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CD-ROM Applications in Professional Military Education (PME)

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Eagle Technology, Inc.

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This effort was conducted to identify the most cost-effective and efficient utilization of Compact Disk-read Only Memory (CD-ROM) within the Marine Corps Professional Military Education (PME) schools at the Marine Corps University (MCU).

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Foreword

The Marine Corps Combat Development Command (MCCDC) sponsored this Operations and Maintenance, Marine Corps (O&M)(MC) effort as part of the Marine Corps Training Support program (Work Unit 98 92WR0W003).

This technical note documents the results of a needs analysis conducted to identify the most cost-effective and efficient utilization of Compact Disk-read Only Memory (CD-ROM) within the Marine Corps Professional Military Education (PME) schools at the Marine Corps University (MCU).

Eagle Technology, Inc. conducted this study and prepared this technical note under contract N66001-89-D-0148. Mr. James Chadbourne served as the contracting officer's technical representative (COTR).

J. C. McLACHLAN
Director, Training Research Department

Summary

The Marine Corps Combat Development Command (MCCDC), contracting through the Navy Personnel Research and Development Center (NPRDC), tasked Eagle Technology Inc. to identify the most cost-effective and efficient utilization of Compact Disk-read Only Memory (CD-ROM) technology in the Marine Corps Professional Military Education (PME) schools. This study will be useful in planning for a new research center at the Marine Corps University (MCU).

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1.0 Introduction

1.1 Purpose

The Needs Analysis (CDRL A001BA) documented in this report was performed to identify the most cost-effective and efficient utilization of CD-ROM within the United States Marine Corps (USMC) Professional Military Education (PME) schools that comprise the Marine Corps University (MCU). This study will specifically support planning for a new research center at MCU.

This Needs Analysis was performed as part of a larger study effort that will include development of a Management Plan (A036AA) that will detail the considerations and methodology for implementing CD-ROM applications at MCU. This subsequent effort will provide the MCU with the documentation necessary to make informed decisions regarding the purchase, implementation, and use of CD-ROM technology for purposes of the planned Marine Corps Research Center (MCRC).

1.2 Background

This two-month study was undertaken at the request of Marine Corps Combat Development Command (MCCDC), Quantico, VA. Included in the mission functions of MCCDC is the requirement to provide PME for military leaders. Military leaders receive this education in the PME schools that comprise the MCU. Quantico has long been referred to as the intellectual hub of the USMC, in part, because the following activities reside there: the Marine Corps Systems Command (MCSC), formerly the Marine Corps Research, Development and Acquisition Command (MCRDAC), responsible for the research, development, and acquisition of weapons and equipment; MAGTF Warfighting Center, responsible for publishing doctrine; Marine Air-Ground Training and Education Center (MAGTEC); Marine Corps University, including most of the PME schools; and Intelligence Center.

To assist these activities in their missions, Congress appropriated $14.1 million for the construction of the MCRC facility to be opened in the spring of 1993. The MCRC will serve as a research center for all activities, enabling access to the resources, publications, and information necessary to effectively do their jobs. The MCRC is not intended as an information warehouse, but as an information factory with emphasis on finding and utilizing information rather than storing it. The ultimate goal of the MCRC is to be a USMC-wide asset, available to everyone in the Marine Corps.

1.2.1 MCRC Goals

The mission of the MCRC is to support the Marine Corps by providing a comprehensive facility for the study of expeditionary and amphibious warfighting. The MCRC will focus on linking scholarly research and PME schools with lessons learned from the field in order to stimulate the development of successful concepts, doctrine, tactics, techniques, and procedures. In relation to this study, the MCRC will serve the following functions:

- To maintain and make available in one central location the necessary books, periodicals, manuals, monographs, films, recordings, electronic databases, and other informational materials required to support and promote educational programs of the Marine Corps' formal schools and related research, instruction, and operational activities.

- To develop, maintain, and promote a comprehensive archival system to include documents and visual media that will provide a freely accessible repository for working copies of documents that are of historical, professional, and doctrinal significance to students of warfighting.

- To develop and maintain an automated document delivery system that will satisfy the informational and learning needs of Marines throughout the world.

- To integrate the library and archival programs with local, regional, national, and international library and archival resources with particular attention to cooperative efforts and the integration of resources and services with other military service school libraries and archives.

- To provide appropriate equipment and trained personnel to enable patrons to locate, access, and utilize this library and other libraries around the world.

- To provide informal guidance and formal instruction to students at all levels in the efficient and effective use of library resources and materials.

1.3 Scope of the Study

In light of the goals of the MCRC, E-Tech will provide MCU with the documentation necessary to make informed decisions concerning the applications for and purchase, implementation, and maintenance of an innovative and cost-effective/efficient solution for storing and readily accessing archival data utilizing CD-ROM technology. This data will be presented in the form of a Needs Analysis and a Management Plan.

An objective of the Needs Analysis was to determine the MCU's needs for storing and accessing data relating to PME. Once a broad description of MCU needs was determined, a survey of CD-ROM vendors was conducted to determine the most effective and efficient use of CD-ROM technology applicable to perceived MCU needs. During this analysis, data was collected pertaining to two primary areas:

- Library/archives services including structural organization, patrons, staff, equipment, holdings, on-line services, current data storage and retrieval process, and future MCRC facilities.

- CD-ROM technology including applications, capabilities/ advantages, limitations/ disadvantages, production/ publishing, system configurations, and general costs.

The Management Plan will include, but not be limited to, an evaluation of hardware and software in terms of capability and cost to meet MCU needs. From this evaluation, three alternative approaches, including justification, will be presented. The following information will be presented and discussed:

- The Management Plan will identify considerations for CD-ROM use. These considerations will include perceived CD-ROM applications pertaining to MCRC, data considerations, targeted end users, pros and cons of using CD-ROM vendors, system training requirements, considerations for integration with existing equipment or on-line services, system implementation and maintenance, and planning for the future.

- The plan will additionally provide guidance for identifying the hardware, software, cost, personnel, and training necessary to implement a CD-ROM system including the milestones for purchasing equipment and implementing such a system.

- The Management Plan will verify the efficiency of CD-ROM technology to meet existing MCU needs and forecast applicability to new or emerging needs.

- Additionally, a bibliography, a list of vendors, and a glossary of terms will be included in the Management Plan.

2.0 Needs Analysis

2.1 Methodology

The Needs Analysis was conducted via a review of CD-ROM literature, interviews with MCU library and archives staff and other key personnel, and a survey of CD-ROM hardware and software vendors.

2.1.1 Data Gathering

In the initial stages of the effort and throughout the effort, E-Tech analysts have conducted an exhaustive search of literature pertaining to CD-ROM technology, applications, hardware/software, and vendors. Much of this data consisted of vendor brochures and pamphlets and magazine and trade publication articles. This data was collected by attending related conferences, requesting information via the mail or phone conversations, and conducting on-site/ phone interviews and library searches.

2.1.2 Interviews with Subject Matter Experts (SMEs)

Based on the information contained in the Statement of Work (SOW) and the procedures for conducting a needs analysis outlined in MIL-STD-1379D, E-Tech developed a survey to interview MCU personnel and other key USMC personnel. The survey (see Appendix A) was designed to gather information pertaining to target audience, current library/archives equipment and resources, data storage/retrieval requirements, current process for retrieving data, current and planned data storage capabilities, and MCRC goals.

Library/archives staff were interviewed as well as other key USMC personnel identified by the government technical point of contact (POC).

As the interviews progressed, it became clear that the personnel being interviewed, depending on their field of expertise or position within MCU, could only respond to portions of the survey. Therefore, subsequent interviews were conducted using the developed survey as a structured outline for gathering information rather than a verbatim script.

2.1.3 Survey of CD-ROM Hardware/Software Vendors

Throughout the effort, E-Tech conducted a survey of CD-ROM hardware and software vendors. The goal of this comprehensive survey was to collect information pertaining to CD-ROM technology including applications, capabilities/limitations, production process, system configuration, and general costs. This data was collected by attending related conferences, requesting information via the mail or phone conversations, and conducting interviews. Much of the data collected from CD-ROM vendors will be presented later in the Management Plan, focusing on data that details the pros and cons of specific vendors.

2.2 Library/Archives Services

2.2.1 Current Library/Archives Organization

The MCU library/archives is structured as two separate organizations under the MCRC.

The library provides both staff and patrons with access to holdings which include books, reference documents, periodicals, newspapers, maps, documents, and media. Other resources may be obtained through several on-line services available and through interlibrary loan.

The archives, which is physically located within the research library but remains a separate entity, provides closely monitored and restricted patron access. The archives contain Marine Corps historical documentation relating to military personnel, World War II and the Korean War, military and personal correspondence, individual research papers, after-action reports, historical photographs and other military documents. The archives also has other off-site locations at Quantico which serve as repositories for archival videos, photographs, films, slides, and other visual media. At present, most of the materials held by the archives have not been inventoried.

2.2.2 Patrons

The MCU library/archives provides its services to a variety of military and civilian personnel. MCU students, instructors and staff comprise the largest percentage of patrons and utilize the facility most frequently. Military dependents, retired military personnel, government contractors, and civilians comprise the remaining population of patrons. These individuals use the library/archives research facilities intermittently. The patrons span a wide spectrum of skill levels for operating computers and researching data.

2.2.3 Current Staff

There are currently 11 staff members including librarians, technicians, a library director, and an archives director. The library staff functions to enable patrons to locate, access, and utilize library/archive resources and materials. The size of the staff and their experience level enables them to provide personalized service to patrons and perform highly specialized duties. They are extremely familiar with the library and its holdings.

To meet the needs of patrons, staff members can, based on the type of request:

- Direct patrons to the resources they need to research a topic, such as the electronic card catalog (MCCAT), specific reference documents, or archives.

