ArchiVISTA: A New Horizon in Providing Access to Visual Records of the National Archives of Canada

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ABSTRACT

IN ORDER TO MAKE more accessible to researchers and the general public the 20,000 editorial cartoons and caricatures in its holdings, the National Archives of Canada developed an optical disc imaging system called ArchiVISTA which merges high resolution imaging technology with the power and flexibility of a fourth generation database language. The authors present a case study of this pilot project after briefly outlining earlier developments in bibliographic control and imaging technology as applied to the National Archives of Canada's graphic records.

INTRODUCTION

When the new gallery of the Canadian Centre for Caricature first opened its doors in Ottawa's lively Byward Market district in June 1989, the public was invited not only to view *The Rogues Gallery*—the inaugural exhibition of Canadian political cartooning—but to avail themselves of the centre's new optical disc image retrieval system, ArchiVISTA. Providing online access to a visual catalog of some 20,000 original editorial cartoons and political caricatures, the ArchiVISTA optical disc system heralds an important new milestone in providing intellectual access to the substantial documentary art and photography collections of the National Archives of Canada.

The Canadian Centre for Caricature was established in May 1986 as a program of the National Archives' Documentary Art and Photography Division. One of the chief aims of the new centre was to increase public awareness of the existing body of cartoons which

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had been collected and preserved by the National Archives since 1906 when, as noted by James F. Kenney (1925), authorization was, for the first time, given to the Dominion Archivist to expend money for the purchase of paintings, drawings, and prints. This goal of raising the public profile and improving accessibility to the caricature collection has been vigorously pursued along many avenues including those of exhibition, publication, and the opening of a new gallery, as previously mentioned. It was also decided to explore the feasibility of using state-of-the-art imaging technology to capture and link each image to a brief, descriptive record in a computer database.

The concept of a visual catalog of art holdings is not a new one. The Public Archives of Canada's report for the years 1959-1969 notes that, in 1964, to assist reference and prevent unnecessary handling, photographic reproductions were made of the paintings and drawings, and a contact print was incorporated into the card catalog. A year later, production of the 5 × 8-inch catalog cards with contact prints from 4 × 5-inch copy negatives was extended to the growing collection of historical photographs. Except for minor improvements, these image-bearing catalog cards remained unchanged for nearly twenty years. In April 1983, with the installation of a new microcomputer system in the then National Photography Collection, the typewritten photo caption was superseded by computerized records from which labels were printed and affixed to the catalog cards. Even though the catalog card still looked much the same as it had before, an important difference was the beginning of an automated file or database of the National Archives' visual documents described at the item level.

Other related automation activities included development of a collection level bibliographic database from which were produced two editions (1979 and 1984) of the *Guide to Canadian Photographic Archives* and, in 1984, implementation by the former Picture Division of the current item level database using MINISIS software on a Hewlett Packard HP3000 minicomputer.

A kindling of interest in the potential benefits of videodisc technology paralleled the National Archives' application of computerized bibliographic information storage and retrieval systems to the administrative and intellectual control of its documentary art and photography collections in the late 1970s and early 1980s. A pilot project was initiated in September 1978 to explore the use of the videodisc as a storage medium for archival records (Mole & Langham, 1982). In 1983, further tests were conducted to determine the feasibility of electronically reproducing black-and-white and color photographic prints. The results were low quality prints that could be used as "proofs;" however, the resolution and density range of the reproductions needed to be improved to meet the departmental

standards for photographic prints (Public Archives of Canada, Annual Report 1984-1985). The following brief outline serves to show that the development of the ArchiVISTA system has built upon an accumulated store of knowledge and experience in both bibliographic databases and imaging technology.

PLANNING AND ANALYSIS

Two separate studies provided valuable information prior to the development of a detailed set of specifications for an optical disc system. In December 1987, conservator Greg Hill completed the Cartoon Materials Survey to establish how the apparent instability of much of the collection should affect the collection policy of the centre. By means of a literature survey, telephone interviews with cartoonists, and an examination of approximately 10 percent of the existing collection, the Cartoon Materials Survey summarized conservation problems and identified resources necessary for the maintenance of the collection based on recommended conservation, storage, and display requirements. Hill also recommended that all cartoons should be copied onto an easily accessible medium for research purposes to minimize their handling. Steps had already been taken to do just that. In February 1988, the National Archives' optical disc advisor submitted recommendations concerning an optical disc system for the centre following completion of a needs assessment and feasibility study (Sylvain, 1988a).

