original data. (See also Compression.)
Data File	Set of related data in which all records are organized alike and which can be accessed under a single name.
DATAROM	Used by Sony as an acronym for their 5.25-in. optical read-only memory disc. Also referred to OROM (Optical Read-Only Memory).
Device Drivers	Device driver software tells the computer how to talk to the CD-ROM drive. These software programs are needed for any microcomputer to communicate with external devices, such as a CD-ROM drive. The software tells the computer how to talk to the CD-ROM drive. They are small programs which have to be written for each device connected to the microcomputer.

Digital Document Storage and Retrieval Systems (DDSAR)	A composite of hardware and software used to manage compound documents.
Digital Video Interactive (DVI)	This technology is a marriage of two separate technologies. A compression technique that enables more than 1 hr of full screen, full motion video with eight channel interleaved audio to be stored on a single compact disc. The second technology is the use of Very Large Scale Integration (VLSI) chip technology to perform the decompression. All of the stored information is digital and can be indexed and retrieved by any application.
Digitizing	Refers to the process of converting graphic representations into digital data that can be processed by a computer system.
Direct-Read-After-Write (DRAW)	Recorded data on an optical memory disc or card may be read immediately after writing (recording); no processing is required.
Direct-Read-During-Write (DRDW)	Refers to the ability to read the information during the writing (recording) process.
Disk Operating System (DOS)	Computer software program that controls the flow of data between the system's internal memory and external disks, e.g. VMS, MS/DOS, CP/M, and UNIX. Examples of a CD-ROM operating system include Reference Technology's STA/File, TMS' LaserDOS, and Digital Equipment Corporation's Uni-File.
Double Density	Term describing the format used to store information on a storage medium such that the capacity is twice that of a standard storage unit.
Double Sided	A storage method that utilizes both sides of a disk.
Drivers, Software	See Device Drivers.
Emulation	*Imitation of a computing function by a system not* originally designed to perform that function.
Erasable Optical Disc (EOD)	An optical disc which allows stored data to be erased or replaced.
Error Correction Code ECC)	A method of data recovery that allows the full recovery of a single physical block of user data which is 2,048 bytes. It is used by the CD-ROM drive and during CD-ROM premastering.

Error Detection Code (EDC)	Used in conjunction with ECCand allows the detection of errors for correction.
Error Rate	The ratio of the amount of erroneously transmitted information to the total amount sent.
Format	The predetermined arrangement or layout of data/ information.
Hard Read Error	Physical bits of data cannot be read by the user since they are usually misplaced or absent from the data bit stream.
Hardware	The mechanical and/or electronic equipment which is combined with software to form a computer system.
High-Sierra Group (HSG)	A logical format standard developed by the CD-ROM industry during a meeting in Nevada. The meeting was held in 1985 for the express purpose of developing a standard logical format for the storage and retrieval of data within the CD-ROM industry.
Information	The meaning derived from data which has been arranged in such a way that it can be displayed, utilized, and/or contribute to a human decision.
Input/Output (I/O)	(a) An acronym used to signify the transfer of data between computer storage and peripheral devices. (b) The equipment or processes which transmit data into or out of a computer's central processing unit (CPU).
Integrated Information Systems	An information system that combines two or more technologies, e.g. CD-ROM and microcomputer.
Interface	(a) The place at which two systems (such as a microcomputers and CD-ROM) meet and interact with each other. (b) Generically, a common interconnection between two components or functions that do not normally interact. It can be a piece of hardware equipment, a common area of computer storage, or some common instructions shared by two or more programs. (c) In the realm of microcomputers, the circuit board that attaches a particular peripheral device to another microcomputers. (See also Controller.)

JUKEBOX	A console which houses multiple optical drives and approximately 200 optical discs. A robotic arm handles the loading and unloading of the specific discs into the appropriate drive.
K (Kilo)	Abbreviation denoting 1,000 units. Normally used with a numeric prefix. When used in the computer area it denotes 1,024 actual units.
Large Scale Integration (LSI)	A chip containing 500 to 20,000 transistors or 1,000 to 64,000 bits of memory.
Light Amplification by Stimulated Emission of Radiation (LASER)	A device which transmits a very thin and coherent beam electromagnetic energy in the visible light spectrum.
Local Area Network (LAN)	(a) A communications network designed to serve a limited geographic area. (b) According to the Yankee Group (Boston, MA), an LAN is "an intra-office, intrabuilding, intrafacility communications system that supports some type of communications processing and transparent information transfer between users and/or electronic devices."
Magnetic Media	A variety of magnetically coated materials used for the storage data by computer systems.
Mass Storage	A device that can hold very large amounts of information cheaply with automated access on demand.
Master	The original recording of a finished program.
Mean Time Between Failure (MTBF)	A statistically derived measure of equipment durability.
Microprocessor	An integrated circuit which contains the logic elements for manipulating data and performing processing operations.
Millisecond	One thousandth of a second. Expressed numerically as 0.001; abbreviated as ms or msec.
MS-DOS	An executive software system developed by Microsoft Inc. and Seattle Computer for use in 16-bit computer systems.
NARA	National Archives and Records Administration.
Nibble (Nybble)	Term for four bits or half a byte.
OCLC	Online Computer Library Center.

Optical Media	A variety of specially coated diskettes used for the storage of data through the transfer of information via LASER technology.
Optical Read Only Memory (OROM)	A generic term referring to all types of read-only optical storage media.
Optical Scanning Device	A device that can view text or graphic images; sense the light emitted, and thereby the position of the images; and translate those findings into on-line graphic data comprehensible to a computer graphics system.
PC-DOS	IBM's version of the Microsoft operating system for the IBM personal computer.
Peripheral Equipment	Supplementary equipment that puts data into or accepts data from the computer such as disk drives and printers.
Peripherals	Devices which can be configured with computer systems as options.
Pit	The microscopic depression in the reflective surface of a CD-ROM.
Premastering	(a) Includes the conversion of digital code, the addition of error correction codes, and the intelligent preprocessing of the data records. (b) This phase of CD-ROM production, machinereadable and bit-stream data must be converted to the CD format. Premastering requires both knowledgeable computer professionals and computer processing power. During this stage 288 bytes (called the "system data") of EDC and ECC are added to each block of user data (2,048) to ensure the full recovery of user block data.
Protocol	A formal set of conventions governing the orderly exchange of data between hardware devices.
RHA	Records Holding Area.
Sector	Smallest addressable unit of an optical data disc's track.
Self-Checking Code	A method of encoding of data that allows an invalid code to detected but not corrected, (e.g., Error Correction Code; Error Detection Code).

Small Computer System Interface (SCSI)	A standard 8-bit parallel interface frequently used to connect computer disk drives to a microcomputer SCSI is becoming the preferred CD-ROM microcomputer connection and provides a logical, rather than a physical, command set.
Software	A set of programs, procedures, and documents concerned with the operation of a data processing system.
Software Drivers	See Device Drivers.
Storage Capacity	The total amount of data that can be stored per unit of media.
System Software	See Executive Software.
Turnkey System	An integrated configuration of preselected hardware and prewritten software designed to accomplish a particular information processing task. The term is most often applied to dedicated computer systems that use minicomputers or microcomputers.
Winchester-Type Disk	A hard surface disk often used as a high-capacity magnetic storage alternative to floppy disks.

APPENDIX B: RECOMMENDATIONS--LIBRARY

Current Environment

1. Within the US Army Corps of Engineers, there are currently 50 libraries whose role is to provide information support services within the Information Management area. These libraries range in size from one person to more than a dozen staff members and collections of a few thousand to half a million items. They form a network that provides resource sharing and bibliographic control to the publications of the Corps. They are linked both through the Online Computer Library Center (OCLC) and through the Corps' LS2000 data base. Because each library is a separate holding location on LS2000, each library in the system can access its own holdings on-line, as well as the entire Corps data base. Libraries are connected to the Corps' LS2000 computer, located at the Office, Chief of Engineers (OCE) Library, either through dial-up phone lines or dedicated lines contracted annually through OCLC.

2. The majority of optical product activity within Corps libraries has centered primarily around replacing commercial on-line data bases with their Compact Disc-Read Only Memory (CD-ROM) counterpart, such as Dialog On Disk and Search CD450. Also, some hard-copy reference materials, such as *Books in Print* and *Microsoft Bookshelf*, as well as personnel manuals and construction specifications have been purchased in CD-ROM form.

3. The CD-ROM versions of card catalogs, referred to as public access catalogs, are not as widespread in the general library community as other CD-ROM applications, but this area has been growing recently. A number of integrated library systems offer CD-ROM versions of their on-line data base for backup and dissemination to remote sites. In addition, vendors are available through contract to produce CD-ROM versions of a library's holdings direct from OCLC input. The OCE Library is planning to convert the Corps' LS2000 data base to CD-ROM through a contract with OCLC Local Systems. This contract will provide a CD-ROM of the entire Corps data base, but since it cannot be separated into individual holding locations as the on-line counterpart, some libraries within the Corps may want to obtain separate CD-ROMs of their own collections.

4. Optical products other than CD-ROM, such as Write Once Read Many, have not been developed as much in the library market, and there is little literature related to this technology as it applies to libraries. By far, the majority of optical products in the library have been developed around CD-ROM data bases by outside sources, so the library often has little choice but to purchase the hardware and software required by the company that sells the CD-ROM product. Those libraries that are producing CD-ROM

discs of their holdings are doing so primarily through vendors outside the library, although there is some movement to bring the premastering production stage into the library through the use of in-house software.

Requirements/Objectives

5. There are as yet no clear-cut rules or formulas to determine cost savings associated with CD-ROM in the library. In fact, a number of librarians contend that CD-ROM is a costly alternative to on-line searching, since current subscription charges for CD-ROM data bases are so high. In any case, each requirement is unique and must be evaluated on its own merits. A spread sheet for comparing CD-ROM costs against on-line costs has been developed and is available on ALIX, the Federal Library Committee's (FEDLINK) bulletin board. Although telecommunication charges are expected to increase, little cost savings will be realized if the volume of searching is not high enough to balance the cost of procuring the necessary hardware and software to search a CD-ROM data base and the cost of the subscription price of each service. In addition, it should be remembered that although the CD-ROM version may suffice for most searches, some data bases will still have to be searched on-line for the latest information, and some CD-ROM data bases may not cover the same years as on-line.

6. Perhaps a major issue that needs to be resolved by libraries replacing on-line searching with CD-ROM is how to charge for CD-ROM searching. This issue has not really been addressed by the library community. Some libraries currently bill on-line searches back to the customer, depending on the length of the search. This lends itself fairly easily to a library's being able to keep up with the charges involved and determining which customers should be billed. However, CD-ROM versions of the on-line data base are paid for on a subscription basis, and there is no built-in mechanism to monitor the length of the searches on the system. In fact, most libraries have been offering the searches free in order to attract customers to CD-ROM. There is also some evidence that users are reluctant to pay the same cost for a CD-ROM search as an on-line search. Yet, the subscription cost for most CD-ROM data bases is currently high, and unless libraries that charge for on-line searches can determine how to charge customers for CD-ROM use, it will result in a loss of revenue for these libraries.

Alternatives

Advantages

7. The CD-ROM technology is not dependent on telecommunication links as on-line data bases. This means that not only can telecommunication charges be avoided or reduced, but the data base is more accessible and there is less likely to be down-time associated with CD-ROM. Remote sites are less tied to the on-line system, thereby resulting in reduced system load and faster response time by the on-line system.

8. The CD-ROM medium cannot be altered or corrupted as on-line data bases. Once mastered, the data are secure and cannot be changed or deleted by users.

9. The CD-ROM discs, once mastered, are relatively inexpensive to duplicate and can be distributed to remote branches or sites for a nominal cost.

10. Space can be saved by converting materials to CD-ROM. Some libraries with integrated library systems have already closed their card catalogs because the data are available on-line. In such instances, CD-ROM can provide valuable backup to an on-line system and enable users to access the data base even when the system is down. Some libraries, however, find they have to keep a hard copy of materials in addition to the CD-ROM because of different indexing and searching parameters and also because the CD-ROM product may not include all the years covered by the hard copy product, which negates any space savings.

11. The CD-ROM product can offer more index points and provide more effective retrieval of material, depending on the software employed.

12. Labor costs can be lowered with the use of CD-ROM, since filing tasks can be reduced or eliminated in some cases. For example, catalog card filing could be eliminated or reduced by converting the card catalog to CD-ROM.

Disadvantages

13. Because of the cost of mastering CD-ROM's, there is a problem with keeping them up-to-date. Some vendors have reduced this problem by developing transparent interfaces between hard disks and CD-ROM discs, so that the hard disk can be updated more frequently, but there is still some amount of delay involved. Erasable, or rewritable, optical discs may alleviate some of these types of problems, but none of the vendors supplying public access catalogs are using this type of technology yet.

14. The CD-ROM products are not easily networked, and although there is some recent development in this area, it has not been adopted so far by any of the vendors supplying the library CD-ROM market. This means users are reduced to searching only on stand-alone machines, and users could experience delays and lines of other searchers waiting to use the same machine.

15. Materials have to be converted to machine-readable form for mastering into CD-ROM. This could mean additional costs involved in converting these materials, for example in deduping or merging records in an aleady existing data base or in scanning hard-copy materials with an optical scanning device.

Recommendations

16. Since the CD-ROM market is currently in a high state of flux and since there are few, if any, standards appearing in either hardware or related software, it is premature to establish agency-wide configurations in the library area. Each manufacturer has its own set of requirements, and libraries seeking to replace on-line data bases with CD-ROM are limited to those choices. However, since these data are supplied largely from agencies outside the library and are not designed to be shared among libraries, the issue of standardization is somewhat reduced. On the other hand, the issue of cost of CD-ROM versus on-line data bases is significant and should be examined before purchasing CD-ROM and evaluated on a regular basis thereafter. Likewise, the question of charging for CD-ROM searching should be addressed in order to assess the impact on the library's budget.

17. Libraries involved in producing CD-ROM versions of their card catalogs have a larger set of choices available, and consequently face a larger problem with standardization if they intend to distribute these data to other libraries. In cases where the library intends to distribute its catalog to remote sites or branches, the library should determine before contracting with a vendor what hardware and software requirements must be met by each remote site to read the CD-ROM product. This could then be combined with a survey of existing CD-ROM hardware and software at each remote site or branch in order to determine the most cost-effective approach. Since a number of libraries have obtained external Hitachi and Philips CD-ROM drives through OCLC, libraries intending to mass distribute their CD-ROM catalogs should explore the possibility of producing a CD-ROM disc that can be read by these machines. Also, since the High Sierra format is currently used in a number of library applications, some consideration should be given to using this quasi-standard. If the library does not intend to distribute its catalog to remote sites or branches, then the question of compatibility becomes less important. Because the data are already on-line on LS2000 and the Corps libraries are tied to this system through dial-up or dedicated lines, the use of CD-ROM for backup of the data base and for distribution to remote branches or sites should be pursued, since CD-ROM can effectively reduce telecommunication costs in such a system and provide some access to the data even when the system is down.

18. Libraries intending to convert full text materials to CD-ROM or other types of optical discs have the largest set of options and the largest problem with standardization. They also face copywrite issues that should be resolved before pursuing such a project. Generally, it is better to obtain as much of the production process as possible from vendors outside the library, since this does not involve a large capital outlay for technology that may quickly become obsolete. However, some of the premastering process may be brought in-house, depending on the need and cost.

19. Although there has been little networking of CD-ROM devices in libraries, this area needs to be considered by libraries planning CD-ROM applications, since networking may require specific formats to be used.