- Assist patrons and provide instruction in utilizing library resources and equipment, such as logging on and utilizing the electronic card catalog (MCCAT), setting up and loading microfilm/fiche readers, or locating information in reference documents such as Books In Print or the Reader's Guide to Periodical Literature.

- Conduct information searches via on-line services.

- Conduct exhaustive searches of specific topics utilizing the library on-shelf holdings.

- Search and retrieve books via the interlibrary loan program.

For archival searches, patrons provide the topic or subject to the archivist, who will then locate and retrieve the document for the patron and make copies if requested. The archivist will also refer patrons to off-site archives storage locations for further assistance.

2.2.4 Existing Equipment

The library/archives facility has the following equipment for library patron and staff use:

- Three computers for electronic card catalog searches using the Marine Corps Catalog System (MCCAT) and On-line Books. Only one of these computers has standard word processing capabilities. One dot-matrix computer printer, hooked to these computer terminals, enables users to print out information.

- One microfilm reader/printer, one microfilm reader, one microfiche reader/printer, and three microfiche readers provide access to government documents, back issues of periodicals, and other documentation provided to the library in a microfilm/fiche format.

- One videotape player with monitor for viewing 3/4" videotapes.

- Two slide viewers with audiotape capability.

- Two computers on loan from Warfighting to read CD-ROM discs as part of an on-going CD-ROM demonstration project.

The library/archives also has the following equipment for staff use only:

- Two computers located at the charge desk to access several on-line services. One of these computers has an automatic bar code reader that allows the bar codes on books to be scanned for automatic processing.

- One computer with printer for use by the archivist. This computer is on loan from one of the PME schools and is currently being used for basic data processing.

- Additionally, one microfiche reader, six computers, and four printers are available for staff use.

2.2.5 Holdings

The majority of the information available for patron access at the research library/ archives is in hard copy form and includes books, reference documents, periodicals, maps, and newspapers. Most books and reference documents are currently listed on the automated card catalog system (MCCAT) and/or card catalog.

Government Printing Office (GPO) documents including Government Accounting Office (GAO) reports, some Army field manuals, census data, and congressional hearings are stored on microfiche.

Back issues of popular periodicals, such as *Newsweek*, the *Marine Corps Gazette*, *Leatherneck*, and *Navy Times* are available on microfilm. Some of these issues date back to the periodical's inception. Current issues of these periodicals are kept at the library in hard copy form until the library either receives these documents on microfilm or sends these documents out to be bound. The library orders specific periodicals on microfilm from University Microfilm, Inc. (UMI) on an annual or biannual basis, depending on funding. Back issues of periodicals that the library wishes to retain in hard copy, or that are unavailable on microfilm, are sent out to be bound annually or biannually.

The majority of the library's holdings are kept indefinitely either in hard copy or on microfiche/microfilm. Only the current copy is kept for those documents that consist of static information that is updated on an annual basis, for instance, directories, yearbooks, and Books In Print.

Since archival data is original documentation, it is maintained permanently in its original form (primarily hard copy and photographs). Archival data is currently being organized into a hard copy "finding aid" for each collection. The finding aid briefly describes the collection, how it is organized, where it is located, and what information is contained in the collection. This finding aid is not automated, although work is currently being done to create a computerized inventory of MCU student Individual Research Papers, from as far back as the early 1900s. This inventory will be automated to search by subject, title, academic year, class, and author.

The library is in the process of bar coding all documents which may be checked out of the facility. The bar coding system, linked with the on-line card catalog system (MCCAT), enables efficient monitoring of the library's inventory. A bar code sticker is placed on each document or book and the bar code number is entered into MCCAT. When a patron checks out a book, library staff use a light pen to electronically read the bar code and the book is automatically entered into the computer and its status (e.g., checked out, on hand) is registered into MCCAT. To date, 7,100 books have been bar coded.

2.2.6 On-line Services

The research library/archives has access to several on-line services which are accessed primarily by the library staff for information searches. On-line services beyond the electronic card catalog system (MCCAT) are only accessible by the staff due to the on-line charges for these services.

2.2.6.1 Marine Corps Card Catalog (MCCAT)

MCCAT is the library's on-line card catalog system containing listings of the books and publications it holds. Each listing contains bibliographic information and current status (checked out, etc.). MCCAT is a menu-driven system designed to allow the user access by entering a password and searching the bibliographic database by author, title, subject, keyword, and call

number. This is done by either entering the information if it is known, or by requesting a display index of authors, titles, and subjects. Information from MCCAT may be downloaded to a computer floppy disk or directly printed out.

Users can readily access MCCAT on any Marine Corps base in the world that is networked to the Marine Corps Data Defense Network (users who would like to be networked may contact their base Information Systems Maintenance Officer). A magnetic tape of MCU library's holdings is sent quarterly to Quantico's Central Design Processing Activity (CDPA) to electronically update MCCAT.

2.2.6.2 On-line Books

On-line Books is an on-line system accessed through MCCAT that has a full-text capability for viewing complete documents and references. There are currently 63 field manuals (FM) on the system with plans to expand this database to include all Marine Corps FMs as well as other Marine Corps technical manuals, publications, and selected commercially available books as copyright issues are resolved. As with MCCAT, the user accesses information by a keyword search of author, title, subject, or call number. However, On-line Books allows the user to pull up and view full text. When a search is conducted, for instance by keyword, the number of book titles in On-line Books are displayed that contain that keyword. The user selects a title, and the full record with synopsis and table of contents is displayed.

The On-line Books system is housed at the CDPA facility at Quantico. On-line Books is an optical reader system, utilizing technology similar to CD-ROM. It is a jukebox-like system capable of containing up to 90 platters that are read optically by a laser beam. The system can hold up to 234,000 300-page books on-line. In fact, it would take just three of these platters to retain all of the MCU library's current holdings. Like CD-ROM, the platters are capable of holding text, graphics, video, and audio. Unlike CD-ROM, however, On-line Books is a WORM (Write Once Read Many) rather than a ROM system. This means that data may be written to the platter once locally at CDPA and stored there to be read as many times as is desired. On-line Books also has a message capability so users can request assistance from MCRC library staff, via the on-line system. On-line Books currently only allows the viewing of text, a limitation of its current software, not the technology. CDPA is currently investigating the possibilities for retrieving and viewing photographs, graphics, animation, and color on-line.

Because On-line Books is accessed through MCCAT, users who are networked to the Marine Corps Data Defense Network can access the system via a password. Accessing users dial up the system using a modem/phone line, or there is direct access if they are local to the system and hard-wired to the network. The system's vendor claims a maximum of 20 seconds per search no matter what platter is accessed, although response time is increased the more physically distant the user. On-line Books is ideal for research because users can download information directly to their PC (by using a user ID via the Electronic Mailing System [ELMS]) to manipulate or edit the data. Whole documents or sections of documents may be directly printed out on a personal printer.

2.2.6.3 Federal Library and Information System (FedLink)

FedLink is a regional network which provides the subscriber with access to a variety of on-line databases at low cost. As a subscriber, MCU can receive discounts on on-line systems; CD-ROM titles, hardware, and software; and can use this service to convert their catalog to an electronic medium.

MCU pays an annual fee as a subscriber to FedLink and incurs additional costs depending on the number of on-line databases accessed.

2.2.6.4 On-line Computer Library Center (OCLC)

OCLC is an on-line bibliographic service that is part of the FedLink network to which the Marine Corps subscribes. At present, OCLC users have access to information on the holdings of approximately 7,000 libraries around the country.

By accessing OCLC, MCU's library staff can create new entries, update bibliographic holdings, request books or other documents through an electronic interlibrary loan system, and utilize the system to generate call number labels for books. These labels can be printed out on the library's printer. The OCLC also creates and ships cards and magnetic tape for inclusion in the library's own card catalog and MCCAT.

Information from the OCLC is sent to Quantico's CDPA quarterly via magnetic tape. This tape is then fed into the CDPA system which, in turn, becomes part of the MCCAT database.

2.2.6.5 DIALOG

DIALOG is an on-line service within the FedLink network. It permits the user to access a variety of bibliographical databases such as Clinical Abstracts, Newspaper Abstracts, and the Federal News Service to conduct searches on specific topics. This information is available in abstract form or in full text. Due to the breadth and size of the DIALOG database and the fact that it does not specifically carry military information, this service is used infrequently. MCU librarians can print information retrieved from DIALOG directly on their printers.

2.2.6.6 Marine Corps Data Defense Network

This is the network that the Marine Corps subscribes to; MCCAT and On-line Books are accessed via this network.

2.2.6.7 Joint Electronic Library (JEL)

The JEL is an on-line service that MCU subscribes to, enabling users from all branches of the military to search for information military-wide. Its database contains joint doctrine focusing on military education. Like On-line Books, JEL has a full-text capability allowing users to view, download to a PC for writing and editing, and print complete documents. Users access the system via modem/phone line and enter using a password. JEL also has an electronic bulletin board and conference capability that allows users to write and view messages concerning the joint doctrinal database.

2.2.6.8 Defense Technical Information Center (DTIC)

DTIC is a clearinghouse of sorts for defense and military documents, studies, and reports. MCU library staff orders these types of documents through interlibrary loan via DTIC. Although DTIC can be accessed on-line, the MCU library utilizes the service by mail, currently free of charge. The library staff assists patrons in focusing on the type of information to be requested, giving an indication of the subjects and keywords needed for a DTIC search. A request form is then completed and mailed to DTIC. A bibliography/abstract will usually be sent to the library within 10 working days. If the patron desires a hard copy of the particular report, another request will be sent to DTIC.