The expressed need for the centre was for a system that would provide quick and easy visual access to the described caricature holdings of the National Archives without having to handle original items, thus facilitating the long-term storage and conservaiton of the collection. Ten different technological means to achieve this goal were initially considered including various forms of photography, microfilm, and optical disc.

Copying of the caricature collection by means of conventional photography—that is, producing reference prints from 4 × 5-inch copy negatives of each item—would prove too time-consuming and laborious, hence costly, beside which was the added inconvenience of lengthy delays between manual image retrieval from a card catalog or filing cabinet and searching a database for the related descriptive records. This latter problem of separate imaging and descriptive systems and its inconvenience to the user also ruled out the use of microfilm unless the 16mm rolls were integrated into a computer-assisted retrieval (CAR) system. Even then, the image-bearing medium was considered too susceptible to scratching and other forms of degradation from frequent use, while no less than a dozen separate rolls would be required for the storage of the entire collection necessitating excessive handling.

A drawback common to CD-ROM (Compact Disc-Read Only Memory) and videodisc-based systems is the need for factory-mastering which, aside from being costly for small production runs, prohibits subsequent additions or changes to be made to the disc. Owing to the ongoing acquisition of substantial numbers of cartoons by the National Archives, this limitation could not be easily overlooked. North American standard NTSC (National Television System Committee) video has the further disadvantage of a maximum of 480 scan lines per image, insufficient to capture, in a single frame, detail as small as 1/100th of the image height, which is representative of approximately 70 percent of the collection.

A problem of all analog systems, including analog WORM (Write Once Read Many) optical discs, is the lack of error detection and correction of information without a digital intermediate step. This causes analog images to deteriorate over time, necessitating eventual recopying with an unknown amount of generation loss. Based upon information available on digital discs made of the same material, analog optical discs were estimated to last about ten years before requiring recopying. Within the archival context, the inherent long-term instability of analog media was considered too serious a flaw on which to base an advanced technology system.

The technology investigation ultimately revealed digital WORM optical disc as the most promising and likely medium on which to base an image capture system, combining high resolution with error detection and correction capabilities to assure minimal generation loss of image quality over an extended period of time, including the foreseeable migration of data necessary to benefit from future technological advancements. In addition, the discs required no factory mastering and would allow for expansion of the image base as more caricatures and cartoons were acquired.

Our euphoria was soon tempered by a growing realization of the digital disc's few shortcomings. High resolution and other desired features were achievable but at the expense of slower, costlier capture devices and large image file sizes, meaning greater numbers of storage media required and slower retrieval speeds. As a consequence, three different approaches to image capture and retrieval were considered: bit mapping, byte mapping, and a hybrid of video, digital, and analog technology.

In the hybrid system, images would be captured at NTSC video resolution, stored onto digital WORM optical discs, and then transferred to analog WORM optical disc for retrieval. The major disadvantage of this approach lay with the low video resolution which would have necessitated additional scanning of many images in order to preserve important details. In both bit map and byte map systems, images would be digitally scanned, stored, and retrieved from digital

WORM optical discs. While sufficiently high resolution could be obtained using either of these methods, bit mapping, involving the scanning of images at one bit per pixel, could only reproduce two tonal levels, white or black, without resorting to some form of grey scale simulation. Byte mapping or grey scale scanning resolves this problem by scanning images at 8 bits per pixel, permitting the capture of up to 256 grey levels. On the other hand, byte mapping was also more costly than either of these two approaches as can be seen from the cost comparison in Table 1.

TABLE 1. CANADIAN CENTRE FOR CARICATURE COST COMPARISON

Costs[1]	*Photography*	*Microfilm*	*Hybrid*	*Bit Map*	*Byte Map*
Capture Equipment[2]	Included	$ 15,800	Included	$ 8,300	$ 27,650
Media	Included	$ 200	$ 3,300	$ 1,550	$ 12,400
Labor[3]	$214,700	$13,500	$38,000	$21,100	$ 30,000
Development	N/A	N/A	N/A	$20,000	$ 32,650
Retrieval System	$ 21,850	$45,850	$22,400	$46,650	$ 46,600
Total Cost	$236,550	$75,350	$63,700	$97,600	$149,300

Notes:
[1]All costs are in Canadian dollars based on estimates prepared in 1987 with the exception of the byte map system which shows actual costs in 1989 Canadian dollars.
[2]Based upon rental, not purchase, of camera or scanner and related equipment.
[3]Includes cost of labor to perform image capture and tagging only. Does not include the cost of descriptive cataloging or subject indexing.