20. A task force, or special interest group, should be established to research and recommend library-related CD-ROM applications within the Corps. Since few guidelines and procedures are established for the installation and use of CD-ROM technology, this organization should also serve as a clearing house of information to lend assistance and advice to Corps libraries purchasing or developing CD-ROM products.

APPENDIX C: RECOMMENDATIONS--PRINTING

Current Environment

1. The decreasing costs associated with Compact Disc-Read Only Memory (CD-ROM) production make this information storage and retrieval technology practical and feasible for the US Army Corps of Engineers (USACE) to consider in pursuing its printing, reproduction, and publishing responsibility. The applications offered by CD-ROM for distributing the mounds of Corps information are of particular interest to project managers, design engineers, draftsmen, legal technicians, engineering staff, analysis, writers, editors, accounting personnel as well as contractor and construction workers. In the long term, a considerable cost savings could be realized through reduced use of printed paper materials, publication warehouse storage space, distribution efforts, and postage expenses. The small size but large storage capacity of a CD-ROM disc are features that support these savings.

2. Now that personal computers (PCs) give Corps personnel and their customers the power to process electronically stored data, it makes sense for the Corps to begin publishing and distributing documents in electronic form. CD-ROM offers users of International Business Machine (IBM) PCs and compatibles with laser printers and a CD player interface to access Corps data bases to search, retrieve, examine, cross-reference and print specified information in whole or part. The discs themselves have a life expectancy in excess of 10 years, no matter how often the data are accessed. They are also highly resistant to damage from mishandling.

3. CD-ROM is an appropriate medium for data used by every Corps Division and District office and laboratory. It allows engineers, office staff, analysts, and general-purpose users to find information easier through keyword searches than through the traditional paper documentation review. An entire series of publications, project data, maps, drawings, or a combination of these products can be included on one CD-ROM disc.

4. Corps use of CD-ROM technology is likely to build slowly. The newness of the technology and the high initial cost of embarking on a CD-ROM project mean that applications must be chosen carefully. For example, a Beta test involving publishing engineer manuals, engineer technical letters, and engineer regulations is currently underway. The data are being converted from the current paper form to electronic machine-readable configuration through the use of optical Character Recognition and Raster Scanning methods. Several locations are being provided software and CD players to participate in the evaluation process. No significant modification for producing the

CD will be needed once the pilot project is completed. Engineering documents were selected because of their wide usage in all Corps program areas.

5. Printing personnel were chosen to work with Corps engineers and the manufacturers/developers of the test CD to provide expertise in format output. The document had to retain the same familiar "look" both on screen and in printed form. This was an important aspect of the test to reinforce the fact that nothing was changed, deleted, or altered in the data capturing process. Each screen of the scanned paper document contains complete textual material, associated pictures, and drawings in-place as they appeared on the original. Less than 0.01-percent error rate is expected from the scanning process.

6. Obviously, the Corps wants the most cost-effective and efficient system available to meet its requirements. CD-ROM appears to be this system. However, the Corps' reluctance to print on this medium is due largely to the small number of offices and customers that have CD players. Few Corps offices and customers have players because very little Corps information is available on CDs. Hopefully, test projects like the one being developed in partnership with the Engineering Division will show the value in using the CD-ROM and resolve this stalemate. CD-ROM drives now cost approximately $600. As the players become more widely used, the General Services Administration price is expected to drop to $200 by 1990. Consequently, the drop in price should stimulate the placement of players in work environments, especially as the Corps begins publishing additional data on CD discs.

7. The dominant cost of CDs is preparing the data and cutting the initial master disc, approximately $10,000. However, each master disc can generate thousands of discs which cost about $10 each.

8. It is natural for PC owners to compare the cost of a disc with its paper alternative. Unfortunately, the cost difference is not sufficient to motivate the purchase of a $600 CD player. Consequently, CD-ROM will never totally eliminate the use of printed paper materials. Paper still remains the most widely accepted medium of communication.

9. The Corps operates 18 field printing plants and 12 duplicating facilities, each supplying millions of pages of printed materials for various projects and programs. In addition to these in-house facilities, procurement from the Government Printing Office totals in the tens of millions of printed items.

10. There are over 850 ENG forms and in excess of 1,205 publications written, stocked, and distributed for various programs. Current storage of these materials requires 12,000 sq ft of warehouse space. Updating, editing, proofing, and redistribution of forms and publications involves numerous Corps personnel. As the demands for reducing costs within the Federal Government continue, many current document management practices will be altered to take advantage of cost-saving improvements in maintenance and distribution functions. CD-ROM can be used as a complementary technology to supplement paper documents while helping reduce the costs of maintaining large storage areas (file cabinets and warehouse space).

11. The following capsules the most basic facts about CD-ROM technology:

Capacity of one CD-ROM:

Ten 1,000 page manuals (100 lb of paper or two complete five-drawer file cabinets).
275,000 typed pages.
1,500 floppy disks.

Essential equipment requirements:

Personal computer (IBM AT/XT or compatibles).
Laser printer (300 DPI) and CD player (5-1/4 in. drive).

12. Categories of Corps publications having CD-ROM applications include the following:

AR - USACE supplements to Army Regulations
EC - Engineer Circular
EM - Engineer Manuals
EP - Engineer Pamphlets
ER - Engineer Regulations
TL - Engineer Technical Letters
Navigational charts
Survey maps
Engineering drawings
Design guides
Mobilization plans
Port facility locations and maps
Water resource projects
Flood-control management studies environmental programs

13. CD-ROM is being used to capture everything from Census Bureau data to postal ZIP codes. Every Federal agency, including the Corps, has information of interest to the general public as well as for its own daily operational needs.

14. To make the initial cost of developing and mastering a CD-ROM more acceptable and manageable, the US Department of Interior's US Geological Survey (USGS) has proposed a unique approach to the problem of in-house production or commercial sector development of a CD-ROM. A draft paper states in part that there is a delicate balance to be reached between the Government's mandate to disseminate public information and private industry's desire to provide innovative profit-making information products and services. As Government agencies pursue the CD-ROM for data dissemination, the issue of competition with the private sector will be raised. Consequently, it is perfectly within the charters of most Government agencies to distribute their information in the most cost-effective manner possible, and thus many are looking to the use of CD-ROM. The USGS has proposed that the private sector be given the "first shot" at the production of any disc that the Government needs. If the private sector is interested in potential commercial sales, the disc would also be made available to the Government at a cost comparable to what the Government itself would have to expend to produce the disc. Although the Government should make every effort not to threaten any company's livelihood by producing similar products, it also should not overpay for a product just to keep a company in business.

15. The initial step, of course, is to determine if any companies are interested in taking the Government's data bases and developing them, at their own expense, into a commercial product. The Government would in turn supply the data bases on a nonexclusive basis to all interested companies and be able to purchase the resulting CD-ROM discs (for internal use only) at substantially discounted prices.

16. By providing private industry with the initial opportunity to develop a particular CD-ROM product and market it freely to the commercial world, the agency would not be accused of unfairly competing with private industry in the production of such a product. Furthermore, the price for the product would simply reflect what the agency would pay if

it were to develop the product on its own. The USGS draft paper concludes that regardless of who produces the disc, Government or industry, the CD-ROM holds great promise in its inherent economies to meet the Government's requirement to make its information available to the public.

Summary

17. The power of the personal computer (with laser printer and CD player) is entering another area, publishing, to increase productivity, offer cost savings, and improve products. CD-ROM is a major step in the evolution of human productivity tools that will assist in the effort to reduce the quantity of publications and printed materials while providing needed information for customers. It also promises to be the conduit to a more advanced and sophisticated world of automated publishing, graphic scanning, laser printing, and print-on-demand options.

18. With the CD-ROM, the Corps can take advantage of an evolving technology that will drive the future publications process in which a document, once written and approved, can be electronically stored and distributed. It will increase productivity and shape the way business is conducted. Compact disc mass storage technologies will be the Corps' publications warehouse of the future. Compact discs assure enormous benefits for the Corps in meeting a customer's requirement. Although not the paperless office notion of a few years back, it is an exciting advancement in publishing to make printed materials more readily accessible and available.

19. To define the scope of CD-ROM use in the Corps and how it would affect current operating practices, a much more in-depth study is required before making further commitments or investments. However, based upon a preliminary review of available systems and experiences of other users within the Government and the commercial sector, CD players could be placed throughout the Corps on existing PCs with laser printers to produce a source of printon-demand for forms and publications.

20. The next logical step for the Corps is to appoint a manager for the CD-ROM project with the responsibility to review all possible applications within the Corps and develop a strategy perhaps along similar lines being considered by the USGS. However, it is now up to top management to determine where the Corps goes from here.

APPENDIX D: RECOMMENDATIONS--RECORDS MANAGEMENT

Current Environment

1. The majority of the US Army Corps of Engineers records are manually maintained in filing cabinets and records holding areas (RHA). However, with the proliferation of microcomputers, local area networks (LANs), and increased access to mainframes in the Corps, many records are currently being processed by computers.

Installed Systems and Procedures

2. Records are currently maintained under the Modern Army Recordkeeping System (MARKS), which replaced The Army Functional Files System on 1 January 1987. The MARKS is governed by AR 25-400-2, which prescribes procedures for managing both records in hard copy and machine readable records (MRR). It provides guidance to ensure permanent preservation of archival information in machine readable form. The media on which MRR are most often recorded are erasable, reusable, and used for rapid manipulation of data. Hard-copy records are manually stored in filing cabinets or in standard record storage boxes in an RHA.

3. The conversion of documents or information to microforms includes microfiche, microfilm, and aperture cards. Approved micrographics projects are designated by Microform Document or Information System (MICRODIS) numbers. There are many Corps-wide MICRODIS projects approved for such information as:

MICRODIS # 3053 - Hydrological and Hydraulic Data Files
3054 - Civil Works Project Files
3055 - Civil Works and Military Construction Drawings and Construction Contract Files (35-m Aperture Cards)
3058 - Standard Construction/Engineering Drawings (35-mm and 105-mm system)
3059 - Geological and Soil Data Files
3060 - Civil Works Project Operations and Maintenance
3061 - Basic Topographic Data Files

3062 - Realty Historical Files (Maps)(35-mm Aperture Cards)
3063 - Realty Historical Files (Documents)
3064 - Permit Files (16-mm Reel System)
3065 - Operation Reports and Log Files
4017 - Permit Files (16-mm Cartridge System)
4099 - Corps Library Documents and Reference Material Material
4100 - Catalog Leases from Showcase Corp. or Information Handling Service

There are a few microform automated retrieval systems installed throughout the Corps, but many systems are simply storage systems with no automated retrieval capability.

Advantages/Disadvantages

Advantages

4. The advantages of hard copy records include the following:

a. Most people are more comfortable with hard-copy records since they are familiar with the filing system.

b. File clerks are trained, and Records Management procedures are easily applied to hard-copy records.

c. Standards are in place for hard-copy records (file folders, cabinets, storage areas, labeling procedures, etc.).

d. Microforms are being accepted more readily now and most offices have fiche readers available. Contracts are in place in some offices which are contracting out their microform production.

Disadvantages

5. The disadvantages of hard copy records include the following:

a. Paper records are bulky, and storage requires a great deal of space (either in filing cabinets or in Records Holding Area/Federal Records Centers' (FRC) boxes). Space is expensive, both in rental cost and overhead (i.e., utilities, cabinets, shelving, etc.).

b. Paper records are easily mutilated, misfiled, or accidentally destroyed. Retrieval is usually time consuming.

c. Hard-copy records are expensive to ship to FRCs or to disseminate to field offices.

d. Hard-copy records are easily duplicated, and because of this, many unnecessary copies are made, which increases cost of storage and copy machine usage.

e. Microforms are more durable than paper, but they can be mutilated or warped, and some media such as fiche and aperture cards are easily lost or misfiled. Retrieval is difficult unless there is an automated retrieval system installed such as the

computer-assisted-retrieval (CAR) systems. Microforms have lower resolution in comparison to optical disc images.

Summary

6. The main objective of Records Management in the Corps is to provide modern, efficient, and systematic management of all records to ensure that commanders and managers at all echelons have the information they need to accomplish their mission. The life cycle management of this information must be accomplished in a manner which will ensure that the information is available to managers in a usable format and that it is properly maintained, stored, retrieved, and preserved. Specific disposition standards are established under MARKS for all records regardless of format or media. Records are subject to these dispositions which prescribe the cutoff, retention period, transfer to the RHA, retirement to the FRC, or destruction.

7. Compact Disc-Read Only Memory (CD-ROM) and other optical disc technology certainly seem to offer possibilities for reducing costs of storing records while providing compact mass storage, fast retrieval, and a higher level of security. There are, however, some questions yet to be answered before applications of optical disc technology are employed to any appreciable extent in the Records Management area. There are three principal categories of optical disc media:

a. CD-ROM--prerecorded discs which are mastered by the vendor. The initial cost of CD-ROM is high, but duplicate discs are inexpensive, which makes this more conducive to areas where many copies of the information will be disseminated.

b. Write Once Read Many (WORM)--discs which are recorded by users and which cannot be altered. The equipment used in producing these discs is not nearly as expensive as that used to master CD-ROM discs. This seems to be geared toward users who do not need mass production of duplicate discs.

c. Erasable Optical Discs (EOD)--a newer technology that is just being developed and allows users to erase an optical disc.

Alternatives

8. Records Management alternatives include the following:

a. Maintain hard-copy records manually and continue doing business the way it has always been done. (The advantages and disadvantages are discussed in paragraphs 4 and 5 in this appendix.)

b. Convert records to microforms using CAR systems for easier, faster retrieval. (The advantages and disadvantages are discussed in paragraph 4 and 5 in this appendix.)

c. Employ optical disc technology in maintaining and storing records.

Advantages

9. The advantages of optical disc technology in maintaining and storing records are:

a. Great savings in space can be realized. A CD-ROM disc is capable of storing as much as

270,000 pages of records
1,500 diskettes
18,000 pages of computer graphics
72 boxes of records (RHA)

b. Optical discs will not warp, break, or scratch.

c. Access time is slower than magnetic media on hard disks, but faster than floppy disks.

d. Mailing costs are minimal.

e. High resolution (compared with microforms).

f. Optical recording provides a level of data security not possible with rewritable storage devices. Data on an optical disc cannot be covertly altered. This is very important for archival purposes.

g. Data on optical discs are much less susceptible to mechanical drive failures.

h. Optical discs can easily augment, rather than replace, magnetic disk storage.

Disadvantages

10. The disadvantages of optical disc technology in maintaining and storing records are:

a. The technology is new and there are no standards set at this time.

b. At this date, optical disc drives are not media-compatible and have no interchange capability.

c. The cost of equipment, or contracting mastering, is high at this point, though expected to come down in the future.

d. The legal aspect of the acceptance of optical disc images in courts of law has not been resolved.

e. The National Archives and Records Administration (NARA) has not given approval for optical storage media to be used as archival (permanent) storage. The NARA is currently studying the benefits/drawbacks of paper, film, and optical disc storage. Results of this study are expected to be published in 1989.

Recommendations

11. Because the optical disc technology is untested, unstandardized, incompatible, and expensive at this moment, no particular application can be recommended for use in the Records Management function. However, it is recommended that Corps Records Management personnel keep abreast of the developments in the optical disc technology because it is predicted to be the medium preferred over microforms and some forms of magnetic media in the very near future. With over 60 vendors now producing CD-ROM

products and the eminent possibility that many vendors will not survive the eventual "shakeout," it is risky at this point to invest in any significant amount of optical disc products. Areas of prime importance are:

a. The establishment of firm standards governing the entire range of the optical disc industry.

b. The NARA's decision on optical disc storage for archival purposes.

c. Determinations by the courts of the legality of information which is entered from optical disc storage.

d. The development of WORM technology which will be user friendly, compatible (effective in an LAN environment), and reasonably priced.