2.2.7 Future MCRC Facilities

2.2.7.1 Staff

The MCRC Staffing Plan indicates that a minimum staff of 33 (30 civilian, 3 military) will be required to operate the new MCRC facility. Eleven of the civilian positions are currently filled (see Section 2.2.3, Current Staff). The remaining 19 civilian positions include:

- Public Services Section: Head of section, circulation technicians, reference librarian and reference technician

- Collection Management Section: Cataloger and catalog technician, book preparation technician, acquisitions technicians

- Archives Branch: Archivists, archives technician, manuscript curator, secretary

- Facility Operations Branch: Computer specialist, audiovisual specialist, and custodial workers.

2.2.7.2 Equipment and Resources

(The decisions regarding the purchase of equipment and resources for the MCRC's new facility have not yet been made. Therefore, data in this area could not be collected and included in this study.)

2.3 CD-ROM Technology

CD-ROM is a permanent optical storage device. Linked to a PC, it becomes a powerful peripheral, putting millions of bits of data at the user's fingertips. While CD-ROM technology is less than ten years old, it is a rapidly emerging field with new applications for use being identified and new commercially available hardware and software being produced every day. CD-ROM stands for Compact Disc Read Only Memory. This means that data can be stored and accessed but not edited. CD-ROM discs are read optically by a laser beam, similar to the way an audio compact disc is played on a home stereo. CD-ROM provides the storage capability of a mainframe system computer on your desk within your existing PC. This technology allows the storage of text, graphics, audio, video, video still frame, and animation---all in a digital form on a single CD-ROM

disc. Today, commercially available, low-cost CD-ROM drives are easily interfaced with a PC to provide a cost-effective delivery platform for CD-ROM.

2.3.1 General Uses/Applications

CD-ROM technology has the flexibility for use in a variety of applications including: storage of technical manuals and archival data for quick reference, retrieval, space savings, and distribution; storage of bibliographic and on-line databases to assist in rapid search and retrieval of data through cross-referencing and indexing; and multimedia applications and interactive training.

Storing and Distributing Data. CD-ROM is ideal for storing large volumes of information which need to be distributed to many people in many locations. This form of information distribution is very cost effective when compared to the expense of printing, copying, and distributing the same information in paper form. If information needs to be updated periodically and has wide distribution requirements CD-ROM is a cost-effective method.

Research Databases. CD-ROM can replace on-line, bibliographic, and card catalog databases while providing quick access, cross-referencing, and retrieval of information.

Multimedia Applications and Interactive Training. CD-ROM is ideally suited for the development of multimedia courseware and instructional/orientation programs. Programs can be developed on CD-ROM to create interactive exhibits, seminars, educational programs, demonstrations, training programs, and orientation packages. The multimedia aspect of CD-ROM (incorporation of text, graphics, audio, and animation) can create interest, attract users to the program, and stimulate learning. CD-ROM is best suited for distributing large amounts of courseware.

2.3.2 Capabilities/Advantages

As an emerging technology, CD-ROM has many capabilities and many advantages over other media, like paper, for storing and readily accessing large volumes of data.

Flexibility. A CD-ROM disc can store several types of data including text, graphics, animation, audio, digitized photos, digitized video still frames, motion video, and computer programs (software).

Storing Vast Amounts of Data. A single CD-ROM disc can hold up to 650 megabytes of information. This is equal to about 270,000 pages of written text or more than 1,500 computer floppy disks (See Figure 1). A single CD-ROM disc can hold 6,000 graphic images, up to 72 minutes of stereo quality audio, or up to 72 minutes of full motion video. There is, however, some give and take in terms of what can be stored. For instance, if 35 minutes of audio are stored on a CD-ROM disc, only 135,000 pages of text may be stored on that same disc.

Reducing Storage Space. CD-ROM is perfect for managing, archiving, and accessing data which is occupying valuable storage space. A single CD-ROM disc can hold data equivalent to approximately 90 linear feet of shelf space and weighing approximately 2.5 tons. This means that several filing cabinets worth of information or an entire encyclopedia set can be stored on one

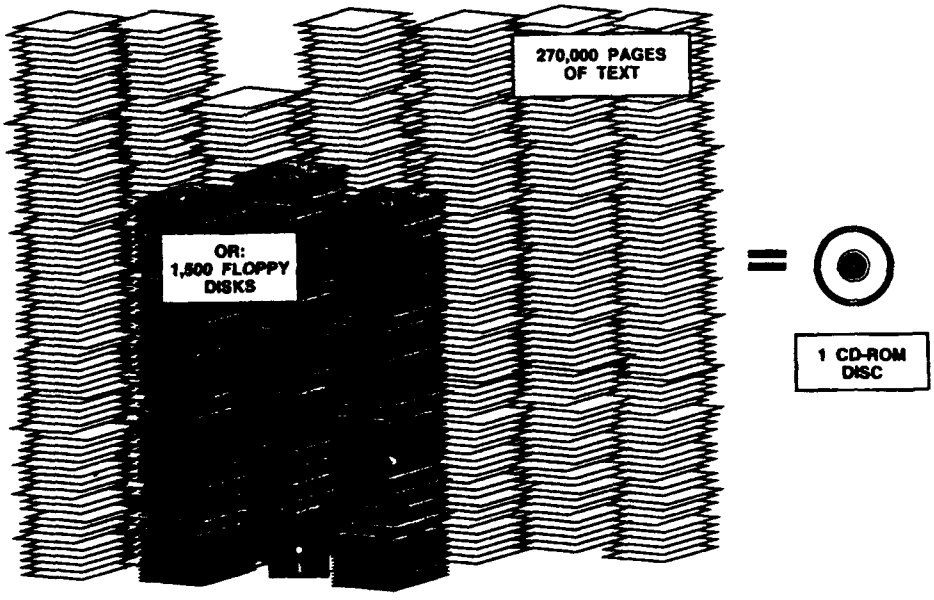

Figure 1. CD-ROM storage capability.

CD-ROM disc. Because of this capability, CD-ROM is ideally suited to applications where storage space is limited, for instance, on board a ship or in the field. The size of the CD-ROM disc also allows proprietary and classified information to be easily secured in a locked desk.

Low Cost. While the initial production costs of CD-ROM are significant, once the disc is mastered, duplicate discs may be purchased at a very low cost. Duplicate discs are needed for distribution or updating to keep information current. Duplicate CD-ROM discs cost from $1 - $2.50 depending on the vendor chosen and the quantity duplicated (i.e., $1 per disc for 10,000 duplicates or $2.50 per disc for 500 duplicates). The costs for storing information on CD-ROM are also very low. For comparison purposes, the following are storage costs per megabyte of data: CD-ROM, $0.024; microfiche, $0.76; floppy disk, $1.70, paper, $4; and hard disk, $10 (See Figure 2).

Distributing Information. CD-ROM is an excellent medium for distributing vast quantities of information to a large population of users in many locations at a very low cost (See Figure 3). It is extremely expensive to print, copy, and distribute large quantities of paper information. For example, 270,000 pages of text can be stored on a single CD-ROM disc. Each duplicate disc can cost as little as $1. The cost of copying this data in paper form, at an average of $.015 per page, would be $4,050 per set. To mail 270,000 pages of text would cost approximately $1,700 in fourth class postage. Because the CD-ROM disc is small, it can be distributed to end users quickly and at a low cost (a CD-ROM disc in its plastic case can be sent first class for $.85).

Ease of Retrieval. When using CD-ROM as a storage medium, research time can be dramatically reduced. Unlike a book, information stored on a CD-ROM is easy to access because of the high speed of the computer and the method developed for data retrieval. Information, not just text, can be retrieved from a CD-ROM disc. If a single fact has to be retrieved, it is just as easy

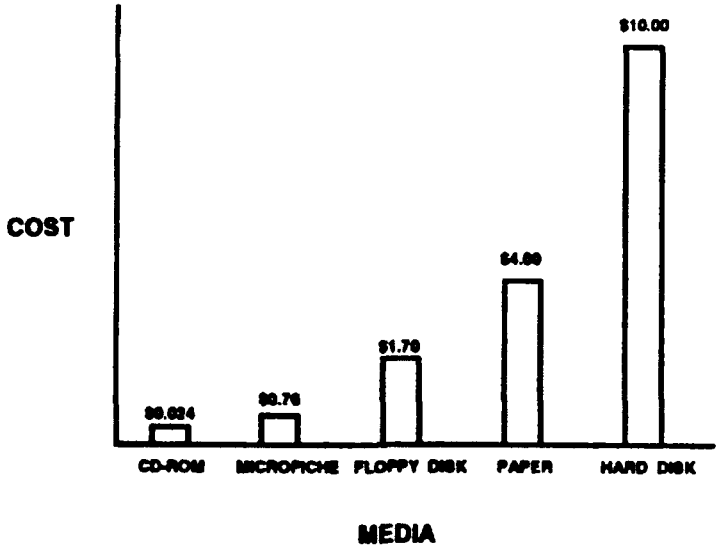

Figure 2. Storage costs of different media (per megabyte of data).

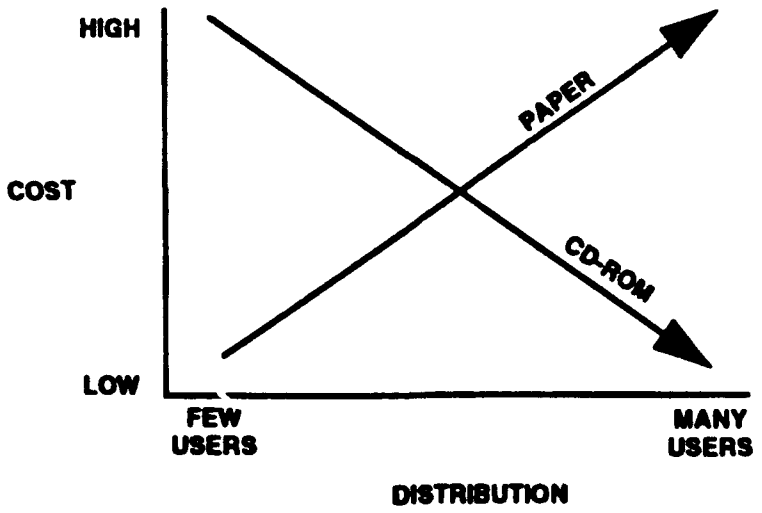

Figure 3. Distribution costs (paper vs. CD-ROM).

and quick to look it up in a book as it is to search a CD-ROM disc (See Figure 4). However, if many facts have to be retrieved and information must be researched and collated, CD-ROM provides a clear advantage over paper. Unlike its paper counterpart, information on CD-ROM can be cross-referenced easily because it is possible to create hypertext links and perform keyword searches of data. CD-ROM can be indexed to search data by subject, title, keyword, or other descriptors depending on the capabilities of the indexing software. Data stored on CD-ROM can also be readily printed or downloaded to a computer's memory for research, writing, and editing purposes.

