The Videodisk: Technology, Applications, and Some Implications for Archives

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Abstract: As a medium of information storage and retrieval, the video or optical disk affords certain advantages such as high-density storage capabilities, image stability, and speed of recall. This article reviews current videodisk technology and discusses some of its strengths, advantages, and problems as well as its potential as a medium of recording, storage, and retrieval for archival materials, both textual and pictorial. Also considered are the experimental and exploratory uses of the videodisk for archival purposes as conducted in pilot programs by the Public Archives of Canada and by the Library of Congress. Although the videodisk is relatively new and as yet has not been adopted as a permanent storage medium on a large scale, its technical potential is such that its use in archives should not be overlooked.

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Introduction: The Past and Recent Past

FROM THE BEGINNING OF DISCERNIBLE HISTORY man has exhibited varying degrees of obsession with the transmission and preservation of his thoughts. Unlike other species, which apparently are content with communication for the moment and concentrate on propagating themselves, man is curious to know what his forebears thought and is anxious to ensure that his successors will have access to at least some of his ideas in the future. Whether the message be chiselled on stone, laboriously transcribed in multiple copies onto the skins of animals, mechanically reproduced in millions of identical paper copies, or electronically encoded and sent through wires or invisible beams, the urge to communicate and to preserve the message is evident. In modern times the institutionalized preservation of these messages gave rise to archives, museums, and libraries. So vast has this accumulation of past thoughts become that the trees often cannot be seen for the forest. A medieval friar's missive and a telex message become information to be used by the scholar or the stockbroker. The managers and guardians of these accumulations become information specialists who manipulate and massage systems, all to fulfill these two tendencies of man. When blights or politics curbed the use of papyrus, countless herds of sheep became the medium for transmission; when parchment proved too expensive, paper provided the answer; and when forests are threatened with extinction, another medium has to be developed. Physically shrinking the message provides one solution. The technology of the last two decades has permitted the reduction of messages to almost infinitesimal dimensions and allows for their full reconstitution. But even this accomplishment is not enough.

The idea of using microfilm as a recording medium on an institutional basis was suggested as early as 1929, although the technology had existed prior to that date. Most of the large microfilming projects carried out by libraries, universities, and archives prior to World War II were concerned with duplicating historical documents and works of an archival nature. One of the earliest was carried out by the Library of Congress between 1927 and 1934 with a generous grant from J.D. Rockefeller. Simply named "Project A," it had, by its completion, copied almost two and a half million documents and manuscripts from Europe, Canada, and Mexico. It should be noted that the project started out using the relatively expensive photostatic method of copying and ended using the less expensive microfilming methods. Such activity continued after the war with such landmark projects as the one carried out by St. Louis University in the 1950s, when it microfilmed more than 300,000 codices from the Vatican Archives.[1] Since then the worth and success of the microformat, in its reduction capabilities and in the economy of its production and storage features, has made this an ubiquitous medium in a variety of institutions.

With its capability to reduce images to under ninety times the original size, the microformat is quite impressive. Computer-output microfilm (COM) has been available for a number of years, and the speed and economy of its production has fairly well ensured its place in the information chain. Although the majority of microfilm is in the reel format, mechanized readers alleviate access time somewhat. Fiche format provides even faster locating capabilities. At the extreme end of micro image technology are computer-

[1]Lester K. Born, "History of Microform Activity," *Library Trends* 34 (January 1960): 349–56.

assisted systems that allow retrieval of a document in about ten seconds.[2] In sum, the microformat is a proven viable recording medium. Yet advances in technology continue to rapidly render past inventions obsolete.

Technical Features of Videodisks

The videodisk is the newest innovation in the field of information storage and retrieval. The most exciting features of this medium reside, however, in its potential. This is not to say that the videodisk is still on the drawing board. As is well known, the commercial sale of movie videodisks for consumer use has been in progress for a number of years. It was in the development of the product for home entertainment that the potential of the medium was discovered.[3]

A commercially sold movie videodisk has about thirty minutes of playing time to a side, and the disc itself has a capacity of up to 54,000 frames or tracks to a side. As in the film original, each of the disk's frames is capable of holding a discrete and reproducible image in the form of codes, in either digital (binary) or analog form. Upon replay these codes are converted to either pictorial or textual images. It is the idea of the 108,000-image capacity per disk, if both sides are recorded in analog signals, that makes the potential of videodisk so attractive. (Digital coding allows for 40,000 tracks per side.)