12. Conversion of microform media to optical disc is touted by several vendors as being simple and inexpensive. With this in mind, a good position to take at this time is to continue to use the media of microfiche/film and watch for the above developments in the optical disc industry. The office of the near future should have a typical configuration which would include a scanner, several integrated workstations, an optical disc storage unit, and a laser printer. Records will be created, distributed, and stored using optical disc and personal computers integrated on a network.

13. As Patricia Seybold stated in her "Office Computing Report": "The CD-ROM industry is still in diapers. We are just beginning to see what it might look like when it can stand and walk on its own. How will it deal with its growing pains? What will it look like as it matures? Will it endure, or will it become the 8-track tape of optical storage technology? These are questions that will not be answered until the fat lady sings."

APPENDIX E: RECOMMENDATIONS--VISUAL

Current Environment

Environment

1. Visual Information (VI) environment includes still photography, graphic illustration (manual and electronic), motion pictures, television (video), exhibitory, audio (sound), and the combination of these media and equipment. The VI environment involves production, presentation, duplication, and distribution of VI products. This environment stocks, stores, lends, and maintains VI products, equipment and systems.

Applications

2. The following list is only a sampling of applications in the VI area that would be enhanced by using Compact Disc-Read Only Memory (CD-ROM) technology:

a. Slide presentation.

b. Computer graphics and animation.

c. Technical training courseware.

d. Video and motion picture production.

e. Kiosk presentation.

f. Duplication and distribution of VI products.

Requirement/Objectives

3. Because of the nature of VI work, that of using a host of media, it is anticipated that CD-ROM technology will eventually augment VI/Graphics day-to-day production. Following is a brief discussion of two specific CD-ROM requirements.

4. **Retrieval system to track all VI pieces/products.** A need exists within the VI community to have a simple way of organizing, tracking, retrieving, and printing copies of products (still photographs, graphic illustrations, etc.) that are produced by VI/Graphics specialists every day. As it stands today, there is no easy way for

VI/Graphics specialists to conduct searches of existing artworks quickly, without manually reviewing the pieces/products as is routinely done during preliminary steps, when staging a presentation, preparing graphic illustrations, developing slide shows, etc.

5. **Kiosk presentation.** Several VI offices are seriously thinking about developing an interactive combination slide/video/audio/motion picture presentation to be placed in visitor centers throughout the US Army Corps of Engineers activities. These Kiosk would allow a visitor to interact with a workstation that would respond to inquiries about the location of a person (or branch, division, etc.) by showing a photo of the individual and giving the phone number, office symbol, room number, and information about the section, branch, and division the person works in. The workstation would respond with a combination of still pictures, video, audio, and motion picture short takes, allowing the requestor to see the branch, individual, etc. Visitors would be able to view a photo of the Corps employee, as well as locate his/her room on a map, by accessing the information from the workstation. Previously, the information would be contained within a telephone directory, on identification badges, and within Corps publications.

Procedures

6. **Requirement analysis.** When a decision is made to use CD-ROM technology, it should include a thorough requirements analysis to define precisely what is expected to be attained from a CD-ROM product. A set of functional requirements provides the basis for the subsequent steps in a proposed build or buy decision.

7. **Marketplace examination.** The marketplace should be examined thoroughly to see if any existing products could meet the office-stated functional requirements. If such a product or products did exist, then the build/buy decision would depend simply on price.

8. **Offer to Industry.** If there were no existing products that could meet the office's stated functional requirements, then an announcement would be made to CD-ROM industry stating the office's requirement for a CD-ROM disc based on the previously defined set of functional requirements.

9. **Final Recourse.** If no companies were interested in developing the Government's data base into a commercial product, the Government's final recourse would be to issue a competitive procurement to produce the desired disc. The original set of functional requirements would serve as the basis for the deliverable in such a procurement. The lowest qualified bidder would be awarded the production contract, with the stipulation that the resulting disc could not be made available as a commercial product.

Training

10. Doing initial research into CD-ROM technology, the training issue has only been discussed insofar as cost of initial and ongoing training when it comes to justifying a CD-ROM system. At the present time, reliable documentation addressing training issues (cost, degree of difficulty, comparison to personal computer (PC) software and hardware, tutorials) cannot be found. However, vendors leave the impression that training is no more complicated than learning a new software package. Training will be addressed in detail after further research has been undertaken.

Cost saving

11. At the present time, no studies have been undertaken to compare the cost of doing business within the VI area using CD-ROM technology. However, it is firmly believed that CD-ROM technology will never in itself totally replace the VI/Graphics media currently being used. It is firmly believed by specialists in the field of VI/Graphics that CD-ROM technology will be an enhancement to an area that is already capable of using multiple media when producing products. Presently, there does not appear to be any substantial cost saving within the VI area; however, CD-ROM offers itself as an additional tool to be used in production of VI/Graphics tasks. The cost to do it via CD-ROM versus conventional ways will probably be the driving force until CD-ROM technology becomes less expensive.

12. The price of printed discs ranges from several hundred to several thousand dollars. Microsoft's **Bookshelf** costs $300 and free information, like Government statistics, reprinted on CD-ROM platters is comparably priced around $300. A typical CD-ROM player retails in the $800 to $1,000 range. Networking has helped bring down that cost, much as it did with expensive laser printers.

13. At this stage, videodisc technology will not reduce the cost of using this medium for storage of graphic drawing, etc. However, it does provide a way to print a copy of an original document filed away without the need to physically locate that document by printing a copy from a stored image on video disc.

Conversion

14. The cost of conversion still appears to be high for capturing existing work into a CD-ROM system for storage, retrieval, and/or distribution. However, the majority of industry is still a bit concerned with converting over to a particular type of CD-ROM medium (3.5-, 5.25-, 12-, or 14-in. disc format) that may become obsolete within a couple of years. The CD-ROM market is still rapidly developing, with newer types of storage media being announced frequently. Further research is required in this area.

Redundancy

15. See paragraphs 109 and 121 in the main text for advantages and disadvantages.

Manpower

16. The use of CD-ROM technology is not expected to increase or decrease current manpower levels within VI offices.

Storage

17. Users should be cautious about the tremendous difference in capabilities in vendor offerings. International Business Machines (IBM's) drive provides 200 megabytes (MB), whereas drives from ISI, Maxtor, and other companies provide more than 800 MB. Pricing also varies from $1,800 to $6,000 for 5.25-in. drives.

18. Optical discs will augment rather than replace, magnetic disk storage. Some of the relatively permanent and less frequently accessed data now will migrate to optical disc. The low media cost per megabyte and 10-year shelf life of optical storage, together with direct access to facilitate retrieval, will draw archival data to optical disc. (Also see paragraphs 109 and 121 in the main text for advantages and disadvantages.)

Alternatives

19. The VI/Graphics offices should consider how these new technologies may assist/augment day-to-day operation. It is firmly believed that eventually most of the alternatives that follow will be at least examined very closely by VI/Graphics offices. Although under the category heading of alternatives, each alternative should be reviewed as available media/tools to use in augmenting VI/Graphics productions.

No change

20. The VI/Graphics offices will be able to continue to function generally without much difficulty. (Also see paragraphs 109 and 121 in the main text for advantages and disadvantages of using CD-ROM technology.)

CD-ROM

21. CD-ROM is a publishing medium, an alternative to printed books. Paradoxically, the technology is stable and mature, even though it has scarcely emerged in the marketplace, because standards which govern the coding of text, data, and images have already been adopted. Standards evolved rapidly because this technology is akin to audio compact discs used in the recording industry. CD-ROM is particularly well-suited to publishing and distributing batches of information that are not subject to constant updates and changes. Examples include library-type data bases (medical, legal, financial) which are updated periodically by subscription, large sets of product documentation, collections of "clip art" to be used in publishing, and parts lists or price lists supplied to distributors, such as auto parts dealers.

WORM technology

22. Write Once Read Many (WORM) is more appropriate for capturing transactions. WORM is used in large, multimedia (text, image, voice, data) data base applications, typically archival in nature, but still requiring ready access to stored data. WORM offers system integrators an unmatched combination of high-capacity, low cost per megabyte, removability, long storage life, direct access, and high data security. It is an ideal storage medium for archival, large on-line data bases, large amounts of data, and CADD/CAM systems that have to store large numbers of images. WORM technology is an alternative to microfilm, microfiche, and paper file systems, all suitable for storing text and images.

23. The disadvantages of WORM technology include lack of recording- and file-interchange format standards, doubts about the maturation of the technology, and confusion about integrating these drives into a system. Fortunately, these objections are being successfully addressed by vendors and industry standards organizations.

Optical subsystems

24. Subsystems emulate current storage devices such as magnetic disks or tape, alleviating potential problems with the operating system and driver interfaces which do not recognize optical discs. Optical subsystems include the optical drive, cable connection to the host, bus adapter, controller, and firmware. Subsystems range in price from $2,000 to $40,000, depending upon capacity. More than 20 vendors now offer subsystems for use with DEC VAXs. A few companies, including Data/Ware Development and Aquidneck, offer subsystems for IBM mainframes. Aquidneck and Optical Storage Solutions are among a growing number of companies offering IBM PC/XT and AT subsystems.

25. Compact Disc Interactive (CD-I) is an extension of two existing optical disc technologies: compact audio discs, used by the recording industry, and CD-ROM discs, which let computer users store data bases of text in a read-only form. A standard CD-I configuration includes a CD-I player, a television, and stereo speakers. On the software side, finished discs should be available in the second or third quarter next year. It is too soon to guess how much CD-I players will cost; software should be priced at an average of $30 per disc.

26. CD-I is effective for assembling special material and could serve as a larger capacity for clip art and sound tracks. CD-I provides a new way of creating in-house promotional presentations, being used by advertisement agencies to create sophisticated, hypothetical storyboards for ad campaigns. It would permit the ad personnel to manipulate and show material in front of clients without tieing up studios, which is expensive. Ads could utilize stereo sound, resulting in a more powerful impact. One main problems ad agencies have with storyboards is getting them to look as real as possible. With CD-I, agencies could generate and display images that are more realistic.

27. The CD-I disc in its player does not depend on a host computer. The CD-I player includes a host computer with memory, operating system, microprocessor, graphics and audio decoder chips, and output ports to television and stereo systems. CD-I will address consumer markets. Video Disc-Interactive (VD-I) supports compression of video signals and has been developed by General Electric. Chips for video compression can be installed in PCs and workstations. CD-I technologies for optical storage devices will be introduced this year. Video disc interactive is closely related to CD-I; products incorporating VD-I may be introduced in 1990.

DVI technology

28. Digital Video Interactive (DVI) is essentially two technologies. One is a compression technique (of up to 100 to 1) that allows over 1 hr of full-screen, full-motion video with eight-channel, interleaved audio to be stored on a single CD. This compression is done on large mainframe computers just before the CD master is made. All of the information--video, image, audio, text--is digital and can be indexed and retrieved by an application.

29. The second technology deals with decompressing and displaying the information from the CD. DVI uses a proprietary, very large-scale integration (VLSI) chip set to perform the decompression and display processing that result in real-time video. The chip set comes on three AT-compatible boards: a video board, an audio board, and a utility board. The boards should initially sell in the $5,000 range when they are released this fall, but will probably drop to under $3,000 by middle of 1989.

30. By providing realistic simulation, DVI is able to take over where today's computerized training programs leave off. Because of the interactive nature of the material (video, audio, text), training becomes customized to the user. For example, high-quality graphics can be combined with video to allow an automotive repair student to see and hear an explanation of the removal of a fuel pump, and then examine and manipulate a model of the fuel pump in another section of the screen (for a medical student, substitute a heart pump). The user can also move to another part of the application to select a catalog of parts or to get text information regarding models or costs of fuel pumps.

31. DVI presentations can be used to inform customers and help them make selections. A new category of "interactive advertisements" may be created. For example, the travel and real estate industries can show a motion video of locations to visit or buy, accompanied by a data base (image and/or text) of attractive features of property or vacation spots. Panoramic views can be captured with a single 360-deg image, digitized in software, unwrapped into a two-dimensional plane, and put under control via mouse or joystick.

32. DVI can be used for sales, marketing, or other presentations. The presenter has access to video, audio, image, graphics, text, etc., and can decide on the course of the presentation in real time. Each presentation can thus be targeted at the audience, even though the audience composition and interests are not known in advance. Currently, presentations about DVI are being done using DVI, and with great success.

33. DVI is designed to be media independent. Mastering and pressing CDs are generally an out-of-house process. With DVI, another step is added: high compression. Video, image, and audio data will be sent to a DVI service center to be compressed. The compressed data, along with other data (text, etc.), will then be put onto a CD master, either at the same center, another center, or at the customer site if it has in-house mastering. The published disc can then be accessed by any DVI-equipped PC.

Turnkey systems

34. Scores of systems integrators now offer turnkey optical systems which can be based on PCs, departmental systems, or mainframes. Turnkey systems include all of the optical components described below as well as any computer hardware. Costs for a turnkey system range from $35,000 to $2 million+ for custom systems. Turnkey optical disc systems are preconfigured combinations of hardware and software designed specifically for the storage and automated retrieval of digitized document images in medium-to-large-scale Records Management applications. These systems combine read/write optical disc media and drives with scanners, video display terminals, laser printers, and related support equipment. Using computers to index documents stored on optical discs, they utilize concepts originally developed for computer-assisted microfilm retrieval (CAR) systems, with which they compete.

35. There are three sizes of turnkey systems: (a) small-scale PCs. $30 to 100 K; 3.5-, 5.25-, 8-in. form factor; 1 to 10 MB/sec data transfer rate, 1 GB/platter; 4,000 to 100,000 pages; LaserData, TAB Products Chorus Data. (b) Medium-scale computers.

$100 to $500 K; 8- and 12-in. form factor; 5 to 10 MB/sec data transfer rate, 1 to 4 GB/platter; 100 K to 1 million pages; FileNet Kodak Wang; (c) Large-scale mainframe. $500 K to $2 million+; 12- and 14-in. form factor; 24 MB/sec data transfer rate, 4+ GB/platter; JUKEBOX libraries; Kodak Plexus, Access, Integrated Automation, and Alpharel.

Erasable optical disc

36. Erasable optical discs will be an alternative to magnetic disks for applications where data can be stored and subsequently replaced. Two characteristics of this medium--high capacity and slow data transfer rates--determine which applications are suitable. High storage capacity makes erasable discs useful for storing images. Applications which utilize this characteristic are the creation and subsequent editing of images, desktop publishing, and imaging. Other applications include workstation computing, document processing, on-line data storage and retrieval, and data backup for all sizes of computers. The relatively slow transfer rate makes this technology more suitable for PCs and workstations than for minicomputers and mainframes.

37. Products are becoming available. Maxtor, Sharp, and Sony will be shipping erasable systems this year. Tandy recently announced an erasable optical disc system. Industry analysts predict that IBM will introduce a large fixed-disc multiple spindle soon, perhaps 8 in., and a 3.5-in. drive for a PC later this year.

38. Maxtor is offering two drives, the Tahiti I, a 5.25-in. drive offering up to 600 MB of on-line total storage, and Fiji I, a 3.5-in. drive with 160 MB of on-line unformatted storage. Average seek times for the two drives are 30 and 100 msec, respectively. Maxtor erasable cartridges will carry prices about $125 to $150.