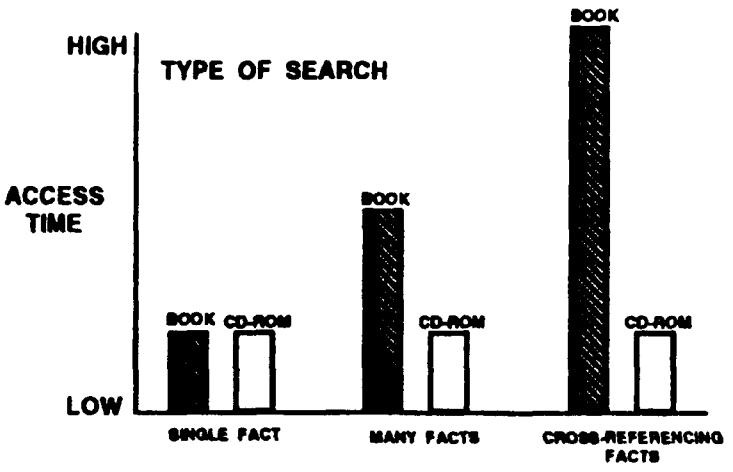

Figure 4. Retrieval capability of CD-ROM.

Data Permanence. The CD-ROM disc itself is physically durable and can withstand extremes in environmental conditions. Data on a CD-ROM disc is highly reliable (resistant to damage), unlike any type of magnetic storage device because CD-ROM discs are not affected by dust or surface scratches. And because a CD-ROM disc is read by a laser beam, the optical head mechanism does not touch the disc. Therefore, no matter how many times the CD-ROM disc is read, it cannot be worn out or damaged. Unlike other computer disks, in the event of a computer failure, there is no chance of damage to the CD-ROM disc. Further, the shelf life of a CD-ROM disc is estimated to be 20 to 50 years.

Standardization. CD-ROM discs and drives are standardized worldwide. This means that CD-ROM discs are compatible with all kinds of computer systems including PCs and mainframes. The structure of CD-ROM data files is governed by an international standard, ISO 9660, so that all CD-ROM data files can be structured to be read by any CD-ROM drive manufactured currently.

Commercially Available. CD-ROM drives are commercially available at a relatively low cost as are a variety of off-the-shelf titles covering many subject areas.

Security. The ability of CD-ROM to store information depends on the physical integrity of the disc. If the disc is broken, the information on it is unrecoverable. In addition, ASCII or other data stored on the disc can be encrypted by any of several methods, with the decryption key stored elsewhere. These characteristics may make CD-ROMs appropriate for storage of sensitive information in the field. However, the discs' small size makes them easy to hide, to steal, or to lose. These factors as well as the time, cost, and specialized equipment required to produce master CD-ROM discs may limit their usefulness in storing classified information.

Read Only Memory. CD-ROM discs can only be read; users cannot edit or alter the data on the disc like they can on a computer. This provides an obvious advantage for data, like books and reference materials, that should not be manipulated.

2.3.3 Limitations/Disadvantages

Read Only Memory. CD-ROM is a read only source; the information on the disc cannot be altered or edited without creating a new disc. But depending on the application, this may be a desirable feature of CD-ROM. (Note: Technology now exists for CD-ROM that can be written to locally).

Slow Access Time. The average access time for CD-ROM of about 300 milliseconds is slow in comparison with the average access time of a computer hard drive which is around 17 milliseconds (the lower the speed, the faster the access). However, there are indexing techniques that can be employed to speed up the accessing time.

Processing. The process for publishing a CD-ROM disc is lengthy and involves the use of vendors, technical experts, and/or additional equipment. For instance, the indexing and retrieval system required to organize the information for ready access is a time-consuming process in itself.

Slow Data Transfer. The data transfer rate of CD-ROM is 150k bytes per second which is considerably slower then most high end computers. The higher the transfer rate, the better the performance and the smoother the playback of video and animation.

Cost. The initial production costs of CD-ROM can be very high. The cost of CD-ROM is prohibitive if little data need to be stored or if the data need only reside in one location. The cost of a duplicate CD-ROM disc is about $1 or $2 but the cost of the master disc is around $1,000 to $2,000. All duplicates are created from the master; if a sufficient amount of discs are duplicated, CD-ROM is very cost effective.

Licensing. A licensing agreement with a vendor is necessary when using a vendor's indexing and retrieval software to access the data. Other licensing agreements and royalty fees may apply.

Data Display. Because one of the points of storing data on CD-ROM is to be able to readily access the data, the data must be stored in a text format (ASCII) that the computer will understand. This means that the data may not look the same as it does in the original document. The spacing, layout, character fonts, type size, and page breaks may be different, depending on the Optical Character Recognition (OCR) software. For instance, fancy fonts can disappear if the OCR

software does not recognize them. It is possible to have the data stored on CD-ROM as an image so that it looks exactly like it does in the original document (WYSIWYG - What You See Is What You Get), but then the data would not be retrievable, and would instead be an electronic page-turner, using considerably more memory space on the disc.

2.3.4 Production/Publishing

To take an original document (source data) and publish it on CD-ROM is an involved and time-consuming process consisting of several distinct steps that require expertise in areas of instructional design, data conversion, quality assurance, search structures, CD-ROM publishing, and, possibly, computer programming. (Figure 5 depicts the CD-ROM production process.)

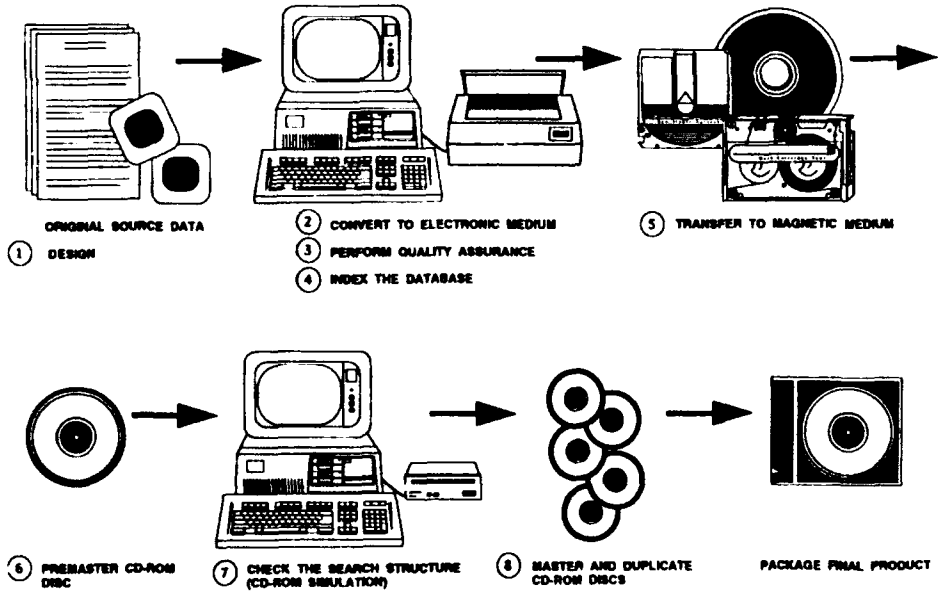

Figure 5. CD-ROM production process.

2.3.4.1 Design

Before actual CD-ROM production begins, many factors must be considered so that each of the production stages is performed efficiently and with the overall end result desired. Personnel with instructional design expertise are required to design the database. Some of these considerations include:

Source Data. Consideration must be given as to what form the data is in that will be published on CD-ROM. Is it paper documentation, microfilm, microfiche, on computer floppy disks, or on a computer's hard drive? What is the condition or quality of the source data?

Type of Information. The type of information, text, photographs, graphics, etc., must also be determined. If the information consists of text, is it fielded text like a spreadsheet or a database, or is it textual information like a book or standard document? This information will help determine the computer memory requirements and resolution requirements necessary for later production stages. Some resolutions are best for print; others for screen display.

Delivery Platform. Consideration must be given to the capabilities (storage capacity, graphics display capability, etc.) of the platforms (computer system) that will be used for accessing data on CD-ROM. It does no good to incorporate fancy features into CD-ROM if the user cannot take advantage of them because of limitations of his computer system.

User Interface. The structure of the data must be given careful thought so that an indexing and retrieval software package may be selected. This software is selected based on its particular features for designing a database and the target hardware system configuration (delivery platform). The indexing and retrieval software is used to create a user interface that allows easy and intuitive use of the CD-ROM system by the end user. Creating a user interface involves designing the layout of the computer screen, menu, and function key structure. Indexing also involves designing the database so that information can be readily cross-referenced, searched, and retrieved. Data preparation, especially designing the indexing and retrieval system, can be the most difficult and most time and labor intensive part of the CD-ROM publishing process. Therefore, the data design stage is the time to consider how data searches will be conducted and how the information will be retrieved (by keyword, as paragraphs, names, images, etc.). The data should also be structured in a standard way so that later revisions can be handled easily. (See Section 2.3.4.4 for more information on indexing and retrieval.)