The disk itself is not any larger in diameter than a standard long-playing record and is about twice as thick (2.5 mm). The coding, which may be for both visual and aural reproduction, has been burned or etched onto the disk with a finely modulated laser. This coding is in the form of microscopic pits and gouges of varying lengths and spacings arranged in a continuous spiral, much like the grooves of a phonograph record. Upon replay the disk, which is rotated at speeds up to 1,800 rpm, is read by a read-head mechanism that projects a laser beam onto the disk across the pits, catches the light thus refracted by the coding, and reconstructs the image. At no point is there any physical contact between the disk and the read-head mechanism. This system of storage and retrieval is also referred to as optical videodisk or laser videodisk. This is an intentionally simple explanation given only to provide a basis for technical reference.[4]

The excitement is in the incredible number of pits that can be packed into a disk. "Potentially, the capacity is approximately one billion characters per disc. This is equivalent to storing more than 1,000 novels or all of MEDLINE on one to three discs."[5] Such a potential is certainly irresistible grounds for speculation. (The problem is how to make the best use of this available density.) For now the technology is struggling with the single-frame concept, for it appears that one film image does not necessarily translate into one videodisk frame. Since the final image is projected through a tele-

[2]William Saffady, *Micrographics.* (Littleton, Colo.: Libraries Unlimited, 1978), 185–202.

[3]Alan Horder, *Video Discs—Their Application to Information Storage and Retrieval.* (Bayfordbury, U.K.: National Reprographic Centre for Documentation, 1978), 7–8. Actually, a prototype of the videodisk was invented by the television pioneer J.L. Baird, and the product, called Baird Radiovision, was put on sale for four months in 1935. Understandably, it was a little too advanced for the time since very few people had heard of television.

[4]The technology of videodisks is explained in numerous articles. Among the most comprehensible and comprehensive is that by Horder (above); the most succinct is Anthony E. Cawkell, "Information Technology and Communications," *Annual Review of Information Science and Technology*, A.S.I.S. 15 (1980): 47. The simplest is Arlene F. Sirkin, "The Videodisc Revolution," *Picturescope* 5 (April 1976): 93–100.

[5]Harold Wooster, "Biomedical Communications," *Annual Review of Information Science and Technology*, A.S.I.S. 17 (1982): 210–11.

vision screen, the problem is with resolution. Most televisions have either 625- or 525-line resolutions, which are not fine enough for the qualitative reproducing of all images.[6] A typical page of text has about six times as many image points as can be resolved on a standard screen; thus, theoretically, one text image will require six video frames for satisfactory resolution.[7] This automatically reduces the disk's capacity from 54,000 to 9,000 images. Certain other images, such as some paintings or large maps, require from 37 to 640 frames for adequate resolution,[8] thus further reducing storage capacity. The higher number of frames required for different types of source images is not, however, immutable. Matrix configuration and overlap shooting techniques have managed to reduce the number of frames required. The ideal of one frame per image is being met in most instances for most types of source material. Furthermore, technological advances are moving to meet the problem both in the method of packing codes and in the development of higher resolution screens of 1,000 lines or more.

The single-image retrieval afforded by the videodisk is accomplished through a freeze-frame technique whereby the readhead and laser beam remain stationary over a single track, which is the equivalent of one frame (or, a number of tracks can be read in repeated sequences if reconstituting the image requires several frames).[9] Retrieval of a desired single image is through a link with a computer program that allows random access to a particular track. The computer portion of a videodisk system is fairly well developed and can be selected from among several commercially available systems. For the most part, however, the software for a large-capacity institutional system still has to be customized.[10]

Advantages and Comparisons

This brief review of videodisk technology points to several advantages, both potential and actual. Among the strengths of the medium are data storage, random access, durability, and economy. Each of these attributes is discussed in detail below.