39. The erasable disc could be used as a substitute for tape backup where the disc's random access, rather than the tape's slower sequential access, is a requirement. As a primary storage, they could wind up in workstations as a companion to Winchesters. Users who share workstations could thus remove and store their own data. Removable media also appeal to users who need to lock up data for security purposes. Just as important are markets driven by data-intensive graphics applications. Industry experts believe, especially with the prices [Maxtor] is talking about, erasable may have its biggest impact on WORM drives. Typical prices for 5.25-in. WORM drives range from about $1,500 to $2,300, depending on quantity. However, WORM drives likely will continue to hold an edge in applications where data are not changed, for example, financial records, engineering drawings, and medical images.

40. Tandy Corp. introduced another type of erasable optical media that is fully playback-compatible with existing CD audio and CD-ROM drives. Called the Tandy THOR-CD, the drive itself will not be available for more than a year. A huge product potential exists for the Tandy High Density Optical Recording (THOR), Tandy executives claim. Its commercialization in CD audio could be rapid, while its applicability in CD-ROM mass memory has been long sought after.

41. The playback technology used in THOR follows the same techniques used in conventional optical discs. However, the Tandy THOR media can be erased, edited, and re-recorded over and over again, company officials said. The president of Tandy Electronics Manufacturing said that the first commercial use will be CD audio. Play and record decks for consumer audio should be available for under $500 and are expected to be out in 18 to 24 months.

Videodisc

42. While the videodisc is not a new technology, more Federal agencies are turning to this medium because of its ability to integrate audio, video, and graphics to provide high-quality training applications that can be mass-produced.

43. Video information currently is recorded on a videodisc's surface in one of two ways: constant angular velocity (CAV) and constant linear velocity (CLV). CAV provides the best format for interactive video. The format is derived from the fact that there are 54,000 distinct tracks (or video frames) on each side of a 12-in. CAV videodisc. Each can display a different still-frame image. When branching from one frame to another, the user can skip all intervening information and go directly to the desired location. It takes less than 3 sec for an end-to-end search. In addition to the radial search capability, the entire set of 54,000 frames can be played in a completely linear mode for 30 min (i.e., a motion picture). Most CAV formats are developed to include both motion and still frames. On each side of a 12-in. CAV disc, the user can perform the following:

a. Fast and slow forward and reverse motion.

b. Browse by scanning forward and backward.

c. Search on a given frame number.

d. Freeze frame, where motion is stopped and a single image is projected from a single frame.

CLV is used primarily for movies and other types of linear-only applications. While the maximum playing time is doubled to 60 min, CLV does not permit the user the *maneuverability of CAV.*

44. **Levels of user interaction.** The videodisc offers three levels of user interaction:

a. **Level One.** Generally using a consumer model or low-level industrial videodisc player, this provides interactivity which is limited to freeze frame, scanning, autostop, chapter search and dual audio capabilities, but only very basic random access and no programmable processing power.

b. **Level Two.** This program uses a small microprocessor built into an industrial/educational model videodisc player. In addition to the Level One capabilities, it provides random access and a programmable memory for player-controlled interactivity.

c. **Level Three.** Any videodisc player controlled by an external computer (a PC) or other microprocessor constitutes a Level Three application. Generally, this configuration is used for applications requiring sophisticated interactivity, scorekeeping, and special user interface devices such as touch screens or light pens.

45. **Custom.** This category includes applications utilizing related storage technologies such as CD-ROM and CD-I as well as those projects requiring mechanical and other nonelectronic components such as simulators.

46. **Disadvantages.** When a training program requires more than the 1/2 hr provided by the CAV videodisc, multiple disc sides are required. This results in user annoyance at changing videodiscs in mid-program, keeping track of multiple videodiscs or floppy diskettes, and increased costs due to increased mastering.

47. The high cost of the hardware and video production has prevented rapid expansion of the use of the videodisc. Interactive video hardware can add approximately

$4,500 to the cost of a PC workstation. Integrated workstations such as IBM's Info-Window and Sony's View System can cost around $9,500. The custom-made interactive video software that creates the desired application represents the largest cost factor at around $300,000. This includes production costs as well as the actual software.

48. Most videodisc players are easily interfaced with computers. The hookup and control procedures now are relatively stable. The one-to-one advantage of video systems is best applied in the area of training. This medium permits the user to move through the material at the individual's pace and to review the subject matter as needed. The anticipated expansion of the use of videodiscs as the basis for Computer Based Training (CBT) will mean opportunities for agencies to achieve cost reduction through program sharing.

Assumptions

49. In the short term, poor performance characteristics of CD-ROM drives are not likely to improve significantly because these shortcomings do not seriously impact applications appropriate for this medium.

50. Twelve-inch WORM drives have inferior reliability compared with other drives. When these drives were first designed, WORM technology was used for backup, and reliability was not very important. This characteristic will improve in time.

51. The 3.5-in. erasable systems have a slow access rate and low capacity compared with 5.25-in. erasable drives. Current 3.5-in. systems are really prototypes and will improve in their performance characteristics.

52. Most printed CD-ROM platters currently available are compilations of information which a buyer compares with on-line services or to paper alternatives.

53. Vertical applications characterized by valuable and stable data will initially drive the CD-ROM market. Medical and legal applications have these characteristics. Financial and economic data, sold as subscriptions with periodic updates by Lotus and others, are now the most common application.

54. Industry applications will flourish once users have invested in drives. References like an encyclopedia, a dictionary, a thesaurus, *Barlett's Quotations*, and so forth could be very useful on CD-ROM even though these applications are not now sufficiently compelling to motivate the purchase of a drive. References are already available on CD-ROM disc. Grolier's published an encyclopedia and Microsoft sells *Bookshelf*, a collection of references. Some Government statistics are also published by third parties on CD-ROM diskettes.

55. The performance of the CD-ROM applications depends to a great extent on the effectiveness of the retrieval software. Search engines that support selection on Boolean operators, menu-driven selection, recognition of synonyms, and associative inquiries will be critical to the success of CD-ROM applications.

56. A wave of erasable 5.25-in. magneto-optic disc-drive systems is about to hit the market, with a variety of companies announcing products that come close to Winchester drives on performance and beat them on capacity.

57. Also appearing are 3.5-in. erasable disc drives and a new class of erasable compact discs. Format standards should be set by the American National Standards Institute

for 5.25-in. nonerasable disc drives this year, and eventually expanded to include erasable discs as well.

58. Industry analysts expected 149,000 write-once and 103,000 CD-ROM shipments in 1988. Unit shipments in both categories were expected to double each year thereafter through 1991. By comparison, the number of 5.25-in. erasable drives shipped should grow from a few thousands drives shipped in 1988 to about 76,000 units in 1991, with most of the growth taking place in 1990 and 1991.

59. Large OEMs will take up to 2 years to evaluate the drives before building them into final systems. Once they are evaluated, though, the erasable systems inevitably will pose a threat to the nonerasable drives--all things considered, a disc that can be erased and rewritten has far more potential applications than one which cannot be erased.

60. Multimedia files are used most often as central, departmental, and work-group files. Multimedia files are especially well suited for active documents--media retrieved on a continuous basis. Ironically, filing needs have come full circle. Computers themselves generate paper, albeit sometimes in a different format, that must be stored. Nevertheless, as documents evolve, there is no survival-of-the-fittest rule to kill off the previous generation of media. Every new kind of electronic device creates a new medium, but it never obsoletes the old one. Instead, there is a proliferation of media. Paper is not enough. Microfilm and microfiche are not enough. There are also computer disks and computer tapes in all shapes and sizes. So will CD-ROM technologies, all of which will augment most, if not all, of the current storage media utilized today.

Advantages

61. The optical disc provides a shared storage resource; thus the data can be retrieved by multiple users. Data migrated to optical storage remain on-line and preserved in computer processing format, reaping a benefit in error reduction because manual handling of microfiche is eliminated, as is the possibility of lost or misplaced media.

62. Optical discs can store whole pages of text and charts together, and reading and writing of data are done by a laser beam that results in a faster access time compared with that of magnetic disks. Optical disc drives also have greater data densities than magnetic storage: A 12-in. optical platter can hold one GB (1-billion characters) of information, which allows a greater amount of data to be stored in a smaller space. The major advantage of CD-ROM and all optical storage devices is its storage capacity.

63. The CD-ROM diskettes are reliable and stable. Shelf life, depending on the underlying substrate, can be 30 years.

64. The major potential advantages of erasable optical disc systems are capacity and durability. There is no tape to break and no direct physical contact with the reading apparatus that could result in a head crash. Other potential advantages include economy, random access, and removable media.

65. CD-ROM provides a means of distributing 600-million characters of data--equivalent to 175,000 pages of ASCII text, plus indices--to any end user with a microcomputer and a $700 drive.

66. Whereas today's average PC random-memory is about 1 MB or less, CD-ROM can expand ROM available on PCs to more than half a gigabyte. With the ROM supplement, applications once unheard of become a strong possibility.

67. Optical disc drives are not direct replacements for magnetic tape or disk drives and cannot be effectively evaluated on the traditional criteria of speed and seek time. Magnetic tape provides low-cost storage on removable media, but data cannot be directly accessed. Winchester disk drives provide direct access, but the media are not removable and the cost per megabyte is high compared with tape. Optical storage offers the combined advantages of direct access and removable media at an on-line cost per megabyte competitive with Winchester drives and a media cost per megabyte competitive with tape.

68. Optical storage provides a level of data security not possible with rewritable storage devices. Data on an optical disc cannot be covertly altered because any attempt to do so will destroy the data themselves.

69. Data on optical discs are also much less susceptible to mechanical drive failures. The objective lens of an optical head is about 0.1 in. from the recording layer, in comparison with the typical 0.00001-in. flying height of Winchester heads. The greater separation between optical head and recording layer leaves room for a transparent substrate, which protects data from the environment and from head contact with the media. Moreover, the protection substrate prevents dust, fingerprints, and other contaminants from compromising optical data. Contaminants on the optical disc surface are not in the laser beam's focus and so do not impede the writing or reading of optical marks in the recording layer itself.

70. CD-ROMs are used primarily for archival purposes, or as a way of distributing data bases and software.

71. Multimedia files solve a problem that has been exacerbated by today's office technology: What does one do with records that will not fit into filing systems designed for letter-size paper? The problem is not a new one. Medical offices, for example, have long had to deal with records ranging from tab-card-size lab reports up through 8-1/2- by 11-in. sheets to X-ray film. Most accounting departments work with a similar range of document sizes. In fact, depending on how loosely the term "media" is defined, the potential for unusual storage requirements is almost unlimited. Any department that depends on media other than letter- or legal-size paper will probably be a user of multimedia files. Today and into the future, that will include almost every department.

72. A single CD-ROM disc is capable of storing up to 650 MB of data. That is as much data as can be stored on 1,500 floppy disks. CD-ROMs can be used to store any kind of information in digital form: data, text, graphics, audio, and video. A CD-ROM disc enables users to easily search and access information from workstations and provides an inexpensive method to reproduce, update, and distribute information.

73. The technology works best when applications require at least 20 to 40 MB of storage. When the amount of information to be stored is less than 10 MB, it is not necessary to switch from floppy disks or diskettes to CD-ROM technology.

74. In addition, when numerous copies are required, CD-ROMs are a low-cost medium. However, when fewer than 100 copies are needed, it is not advantageous to reproduce the CD-ROMs.

75. Image-based document-management systems, using high-capacity, low-cost optical disc storage, may offer the solution to the problem of too much paper. Customer-service environments that deal with high volumes of paper and whose client relationships depend on that paper are the ideal application areas for image-based systems. With an electronic document-management system, employees can bring up documents almost instantaneously during a transaction. This capability is totally new and is the cornerstone of the new approach to automation.

Disadvantages

76. Due to the lack of industry standards, discs are not interchangeable and must be used with the appropriate drive. Approximately 15 companies manufacture optical discs. Optical drives will be available in several form factors: 3.5, 5.25, 8, 12 and 14 in. The two most common drives are the 5.25-in. form factor for use with PCs and the 12-in. drive for use with departmental and mainframe computers.

77. Other disadvantages of optical disc storage include the following:

a. Optical disc storage requires large initial investment of time and money.

b. This medium has slower retrieval times than magnetic media.

c. It is only effective as a publishing or archival medium until erasable versions are available.

d. Even with a lower price, traditional CD-ROM is less flexible for storage and backup concerns because it is a read-only medium.

e. CD-ROMs cannot be easily updated hourly or weekly, although material that needs to be updated monthly or quarterly can be updated economically.

f. Applications are obstacles, as well as lack of interchangeability among drives. The non-writability of CD-ROM and WORM drives is an advantage for archival applications in which lack of volatility is essential. However, a CD-ROM disc arrives at a site unable to be altered. For that reason, many users have opted for WORM drives, optical drives whose data can be altered--once.

g. Many view erasable optical disc drives as slow. Their access time is slower compared with magnetic disks, and there is a current lack of standards.

h. Hard disks traditionally have seek times that are at least twice as fast as those of optical discs. More important is that, except for the new Advanced Graphic Applications Inc. (AGA) Discus system, 3M and Olympus, no two manufacturers have yet attempted to hammer out an erasable optical standard.

Standards

78. No two optical disc drives available today are media compatible. Media interchange standards are being developed to overcome these concerns. The most advanced standards activity is directed at 5.25-in. optical disc, with coordinated projects being conducted by the American National Standard Institute, the International Standards Organization (ISO), the Japanese Institute Of Standards, and the European Computer Manufacturers Association. The 5.25-in. optical standard will dovetail with a 5.25-in. erasable optical disc standard, thus enabling multifunction drives to handle both write once and erasable media.

79. There are four sets of CD-ROM standards. The first is the physical layout of the disc--or how the tracks are engraved. Interpretation of the data, a second standard, describes how to read the digital information from the 660-MB physical disc. The third standard is the High Sierra Format, which imposes a restructuring of the disc, creating discrete files and directories. Instead of a long, 660-MB disc, it is broken down into files.

80. The High Sierra Format was established in 1985, when CD-ROMs did not have a set format and there were few CD-ROM drives. Participants, including Microsoft, Digital Equipment Corp., Apple Computer Inc., and International Business Machines Corp., formed an ad hoc group to arrive at a standard. They met in the High Sierra Hotel (hence the name) and defined the disc format.

81. The High Sierra standard has gained approval by the ISO, although two separate standards have emerged--the High Sierra Format and the ISO's standard--which differ in small ways.

82. The standards for physical layout, data interpretation, and file formats have all been established. The fourth standard, which involves the CD-ROM playback device, is still emerging. The playback device can be hooked up to an IBM PC or compatible, and Apple Computer Inc. has a CD-ROM for the Macintosh. This is the area where standards are least set.

Recommendations

83. Recommendations are as follow:

a. Increase participation within the Special Interest Group on CD-ROM Applications and Technology (SIGCAT) Federal User Group.

b. Establish functional groups to address CD-ROM applications and usages within each information discipline within the Corps.

c. Establish a center point (point of contact (POC) or office) within the Corps to funnel all proposed, planned, and/or operational CD-ROM projects. The POC/office would act as a clearing house and source of research for offices that plan on establishing CD-ROM applications.

d. Because of the nature of VI/Graphics offices, proceed with ideas and propose plans and projects, provided these projects are local in scope. However, it is too soon to be proposing a CD-ROM system that would be deployed Corps-wide. CD-ROM technologies are changing at such a rapid pace that it is better to wait until the market settles within the VI/Graphic area.

APPENDIX F: RECOMMENDATIONS--SCIENTIFIC AND ENGINEERING

Current Environment

1. Scientific and Engineering (S&E) oriented systems are traditionally resident on all tiers of the Corps' automation architecture. Design analysis is supported by the Corps' engineering program library and commercial software available on mainframe and microcomputer systems. Graphics are supported by the Graphics Compatibility System subroutine library. Computer-Aided Design and Drafting (CADD) is resident on dedicated minicomputers and networked microcomputers or workstations, generally provided by the Intergraph Corporation.