EVALUATION AND DESIGN

A set of more than seventy criteria, augmented by product demonstrations and test samples, was used to evaluate bit map and hybrid systems in terms of input, storage, indexing, retrieval, output, and general system requirements for the Canadian Centre for Caricature's application as well as for the more varied needs of the Documentary Art and Photography Division, with its holdings of more than 10 million photographs, 200,000 works of art, and a national collection of postage stamps. Each criterion was assigned a weight value from 1 to 10, depending on its relative importance to each application. For example, the capability to scan continuous tone color images was assigned a very low weight for the caricature application, with less than 5 percent of its holdings in color, while

having a very high weight for the combined holdings of art, photography, and philately in which color plays a much more prominent role.

Based on this evaluation and market survey, conducted by managers of the Documentary Art and Photography Division in conjunction with the Optical Disc Advisor, a decision was reached to develop a detailed set of specifications for the procurement of an optical disc system with bit map functionality as a minimum but with the desirable capability of byte mapping. This approach was taken partly because, after considerable discussion with numerous industry representatives, it became apparent that no turnkey system then on the market met all needed requirements. At the same time, a responsive chord was struck with a small number of companies who saw in our application an opportunity to develop a market for state-of-the-art imaging systems for cultural property agencies including, but not limited to, archives, museums, art galleries, and libraries in government and the private sector.

While the scope of this article precludes lengthy discussion of all or most of the many system specifications, some key requirements are worth mentioning at this point. Image capture was to be performed on site in order to minimize the stresses or potential hazards to which the collection of archival drawings could be subjected. The image capture subsystem had to be provided on a rental basis and operated as a contracted service since, given the prevailing mood of restraint, the expenditure of any human resource allotment to a function which was not our direct responsibility would be unjustifiable. The image capture device had to accommodate originals ranging in size from 11 × 15 inches or smaller up to 34 × 44 inches and, in tonal characteristics, from black-and-white line and continuous tone drawings with the desirability of handling color. Sufficient resolution was required such that, on printing or display, detail as small as 1/100th of the image height could be seen clearly. The system had to be capable of printing reference-quality prints, although publishable-quality printing was highly desirable. The maximum response time for image display was ten seconds for continuous tone images and five seconds for black-and-white line drawings.

Certain requirements were necessitated by departmental or federal policies. In keeping with the Canadian government's official languages policy, for example, the database and user interface had to be fully bilingual. Specification of AT-class machines running on MS-DOS as the departmental standard for workstations precluded serious consideration of other systems such as Macintosh or UNIX.

A Request For Proposal (RFP), together with detailed system specifications (Sylvain, 1988b), was sent out on July 22, 1988 to about

twenty potential vendors in Canada and the United States. The specifications were divided into three sections dealing with the image capture subsystem, the image retrieval subsystem, and contract conditions such as acceptance criteria, training, service, maintenance, and financial terms. Specifications were designated as either mandatory, meaning any bid not meeting such a specification would be sufficient reason for disqualification, or desirable, in which case a point rating was assigned by a technical evaluation team. A bidders' conference was held in August to give interested parties an opportunity to ask questions related to the RFP or specifications and to view the collection and facilities provided by the National Archives of Canada for on-site image capturing at its headquarters in Ottawa. Of the six bids that were tendered, that of Fifth Dimension CAD/CAM Systems of Ottawa was selected as the winning proposal, offering all mandatory, and the highest number of desirable, features at the lowest cost.

IMAGE CAPTURE

The image capture subsystem is composed of an Eikonix EC850 planetary photodigitizing camera, an 80386-based IBM AT compatible microcomputer with a VISTA videoprocessor board, VGA controller, a 19-inch 1024 by 768 image monitor, a 14-inch data monitor, and Laserdrive 810 5¼-inch digital WORM optical disc drive. The capture subsystem configuration which shows the system being used for quality control of scanned images is illustrated in Figure 1.