Data Storage: Two concepts are involved. One is the single-frame concept, which allows for the transmission of a single track to faithfully reproduce the image. In this category up to 108,000 frames are available on each two-sided disk. The other concept is the storage of textual and numeric data in digital form. These bits and bytes are extremely computer compatible, and the bit density per disk exceeds that of any other storage medium of comparable surface area (compare magnetic tapes, disks, and microforms).[11] Bit storage can attain

[6]Horder, *Video Discs*, p. 24.

[7]David Becker, "Automated Language Processing," *Annual Review of Information Science and Technology*, A.S.I.S. 16 (1981): 116.

[8]Dennis Mole and Josephine Langham, *Pilot Study of the Application of Video Disc Technology at the Public Archives of Canada.* (Ottawa: Public Archives of Canada, 1982), p. 10.

[9]Horder, *Video Discs*, p. 23–24.

[10]Office data storage and retrieval systems that use optical disks are available, such as the Toshiba DF-2000. Other Japanese, French, and American firms are also readying in-house systems for business technology markets. See Dick Moberg and Ira M. Laefsky, "Videodiscs and Optical Data Storage," *Byte* 5 (June 1982): 142–60.

[11]The surface area occupied by one frame of a 98-image microfiche is 160 mm^2; a single image on a 3,000-frame ultrafiche occupies 5 mm^2. By comparison, the frame equivalent on a two-sided videodisk, or one track average, takes up 0.5 mm^2. Alan Horder, "Video Discs—Their Potential in Information Storage and Retrieval," *Reprographics Quarterly* 12 (Spring 1979): 48.

10,000 million per side, and the number can be quadrupled if both sides are used with layering of the levels of data.[12] By comparison, a 2,400-foot magnetic reel with 1,600 bytes to the inch carries 368.64 million bits. The frame per image concept, however, will yield appreciably lower capacities for reasons already given. In any case, storage capacity is immense.

Random Access: When linked to the appropriate computer program, the address of each frame can be directly accessed. These addresses can be numbered from 1 to 54,000 or reconstructed in different series to save coding space. This type of access is clearly superior to the sequential mode of magnetic tape and reel microfilm. Compared even with computer-assisted microfilm systems where optimum retrieval time is ten seconds for the first document and about one second for each document thereafter, the optical disk can be accessed in a few hundred milliseconds at its fastest.[13] Magnetic tape is faster, especially for sequentially stored information, but the physical loading and unloading, due to limited storage capacity, and contact with the read device are drawbacks. Magnetic disks are more convenient and faster, but they too have limited storage and access capacity in comparison to the videodisk.

Durability: In comparison with magnetic tape, the videodisk is evidently superior. First, the coding is coated with one of several types of protectant; second, the disk itself does not make contact with the read-head mechanism so there is no wear through friction. As to its long-term preservation capabilities, there are no hard and fast standards at present, although archival life has been claimed for periods between ten and forty years.[14] Magnetic tape, on the other hand, is notorious for its instability. Even under ideal conditions and with care in handling, it "cannot be left indefinitely without maintenance and recopying. It is recommended that tapes be re-tensioned at six-monthly intervals and transcribed every twelve months."[15] Although microfilm of archival quality has a life expectancy of well over a century, this is under the most ideal of circumstances and storage conditions.[16] In practice, microfilm usage entails abrasive contact with the reading machine mechanism and exposure to heat and light sources that can and do accelerate its deterioration. "The point is that archival silver film, archivally processed, cannot be counted on to last permanently unless it is also archivally stored and handled as little as possible."[17] Overall it seems that videodisks will provide a conservative quality

[12] Horder, *Video Discs*, p. 27.

[13] Surachai Suthasinekul, "Microfilm vs Optical Disc as Storage Medium for Document Retrieval and Dissemination," *Communicating Information: Proceedings of the 43rd ASIS Annual Meeting*, 1980, p. 102.

[14] The low end is mentioned by Fred E. Marsh, "Video Technology," *Journal of the American Society for Information Science* 33 (July 1982): 243. The claim of forty years is made by Toshiba Industries. See Edward S. Rothchild, "Optical-Memory Media: How Optical Disks Work, Who Makes Them, and How Much Data They Can Hold," *Byte* 8 (March 1983): 88. Mole and Langham refer to a range of ten to 100 years and estimate fifty years is a reasonable life for an optical disk. (*Pilot Study*, p. 15).