Installed data storage and distribution systems and procedures

2. Large data base applications exist in the S&E area related to construction specifications, CADD, hydrology, earthquake records, soil borings, hydrographic surveys, mapping, coastal processes, project management, technical publications, and computer program libraries.

3. Mainframe and minicomputer distribution is through dedicated telecommunications lines or dial-up modems for on-line data and through paper reports or magnetic tapes for static data. Hydrologic data from Watstore and National Weather Service computers is accessed by on-line and interactive systems. Construction specifications are distributed through the Specbase and National Institute of Building Sciences (NIBS) Construction Criteria Base by on-line access to CDC mainframes. Technical publications such as technical reports and computer program documentation are generally distributed by mailing paper documents. CADD applications using Intergraph software based on Digital Equipment Corporation minicomputers utilize a local area network (LAN) to effect the transfer of drawing files between the host minicomputer and workstations in a specific site. The distribution of other mainframe/minicomputer-based data is primarily by magnetic tape media, customized for each vendor's specialized format requirement. This includes the Corps and Hydrologic Engineering Center (HEC) program libraries, Graphics Compatibility System (GCS), earthquake accelerometer data, and Beach Profile Analysis System data distribution procedures.

4. Microcomputers have expedited the transfer of data through the use of on-line file transfers between the microcomputer and mainframe/minicomputer and the mailing of floppy diskettes between sites. The use of micro-based LANs or micro-to-micro file transfers has seen limited application for data distribution. The NIBS Construction Criteria Base is distributed on floppy disks or on a CD-ROM disc. A large fraction of the Corps, HEC, and GCS libraries have been adapted for the microcomputer environment and are distributed by floppy disks periodically. The Coastal Engineering Research Center and Construction Engineering Research Laboratory also distribute program libraries via floppy disk mailings.

Disadvantages

5. The primary deficiencies in current S&E data storage and distribution systems are considered to be the cumbersome and expensive characteristics of magnetic tape preparation and mailing; expense and time intensive characteristics of on-line data transfer; and system administration aspects related to data currency, security, and integrity for widely distributed magnetic media. Communications between host computers is limited in scope, typically requiring operator intervention and commercial telephone lines.

Advantages

6. On-line access to data bases provides the most efficient storage medium in high-capacity magnetic disk drives, and the facilities for system administration of mainframe systems are superior to other systems. Floppy disk medium is the most inexpensive for smaller distributions of data. The Corps currently has hardware installed to support the magnetic tape distribution systems.

Summary

7. The Corps must apply new technology, as appropriate, to ensure that the highest professional standards are maintained in the area of S&E data, as this is its primary product. Economy and data integrity are issues that are directly affected by Information Management (IM) policy. Internal and external customer support, cost effectiveness, reduction of duplication, compatibility, timeliness, quality control, and system administration are all affected by the media used for storage, access, and distribution of S&E data. The Corps must strive to ensure that IM policy is dynamic in nature and reflects state-of-the-art technologies.

Alternatives

8. It is assumed that the Corps' requirement for data storage and distribution systems will continue to increase geometrically for the near term. Also, it is assumed technological advances in data storage, retrieval, and communications systems for S&E data will increase capacities and reduce unit costs geometrically. Thirdly, data storage and distribution will become critical benchmarks in systems design as processing and software considerations become a smaller fraction of the associated direct costs of system development and operation.

Available systems

9. Continued use of the currently employed or standard systems and procedures for storage and distribution of S&E data must be considered for each application area. The applications considered having high potential for benefiting from optical storage technology are those which exhibit largely static data, large data bases (100 megabytes), and wide distribution. Applications which do not meet these criteria would have a higher unit cost for distribution than current systems and would experience system degradation when time sensitive data involved.

Commercial systems

10. Commercially available, "off-the-shelf" applications and systems are viable for consideration for many S&E applications. Labor and hardware intensive applications, such as those requiring replication of optical discs, large-scale or frequent distributions, or high throughput data bases, would appear to have the highest potential. Additionally, products for external customers would benefit from the versatility and conformance to industry standard data formats afforded by commercial systems. Conversely, for transient data requiring intensive in-house management, commercial systems would tend to be cumbersome and expensive to operate.

Application/system development

11. The development of data storage or distribution systems would normally be reserved for applications where sufficient uniqueness exists or performance requirements are such that additional expense, implementation time, and loss of transportability are justifiable.

Recommendations

12. Consideration of CD-ROM and optical storage technologies for the storage and distribution of digital data is strongly recommended. It is obvious that optical storage is cost effective in many applications. The adoption of International Standards Organization standards for CD-ROM makes this technology especially stable for the near term. Commercially available data bases on CD-ROM provide potential for immediate performance increases over current systems. It is also obvious that the mechanisms for defining ongoing functional requirements for S&E applications (special interest groups, steering committees, etc.) must address the CD-ROM and optical storage technologies. Distribution of program libraries and archival of S&E data should be addressed in the Automation functional area. Distribution of technical publications should be addressed in the Printing and Publications or Library functional areas.

Short Term

13. The Field Information Management Users Group (FIMUG) should continue research on the optical storage technology by establishing a mechanism which can review

S&E data storage and distribution requirements. The initial activity of this mechanism would be to adopt a standard CD-ROM reader and configuration which would afford the Corps S&E community maximum exposure to currently available data bases, e.g. Specbase and US Geological Survey terrain data. Secondly, a comprehensive review of current Corps products distributed in digital form should be made. Thirdly, a comprehensive review of current data base applications should be made.

Long Term

14. The previously established mechanism would continue to compile functional requirements on an ongoing basis. Additionally, a review of optical and other storage and distribution technologies should be made. The defined applications would be analyzed and compiled into a prioritized list for transition to alternative storage technologies. Concentration of effort should be directed at distribution applications with data base applications being coordinated with the Automation subcommittee of FIMUG.

APPENDIX G: RECOMMENDATIONS-- AUTOMATION

Current Environment

1. Automation in the Corps of Engineers is effected utilizing various computer architectures, all of which support data transfer and storage functionality.

2. Mainframe systems primarily support on-line access to data bases and reporting facilities. Typically, the Corps develops mainframe systems on its own Honeywell DPS8 computers or the TSP contractor's Control Data Corporation series of computers.

3. Minicomputer systems are primarily used for specialized applications at the District level and as front end processors to the mainframe systems. Harris minicomputers are used for financial, office automation, water control, and data base applications as well as remote job entry applications. Recently, Sperry and Harris Unix based minicomputers have been acquired for stand-alone office automation applications.

4. Microcomputers are used in all areas of Automation and have found broad acceptance by the Corps. Applications are typically stand alone, using off-the-shelf software for data base, word processing, and spreadsheet applications. The most popular microcomputer is the standard Zenith ZX-248; however Apple microcomputers have a large installed base.

Installed data storage and distribution systems

5. Mainframe systems use high-capacity magnetic disk drives for providing on-line access to data base files and program libraries. Specialized data base applications may use removable magnetic disk packs. Distribution of data is primarily in the form of reports transmitted via paper, remote job entry synchronous data communications to minicomputers, or microfiche. Distribution of program libraries is traditionally via magnetic tapes. Archival and backup of on-line data are by magnetic tape library facilities. Some systems have been developed which transfer data using microcomputers connected through asynchronous communications devices.

6. Minicomputers have magnetic disk drives with less storage capacity than mainframes. Data distribution capabilities, however, exceed those of the mainframes in

the areas of interfacing, networking, and integration. Generally, minicomputers lend themselves to acting as servers to shared resources, as central nodes in distributed applications, and as remote job entry facilities. Archival, backup, and program library functions are performed with systems analogous to mainframe systems.

7. Microcomputers in the Corps have primarily operated in a stand-alone mode with floppy and fixed disk drives associated with each station. The primary application for microcomputers has traditionally been word processing, with data distribution via paper documents, mailing floppy disks, or file transfer using telecommunications through dial-up modems.

Disadvantages

8. The cumbersomeness, expensiveness, and volatile nature of magnetic tape and paper media for distribution of data are the primary deficiencies in current mainframe and minicomputer systems. Conformance to standards is deficient for magnetic tapes, restricting their portability between mainframes and between minicomputers.

9. The capacity of microcomputer magnetic disks is inadequate for many data base applications. The limited capacity of archival and backup systems for microcomputers discourages proper system administration procedures from being performed.

Advantages

10. Magnetic disk drives are cost effective and exhibit high throughput which appears unrivaled for on-line data storage and access. For limited quantities of data, high-speed, reliable communications links provide reasonable data transfer rates for both asynchronous and synchronous devices. The communications networks of the Corps provide extensive horizontal and vertical data distribution functionality.

Requirements summary

11. The Corps must apply new technology, as appropriate, to ensure that its automated systems are efficient, reliable, and effective in supporting the functional areas of Information Management (IM) and its production systems. Economy and data integrity are issues that are directly affected by IM policy. Internal and external customer support, cost effectiveness, reduction of duplication, compatibility, timeliness, quality control, and system administration are all affected by the media used for storage, access, and distribution of digital data. The Corps must strive to ensure that IM policy is dynamic in nature and reflects state-of-the-art technologies.

Alternatives

12. It is assumed that the Corps' requirement for data storage and distribution systems will continue to increase geometrically for the near term. Also, it is assumed that technological advances in data storage, retrieval, and communications systems for digital data will increase capacities and reduce unit costs geometrically. Thirdly, data storage and distribution will become critical benchmarks in systems design as processing and

software considerations become a smaller fraction of the associated direct costs of system development and operation.

Available systems

13. Continued use of the currently employed or standard systems and procedures for storage and distribution of digital data must be considered for each application area. The applications considered having high potential for benefiting from optical storage technology are those which exhibit largely static data, large data bases (100 megabytes), and wide distribution. Applications which do not meet these criteria would have a higher unit cost for distribution than current systems and would experience system degradation when time sensitive data are involved.

Commercial systems

14. Commercially available, "off-the-shelf" applications and systems are developing in the areas of microcomputer Compact Disc-Read Only Memory (CD-ROM) readers and Write Once Read Many systems. Labor and hardware intensive applications, such as those requiring replication of optical discs, large-scale or frequent distributions, or high throughput data bases, would appear to have the highest potential for migrating from traditional storage and distribution technologies to optical storage technology. Additionally, products for external customers would benefit from the versatility and conformance to industry standard data formats afforded by commercial systems. Conversely, for transient data requiring intensive in-house management, commercial systems would tend to be cumbersome and expensive to operate.

Application/system development

15. The development of data storage or distribution systems would normally be reserved for applications where sufficient uniqueness exists or performance requirements are such that the additional expense, implementation time, and the loss of transportability are justifiable.

Recommendations

16. Consideration of CD-ROM and optical storage technologies for the storage and distribution of digital data is strongly recommended. It is obvious that optical storage is cost effective in many applications. The adoption of International Standard Organization (ISO) standards for CD-ROM makes this technology especially stable for the near term. Commercially available data bases on CD-ROM provide potential for immediate performance increases over current systems. It is also obvious that the mechanisms for defining ongoing functional requirements for automation applications (special interest groups, steering committees, etc.) must address the CD-ROM and optical storage technologies.

Short term

17. The Field Information Management Users Group (FIMUG) should continue research on the optical storage technology by establishing a mechanism which can review digital data storage and distribution requirements. The initial activity of this mechanism would be to adopt a standard CD-ROM reader and configuration which would interface with the current microcomputer architecture and afford maximum exposure to currently available data bases from Government and commercial sources. Secondly, a comprehensive review of current Corps products distributed in digital form should be made. This includes distribution of program libraries and Computer-Aided Design and Drafting products, for examples. Thirdly, the migration of archival and backup systems for micro, mini, and mainframe computers to WORM technology should be analyzed. Lastly, a comprehensive review of current data base applications should be made.

Long term

18. The previously established mechanism would continue to compile functional requirements on an ongoing basis. Additionally, a review of optical and other storage and distribution technologies should be made. The defined applications would be analyzed and compiled into a prioritized list for transition to alternative storage technologies. Concentration of effort should be directed at distribution applications with archival, backup, and data base applications being coordinated with the automation subcommittee of FIMUG.

APPENDIX H: HARDWARE/SERVICE VENDORS

Acctex Information Systems
131 Steuart Street
Suite 600
San Francisco, CA 94105
(415) 543-4290
Controller Boards
CD-ROM, WORM

Advanced Graphic Applications
90 Fifth Ave.
New York, NY 10011
(213) 337-4200
Erasable Optical Drive

Advanced Touch Systems
9669 Distribution Avenue
San Diego, CA 92121
(619) 693-9001
Videodisk

AIMTECH Corporation
77 Northeastern Boulevard
Nashua, NH 03062
(603) 883-0220
Videodisk

ALDE Publishing
(Applied Laser Disc Efficiencies)
7840 Computer Avenue
P.O. Box 35326
Minneapolis, MN 55435
(612) 835-5240
CD-ROM, CD-I

Alphatronics Inc.
PO Box 13687
Research Triangle Park
Durham, NC 27713
(919) 544-0001
WORM, EOD

Alot
10 Victor quare
Suite 600
Scotts Valley, CA 95066
(408) 438-7400
CD-ROM

Amdek Corporation
1901 Zanker Road
San Jose, CA 95112
(408) 436-8570
CD-ROM, WORM

American Technology Resources
P.O. Box 21
1245 N. Providence Road
Media, PA 19063
(215) 565-6434
Videodisk, CD-ROM, WORM

Apple Computer, Inc.
20525 Mariani Avenue
Cupertino, CA 95014
(408) 973-6144
CD-ROM, WORM

Aquidneck Systems
International, Inc.
650 Ten Rod Road
North Kingston, RI 02852
(401) 295-2691
WORM

Atari Corporation
1196 Borregas Avenue
Sunnyvale, CA 94086
(408) 745-2000
CD-ROM

Auto-Graphics, Inc.
3201 Temple Avenue
Pomona, CA 91768
(714) 595-7204
CD-ROM

BCD Associates, Inc.
7510 North Broadway
Suite 205
Oklahoma City, OK 73116
(405) 843-4574
Controllers

Bell & Howell
Document Management Products Division
6800 McCormick Road
Chicago, IL 60645
(312) 675-7600
WORM

Bibliographical Center for Research
1777 South Bellaire
Suite 425
Denver, CO 80222
(800) 525-0190
CD-ROM Non-profit library cooperative/
network; CD-ROM

CaliPer (California Peripherals Corp.)
19701 South Vermont Avenue
Torrance, CA 90502
(213) 538-1030
CD-ROM, WORM

Cameron Computers, Inc.
29 Goodway Drive, East
Rochester, NY 14623
(716) 427-8190
Laser Databank; WORM

Carl M. Rodia, Consulting
13 Locust Street
Trumbull, CT 06611
(203) 261-1365
CD-ROM, WORM, CD-I, OROM

Cauzin Systems, Inc.
835 South Main Street
Waterbury, CT 06706
(800) 533-7323
CD-ROM, OROM, CD-I, Optical
Memory Card

CD Technology
780 Montague Expressway # 407
San Jose, CA 98131
(408) 432-8198
CD-ROM

Cherokee Data Systems
1880 South Flatiron Court
Complex H
Boulder, CO 80301
(303) 449-8850
WORM

Chester Technical Services
47 Clapboard Hill Road
Guilford, CT 06437
(203) 453-6209
CD-ROM

Chinon America Inc.
Information Equipment Division
6374 Arizona Circle
Los Angles, CA 90045
(213) 216-7611
CD-ROM

Compact Disc, Inc.
1908 Rainbow Drive
Silver Spring, MD 20904
(301) 384-0012
DiscPorter Library System