Illumination is provided by two 1 Kilowatt Lowel Tota lights on stands, each equipped with a constant voltage regulator power supply. Neither the high-intensity quartz lamps which came with the Eikonix camera stand nor fluorescent lights proved satisfactory, the former providing too much heat and uneven illumination while the 60 Hertz flicker of the fluorescent lights caused the scanned image to have alternating bands of lighter and darker lines.

Prior to image capture, original drawings were arranged by size groupings and artist on nearby shelving. This minimized the need to adjust the camera head height for every scan and assured whatever similarity might exist in gross image characteristics as a result of an artist's style and use of materials. At the start of each capture session, the system would be initialized so as to establish minimum and maximum density values. After scanning, the original drawings were again placed on shelves from which they were stored away in archival containers by custodial staff.

To scan an image, the camera operator places the original drawing on the illuminated bed of the photodigitizing camera and focuses the 55 mm Nikkon Macro lens using electronic feedback. The thickness of a horizontal bar on the monitor varies as focus

is adjusted, displaying the difference in intensity between adjacent pixels. Maximum sharpness is achieved when the focus bar appears thickest. Exposure, affecting image density and contrast, can be adjusted via the lens aperture or by increasing or decreasing the exposure time of each step in the scanning. In practice, the fastest scan rate was usually used with the exposure being adjusted by opening up or stopping down the lens aperture.

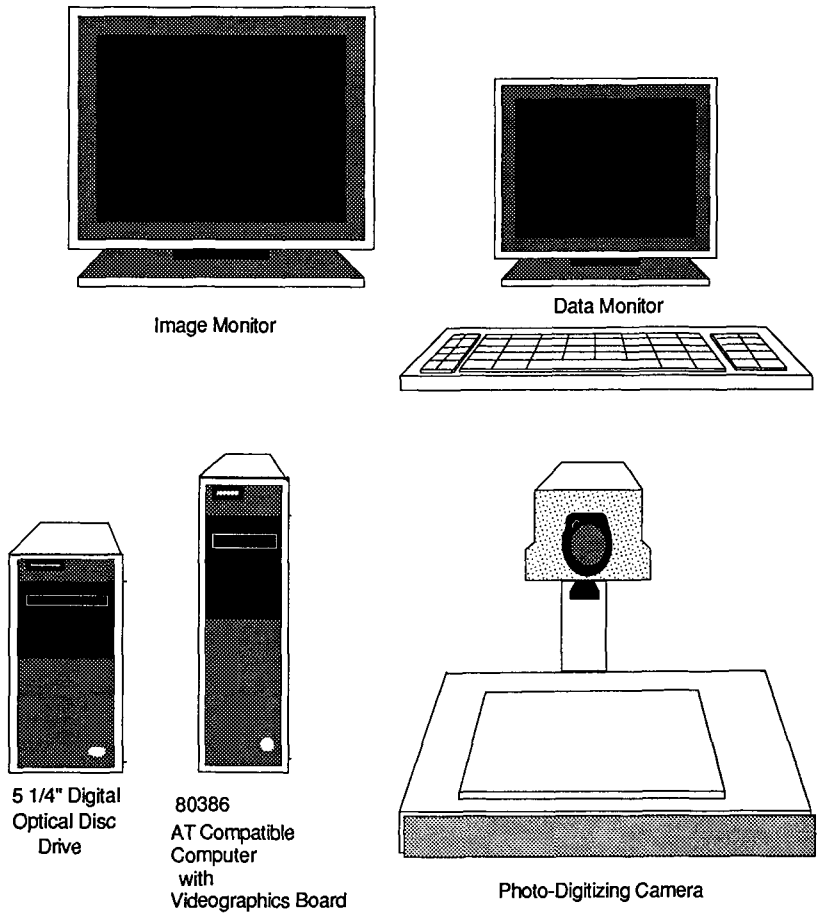

Figure 1. ArchiVISTA Capture Station.

The camera has a small linear array located at the film plane of the lens. As the array moves across the image, each pixel of the element emits an electrical signal which is proportional to the intensity of the light which strikes it. These electrical signals are digitized and stored in the memory of the videoprocessor board. The videoprocessor displays the stored data one scan line at a time,

providing the camera operator with instantaneous feedback as the image is gradually built up. This allows the operator to assess the image quality and, if need be, interrupt the scan; adjust variables such as focus, exposure, or lighting; and rescan the image. Once the entire image is scanned, the operator is prompted to accept or reject it.