[15] Michael Roper, "The Changing Face of the File: Machine-Readable Records and the Archivist," *Archives* 14 (Spring 1980): 149.

[16] *American National Standard Specifications for Photographic Film for Archival Records, Silver Gelatine Type, on Cellulose Ester Base*, PH 1.28 (New York: ANSI, 1981). For polyester base support, refer to ANSI PH 1.41 (1981); see also Saffady, *Micrographics*, p. 78–79.

[17] Pamela W. Darling, "Microforms in Libraries: Preservation and Storage," *Microform Review* 5 (April 1976): 97.

that will stand up to constant use that surpasses the other two media mentioned. Ease and economy of replication are other factors to be included in its preserving qualities.

Economy: This is the most difficult question to address, and most answers will be tenuous at best. Since this is a nascent technology, costs are high because many of the developments are barely beyond the experimental stage. Some figures and trends do, however, crop up. In 1980 it was estimated that the cost of mastering a disk (converting a disk from videotape) was $4,000; the next year the mastering cost fell to $3,000, and the price per copy of between 100 and 1,000 copies was $10.[18] Costs per image stored on videodisks for 1980 as compared to other media were: Tellurium videodisk—.0125¢; silver halide videodisk—.005¢; microfiche (72X COM)—.0045¢; microfilm (100 feet)—.004¢; magnetic tape (2,400 feet)—.017¢; magnetic disk pack—.625¢.[19] While these prices are not quite competitive at present, they can safely be expected to drop as development proceeds beyond the first generation of videodisk systems.

The foregoing comparative review helps to explain in part the growing enthusiasm for videodisk as a storage medium. One author has pointed out that "the optical system is just too powerful to ignore or to keep down for long."[20] To do so will be to willfully ignore a powerful medium and its potentials. There is little doubt that the videodisk will find its appropriate place in those institutions charged with the responsibility of conserving man's documentary heritage.

Two Case Studies

Libraries, manuscripts collections, and archives that are open to the public are burdened with a dual and often times opposing responsibility. On the one hand, the user must be allowed reasonable access to the institution's resources, while at the same time the institution is charged with the preservation and safeguarding of its collection. In attempting to fulfill these responsibilities, various methods have been and are being used, from the provision of facsimile copies to microcopies. It is possible, however, that these copies may not even survive as long as the original might. Furthermore, the problem of access is not appreciably alleviated because of the immense amount of unique material in the manuscripts and records categories.

Many of the institutions that have adopted the videodisk storage and retrieval medium are doing so on an experimental basis.[21] This caution is quite understandable because of the still developing technology and the initial costs involved. Any savings that might be made through in-house production are precluded for the present by extremely high start-up costs.[22] The combined results of these projects, however, should contribute to standardization of pro-

[18]These two figures were given by Becker (p. 116) and Wooster (p. 210), respectively.

[19]Gerald O. Walter, "Will Optical Disk Memory Supplant Microfilm?" *Journal of Micrographics* 13 (July/August 1980): 30.

[20]Charles Sneed, "The Videodisc Revolution: What's Ahead for Libraries?" *Wilson Library Bulletin* 55 (November 1980): 189.

[21]*Videodisc/Videotex* publication has started a "Videodisc Projects Directory" that lists in each issue a number of institutions that are engaged in videodisk storage and retrieval methods. To date, more than three dozen institutions are listed. Excluded are offices and companies using commercially available systems.

[22]Alexander Lee Nyerges, "Museums and the Videodisc Revolution: Cautious Involvement," *Videodisc/Videotex* 2 (Fall 1982): 272.

cedures and hardware and, ultimately, to lower costs.