Computer Upgrade Corp.
2910 East La Palma Ave.
Suite A
Anaheim, CA 92806
(714) 630-3457
CD-ROM, WORM, EOD

Cubic Corporation
9333 Balboa Avenue
San Diego, CA 92123
(619) 277-6780
CD-I

Daicel (USA), Inc.
611 West Sixth Street
Suite 2152
Los Angeles, CA 90017
(213) 629-3656
WORM

Dataware, Inc.
2 Greenwich Plaza
Suite 100
Greenwich, CT 06830
(203) 622-3908
CD-ROM, WORM, OROM

Del Mar Group, Inc.
722 Genevieve
Suite M
Solana Beach, CA 92075
(619) 259-0444
CD-ROM

Delta Microsystems Inc.
5039 Preston Ave.
Livermore, CA 94550
(415) 449-6881
WORM

Deltaic Systems
1977 O'Toole Ave.
Suite B206
San Jose, CA 95131
(408) 954-1055
WORM, EOD

Denon
222 New Road
Parsippany, NJ 07504
(201) 575-7810
CD-ROM

Digital Equipment Corporation
2 Mount Royal Avenue (UP01-3)
Marlboro, MA 01752
(617) 480-4820
CD-ROM

Digital Video Corporation
369 N. Orange Avenue
Orlando, FL 32801
(305) 425-1999
DVI

Distributed Image Systems Corporation (DISCORP)
290 Easy Street #5
Simi Valley, CA 93065
(805) 584-0688
WORM

Drexler Technology Corporation
2557 Charleston Road
Mountain View, CA 94043
(415) 969-7277
Optical Memory Card

Eastman Kodak Co.
343 State Street
Rochester, NY 14650
(716) 724-5130
WORM

EMULEX Corporation
3545 Harbor Boulevard
Costa Mesa, CA 92626
(800) EMULEX3
Optical Subsystem, WORM Controllers

FileNet Corporation
3565 Harbour Boulevard
Costa Mesa, CA 92626
(714) 966-2344
FileNet Document-Image Processor

Fujitsu America, Inc.
3055 Orchard Drive
San Jose, CA 95134
(408) 432-1300
WORM

General Research Corporation, Library Systems
5383 Hollister Avenue
Santa Barbara, CA 93111
(800) 235-6788
Laser-Quest, CD-ROM

High Vacuum Equipment Corp.
110 Industrial Park Road
Hingham, MA 02043
(617) 749-9000
CDC-1000, CD-ROM, CD-I

Hitachi America, Ltd.
950 Elm Avenue
San Bruno, CA 94066
(415) 872-1902
CD-ROM, WORM

Hitachi Sales Corporation
East Coast Office
Natick, MA 01760
(617) 655-5501
CD-ROM, WORM

Hitachi Sales Corporation
2 Lincoln Centre
5420 LBJ Freeway, Suite 865
Dallas, TX 75240
(214) 991-7983
CD-ROM, WORM

Hitachi Sales Corporation of America
401 West Artesia Boulevard
Compton, CA 90220
(800) 262-1502
Laser Video, CD-ROM, WORM

I.B.M.
3301 Windy Ridge Parkway
Marietta, GA 30067
(404) 988-2351
InfoWindow, CD-I

Image Access, Inc.
P.O. Box 810
Trabuco Canyon, CA 92678
(714) 858-8553
CD-I

Image Storage/Retrieval, Inc.
850 Bear Tavern Road
West Trenton, NJ
(800) 524-0897
CD-ROM

Imnet Corporation
34 Maple Avenue
P.O. Box 2018
Pine Brook, NJ 07058
(201) 882-6555
Complete Systems, JUKEBOX, WORM

In Service, Inc.
765 Route 83
Suite 114
Bensenville, IL 60106
(312) 860-9822
Service, CD-ROM, WORM, CD-I, OROM

Info Express, Inc.
14320 NE 21st Street
Suite 18
Bellvue, WA 98007
(206) 641-3434
CD-ROM, WORM, CD-I

Information Storage, Inc.
2768 Janitell Road
Colorado Springs, CO 80906
(303) 579-0460
WORM

Integrated Automation, Inc.
1301 Harbor Bay Parkway
Alameda, CA 94501
(415) 769-5400
Optical Memory Card, WORM

Intellegent Systems Design, Inc.
NCR Center, Suite 101
15400 SE 30th Place
Bellevue, WA 98007
(206) 641-8012
CD-ROM, WORM, CD-I

InterFile Corporation
755 North Mary Avenue
Sunnyvale, CA 94086
(408) 738-3900
WORM, InterFile 2000

Introl Corporation
2675 Patton Road
St. Paul, MN 55113
(612) 631-7600
WORM, Interface Adapters

Kom, Inc.
14180 W. 78th Street
Suite 120
Eden Prairie, MN 55344
(800) 267-0443
OPTIFILE II, WORM

Laser Magnetic Storage
International Company
4425 Arrowswest Drive
Colorado Springs, CO 80907
(303) 593-7900
CD-ROM, WORM, System Units

Laser Recording Systems, Inc.
270 Sparta Avenue
Suite 303
Sparta, NJ 07871
(201) 729-3055
Complete Document Systems,
CD-ROM, WORM

LaserData, Inc.
10 Technology Drive
Lowell, MA 01851
(617) 937-5900
CD-ROM, WORM

LaserDrive, Ltd.
1101 Space Park Drive
San Jose, CA 95054
(408) 970-3600
WORM

Lasertrak Corporation
6235-B Lookout Road
Boulder, CO 80301
(800) 255-TRAK
CD-ROM

Lazersoft, Inc.
11812 Northcreek Parkway North
Suite 200
Bothell, WA 98011
(206) 485-1555
Optical Data Storage Systems, WORM

Marubeni America Corporation
2000 Town Center
Suite 2150
Southfield, MI 48075
(313) 353-7060
CD-ROM, WORM, CD-I, OROM

Maximum Storage
5025 Centennial Boulevard
Colorado Springs, CO 80919
(303) 531-6888
MAXSYS-PC Optical File System,
WORM

Maxtor
211 River Oaks Parkway
San Jose, CA 95134
(408) 432-1700
WORM

Meridian Data, Inc.
4450 Capitola Road
Suite 101
Capitola, CA 95010
(408) 476-5858
CD-ROM

Micro Design International
6985 University Blvd.
Winter Park, FL 32792
(407) 677-8333
CD-ROM, EOD, WORM

Micromedex, Inc.
660 Bannock Street
Suite 350
Denver, CO 80204
(800) 525-9083
CD-ROM

MicroTRENDS, Inc.
650 Woodfield Drive
Suite 730
Schaumburg, IL 60173
(800) 624-7279
Apple IIe Interface, WORM, CD-ROM,
Complete Image Management Systems

Mitsubishi Electronics America
Computer Peripherals Division
991 Knox St.
Torrence, CA 90502
(213) 217-5732
WORM

N/HANCE Systems
908 Providence Highway
Dedham, MA 02026
(800) BUY-WORM
WORM, Optical Disc Systems

Online Computer Systems, Inc.
20251 Century Boulevard
Germantown, MD 20874
(800) 922-9204
CD-ROM, WORM, CD-I

Optical Disc Corporation
17517-H Fabrica Way
Cerritos, CA 90701
(714) 522-2370
CD-ROM, CD-I

Optical Media International
485 Alberto Way
Los Gatos, CA 95032
(408) 395-4332
CD-ROM, CD-I, WORM

Optimem
297 North Bernado Avenue
Mountain View, CA 94042
(415) 964-2211
WORM

Optotech, Inc.
740 Wooten Road
Colorado Springs, CO 80915
(303) 570-7500
WORM

Pacific Electro Data, Inc.
14 Hughes
Suite B205
Irvin, CA 92718
(714) 770-3244
SCSI interface cards

Pacific Interactive
1010 Turquoise Street
Suite 206
San Diego, CA 92109
(619) 488-6300
CD-ROM, WORM, CD-I

The Palantir Corporation
2500 Augustine Drive
Santa Clara, CA 95054
(408) 986-8006
Compound Document System

Panasonic Industrial Company
2 Panasonic Way
Secaucus, NJ 07094
(201) 348-7000
CD-ROM, WORM

Pencom International Corp.
776 Palomar Avenue
Sunnyvale, CA 94086
(408) 720-1800
CD-ROM, WORM, CD-I, OROM

Pentax Teknologies Corp.
880 Interlocken Parkway
Broomfield, CO 80020
(303) 460-1600
CD-ROM, WORM, CD-I

Perceptronics
1911 North Fort Myer Drive
Arlington, VA 22209
(703) 525-0184
Laser Mapping System, CD-ROM,
WORM

Peripheral Land Inc.
47421 Bayside Pkwy.
Fremont, CA 94538
(415) 657-2211
EOD

Phillips Information Systems, Inc.
2111 Wilson Boulevard
Suite 435
Arlington, VA 22201
(703) 875-2222
CD-ROM, Controllers

Phillips Information Systems, Inc.
15301 Dallas Parkway
Suite 300, LB35
Dallas, TX 75248
(800) 527-0204
CD-ROM, Controllers

Phillips Subsystems & Peripherals, Inc.
1111 Northshore Drive
Building 2, Suite 726
Knoxville, TN 37919
(615) 558-5200
CD-ROM, CD-I, WORM, OROM

Planning Research Corporation
PRC Government Information Systems
1500 Planning Research Drive
McLean, VA 22102
(703) 556-1423
Optical Image Systems, WORM

Planning Research Corporation
Government Information Systems
System Integration Division
1500 Planning Research Drive
McLean, VA 22121
(703) 661-5070
Optical Document Management Systems, WORM

Polyform, Inc.
516 South 5th Avenue
Mt. Vernon, NY 10550
(914) 668-4700
Optical Memory Card, CD-ROM, WORM, CD-I, OROM

Procom Technology Inc.
200 McCormick Ave
Costa Mesa, CA 92626
(714) 549-9449
CD-ROM

PSI Technologies Corporation
3949 S. Lamar Boulevard
Suite B
Austin, TX 78704
(800) 833-2998
Magnetic tape to Optical Storage, Portable Optical Storage System, WORM

RACET Computes Ltd.
3150 East Birch St.
Brea, CA 92621
(714) 579-1725
EOD

Rancho Technology
Rancho Technology Center
8632 Archibald Avenue
Suite 109
Rancho Cucamonga, CA 91730
(714) 987-3966
SCSI Interfaces/Controllers

RCA Government Communications
Systems Division
Bldg. 2-4
Camden, NJ 08102
Optical Storage Systems, WORM

Reference Technology, Inc.
5700 Flatiron Parkway
Boulder, CO 80301
(303) 449-4157
CD-ROM Systems

Reference Technology, Inc.
2070 Chain Bridge Road
Suite 500
Vienna, VA 22180
(703) 883-0838
CD-ROM Systems

Reference Technology, Inc.
24165 Summit Woods Drive
Los Gatos, CA 95030
(408) 983-5700
CD-ROM Systems

Reference Technology, Inc.
5655 Lindero Canyon Road
Building 100
Westlake Village, CA 91362
(818) 991-1202
CD-ROM Systems

Reference Technology, Inc.
7027 Nicki Street
Dallas, TX. 65252
(214) 931-9618
CD-ROM Systems

S & S Electronics, Inc.
150 Industrial Avenue
Lowell, MA 01852
(617) 458-4100
Service for CD-ROM, WORM

Sony Corporation of America
655 River Oak Parkway
San Jose, CA 95014
(408) 432-0190
Optical Memory, CD-ROM

Storage Dimensions
2145 Hamilton Ave.
San Jose, CA 95125
(408) 879-0300
WORM, EOD

Sumo Systems
1580 Old Oakland Rd.
Suite C103
San Jose, CA 95131
(408) 453-5744
EOD

Summus Computer Systems
17171 Park Row
Suite 300
Houston, TX 77084
(7130 $92-6611
EOD

Talus Corporation
16780 Lark Avenue
Los Gatos, CA 95030
(408) 354-5322
Optical File System

TECEX
1061 S. Melrose Avenue
Placentia, CA 92670
(800) 854-5112
WORM Archiving System

TMS, Inc.
110 West Third Street
P.O. Box 1358
Stillwater, OK 74076
(405) 377-0880
CD-ROM

Toshiba America, Inc.
Disc Products Division
9740 Irvine Boulevard
Irvine, CA 92178
(714) 583-3125
CD-ROM, WORM

3M-Office Systems Division
3M Center
Bldg. 220-10W-01
St. Paul, MN 55144
(612) 733-9534
Document Management Systems, WORM

Varitel Video
350 Townsend Street
San Francisco, CA 94107
(415) 495-3328
CD-ROM, CD-I

Verbatim Corporation
323 Soquel Way
Sunnyvale, CA 94086
(408) 773-5777
Erasable Optical Systems, Magnetic/
Optical Systems

Videodiscovery
1515 Dexter Avenue North
Suite 200
Seattle, WA 98109
(206) 285-5400
Interfaces, Controllers

Wang Laboratories, Inc.
1 Industrial Avenue
Lowell, MA 01851
(800) 22-LINCS
Integrated Image Systems

ZETACO, Inc.
6850 Shady Oak Road
Eden Prairie, MN 55344
(612) 941-9480
Optical Storage Subsystems, WORM

APPENDIX I: SOFTWARE SUPPLIER LIST

Courseware

ALTA Associates
555 Metro Place North
Suite 175, Dublin, OH 43017
614-792-2222 Robert Archibald, President

Generic courseware on interactive videodisc forthcoming; videodisc; training; expertise in nuclear and conventional power plants.

Health EduTech, Inc
7801 East Bush Lake Road
Minneapolis, MN 55435
612-831-0445 Carol Hobson, Marketing Manager

Interactive videodisc courseware including: Sexually Transmitted Diseases Information Program; Interactive Math Series: Basic Math Program; Applied Algebra; Program Interactive Science Series: Plants Course, Animals Course, Weather Course, Energy Course; Health Hazards in the Workplace; Health Care Orientation Series: Infection Control, Fire Safety, Electrical Safety, Back Safety; AIDS - An Adult Education Program: Wordstar Mentor Series; Personal Consultant Series: PC Mentor; Keyboard Concepts and Computer Controls; Disks, Drives, and DOS; Using Applications Programs; WordStar Mentor Series; Personal Consultant Series; Design, development, production, and marketing of generic courseware for interactive videodisc; videodisc.

NCR Corporation
New Instructional Technologies Group
9391 Washington Church Road
Miamisburg, OH 45342
513-445-3770 John Marohl, Assistant Vice President,
Customer Service

Videodisc courseware; Personal Computers: DOS; Personal Computers: Concepts; Retail Environments: Concepts; Basic Teller Training; InteracTV2: Product Information; InteracTV2: Programming the System; Data Communications: Concepts; Data Communications: Fault Analysis; Video Display Terminals: Concepts; videodisc

Online Computer Systems, Inc.
20251 Century Boulevard
Germantown, MD 20874
800-922-9204
301-428-3700
Joe Florio, Manager, Business Development Information Systems

Custom turnkey systems; interactive technical training courseware; GATE (Global Approach to Technical Education); applications developer, systems integrator; document display/delivery using CD-ROM/videodisc applications for information delivery; videodisc, CD-ROM, WORM, CD-I.