2.3.4.2 Data Conversion to an Electronic Medium

If the source material is not in an electronic medium (i.e., computer files), it must be converted so that data manipulation can be performed later in the production process. Such source material includes paper documentation, microfiche /microfilm, photographs, graphics, maps, etc. Data on floppy disks or a computer's hard drive are already in electronic form.

Source material can be converted in three ways: keyboard data entry, image scanning, and OCR scanning.

Paper Documentation. Data in paper format can be converted by either entering the data onto a PC via keystroking or by electronically scanning the document and processing it through OCR software. Scanning a document stores it as an image on a magnetic medium. An image cannot be manipulated like text can in a word processor. In order to manipulate text that is in an image form, the image must be converted to a format that is computer usable or machine readable. This format is called ASCII (American Standard Code for Information Interchange). Running the data through OCR software converts the data from an image to ASCII format so that the data can be manipulated by a computer. Both keystroking and OCR scanning are labor intensive.

Microfiche/Microfilm. The conversion of microfiche/ microfilm materials to an electronic medium can be a problem. Although many companies claim the ability to convert

microfiche directly to ASCII text by scanning, the results are poor and in many cases may not be usable. With advances in the application of CD-ROM technology being made every day, it is possible that in the future this may be a viable option, but the technology is not quite there. If microfiche/microfilm data is desired on CD-ROM, it is recommended that the data be obtained in its original form (as a paper copy or, possibly, magnetic medium) and converted to an electronic form from this medium. If a great deal of microfiche/microfilm will be stored on CD-ROM and produced over a period of years, consideration should be given to converting data from a paper form to an electronic medium before or in place of putting it onto microfiche/microfilm.

Photographs and Graphic Images. Photographs and graphics can be converted by either an electronic scanner or by using a video camera. There are advantages and disadvantages with both methods which must be considered before a choice is made. However, using a video camera is probably best where volume is great. Scanning graphic images and photographs is more labor intensive than scanning text documents because the resolution (number of dots per inch) changes, requiring an artist to touch up jagged edges on artwork or redraw some lines. Graphics and photographs are not processed through OCR software.

Data conversion, whether it be for paper documents, microfiche/microfilm, or images, can be done in-house with the appropriate equipment (PC, OCR software, and scanner) or it may be sent to a vendor who will perform these services.

2.3.4.3 Quality Assurance

The ASCII version of the document must be spell checked and checked for accuracy. This involves comparing the original source document to the computer file. Again, this is a time consuming process depending on how much data needs to be processed and how many errors in typing or scanning occurred. Scanning using OCR software typically has a 95-99% accuracy rate. This means that there could be between 20 and 100 errors per page, requiring a lot of work on a word processor to correct the mistakes. For instance, different fonts and type sizes in a document can produce many errors when using OCR. Entering the data on a PC by a qualified typist may produce fewer errors, depending on the sophistication of the OCR software. OCR software packages vary; some incorporate a verification stage that reduces the amount of spell checking and quality assurance required. Today, there are high-end OCR softwares that provide rapid document conversion and produce very few errors. The trade-offs between creating a data file via keystroke or OCR scanning, and the editorial time needed to correct errors must be considered.

Quality assurance can be done in-house with the appropriate equipment (PC and word processing software) or this may be done by a data conversion service vendor. However, not all vendors will perform quality assurance of a document after it is scanned.

2.3.4.4 Preparation of the Data File by Indexing

In order to take advantage of the search and retrieval capabilities of CD-ROM technology, the source data must be indexed. Indexing the data is the process of setting up the data files so that the data can be retrieved. The sophistication of the indexing and retrieval system will determine how user friendly the system is and how accessible the data is to the user. Indexing is one of the most critical steps in developing a CD-ROM product for it can enable the user to access

information in ways that facilitate research and stimulate learning. It can put the user in control and let him decide what is significant and what is not.

The first step in indexing is the creation of the user interface. This is done by designing the layout of the computer screen and the menu and function key structures. The second step in indexing involves organizing the data for retrieval. Without this organization, the CD-ROM disc becomes nothing more than an electronic page-turner. The retrieval method is designed in accordance with the menu and function key structure. An instructional designer should perform both steps to ensure that the indexing and retrieval system is user friendly.

A second step in indexing involves structuring the data to a recognized standard governing the type of data (e.g., text, graphics, audio, video). The format data is in must be compatible with the indexing and retrieval software used to structure the database for ready access. The preferred formats for medium storage are based on Computer-aided Acquisition and Logistics Support (CALS) standards (see Section 3.3.2.11, Emerging Standards). CALS standards govern the format for all types of media. These neutral formats prevent data obsolescence so that if the particular format no longer exists, or is upgraded, this format will allow the information to be meaningful. For instance, CALS specifies the use of Standard Generalized Markup Language (SGML) as the standard for the exchange of text data. SGML is a set of rules for defining generalized markup applications. A markup language identifies text or sections of text and specifies what processing functions should be performed on them. For instance, bolding text, setting tabs, identifying section headings or paragraphs are examples of markup. Markup allows data to be stored, searched, and accessed because it specifies information the computer needs to perform these functions. SGML creates an environment where the commands for a tab set, indent, justified margins, and hyper links etc. are the same whether a document is a military publication, government publication, or newspaper. This enables easy transfer of data between military services, government agencies, and the private sector. The SGML standard is universal so that a text file using SGML can be read by any commercially produced hardware or software. There are CD-ROM SGML authoring tools available to format a text file using SGML markup.

Since some preliminary work such as file definition must be done, it is necessary to determine what type(s) of information is to be stored on CD-ROM. There are three types. Textual information is usually lengthy and has no field structure. It consists of books, documents, and word processing files. The second type, fielded information, has specific data recorded in specific fields like spreadsheet and database information. The third type, image information, includes graphics, line drawings, and photographs. The file definition process varies for each of these information types.

Indexing full-text information (most of the data at MCRC) requires less work than does fielded information. Data retrieval is performed through free-text searching using a variety of search types set up by the designer of the database:

- Keyword and subject searches allow the user to type in a keyword for the computer to search. Generally, the number of occurrences of that keyword is displayed along with their location in the text. The user simply clicks on the occurrence that he would like to view. A comprehensive word index in which every word in the text (except stopwords) appears is sometimes used as an index that enables the user to select the word he wants to search.

- Hypertext searches define associative links between data that, when clicked on, provide nonlinear viewing of information. This allows the user to follow his train of thought and examine information in any order he wishes and at any level of detail desired by selecting the highlighted topic he wants to view.

- Boolean searches (named after the mathematician George Boole) allow the user to combine terms with AND, OR, and NOT to refine or expand searches. For instance, if research is being conducted on chemical warfare in Iran, the subjects chemical, warfare, and Iran can be combined in one search. That is, "warfare and chemical and Iran" would be simultaneously searched instead of searching for all general references to chemical warfare and then narrowing those to occurrences in Iran. Where a database is large, Boolean searches can save much research time.

All indexing systems take up additional storage space on the CD-ROM disc, in fact, some can take as much as 1/3 of the disc's memory. Therefore, it is not advantageous to have all words indexed for searches. Words that will not help a search, like "the," "and," "at," can be eliminated from the indexing system. Indexing software packages generally come with a list of these "stopwords" that are excluded from the indexing system. This list can be modified to add or delete words to suit your needs. All words not on the stopword list will be indexed and be searchable.

Once the data have been indexed, the computer will organize the data according to the previously set parameters.

There are many commercially produced indexing and retrieval softwares that enable the user to create the data file structure. These softwares must be reviewed carefully because some require a computer programmer to use them. Regardless of the software chosen, an instructional designer, one who is versed in screen design and layout and search types, is needed.

Indexing can be done in-house with the appropriate equipment and personnel (PC or mainframe computer, CD-ROM indexing software, and an instructional designer) or this process can be done completely by an outside vendor. One word of caution, however, is that while vendors may be very familiar with their product, they may not have the instructional design background that allows them to make the product user friendly.

2.3.4.5 Transfer of Data to Magnetic Medium

Once data has been indexed, it must be converted to a magnetic medium so that it can be mastered into a CD-ROM disc. Magnetic media include computer floppy disks, computer hard drive, 9-track tape, and data cartridge tape. The type of magnetic medium chosen must be an acceptable input medium for the CD-ROM vendor who will master the disc. For instance, it would not be practical to submit, say, 1,500 computer floppy disks to a vendor (i.e., the vendor does not accept a computer's hard drive as an input medium). Data transfer can be handled in-house with the appropriate equipment (PC, software for interface and downloading, and the magnetic medium hardware; e.g., 9-track tape drive) or it can be contracted to a vendor.

2.3.4.6 Premastering the Data

Premastering formats the data to the ISO 9660 standard for CD-ROM discs. ISO 9660 is an international standard for structuring or formatting the files stored on CD-ROM. ISO 9660 is the accepted standard in the CD-ROM industry, allowing CD-ROM discs using this standard to be read by any CD-ROM drive manufactured currently. The ISO 9660 standard must be adopted. The first reason involves the operating system which the application will be running on. Microsoft Corporation developed a device driver called MSCDEX, available as an extension to MS-DOS (the operating system for IBM-compatible PCs). When MSCDEX software is installed on a PC equipped with a CD-ROM drive, MS-DOS users can communicate with all CD-ROM discs and drives conforming to the ISO 9660 format. This means that common MS-DOS commands like Dir and Copy will work on files stored on CD-ROM disc. Another reason is that, today, most commercially-produced indexing and retrieval software requires CD-ROM discs to be in ISO 9660 format. A final reason is that adoption of the ISO 9660 format can compensate for slow retrieval performance of a CD-ROM drive, making the application perform better.