When a scanned image is accepted, it is stored in the videoprocessor board's 4 megabyte RAM buffer and the operator is prompted to enter image tagging information consisting of essential control data. This includes the accession and item number of the original drawing, the operator's name, and the date of capture. The accession and item number, uniquely identifying every holding within the collection, provides a link to any corresponding descriptive record in the National Archives' MINISIS database and also allows the system to display this number in the upper right hand corner of each image written to optical disc. The system automatically assigns a frame or tag number as well as the number and side of the optical disc in the optical disc drive. Before writing the image to the optical disc and the tagging information to a file on the hard disc, the operator is prompted to verify the accuracy of the tagging information.

The system-supplied tag number serves both as the MS-DOS image and disc header file names, differentiated by the extensions TGA and CRP respectively. The header file, in ten bytes, documents cropping, resolution, and the number of bits per pixel at which each image was scanned. The image file is automatically time and date stamped by the disc operating system (DOS), permitting the number of images scanned per day and time per image to be easily determined. With the exception that partitions can be larger than 32 megabytes, the optical disc software emulates a standard DOS hard disc. This facilitates hardware/software compatibility with, and file transfers to, other DOS-based systems.

Development of the ArchiVISTA image capture subsystem commenced with the awarding of a contract to Fifth Dimension CAD/CAM Systems Inc. in September 1988. After four months of development and testing, the go-ahead was given to begin image capture of the caricature collection. We chose not to use compression methods in capturing after noticing image deterioration in decompressed images which, upon magnification, displayed checkerboard type patterns. This decision reflects the high level of importance that was attached to achieving as faithful a reproduction of the original archival document as possible. Instead, we achieved an even greater economy of scale in the compression of images than had been originally anticipated by opting for storage of the digitally-captured images on a videodisc-based retrieval system, which is described in greater detail under Image Retrieval.

All drawings were scanned border to border so as to capture any inscriptions or annotations outside the cartoon and to preserve the relationship of image to support. A second scan was performed just on the image area of drawings with borders more than 30 percent of the surface area in order to capture sufficient detail without having to scan at a higher, but slower, more space-consuming, resolution. Special attention was also given to ensure that the camera operator preserved, rather than filtered out, any stains, smudges, or what otherwise might be considered undesirable picture elements.

Line art and continuous tone drawings, comprising 70 percent of the collection, were scanned in black and white with eight bits per pixel at 1024 × 768 resolution. The resultant file size of 0.75 megabytes meant that approximately 1,000 images could be stored per 800 MB 5¼-inch digital WORM optical disc. Scanning of these images was completed the first week in July 1989. Later improvements in the scanner interface software increased the capture speed by about 75 percent so that toward the end of the project an average of 250 line art drawings could be scanned per day.

The 25 percent of the collection containing dry transfer materials such as "Lettratone" was scanned in black and white with eight bits per pixel at 2048 × 1536 resolution, at a rate of 150 per day. The 3 MB file size allows approximately 250 of these images to be stored per 800 MB optical disc. The higher resolution was necessary to avoid moire patterns or visual resonance. The frequency of the halftone dots on dry adhesive, used by some cartoonists to simulate grey tones, is higher than the scanning spatial frequency, causing the displayed image to appear to be vibrating. By sampling at a higher frequency, this disturbance was eliminated. Color images, constituting only 5 percent of the collection, were scanned 32 bits per pixel at 1024 × 768 resolution, permitting faithful reproduction on the monitor of a Kodak color test chart. File size of the color images is also 3 megabytes.

Customer acceptance of the contracted image capture and tagging was provided by performing quality control on a random sample of 10 percent of every 2,000 scanned images. A visual inspection of the displayed image and its corresponding database record was compared against the original drawing to verify the accuracy of the tagging information and assess the quality of image reproduction. Fortunately, all quality control checks performed to date have fallen within the 1 percent error rate considered acceptable.