Among the first and most significant videodisk projects was that launched in 1978 by the Public Archives of Canada (PAC). The goal was largely experimental and exploratory; it was intended "to investigate the possibility of using videodisc as a means of handling some of the access and conservation problems involved in the preservation of information recorded on the materials found in a modern archives."[23] At this relatively early date there was a great deal of trial and error and many false starts were made by both manufacturers and client. PAC had originally contracted with MCA of Los Angeles for provision of the disk player, to be delivered for a combined demonstration by October 1979. Technical difficulties prevented MCA from delivering a player to the Canadian archives in time, but an acceptable player was acquired from Thomson C.S.F. (France). It is interesting to note that many of the current video projects use Thomson C.S.F. model players based on this first version. Other components of the system (microcomputer, keyboard, monitor screens) were selected from existing models. The access program was custom written. Recording transfer used was from 16-mm film to videotape to disk. The end result was a two-sided disk that had a 108,000-frame capacity encoded (digital) to store 37,000 images, in both color and black-and-white, along with audio track. Access time, image, and audio quality were judged to be good to excellent. The source materials stored ranged from illustrations to maps to texts. This early project proved the viability of videodisk as a medium of storage and access.

Between the summers of 1981 and 1982 the National Library of Canada (NLC) carried out a project that resulted in a two-sided disk containing four programs: one movie (16-mm originally) and three slide shows. The latter drew from an even wider range of still source materials and further demonstrated the capabilities of videodisks. The disk was designed to be a public relations program.[24]

The largest current project is undoubtedly that being conducted by the Library of Congress (LC). Labeled the "Optical Disk Pilot Program," it is intended to take three years to complete from its inception in 1983. Primarily the medium is being explored as a preservation means, since a fair number of LC's eighty million items are in danger of deterioration. At the same time, the project will devise means for user access to the stored information.[25]

Two distinct approaches are being taken in LC's project. For pictorial materials the transfer method is similar to those mentioned above; for high resolution, however, 35-mm color film is being used as the initial recording medium. In all, more than 120,000 images are expected to be stored, with source materials ranging from prints to photographs to glass negatives. Many of the items in the last category have never had positive images made because of their fragility. An interesting development is that the videodisk image will transmit a positive image because of the ability to manipulate the coding. The original images will be stored in color; and one clear advantage of disks is that on disks, unlike filmed or printed

[23]Mole and Langham, p. 5. This entire work is an account and analysis of the PAC project.

[24]Sabine Sonnemann, "The Videodisc as a Library Tool," *Special Libraries* 74 (January 1983): 7–13. This entire article deals with the NLC project.

[25]Library of Congress. Planning Office. *Optical Disk Pilot Program* (1983). Also see: *Wilson Library Bulletin* 57 (January 1983): 376. Background information was also provided through interviews with Robert N. Lisbeth, Prints and Photographs Division, Library of Congress.

versions, the color will not fade. Color transparencies are notorious for their tendency to fade unless sealed and stored at temperatures below freezing. The attention given to recording photographic images is warranted because negatives and prints are recognized as particularly fragile and unstable storage media.

Another goal of the project is to record 500,000 images of text from frequently used periodicals. There is no filmed intermediary stage; the document is placed before a high-speed scanner that will digitize the information for direct transfer to laser writing on the disk. Perhaps a more significant development in dealing with texts is that a 2,200-line resolution screen has been developed by Sony for playback, thereby eliminating some of the problems associated with text materials and decreasing the use of an optical disk's 108,000-frame capacity. The most time-consuming aspect of the project will be the tagging of frames for access and building an index.

Archival Implications

All of the materials presently being put on disks—textual, photographic, cartographic—are also types of material housed by archives; and, except for certain problems with textual material—problems that no doubt will be solved—all archival materials can feasibly be put on disks. The preservation, space, and access advantages have already been reviewed. Yet, apart from the Library of Congress project to put some half-million text images on disk, not one of the projects is actively considering the recording of any appreciable portion of its manuscripts or records holdings onto disks. Rather, the emphasis thus far has been on pictorial and illustrative materials.

The reasons for this reluctance are in many ways evident and have to do with the inherent structure, organization, and holdings of archives and the modes of access presently provided. First, one will have to address the question of quantity. The problems of labor and expenses can best be illustrated by considering a parallel activity whereby each item has to be handled. It was estimated that it would take 5,000 man-years to stamp each of the two and a half billion documents in NARS, at a cost of $20 million in 1960 currency.[26] This cost is with very low initial investment and overhead. The cost of recording that number of items onto disks will be much higher. It is tempting, nonetheless, to speculate that all those items can be stored on 9,259 disks, or half that number if the technology allows for efficient layering of the frames, and that the disks will only occupy 771 linear feet of shelf space if stored vertically with a generous allotment of one inch per disk. The very real problem if such a fabulous enterprise were undertaken would be the indexing for access. Another question to be considered before even recording the first document is whether it will be used or will merely be regarded as a substitute for microfilm. User resistance to microforms is well known; but on the other hand, some contend that users really do not care what the medium is.[27] The argument will be made, of course, that no scholar with any pro-