Sandy Corporation
1500 West Big Beaver Road
Troy, MI 48084

Videodisc courseware design and development; consulting in videodisc/CBT design, development, technical training, and task analysis; authoring system: LS/1, IBM Info-Window; videodisc

SETS (Synergistic Educational Technology Systems)
4405 Vineland Road C-4
Orlando, FL 32811
305-422-7444
Wade Dunn, President

Small Business Disc: How to Start & Run a Small Business Video/RGB switching device (switches monitor between mono & color); videodisc production; SETS Interactive Personal Computing (4 discs); SETS Computacion Personal Interactiva (Spanish version); SETS/GTE Telephone Selling Skills; generic courseware (Level III); videodisc

System Impact, Inc.
4400 MacArthur Boulevard, N.W.
Suite 203
Washington, DC 20007
800-822-4636
202-342-9369
Nancy M. Hackett, Asst. Director of Marketing

Core Concepts in Science & Mathematics; videodisc curriculum courseware; videodisc

Erasable Optical Media

Verbatim Corporation (subsidiary of Eastman Kodak)
323 Soquel Way
Sunnyvale, CA 94107
408-773-5777
Chandran Cheriyan, Marketing Manager, Magneto Optic Drive & Media

Erasable optical media: Thermo-Magneto-Optic (TMO) system

Graphics

Arctan Graphic Arts, Inc.
8 Prince Street
Rochester, NY 14607
716-244-6327
William C. Wygant, President

Arctan Computer Graphic Art Service; cell animation, tiles and text, sci/tech illustrations; business charts/graphs; videodisc, CD-ROM, WORM, CD-I

AT & T Electronic Photography & Imaging Center
7351 Shadeland Station Suite 100
Indianapolis, IN 46256-3921
800-858-TRUE

Computer graphics hardware and software; Picture Power Slide Presentation Software; manufacturer of Truevision (TARGA, VISTA, ICB, VDA/D, & TIPS)

Creative Technologies Corp.
4820 N. Spring Street
Evansville, IN 47711
812-422-4112
J. Mark Patrick, Executive Vice President

Overlay One (graphics overlay board); Interactive Software Set (software tools); NOVA Science Quiz (interactive video exhibit); IPOP (interactive point of purchase) video controllers; IPOP Kiosks; overlay boards for IBM environment; videodisc

Image Storage/Retrieval, Inc.
850 Bear Tavern Road
West Trenton, NJ
800-524-0897
T. Towers, President

Portable graphics workstation; CD-ROM

MetaMedia Systems, Inc.
20251 Century Boulevard
Germantown, MD 20874
301-428-9160
Tom Held, President

Custom turnkey interactive device; custom courseware production, postproduction, computer graphics services, premastering facilities, interactive systems; consulting in production, postproduction, customer courseware; videodisc, CD-ROM

Norpak Corp.
10 Hearst Way
Kanata, Ontario K2L 2P4
Canada
613-592-4164
Edward Davies, Vice President, Marketing

Graphic display generator PCX6; decoder (SFW6); videotex decoder (VTX6AX); videodisc

Stokes Slide Services, Inc.
7000 Cameron Road
Austin, TX 78752
512-458-2201
John R. Stokes, President

Premastering of still images; videodisc

Tele-Edit, Inc.
10 South 5th Street #640
Minneapolis, MN 55402
612-333-5480
John Gorski, President

Video post production and graphics; videodisc

Universal Images
26011 Evergreen
Suite 202
Southfield, MI 48076-4472
313-357-4160
Petra Hellthaler

Computer graphics and animation; consulting in application of proprietary database management for discs as they apply to multiple playback for announcement shows and speaker support; videodisc

Varitel Video
350 Townsend Street
San Francisco, CA 94107
415-495-3328
John Cheney

Data video reader; CD-ROM, CD-I

Graphics Software

AT & T Electronic Photography & Imaging Center
7351 Shadeland Station Suite 100
Indianapolis, IN 46256-3921
800-858-TRUE

Picture Power Slide Presentation

Chester Technical Services
47 Clapboard Hill Road
Guilford, CT 06437
203-453-6209
Jim Hannon, Vice President

Sony Communications Group (interactive learning systems i.e., language labs); Sony Intelligent Systems Group (videodisc, interactive video, CD-ROM, computer-aided instruction, large screen display devices); consulting in product needs for environments; product installation and service; graphics software: Mavigraph; still imaging: ProMavigraph; videodisc CD-ROM

Image Concepts, Division of ICIS, Inc.
P.O. Box 211
West Boylston, MA 01583
617-835-3273
Clif Nickerson, Marketing Manager

C-QUEST Picture Cataloging & Retrieval Software; videodisc, CD-ROM, WORM, CD-I, OROM

Retrieval Software

New Media Graphics Corp.
279 Cambridge Street
Burlington, MA 01803
617-272-8844
Martin Duhms, President

Scrypt; NMG-Fonts; NMG-Slide; NMG-Paint; PC-GraphOver (controller); GraphOver 9500 (controller); kiosk; systems intergrator; videodisc

Interactive Audio

Earth View, Inc
343 State Street
Rochester, NY 14650
716-724-5130
Darrell Meyer, Product Sales Manager

WORM: Optical Disk System 6800 (14-inch); WORM; Design, scripting, recording

Interactive Video

Advanced Systems, Inc.
155 E. Algonquin Road
Arlington Heights, IL 60005
800-822-2398

Interactive programming video courseware; videodisc

Chester Technical Services
47 Clapboard Hill Road
Guilford, CT 06437
203-453-6209
Jim Hannon, Vice President

Sony Communications Group (interactive learning systems i.e., language labs); Sony Intelligent Systems Group (videodisc, interactive video, CD-ROM, computer-aided instruction, large screen display devices); consulting in product needs for environments; product installation and service; graphics software: Mavigraph; still imaging: ProMavigraph; videodisc CD-ROM

GWF Associates
960 Holmdel Road
Holmdel, NJ 07733
201-946-9790
George Feehan, President

Interactive video productions; videodisc

Meta Training Design, Inc.
Suite 901-701 Evans Avenue
Etobicoke, Ontario M9C 1A3
Canada
416-844-3135
Michael Barnes, Managing Director

Interactive laser video program; custom interactive video software design; videodisc

National Film Board of Canada
Technical Research & Development
P.O. Box 6100, Station A
Montreal, Quebec H3C 3H5
Canada
514-283-9143
Ed H. Zwaneveld, Director, Technical Research & Development

Interactive Video Authoring/Simulation Workstation; single frame stockshot sampling system; consulting in new technology development in pre-production, production, post-production, and distribution of media; videodisc

Online Computer Systems, Inc.
20251 Century Boulevard
Germantown, MD 20874
800-922-9204
301-428-3700
Joe Florio, Manager, Business Development Information Systems

Custom turnkey systems; interactive technical training courseware; GATE (Global Approach to Technical Education); applications developer, systems integrator; document display/delivery using CD-ROM/videodisc applications for information delivery; videodisc, CD-ROM, WORM, CD-I.

Interactive Video System

Allen Communication, Inc. - supplier
Baker Videoactive
High Tech Manufacturers, Ltd. - LYNK Video Editor/Interactive Video
IBM Infowindow System (touch screen I.B.M.)
Interactive Training Systems, Inc. (ITS) - (Level 3) Design & development
Spafax USA, Inc. - Interactive video system and program

Interactive Videodisc Programming

C.A.V Productions, Inc.
793 Pharmacy Avenue
Scarborough, Ontario, M1L 3KL
Canada
416-288-1224
Jamie Yeo, Executive Vice President, Production & Design

Custom interactive videodisc production, design, programming; generic videodisc product sales; Laservision and Laserfilm (videodisc); videodisc

Media Learning Systems
120 West Colorado Boulevard
Pasadena, CA 91105
818-449-0006
James F. Griffith, President

Microdex Learning Center; systems integrator, dealer (Sony Intelligent Systems, IBM, Pioneer, VAR); interactive videodisc design, production, programming,; authoring system: IBM LS/1; production, postproduction, and videodisc premastering (in-house); consulting for videodisc program and courseware development, format selection, learning center design; IBM MAP for InfoWindow systems; videodisc

Interactive Videodisc Simulations

MindBank, Inc
115 Evergreen Heights Drive
Pittsburgh, PA 15229
412-931-7500
Linda George, Vice President

Writing For Results; Make the Telephone Work for You The Business Disc; The Name Game; Make the Telephone Sell For You; Introduction to Marketing; Interactive videodisc courseware and simulations; videodisc

Interactive Visual Management Information Language

Video Interactive Computing, Inc.
12777 Jones Road
Suite 481
Houston, TX 77070
713-955-5004
Sherry Barker, Manager of Public Relations

LaserFlex; videodisc, value added vendor; data preparation

Video and Motion Picture Production Equipment

FERCO, Inc.
707 11th Avenue
New York, NY 10019
212-245-4800
Russell Guenther, Systems Engineer

Videodisc players; interactive systems; Sony Intelligent Products; Level III; components, display products; video and motion picture production equipment sales, rental service; videodisc

APPENDIX J: CURRENT APPLICATIONS/PROJECTS

National Archives:	Working in conjunction with GSA to draft Electronic Records Management Rule.
	Test of optical, film, and paper storage systems for cost and benefit comparisons. The test will use the 1.5-million images from the Tennessee Confederate Compiled Military Service Records.
Library of Congress:	Using Compact Disc-Read Only Memory (CD-ROM) for the generation of a Compact Disc Machine Readable Cataloging (CDMARC) product. A second project that will contain most of the bibliographic records of the Library is also in process.
House of Representatives:	In the initial stages of applying optical disc technology to store and process over 1 million personnel and payroll documents.
US Geological Survey:	CD-ROM disc of Eighteen Earth Science Data Bases
	Water Resources Scientific Information Center, 200,000 water-related abstracts.
	National Earthquake Center, Seismic Event Disc.
Veterans Administration:	St. Louis Regional Center, record storage for 35 million veteran and dependents record storage; 20 million of the records are active at one time.
National Technical Information Service	Has licensed to private industry for the preparation and sale of the available data bases, currently three commercial firms have licensed for the use of the data bases.

US Postal Service	Installed CD-ROM based system for zip code information systems; 438 units have been placed in 200 facilities.
Census Bureau	Ten-disc set of the Statistical Census Data.
National Bureau of Standards	NBS Institute for Computer Science operates a CD-ROM laboratory for testing of the CD-ROM technology. The laboratory is open to Government agencies.
National Aeronautic Space Administration	NASA scientific data base CD-ROM and Voyager 2 images of Uranus.
Army Communications Electronics Command Center for Software Engineering	Documentation storage baselines for the mission critica communications switches TRI-TAC, AN/TTC-39, AN/TTC39A, and the AN/TYC39. The documentation baseline also includes all system specific updates.
Federal Aviation Administration	Use of optical storage for the monitoring of take-off and landing slots at the most congested American airports.
Anaheim Police Department	Write Once-Read Many (WORM) technology used to store and retrieve all of the administrative and investigative records.
Corps of Engineers	A message was sent to all CIMs requesting identification of any optical projects and interest in same--the following responses were received: CESAS-IM, very interested in optical subjects--POC Joyce Edenfield, IM-S, (912) 944-5770. CEWES-IM-A, The Corps Specification group at OCE is supporting the CCB project. This is a TRI-Service project for the development of guide specs, etc. POC is Roger Seeman at OCE. Corps Library Program is in the initial stages of developing a CD-ROM of the LS/2000 data base. POC Sarah Mikel (202) 272-1008. CERLIMO, POC (217) 352-6511, xt 510. CEORP-IM, Has installed the CD FICHE system from USA Information Systems, Inc. The system supports the National Stock Inventory Information for the Logistics Management Office.

Private Company Production of Government CD-ROM Applications

Alde Publishing 4820 West 77th Street P.O. Box 35326 Minneapolis, MN 55435 (612) 835-5240	ADA Source codes, templates and utilities Supply and Procurement Information
Auto-Graphics Inc. 3201 Temple Avenue Pomona, CA 91768 (800) 325-7961	Subscription service for Government documents
Brodart Automation 500 Arch Street Williamsport, PA 17705 (800) 223-8467	GPO catalog: Depository and Nondepository titles.
Department of Atmospheric Sciences University of Washington Seattle, WA 98195 (206) 545-0910	Northern Hemisphere Meteorological Data for the years 1940-1980.
DeLorme Mapping Systems P.O. Box 298 Freeport, ME 04032 (207) 865-4171	Worldwide vector-based atlas.
Dialog Information 3460 Hillview Avenue Palo Alto, CA 94304 (800) 334-2564	National Technical Information Service, 5 years.
ERM Computer Services Inc. West Chester Pike West Chester, PA 19382 (800) 544-3118	Federal and State environmental 999 issues.
Geovision Inc. 270 Scientific Drive Suite 1 Norcross, GA 30092 (404) 448-8224	Maps at the National, State and metro levels.

Highlighted Data P.O. Box 17229 Washington, DC 20041 (703) 241-1180	US geographics for use with the Macintosh.
Information Handling Services Inc. 2001 Jefferson Davis Hwy. Suite 1201 Arlington, VA 22202 (703) 521-5000	Personnel Information.
Innovative Technology Inc. 7927 Jones Branch Drive McLean, VA 22102 (703) 734-3000	Technical Logistics Reference Network, Federal Catalog System.
McGraw-Hill Book Co. 11 West 19th Street New York, NY 10011 (212) 512-2000	Science and Technology Encyclopedia Dictionary of Scientific Terms
Microsoft 16011 NE 36th Way Redmond, WA 98073 (206) 882-8080	US Government Statistics.
National Institute of Building Sciences 1015 15th Street NW Suite 700 Washington, DC 20005 (202) 347-5710	Construction guides for selected government agencies.
National Standards Association Inc. 5161 River Road Bethesda, MD 20816 (800) 638-8094	Parts and products procured and stocked by the US Government.
ROM Publishers Inc. 1033 O Street Suite 300 Lincoln, NE 68508 (402) 476-2965	Legal libraries by region.
SilverPlatter 37 Walnut Street Wellesly Hills, MA 02181 (617) 239-0306	Government Printing Office Database. Corporate and industrial research reports. Abstracts in librarianship and related fields.

US Department of Commerce, Patent and Trademark Office Washington, DC	Patent and trademark information from 1969 to present. These data are available by assignee, classification, and patent bibliography.

Computer Product Listings

USA Information Systems Inc. 3303 Duke Street Alexandria, VA 22314 (800) USA-8830	Automated Logistics Procurement System including Mcrl/ml-c/il/amdf/miapl and procurement history files.
VLS Inc. 310 South Reynolds Road Toledo, OH 43623 (419) 536-5820	Code of Federal Regulations.
Diversified Data Resources Falls Church, VA (703) 237-0682	Catalog of available CD-ROM applications
GML Corporation Lexington, MA (617) 861-0515	Specifications and pricing for mainframe, mini- and and microcomputer hardware and software products.
International Computer Programs Inc. (317) 844-7461	Mainframe, mini- and microcomputer software and services index.
Microsoft Corporation Redmond, WA (206) 882-8080	Programmers Library, 20,000 pages of reference materials force software and hardware.
Ziff Communications Co. New York, NY (212) 503-4400	Full text and abstracts of the most recent 12 months of 32 computer industry publications and articles from 135 newspapers, magazines and journals.
Bureau of Electronic Publishing, Inc. 141 New Road Parsippany, NJ 07054 (201) 808-2700	Has an on-line CD-ROM library for free investigation of many commercial CD-ROM titles. The service can be accessed by contacting the company and requesting a password. The company will transmit a password and all necessary instructions to the requestor via FAX. If FAX is unavailable, the information will be mailed.

APPENDIX K: SYSTEMS ANALYSIS/REQUIREMENTS TEMPLATE

This appendix will provide an outline for requirements analysis preparation. The outline is sufficiently generic to be applicable to the full range of Information Management (IM) operations. It should be noted that the format of the analysis is relatively arbitrary, but the approach to identifying functional requirements and analyzing alternative solutions is the primary objective of this appendix.