Premastering also includes adding headers, sync patterns, error detection and correction codes, and system and applications codes. This is a one-step process which is controlled and completed by a computer.

Premastering can be done in-house with the appropriate equipment (PC and a CD-ROM premastering software package) or by an outside vendor. It is highly recommended that this step be performed by a vendor.

2.3.4.7 Checking the Search Structure for Proper Retrieval of Data (CD-ROM Simulation)

Once the data has been premastered, it is important to check the search structure to ensure it does what it should in terms of retrieving data. This is a quality assurance process to validate the menu, function key, and data structure prior to mass production of CD-ROM discs. This can be done in-house with the appropriate equipment (PC and CD-ROM software with simulation feature) or by a CD-ROM vendor. It is highly recommended that this be performed by a vendor. If it is done by an outside vendor, the following will occur:

- If the data is not premastered, the vendor will complete this process.

- The vendor will create one CD-ROM disc (master) which is called a check disc. The check disc is sent to the client along with the input data. The client will test the CD-ROM disc to validate the menu, function key, and data structure prior to giving the vendor permission to create duplicates. If any mistakes are found, the client will make corrections to the input data and return it to the vendor who will create a new master.

- The check disc is an option that the client may or may not choose. There is usually an additional cost if a check disk is requested. The cost of the check disc is about a fourth of the cost of creating a master. If a check disc is not requested and the master disc is incorrect the client will have to pay the full price for a new master to be created.

2.3.4.8 Mastering the CD-ROM Disc

The final step in CD-ROM production/publishing is the creation of the master disc and duplication of CD-ROM discs. Because this process requires specialized, costly equipment, it can only be performed by a vendor. The data created for the CD-ROM disc and stored in the vendor-accepted magnetic medium is sent to the vendor who will master the initial disc and make as many duplicates as requested.

2.3.5 System Configurations

2.3.5.1 PC with CD-ROM Drive

This delivery platform is the lowest-end system configuration, easily upgradable from typical computer systems sitting on desktops. The configuration consists of a standard PC with DOS 3.1+, 640K RAM, at least a 20 megabyte hard drive, a VGA graphics card, a VGA color monitor, and a CD-ROM drive with an access time of under 380ms. There are several optional setups using this configuration:

Portable Field Workstation. A portable field workstation consists of a laptop computer with an external portable CD-ROM drive. This setup allows effortless transport to field locations for access to technical, maintenance, training, and other documentation as required by military personnel in the field.

Stand-Alone Workstation. A stand-alone workstation consists of a standard PC with color monitor and either an internal or external CD-ROM drive. This setup is used for office or library use and for training applications where it is desirable to have only one user access a single CD-ROM disc. If the user needs to access another CD-ROM disc, it simply requires removing the current CD-ROM disc from the drive and replacing it with another disc. Using this setup, if several users must access the same disc, several copies of the CD-ROM disc must be made available.

Stand-Alone with Multiple CD-ROM Drives. This setup consists of a standard PC with color monitor and multiple or stackable CD-ROM drives. Vendors carry a variety of multiple CD-ROM drive housing units for networking multiple drives. Anywhere from 2 to 23 CD-ROM drives can be interfaced to a single workstation depending on the system. This setup allows one user to access as many CD-ROM discs as there are drives without having to remove and insert any CD-ROM discs.

Networked Workstations with Multiple CD-ROM Drives. This setup is ideal for applications that require multiple users sharing the same database. This configuration requires a network, installation of CD-ROM networking software onto a file server, the desired number of CD-ROM drives, and the interface of the desired number of computer terminals or PCs to the network.

2.3.5.2 Multimedia PC (MPC)

This platform is a standard PC-based configuration used by a growing number of multimedia publishers. A 10-MHz or faster 386+ PC can be upgraded to an MPC for around

$1,000. The upgrade normally includes a sound board, a CD-ROM drive, Microsoft Windows 3.0 and Multimedia Extensions 1.0. The standard states a minimum of DOS 3.3+, 20 megabyte hard drive, VGA graphics card, and VGA color monitor.

2.3.5.3 Digital Video Interactive (DVI) with CD-ROM

This high-end platform is based on a PC equipped with an Intel DVI board to provide full screen, full motion video from CD-ROM. If full motion video is required, a DVI configuration is necessary. Other requirements include: MSDOS 5.0, Microsoft CD-ROM extensions, powered speakers, Microsoft serial mouse, Qualitas 386MAX, VGA graphics adapter with feature connector, and a VGA color monitor. The CD-ROM player must be one of the following: Sony CDU-6110 or Sony CDU-6111 or Sony CDU-541 or Toshiba XM3201A1 or Toshiba XM3201B1. IBM offers an option to its Ultimedia configuration which provides DVI capabilities.

2.3.6 General Costs

With the CD-ROM field expanding and changing every day, it is difficult to pinpoint specific costs for hardware and software. This section includes general costs for the hardware required to read CD-ROM. (The costs for producing CD-ROM including hardware, software, and vendor services will be discussed in the Management Plan, Section 3.4.)

CD-ROM Drives. Drive prices range from $400 to $1,200. Some drives may require an interface card to connect it to the computer, which may or may not be included in the price of the drive. This interface card runs approximately $100 to $200.

VGA Upgrade. An existing PC can be upgraded to a VGA system for a very low cost. The cost of a VGA graphics card ranges from $100 to $400 and the cost of a VGA monitor ranges from $300 to $1,000.

PC. The cost of an IBM-compatible PC ranges from $1,200 to $3,000.

MPC Platform. The cost of a complete MPC platform is approximately $2,500 to $3,500.

DVI Platform. The cost of a complete DVI platform can range from $3,500 to $4,500.

Portable Field Workstation. The general cost for a portable CD-ROM system is approximately $3,000: $500 for a lightweight CD-ROM drive and $2,500 for a laptop computer with VGA display.

2.3.7 CD-ROM System Considerations

2.3.7.1 Drive Interface

Some CD-ROM drives may require an interface card to run on an IBM PC. The cost of this interface card ranges from $100 to $300. Other drives will plug into the Small Computer System Interface (SCSI) port in the back of the computer. The SCSI port interface is standard in

the computer industry. For future expandability, it is recommended that SCSI-interface, CD-ROM drives be purchased.

2.3.7.2 Display of Graphics

Computers have varying degrees of image resolution depending on their graphics capabilities. The higher the resolution of the monitor, the greater the clarity and preciseness of the graphic image, photograph, or image. Standard IBM-compatible PCs have CGA, EGA, VGA, or Super VGA displays.

CGA. Color Graphics Adapter has two resolution modes, 320 vertical lines by 200 horizontal lines with four colors simultaneously displayed, or 640 vertical lines by 200 horizontal lines with two colors simultaneously displayed.

EGA. Enhanced Graphics Adapter has a higher resolution than CGA of 640 vertical lines by 350 horizontal lines with 16 colors simultaneously displayed.

VGA. Video Graphics Array has a higher resolution than EGA and has two resolution modes. 640 vertical lines by 480 horizontal lines with 16 colors simultaneously displayed and 320 vertical lines by 200 horizontal lines with 256 colors simultaneously displayed.

Super VGA. Super VGA has a greater resolution than VGA of 800 vertical lines by 600 horizontal lines or 1024 vertical lines by 768 horizontal lines and 256 colors simultaneously displayed.

To display graphics well the computer should have a VGA or Super VGA card and monitor. This is a simple upgrade done by replacing the current display card within the computer's hardware with the new display card. These cards cost approximately $100 to $500 per computer. A VGA monitor can range from $300 - $800. Most vendors of commercial titles require a computer with a VGA monitor to read their titles.

3.0 Management Plan

3.1 CD-ROM Applications

This section will provide the MCU with the information and documentation necessary to make informed decisions concerning the purchase and implementation of CD-ROM technology at the MCRC. The following factors will affect decisions concerning CD-ROM.

3.1.1 Storing and Accessing Data

CD-ROM technology is ideal for library services because it allows permanent mass storage of text and images in digital form. In addition, users can search, cross-reference, and retrieve electronically-stored information faster than they can manipulate the same data in paper-based form. CD-ROM also has a multimedia aspect that allows text, audio, animation, and graphics to be combined into a highly motivational learning experience. If the needs of the MCRC's new facility meet any of the requirements listed in Section 2.3.1, General Uses/Applications, CD-ROM technology can help fulfill these goals. The following applications make effective use of CD-ROM and may apply to the MCRC.

3.1.1.1 Periodicals, Reference, and Bibliographic Materials

CD-ROM can be used to store and retrieve bibliographic data and abstracts of library resources. Storing the data on CD-ROM discs can save space and increase the speed and the comprehensiveness of research. Although the MCU library's holdings are available on-line through MCCAT and On-line Books, the majority of the archives' holdings have yet to be inventoried and may be permanently inventoried on CD-ROM.

Currently, most of the archives' holdings are original documents and photographs. These materials are closely monitored and patron access is restricted. Patrons may access the materials only when assisted by the archives director. The restrictions on accessing data are even greater at some of the off-site repositories, making some material difficult to obtain. While it is true that part of the experience of researching original documents is reliving the history that comes through actual contact with the documentation, these documents are old and many are fragile, precluding much physical contact by the researcher. Archival documents and photographs that are accessed the most can be stored on CD-ROM discs so that they are readily available for patron access and research.

Today, many vendors specialize in publishing commercially available titles on CD-ROM that may be purchased for use in a research center. These titles range from well-known magazines and newspapers to encyclopedias, educational programs and tools, music, elaborate graphics, environmental issues, maps, U.S. history and wars, literary works, and other reference materials. CD-ROM can be used to store periodicals (e.g., magazines and newspapers) and other materials that are not available through MCCAT and On-line Books. Many periodicals are already commercially available on CD-ROM and can be identified and purchased by contacting vendors who specialize in publishing titles. Having this material on CD-ROM will allow library patrons to download periodical articles from CD-ROM disc directly to computer floppy disks. Once the data is downloaded to floppy disks, the user can manipulate the data for research and report writing. The

MCU may determine that CD-ROM is a viable option for storing and publishing their own Marine Corps-generated data. The Marine Corps could then duplicate and sell these discs in order to recoup some of the production costs. This option should be investigated by contacting the vendors that specialize in this area if the MCU does decide to produce its own discs.