Image Retrieval

Development of the ArchiVISTA image retrieval subsystem prototype started immediately following acceptance of the image capture subsystem. Although we had originally envisaged using

digital WORM optical disc for retrieval, the use of videodisc technology was proposed as a superior means of meeting or exceeding the specified speed and resolution for display and printing. This approach involves dividing each digital image into four NTSC video frames using a videoprocessor board and storing these, along with one overall frame of the original drawing, onto 1-inch "C" type videotape for mastering to 12-inch videodisc. Retrieval from the videodisc is accomplished by seamlessly recombining the quadrant images into a single high resolution image. The overall, or fifth, frame will be used for simultaneous viewing of up to four different drawings on a high resolution monitor. In anticipation of the demand for decentralized access, the overall frame can also be used in retrieval systems not equipped with high resolution monitors. Moreover, the videoprocessor's capability to handle real time video display of NTSC resolution opens up the possibility of making available moving images, sound, and data in conjunction with high resolution images to prepare, for example, an audiovisual tutorial.

The database management system (DBMS) selected for ArchiVISTA was ZIM, a fourth generation language product of Zanthe Information Inc. ZIM supported the need for a fully bilingual database and user interface, Boolean searching, and the ability to enter descriptive records composed of variable length and repeatable fields either directly or through file transfers from MINISIS, a minicomputer-supported DBMS widely used within the National Archives of Canada for the description of archival holdings. In addition to a data entry module, the user interface provides a search screen with which the user can specify or browse one or more of the following access points: subject, artist, publication, place, date, and unique item numbers.

When a search is executed, the user is provided the option of modifying the search parameters or viewing the hit file of images and corresponding descriptive records. Current display time is an acceptable seven seconds per image, although some effort is being made to further reduce it to around three seconds. The user can also pan across or zoom in on a portion of a selected image using a mouse while a help feature can be called upon at any time to provide context sensitive assistance. The equivalent of newspaper quality images can be printed on ordinary bond paper using a standard laser printer specially equipped to reproduce 100 line per inch halftone images.

The ArchiVISTA system was demonstrated to senior managers of the National Archives of Canada on March 21, 1989. Spurred by their strong interest and high-level support, work began in earnest to showcase a prototype of the ArchiVISTA retrieval workstation at the official opening of the new exhibition gallery of the Canadian Centre for Caricature on June 22, 1989. An online tutorial was prepared and 250 images were selected and copied onto an analog WORM optical disc

using the quadrant method discussed earlier. These were, in turn, linked to their corresponding descriptive records which had been downloaded from MINISIS. Among the final touches, a custom wooden cabinet was made to house an IBM AT 80286 compatible microcomputer with VISTA videoprocessor board, an 8-inch analog WORM optical disc drive, a 14-inch data monitor, a 19-inch high resolution image monitor, keyboard, and mouse (see Figure 2). All was ready. With the ribbon-cutting ceremony marking the official opening of the new gallery of the Canadian Centre for Caricature, ArchiVISTA made its public debut.