[26]Kenneth W. Duckett, *Modern Manuscripts: A Practical Manual to Their Management, Care, and Use.* (Nashville: American Association for State and Local History, 1975), p. 233. Duckett gives the figure as 5,000 man-hours, which in all probability should be 5,000 man-years. At a cost of $20 million, 5,000 hours comes to $4,000 an hour, which is exorbitant by any standards! The cost per hour based on 5,000 man-years comes to almost $2.00 an hour, which is reasonable by the currency value and labor costs of 1960.

[27]Mole and Langham, p. 6. They also report that thus far it is difficult to evaluate user attitudes toward the PAC videodisk system (p. 17). Another factor that might be considered is that a generation of youths is being reared, both at home and in school, with an unprecedented exposure to screen-fed information. Perhaps they will not find the television screen so repugnant.

fessional pride would deign to use an ersatz image. The most reasonable response would be that the electronic images will assist him in selecting which of the "real" documents to call for.

Such arguments as to the merits and drawbacks of the videodisk in archives can continue ad infinitum and will become a parlor game after a while. At this point it would seem redundant to speculate further upon the place of this technology in the archives. Its advantages have been stated and inferred; and the power and capacities of the medium, although still in its infancy, are evident. In the next few years, when its potentials are realized, the question will likely be not should we use the optical disk, but when?

Lest there be detected in the preceding a strain of unbridled enthusiasm for this medium, a tempered and even critical observation is in order. It should be recognized that to date archival uses of the videodisk have largely been of an experimental and exploratory nature. In both the Public Archives of Canada and the Library of Congress projects, the pilot aspects of these undertakings should not be forgotten. Although the PAC experiment was successful and demonstrated the feasibility and even desirability of using the videodisk medium of access, recording, and conservation, the continuing use of this medium on a permanent basis is by no means assured or even justified. The PAC report concludes with an implied recognition that, even with funding and a willingness to experiment, a national archive or library cannot go the route alone. "It is hoped that research companies will respond to archival needs and that the PAC pilot project has played a role in this."[28] In the current undertaking by the Library of Congress, the project's experimental and conditional nature is even more pronounced: "if the disks help the Library perform its work better, more use will be made of them in the future. If not, little further use of them will be made."[29] Involved is not only the use and refinement of videodisk technology, but, more important, the identification of the areas of need (text, non-print) and, finally, evaluation of usage. It is the result of these latter activities that may determine whether there is a viable place for the videodisk in the archival world. There is a commitment to explore and experiment, but unless there is sound justification, we have no obligation to adopt this technology.

It is easy to be seduced and become intoxicated by a novel technology. In the near future, when it might become feasible to store vast amounts of information on ever smaller recording dimensions, a question of what to record and preserve should be addressed. Present physical limitations as to what amounts of material can be housed impose an inherent selection and destruction policy. If these limitations are removed in the future, when it becomes possible to preserve all of man's utterances, should all the noise that he makes be recorded simply because the means to do so exists? The situation will no doubt adjust itself by that time, but I would like to end with a comment by Daniel Gore, who refers to both the metaphor of the Alexandrian Library, which presumed to house all knowledge, and to the multimillion-volume research libraries that far exceed the Alexandrian vision: "The solution to the growth problem will be found ... not in the development of new technology to shore up the cracking foundations of the

[28]Ibid., p. 17.

[29]Carl Fleischhauer, "Research Access and Use: the Key Facet of the Nonprint Optical Disk Experiment," *Library of Congress Information Bulletin* 42 (12 September 1983): 312–16.

ever-climbing Tower of Babel, but in thinking carefully about that most perplexing of problems, How large should a library be.''[30]

[30]Daniel Gore, *Farewell to Alexandria.* (Westport, Conn.: Greenwood Press, 1976), p. 166.