Requirements Analysis for Implementing CD-ROM/Optical Storage Technology

1. Current Environment:

[describe the physical, organizational, and functional characteristics of the operation being analyzed]

A. Installed systems and procedures
[describe current applications, systems, and procedures]

B. Identified Deficiencies
[e.g., storage, manpower, redundancy, cost]

C. Identified Advantages
[e.g., familiarity, expertise, standards]

2. Requirements Summary:

[e.g., customer support, cost effectiveness, reduce duplication]

3. Alternatives:

[stipulate assumptions]

[address advantages and disadvantages of each alternative]

A. Available systems
[address the current employed or standard systems, procedures]

B. Commercial systems
[address commercially available, "off-the-shelf" applications/systems]

C. Application/system development
[address uniqueness, lack of available applications, performance]
[in general: consider no change, CD-ROM, contract, micro versus local area network (LAN) versus on-line;

address advantage/disadvantage for each alternative;

consider portability versus performance trade-off]

4. Recommendations:

[identify selected alternative and the basis for selection;

project the useful lifetime of the alternative and its replacement;

identify mechanisms for defining ongoing functional requirements.
(special interest groups, steering committees, etc.)]

APPENDIX L: DRAFT OF ELECTRONIC RECORDS MANAGEMENT REGULATION 36 CFR PART 1234

Draft of the National Archives and Records Administration (NARA) Electronic Records Management (36 CFR Part 1234) regulation submitted to the Office of Management and Budget (OMB) for review and coordination.

This is the final rule submission and revises NARA regulations concerning Federal agencies' electronic records. This revision will mandate procedures to manage electronic records, to provide for the selection and maintenance of electronic storage media, to define and establish the Judicial use of electronic records, and to follow the legal requirements for the disposition of such records. As a result, regulations will more effectively deal with the issues associated with data base management systems and office automation technologies. Identical regulations will be issued simultaneously by the General Services Administration (GSA) and be published at FIRMR 201-45.2.

On December 5, 1988, NARA published a notice of proposed rulemaking in the Federal Register (53 FR 48936). On December 27, 1988 (53 FR 52202), NARA formally extended the comment period to February 3, 1989, in order to allow Federal agencies and the public more time to comment. By March 20, 1989, NARA had received comments from 18 Federal agencies, two private organizations, and one member of Congress. NARA believes that the rule, as now revised, accommodates valid criticisms and suggestions. It is anticipated that the rule will be accepted as written, with minor or no changes. The final rule was submitted to OMB for consideration in October, 1989.

List of subjects in 36 CFR Part 1234: Archives and records

For the reasons set forth in the preamble, Chapter XII of Title 36 of the Code of Federal Regulations is amended to read as follows: PART 1234 - ELECTRONIC RECORDS MANAGEMENT Sec.

Subpart A -- General

Subpart B -- Program Requirements

SUBPART A -- General

1234.1 Scope of Part.

This part establishes the basic requirements related to the creation, maintenance, use, and disposition of electronic records. Electronic records include numeric, graphic, and text information, which may be recorded on any medium capable of being read by a computer and which satisfies the definition of a record. This includes, but is not limited to, magnetic media, such as tapes and disks; and optical disks. Unless otherwise noted, these requirements apply to all electronic records systems, whether on microcomputers, minicomputers, or main-frame computers, regardless of storage media, in network or stand-alone configurations. Guidance on electronic records management and related issues may be obtained from the National Archives and Records Administration, Agency Services Division (NIA) Washington, DC 20408 and the General Services Administration. Office of Innovative Office Systems (KO). Washington, DC 20405.

1234.2 Definitions.

Basic records management terms are defined in 36 CFR 1220.14. As used in Part 1234--

"Data base" means a set of data, consisting of at least one data file, that is sufficient for a given purpose.

"Data base management system" means a software system used to access and retrieve data stored in a data base.

"Data file" means related numeric, textual, or graphic information that is organized in a strictly prescribed form and format.

"Electronic record" means any information that is recorded in a form that only a computer can process and that satisfies the definition of a Federal record in 44 USC 3301.

"Electronic records system" means any information system that produces, manipulates, or stores Federal records by using a computer.

"Information system" has the meaning given to it by the Office of Management and Budget in circular No. A-130: "the organized collection, processing, transmission, and

dissemination of information in accordance with defined procedures, whether automated or manual."

"Text documents" means narrative or tabular documents, such as letters, memorandums, and reports, in loosely prescribed form and format.

SUBPART B -- Program Requirements

1234.10 Agency Responsibilities.

The head of each Federal agency shall ensure that the management of electronic records incorporates the following elements:

(a) Assigning responsibility to develop and implement agencywide programs for the management of all records created, received, maintained, used, or stored on electronic media: and notifying the National Archives and Records Administration, Office of Records Administration (NIA), Washington, DC 20408 and the General Services Administration. Regulations Branch (KMPR), Washington, DC 20405, of the name and title of the person assigned the responsibility.

(b) Integrating the management of electronic records with other records and information resources management programs of the agency.

(c) Incorporating electronic records management objectives, responsibilities, and authorities in pertinent agency directives and disseminating them throughout the agency as appropriate.

(d) Establishing procedures for addressing records management requirements, including recordkeeping requirements and disposition, before approving new electronic records systems or enhancements to existing systems.

(e) Ensuring that adequate training is provided for users of electronic records systems in the operation, care, and handling of the equipment, software, and media used in the system.

(f) Developing and maintaining up-to-date documentation about all electronic records systems that is adequate to: specify all technical characteristics necessary for reading or processing the records; identify all defined inputs and outputs of the system; define the contents of the files and records; determine restrictions on access and use; understand the purpose(s) and function(s) of the system; describe update cycles or conditions and rules for adding information to the system, changing information in it, or deleting information; and ensure the timely, authorized disposition of the records.

(g) Specifying the location, manner, and media in which electronic records will be maintained to meet operational and archival requirements, and maintaining inventories of electronic records systems to facilitate disposition.

(h) Developing and securing NARA approval of records disposition schedules, and ensuring implementation of their provisions.

(i) Specifying the methods of implementing controls over national security-classified, sensitive, proprietary, and Privacy Act records stored and used electronically.

(j) Establishing procedures to ensure that the requirements of this Part are applied to those electronic records that are created or maintained by contractors.

(k) Ensuring compliance with applicable Governmentwide policies, procedures, and standards such as those issued by the Office of Management and Budget, the General Accounting Office, the General Services Administration, the National Archives and Records Administration, and the National Institute of Standards and Technology.

(l) Reviewing electronic records systems periodically for conformance to established agency procedures, standards, and policies as part of the periodic reviews required by 44 U.S.C. 3506. The review should determine if the records have been properly identified and described, and whether the schedule descriptions and retention periods reflect the current informational content and use. If not, or if substantive changes have been made in the structure, design, codes, purposes, or uses of the system, submit an SF 115, Request for Records Disposition Authority to NARA.

SUBPART C -- Standards for the Creation, Preservation, and Disposition of Electronic Records

1234.20 Creation and Use of Data Files.

(a) For electronic records systems that produce, use, or store data files, disposition instructions for the data shall be incorporated into the systems design.

(b) Agencies shall maintain adequate and up-to-date technical documentation for each electronic records system that produces, uses, or stores data files. Minimum documentation required is a narrative description of the system; physical and technical characteristics of the records, including a record layout that describes each field including its name, size, starting or relative position, and a description of the form of the data (such as alphabetic, zoned decimal, packed decimal, or numeric), or a data dictionary or the equivalent information associated with a data base management system including a description of the relations between data elements in data bases; and any other technical information needed to read or process the records.

1234.22 Creation and Use of Text Documents.

(a) Electronic records systems that maintain the official file copy of text documents on electronic media shall meet the following minimum requirements:

(1) Provide a method for all authorized users of the system to retrieve desired documents, such as an indexing or text search system;

(2) Provide an appropriate level of security to ensure integrity of the documents;

(3) Provide a standard interchange format when necessary to permit the exchange of documents on electronic media between agency components using different software/operating systems and the conversion or migration of documents on electronic media from one system to another; and

(4) Provide for the disposition of the documents including, when necessary, the requirements for transferring permanent records to NARA (see 1228.188 of this chapter).

(b) Before a document is created electronically on electronic records systems that will maintain the official file copy on electronic media, each document shall be identified sufficiently to enable authorized personnel to retrieve, protect, and carry out the disposition of documents in the system. Appropriate identifying information for each document maintained on the electronic media may include: office of origin, files code, key words

for retrieval, addressee (if any), signature, author, date, authorized disposition (coded or otherwise), and security classification (if applicable). Agencies shall ensure that records maintained in such systems can be correlated with related records on paper, microform, or other media.

1234.24 Judicial Use of Electronic Records.

Electronic records may be admitted in evidence to Federal courts for use in court proceedings (Federal Rules of Evidence 803(6)) if trustworthiness is established by thoroughly documenting the recordkeeping system's operation and the controls imposed upon it. Agencies should implement the following procedures to enhance the legal admissability of electronic records.

(a) Document that similar kinds of records generated and stored electronically are created by the same processes each time and have a standardized retrieval approach.

(b) Substantiate that security procedures prevent unauthorized modification or deletion of a record and ensure system protection against such problems as power interruptions.

(c) Identify the electronic media on which records are stored throughout their life cycle, the maximum time span that records remain on each storage medium, and the NARA-approved disposition of all records.

(d) Coordinate all of the above with legal counsel and senior IRM and records management staff.

1234.26 Security of Electronic Records.

Agencies shall implement and maintain an effective records security program that incorporates the following:

(a) Ensures that only authorized personnel have access to electronic records.

(b) Provides for backup and recovery of records to protect against information loss.

(c) Ensures that appropriate agency personnel are trained to safeguard sensitive or classified electronic records.

(d) Minimizes the risk of unauthorized alteration or erasure of electronic records.

(e) Ensures that electronic records security is included in computer systems security plans prepared pursuant to the Computer Security Act of 1987 (40 USC 759 note).

1234.28 Selection and Maintenance of Electronic Records Storage Media.

(a) Agencies shall select appropriate media and systems for storing agency records throughout their life, which meet the following requirements:

(1) Permit easy retrieval in a timely fashion;

(2) Facilitate distinction between record and nonrecord material;

(3) Retain the records in a usable format until their authorized disposition date; and

(4) When appropriate, meet requirements for transferring permanent records to NARA (see 1228.188 of this chapter).

(b) The following factors shall be considered before selecting a storage medium or converting from one medium to another:

(1) The authorized life of the records as determined during the scheduling process;

(2) The maintenance necessary to retain the records;

(3) The cost of storing and retrieving the records;

(4) The records density;

(5) The access time to retrieve stored records;

(6) The portability of the medium (that is, selecting a medium that will run on equipment offered by multiple manufacturers) and the ability to transfer the information from one medium to another (such as from optical disk to magnetic tape); and

(7) Whether the medium meets current applicable Federal Information Processing Standards.

(c) Agencies should avoid the use of floppy disks for the exclusive long-term storage of permanent or unscheduled electronic records.

(d) Agencies shall ensure that all authorized users can identify and retrieve information stored on diskettes, removable disks, or tapes by establishing or adopting procedures for external labeling.

(e) Agencies shall ensure that information is not lost because of changing technology or deterioration by converting storage media to provide compatibility with the agency's current hardware and software. Before conversion to a different medium, agencies must determine that the authorized disposition of the electronic records can be implemented after conversion.

(f) Agencies shall back up electronic records on a regular basis to safeguard against the loss of information due to equipment malfunctions or human error. Duplicate copies of permanent or unscheduled records shall be maintained in storage areas separate from the location of the records that have been copied.

(g) Maintenance of magnetic computer tape.

(1) Agencies shall test magnetic computer tapes no more than 6 months prior to using them to store electronic records that are unscheduled or scheduled for permanent retention. This test should verify that the tape is free of permanent errors and in compliance with National Institute of Standards and Technology or industry standards.

(2) Agencies shall maintain the storage and test areas for computer magnetic tapes containing permanent and unscheduled records at the following temperatures and relative humidities:

Constant temperature - 62° to 68° F.
Constant relative humidity - 35% to 45%

(3) Agencies shall rewind under controlled tension all tapes containing unscheduled and permanent records every 3-1/2 years.

(4) Agencies shall annually read a statistical sample of all reels of magnetic computer tape containing permanent and unscheduled records to identify any loss of data and

to discover and correct the causes of data loss. In tape libraries with 1800 or fewer reels, a 20% sample or a sample size of 50 reels, whichever is larger, should be read. In tape libraries with more than 1800 reels, a sample of 384 reels should be read. Tapes with 10 or more errors shall be replaced and, when possible, lost data shall be restored. All other tapes which might have been affected by the same cause (i.e. poor quality tape, high usage, poor environment, improper handling) shall be read and corrected as appropriate.

(5) Agencies shall copy permanent or unscheduled data on magnetic tapes before the tapes are 10 years old onto tested and verified new tapes.

(6) External labels (or the equivalent automated tape management system) for magnetic tapes used to store permanent or unscheduled electronic records shall provide unique identification for each reel, including the name of the organizational unit responsible for the data, system title, and security classification, if applicable. Additionally, the following information shall be maintained for (but not necessarily attached to) each reel used to store permanent or unscheduled electronic records: file title(s); dates of creation; dates of coverage; the recording density; type of internal labels; volume serial number, if applicable; number of tracks; character code/software dependency; information about block size; and reel sequence number, if the file is part of a multi-reel set. For numeric data files, include record format and logical record length, if applicable; data set name(s) and sequence, if applicable; and number of records for each data set.

(7) Agencies shall prohibit smoking and eating in magnetic computer tape storage libraries and test or evaluation areas that contain permanent or unscheduled records.

(h) Maintenance of direct access storage media.

(1) Agencies shall issue written procedures for the care and handling of direct access storage media which draw upon the recommendations of the manufacturers.

(2) External labels for diskettes or removable disks used when processing or temporarily storing permanent or unscheduled records shall include the following information: name of the organizational unit responsible for the records, descriptive title of the contents, dates of creation, security classification, if applicable, and identification of the software and hardware used.

1234.30 Retention of Electronic Records.

Agencies shall establish policies and procedures to ensure that electronic records and their documentation are retained as long as needed by the Government. These retention procedures shall include provisions for,

(a) Scheduling the disposition of all electronic records, as well as related documentation and indexes, by applying General Records Schedules (particularly GRS 20 or GRS 23) as appropriate or submitting an SF 115. Request for Records Disposition Authority, to NARA (see Part 1228 of this chapter). The information in electronic records systems, including those operated for the Government by a contractor, shall be scheduled as soon as possible but no later than one year after implementation of the system.

(b) Transferring a copy of the electronic records and any related documentation and indexes to the National Archives at the time specified in the records disposition schedule in accordance with instructions found in 1228.188 of this chapter. Transfer may take place at an earlier date if convenient for both the agency and the National Archives and Records Administration.

(c) Establishing procedures for regular recopying, reformatting, and other necessary maintenance to ensure the retention and usability of electronic records throughout their authorized life cycle (see 1234.28).

1234.32 Destruction of Electronic Records.

Electronic records may be destroyed only in accordance with a records disposition schedule approved by the Archivist of the United States, including General Records Schedules. At a minimum each agency shall ensure that:

(a) Electronic records scheduled for destruction are disposed of in a manner that ensures protection of any sensitive, proprietary, or national security information.

(b) Magnetic recording media previously used for electronic records containing sensitive, proprietary, or national security information are not reused if the previously recorded information can be compromised by reuse in any way.

Dated:

DON V. WILSON
Archivist of the United States

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