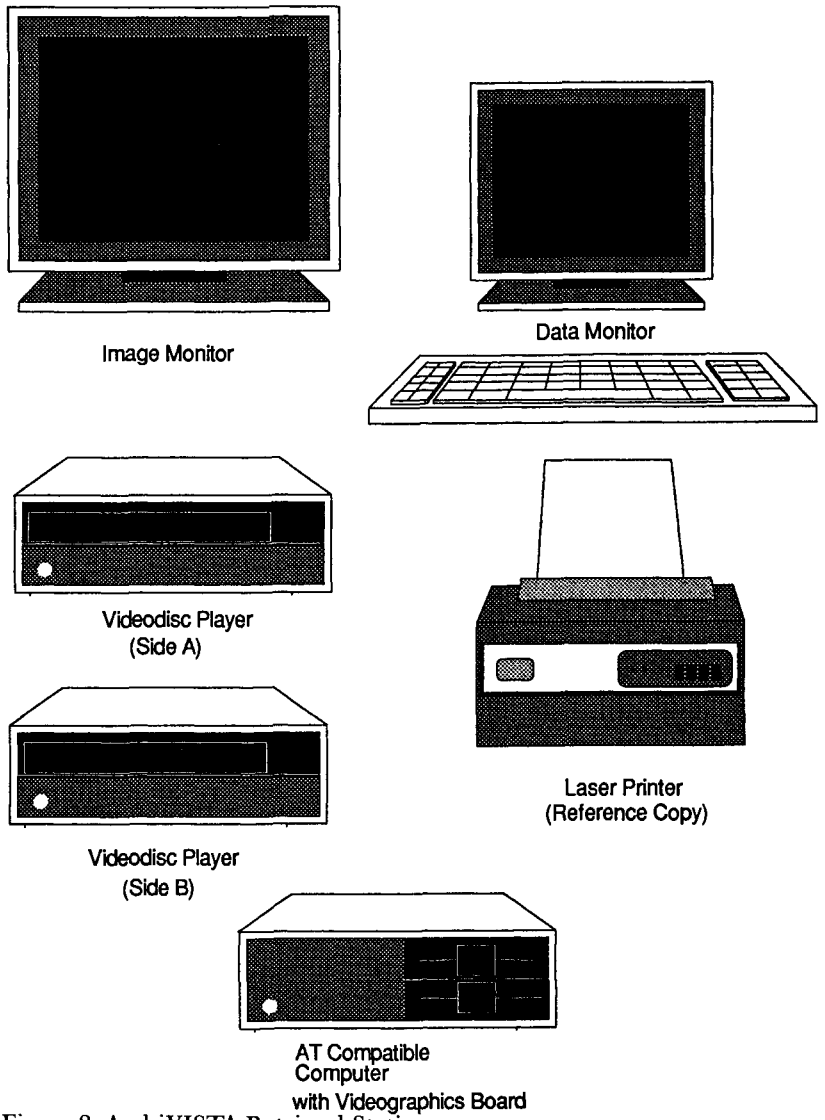

Figure 2. ArchiVISTA Retrieval Station.

CONCLUSION

An application for the transfer of the National Archives of Canada's EDP records to 12-inch digital WORM optical discs for long-term storage began not long after the start up of the Canadian Centre for Caricature's application. With the scanning of the last of the centre's original drawings nearing completion, the contents of the thirty-odd 5¼-inch digital WORM optical discs will soon be copied to the glass-encased 12-inch optical discs as a backup. This should prove more economical than using ArchiVISTA's ability to back itself up onto a second set of 5¼-inch optical discs as well as conform to a standardized procedure for the preservation of electronic data within the National Archives of Canada.

For retrieval purposes, it is anticipated that the entire collection of 20,000 images can be stored on the two sides of one 12-inch videodisc. Once a videodisc has been mastered and copied, the optical disc drive in the retrieval station will be replaced by two videodisc players, each holding one side of the videodisc. Although one player would be sufficient, the use of two will eliminate handling of the image-bearing medium by staff or the general public, simplifying use of the system.

Some improvements to the ArchiVISTA software are still needed, principally in the reduction of printing and display times. Minor enhancements of the retrieval subsystem user interface and implementation of an interactive thesaurus are also planned. In addition to the retrieval station already at the new exhibition gallery of the Canadian Centre for Caricature, the image capture subsystem will be converted to a retrieval station for installation in the Documentary Art and Photography Division's main reference room where it will be used to provide access for researchers at the National Archives' headquarters. Two additional retrieval stations have been purchased, one to enable staff to perform in-depth subject indexing of the caricature collection and support other cataloging and database administration functions, the other to be used in providing a centralized reference service.

Plans are also underway to modify the ArchiVISTA system so that it can be used for the high-resolution capture, display, and printing of continuous tone, black-and-white photographs. A collection of approximately 32,000 photographic negatives documenting various facets of Canadian transportation history has been selected for this purpose. The collection, consisting largely of glass plate, cellulose nitrate, and cellulose acetate negatives, has been physically reorganized, resleeved, and reboxed in archival storage containers and an automated, item-level finding aid prepared. Among the ArchiVISTA system enhancements needed are provision for image capture at 4096×3072 resolution and the ability to reverse the polarity

of stored images so that negatives can be viewed or printed directly as positives. The success or failure of this project will, undoubtedly, have major implications on the photographic services and preservation copying program of the National Archives of Canada.

At the time of this writing (September 1989), the authors have presented just a preliminary progress report on the pilot application of the ArchiVISTA optical disc system. Though some work remains to be completed for the Canadian Centre for Caricature, the ongoing development and application of the ArchiVISTA system to other collections and functions within the National Archives of Canada is already assured. Significantly, the use of optical disc technology has progressed within the span of a decade from a tentative field of investigation to a practical and effective means of assisting archivists and information specialists in the preservation and control of an important segment of the nation's cultural heritage. The advent of ArchiVISTA ends a quarter-century old tradition of the image-bearing card catalog and spells a new chapter in providing access to the rich visual collections of the National Archives of Canada.

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