At present, automated searches are performed on-line by MCRC library staff. CD-ROM can enable patrons to perform automated searches of literature and reference materials themselves. Data that was once available in an on-line format is now commercially available on CD-ROM. These possibilities should be investigated by contacting the vendors that provide this service. Although on-line and bulletin board services can provide up-to-the-minute information, the transfer of data, particularly video, is generally slow or not practical, depending on the volume. For instance, it would take over 25 days to transfer, via an on-line service, the data equivalent to what can be stored on one CD-ROM disc. It would be much faster (and cheaper) to send the user a copy of the CD-ROM disc rather than use the on-line service.

CD-ROM can be an effective solution for storing Individual Training Standards (ITS) documentation and Military Standards. It can provide immediate access to training or military standards necessary in the performance of daily activities by military personnel. This information will take up less physical storage space if it is stored on CD-ROM discs instead of paper documents, and it will be less expensive to print and copy. The contents of numerous manuals may be stored on a single CD-ROM disc. Distribution costs of CD-ROM discs are far lower than the costs incurred for shipping this documentation if it is in paper form. It will also ensure that the most recently updated versions of the standards are available to all users in a time efficient manner.

Encyclopedias and other references may be stored on multimedia CD-ROM. Users can search, cross-reference, and locate information in an electronic form faster than in a paper-based form. The multimedia aspect of CD-ROM allows text, audio, animation, and graphics to be stored, creating a database of reference information that stimulates interest by the user and motivates learning.

Since CD-ROM can store hundreds of high-resolution images and can access them quickly, CD-ROM befits storing maps. Map images on CD-ROM can be sequenced or tiled together to allow a screen to pan and zoom over large areas. Maps and aerial photographs can be compared on the same disc. CD-ROM maps can contain data to create overlays; one or many overlays can be superimposed on a map image to depict only the specific information required and to prevent image clutter. With a pointing device (pen, mouse, or trackball) and the proper software, map images can be annotated on screen. The map files can also incorporate information allowing users to locate features by their coordinates or by name.

3.1.1.2 Distribution of Reference Materials

CD-ROM discs are ideally suited for storing periodicals, technical manuals, and other reference materials that are continuously updated and redistributed to many people, including personnel in the field. Portable CD-ROM drives are now commercially available, although they must be thoroughly investigated to determine if they are both cost-effective and rugged enough to work reliably in their intended field environments. These systems may be particularly valuable to personnel in the field who cannot be networked to a system like On-line Books but still need these

resource materials to perform their jobs. The lack of storage and transportation space makes CD-ROM an effective alternative to carrying many publications and manuals into the field. USMC holdings stored in On-line Books can be downloaded to a CD-ROM disc and easily distributed at a low cost. Likewise, if those periodicals not available on On-line Books are stored on CD-ROM discs at the MCRC, duplicate discs can be made and distributed to users around the world and in the field.

Marine Corps Institute (MCI) materials are also excellent candidates for CD-ROM. Self-paced correspondence courses on CD-ROM could be made available to users with a significant savings in shipping costs. In this format, MCI courses could be more easily distributed to personnel in the field at sea at other Marine Corps sites throughout the world, enabling more personnel to take advantage of the courses offered by MCI.

Marine Corps Orders (MCO) can also be published on CD-ROM to be stored and distributed more efficiently. Documents can be published on CD-ROM on a quarterly basis, ensuring that the latest version of these directives are available to users. Shipping costs would be significantly reduced, and the additional costs of reproducing and distributing change pages and addenda would be eliminated by having the latest version of MCOs on CD-ROM disc.

3.1.2 Multimedia Training Applications

CD-ROM is a great medium for the development of multimedia courseware and instructional/orientation programs. The multimedia aspect of CD-ROM (incorporation of text, graphics, audio, and animation) stimulates interest and attracts users. Multimedia CD-ROM can also incorporate motion video, although motion video can cost substantially more to produce and can take up a great deal of memory for storage. However, the rapid replacement of small portions of the screen with animation can simulate motion. At the low cost of approximately $500, a CD-ROM drive may be added to an existing PC to create a multimedia hardware platform. Potential uses for multimedia CD-ROM programs include interactive exhibits, seminars, educational programs, demonstrations, training programs, and orientation packages. Today, many multimedia programs, covering a variety of diverse topics, are commercially available.

Because the MCRC's new facility has not yet opened and will occupy greater space than the current library and archives, patrons and staff will have to be oriented to the facility to take advantage of its resources. One of the goals of this new facility is to make it easy for staff and patrons to use the MCRC. This can be done by using CD-ROM as a multimedia delivery platform for interactive instruction/programming. For instance, a training/orientation program could be developed to train new staff members and orient patrons to the new facility and its resources. This program could incorporate scanned-in photographs of MCRC staff members with audio or text descriptions of their functions. This program could also display photographs, graphics, or schematics of the facility so that users can learn the location of holdings, equipment, staff offices, study rooms, and fire exits. The program could also serve as a help system to guide patrons in using MCCAT, On-line Books, and other MCRC resources. The applications are endless, and all can be delivered on multimedia CD-ROM.

Multimedia delivery platforms using CD-ROM for training can promote student interest and increase student retention of material. Studies show that interactive training that allows

the student to experience the material through sight, sound, and interactivity has a higher transfer of learning (30-50%) than traditional lecture-based instruction. Interactive training can further be conducted according to the student's schedule rather than being dictated by the instructor's schedule. CD-ROM is particularly effective for field or shipboard training applications where storage space is limited but training must continue.

If CD-ROM is used in interactive training, it can be a storage medium for all the associated materials in the courseware, or can store only audio in a course which requires a large volume of audio information (up to 72 minutes). CD-ROM training systems may be programmed as a multimedia-mode CD-ROM capable of mixing text, graphics, and audio on a single CD-ROM disc. The user simply accesses the training program by inserting the CD-ROM disc into the drive and typing a password to start the program. Multimedia CD-ROM will play on any commercially available CD-ROM drive that has an audio output. Because CD-ROM cannot be edited, this application is best suited to training programs that will not continually change or need to be updated. If a training program requires frequent changes, CD-ROM may be programmed for audio only to provide the audio to complement a computer-based training (CBT) program at a very low cost. For instance, CD-ROM may be used to store the audio portion of an interactive videodisc (IVD) training program. Unlike CD-ROM, IVD requires specialized delivery hardware and costly software. CD-ROM can provide an effective and cost efficient solution to training sites that incorporate CBT or IVD training.

Certain standards and conventions should be followed when designing new CD-ROM courseware to ensure a quality product: The courseware should be highly interactive; the courseware should have multiple levels to address varying skill levels among students (this can be accomplished using hypermedia); and the courseware should employ a variety of media (e.g., motion, sound, text, graphics).

3.1.3 Other USMC Applications - Field Use

Although this study focuses on the MCRC and the CD-ROM applications that apply to it, it is also important to discuss other applications of CD-ROM within the Marine Corps for field and other use. Because of CD-ROM's ability to store vast amounts of data, the technology is useful for shipboard applications or other applications where storage space is limited. CD-ROM has endless applications and possibilities. The following list is not all inclusive, but it may provide some ideas for other ways in which CD-ROM can be incorporated into the Marine Corps.

CD-ROM can be used as a storage medium for technical and maintenance documentation and schematics. This information could then be used as a job aid by field technicians who require fast retrieval of technical information for troubleshooting, diagnosing, repairing, and recovering system parameters, components, or equipment.

The feasibility of using CD-ROM for field technicians was demonstrated during Operation Desert Storm. Several thousand computers equipped with CD-ROM drives were deployed in Saudi Arabia in support of weapons systems such as the Patriot missile. Both maintenance documentation and operations manuals were available on-line to support operations. The advent of portable CD-ROM will mean having large numbers of equipment operation and repair manuals available literally at the technician's fingertips. This application is particularly

effective for those Marine Corps Military Occupational Specialties (MOS) where personnel may not be able to carry many reference materials with them on repair runs, for instance: telephone and cable systems technicians, radio repairers, radar technicians, or aircraft mechanics. Storing technical documentation, photographs, schematics, blueprints, and even maps on CD-ROM may also be useful to a construction surveyor. However, factors such as the size and resolution of the computer's monitor affect how effectively some documents can be displayed. There are a number of techniques for displaying this kind of data (e.g., scrolling the data, overlaying the data, displaying the data in windows), and a study should be undertaken to identify the most effective technique for each particular application.

A possible drawback to using CD-ROMs in the field is their sensitivity to shock and vibration. The discs themselves are not damaged, but the vibration of the drive unit while the disc is being read can cause tracking errors. These errors may either make a disc unreadable or cause reading to take a very long time as long as the unit is being vibrated. The severity of the problem depends on the type and strength of the vibration and on the design of the drive. Portable units contain built-in shock absorbers to reduce the problem. Some of these units have been used in military vehicles traveling over paved roads without any problems. Information on the use of CD-ROM in other vehicles in more extreme environments is limited.

CD-ROM can be used for identifying and selecting parts from catalogs. A parts catalog on CD-ROM can allow the user to search by part number, product, model, description or any combination in a matter of seconds. This is much faster than searching through a paper-based system. Parts catalogs are generally large and need to be shipped to many users across the country. Putting this information on CD-ROM can save significant printing and shipping costs. A CD-ROM system could also be connected to an ordering system so that parts may be electronically ordered. In terms of this application for the Marine Corps, current procedures for storing supply records and maintenance management reports, equipment repair orders, etc., can be examined to determine if CD-ROM would be an effective solution for rapidly searching and accessing this information.

One final application for CD-ROM may be as a job aid to provide a method of rapid and precise threat recognition. Photographs and documentation of enemy aircraft, vehicles, weapons, and military clothing and insignias can be stored on CD-ROM for rapid cross-referencing and identification of threats. The CD-ROM technology is perfect for distributing this information to various locations so all users get the same and most current data, allowing standardization in training and information. This application has many advantages for shipboard, aircraft, and field use.

3.2 Considerations for CD-ROM Use Within MCRC

Before any CD-ROM system is purchased for the MCRC or any titles are developed or acquired, it is essential that well-informed decisions be made so that the operational system meets the needs of the MCRC. Any decision should be based on an awareness of the other resources which may be tapped regarding CD-ROM technology; determining what will be stored on disc; identifying end users and requirements for staff and user training; evaluating equipment considerations, requirements for setting up workstations, and commercially available CD-ROM titles; identifying and implementing operating procedures for the establishment and use of CD-ROM and other on-line systems; and the role of the MCRC in the future for forecasting CD-ROM

needs. This section will detail the factors that should be considered before a CD-ROM system is implemented.

3.2.1 Capitalizing on Available Resources

To assist in planning the selection and implementation of a CD-ROM system, it will be essential to tap as many sources as possible. Organizations at Quantico and within the Marine Corps who have had experience with CD-ROM systems, trade literature, and conferences and expositions that feature the latest in CD-ROM technology are valuable resources to utilize when designing a CD-ROM system to best meet the needs of the staff and patrons of the MCRC. The following list of resources is provided to serve as a starting point in investigating the application of CD-ROM.

3.2.1.1 Warfighting Center and Central Design and Programming Activity (CDPA)

In a joint effort with representatives from the Warfighting Center and CDPA, USMC personnel have published three CD-ROM discs: WarCHEST, Promotion Board Prototype, and FightSMART. In this effort, most of the preparation and production of the CD-ROM materials was accomplished in-house, providing a valuable resource for the development of a customized CD-ROM product for the MCRC. Lt Col Lohman (703) 640-4710 is the POC for this effort and can provide insight into the process and considerations for the in-house production of CD-ROM.

CDPA's mission is to provide computer design and programming support for the Marine Corps and to investigate emerging technologies such as CD-ROM and their possible application in support of the Marine Corps and its mission. Because CDPA houses and controls the On-line Book system, this activity may provide insight regarding the integration of the On-line Books system with CD-ROM to enable the capabilities of each system to complement one another. Linda Salisbury (703) 640-2070 is the POC.

In addition, CD-ROM capabilities are being utilized in the development of lessons learned from Desert Storm. When completed, the CD-ROM disc will allow the user to access such information as after action reports, briefing transcripts, battlefield reports, and doctrinal publications dealing with desert operations.

3.2.1.2 Marine Corps Computer and Telecommunications Activity (MCCTA)

MCCTA provides technical direction and support for automated information systems and systems life-cycle management for the Marine Corps. MCCTA sections include telecommunications, computers, contracting, and plans and policies for Marine Corps information management. The MCCTA's function identifies it as an essential resource for the planning and management of MCRC's CD-ROM system and the integration of CD-ROM with other Marine Corps automated systems. Currently, Lt Col Lohman serves as the head of Plans and Policies at MCCTA. He is assisted by Cathy Muzbeck and both may be reached at (703) 640-4719. Ms. Muzbeck, who serves as a computer systems analyst, is responsible for identifying and monitoring the progress of other Marine Corps automated information projects. Ms. Muzbeck is also currently involved in an effort to develop an Information Resource Manual in CD-ROM for MCCTA technical publications. In establishing a liaison between the MCRC and MCCTA, the MCRC can

remain informed concerning the current application of CD-ROM throughout the Marine Corps and can identify efforts or products which may be integrated with MCRC CD-ROM holdings/system. In addition to the projects at CDPA, the following projects are also underway:

- The use of optical storage and visual imaging systems for storing and accessing fitness reports. This effort is being conducted by Manpower, Management Information System Division, Navy Annex. The POC is Capt Hochstetler (703) 614-4115.

- Storage of Marine Corps' after action reports on CD-ROM. Warfighting Center, Analysis and Review, Quantico is the sponsor of this project. The POC is Capt Galloway (703) 640-3235.

- Storage of Marine Corps System Command (MARCORSYSCOM) technical publications on CD-ROM. The POC is Major Minnema (703) 640-3344.

3.2.1.3 Marine Corps Publication Distribution System (MCPDS)

MCPDS is examining the feasibility of CD-ROM technology for managing and distributing Marine Corps publications. It will be important for the MCRC to track this effort to help identify the potential uses of CD-ROM as a reference source within the research center and determine the potential for MCRC and MCPDS to establish and utilize CD-ROM in a cooperative venture. This effort is sponsored by Headquarters, Marine Corps (Code AR); Major Pierce (703) 614-5470 serves as the POC.

3.2.1.4 Technical Documentation, MARCORSYSCOM

The Technical Documentation Branch of MARCORSYSCOM is responsible for acquiring technical publications for this division. Once ordered, technical publications can arrive in a variety of forms: magnetic tape, floppy disk, hard copy, or on CD-ROM. Once they arrive, they are forwarded to the Electronic Technical Publications Systems (ETPS) in Albany, GA where they are converted to the format requested by MARCORSYSCOM. Presently, Department of Defense (DoD) standards, GSA catalogs, civilian personnel regulations and other government documents are being converted to CD-ROM. Currently, the technical documentation branch requires ISO 9660 and SGML formats be used to create CD-ROM discs (see Section 3.3.2.11, Emerging Standards, for more information). The MCRC may wish to utilize this source for determining the process by which MARCORSYSCOM acquires discs in CD-ROM, and what titles the Technical Documentation Branch has or intends to convert to CD-ROM. The POC is Ms. Jean Oravitz (703) 640-4206/4266.

3.2.1.5 NAVAIR

POC Mr. Bill Walker, PMA 205-1H, has established a committee to monitor the development of emerging DoD and non-DoD standards governing the production of CD-ROM. Mr. Walker may be reached at (703) 692-2137.

3.2.1.6 Information Systems Committee

This Quantico committee has been established to identify and prioritize documents and other materials for incorporation into the On-line Books system and on CD-ROM in support of the MCRC. Chaired by Mr. Bill Greenup (703) 640-2248, Director of the MCRC, the committee will meet quarterly and include representatives from Warfighting, Intelligence, MARCORSYSCOM, MCCDC, Training and Education, MCU, and CDPA.

3.2.1.7 Conference and Resource Publications

Several conferences, held annually, present programs and exhibits concerning CD-ROM and automation in libraries. These conferences provide participants with the opportunity to learn about the latest in automation technology used in libraries. Mr. Pearce Grove (703) 640-2248, Library Director for MCU, is the POC for information regarding the following conferences: Computers in Libraries; National Library Association Conference; and the Southeastern Library Association.

Trade expositions also provide opportunities to learn about and examine the latest in CD-ROM technology. Many of the expositions are held annually, although the location changes from year to year. The following expositions are a few of the largest:

- 1992 CD-ROM Expo, to be held in Boston, Massachusetts from 30 September - 2 October 1992. To inquire about this event, call (800) 225-4698.

- PC Expo, to be held in New York City from 23-25 June 1992. Call Bruno Blenheim, Inc. (800) 829-3976 for information.

- The International Conference and Expo on Multimedia and CD-ROM was held 10-12 March 1992 in San Jose, California. To inquire about obtaining materials from the conference, lists of exhibitors, and scheduling for future conferences, call (203) 964-8287.

The following technical and trade publications are available for use as resource or reference documents for CD-ROM and other automated technologies. Information regarding the latest applications, equipment, technological advances, and commercially produced titles can be very useful when planning a CD-ROM system. These publications also provide information regarding upcoming conferences and expositions. Some of these publications include:

- CDROM EndUser, Helgerson Associates. Free monthly magazine. (800) 688-3374.

- CDROM Professional, Pemberton Press, Inc. Annual subscription, $46. (203) 227-8466.

- MacWorld, PC World Communications, Inc. Annual subscription, $30. (415) 243-0505.

- PC World, PC World Communications, Inc. Annual subscription, $20. (415) 243-0505.

3.2.2 Determining What Will be Accessed on CD-ROM

After preliminary research into CD-ROM technology is completed, a set of key decisions will have to be made concerning what information will be accessed on CD-ROM. A decision-making authority (a single person or a committee) should be identified to make these determinations. Once a decision authority is established, solid decisions can be made in order to benefit optimally from the technology, and the following questions can be addressed:

- What material will be converted to CD-ROM?
- What commercial titles (if any) will be purchased?
- How often will updated CD-ROMs be issued?

Many of the library's current holdings are prime candidates for CD-ROM technology: bibliographic data and abstracts, archival holdings, periodicals, encyclopedias, and other references. Early decisions should be made on the basis of the most important patron and MCRC needs. In deciding what materials to convert to CD-ROM format, the following factors should be considered in relation to those needs:

Frequency of Use. Convert materials that are already used frequently, or those whose use needs to be encouraged and promoted.

Cost Savings. Cost savings may be realized by having materials easily accessible on CD-ROM rather than available through on-line services that can be both costly and time-consuming to use. Also, some of materials the MCRC currently acquires on microfiche are now available on CD-ROM. Deciding to acquire them in the CD-ROM medium will result in a great saving over later conversion from microfiche. It is more efficient and economical to capture materials in CD-ROM format at the outset than to send them out for conversion at a later time.

Physical Space Savings. If space now is or soon will be a critical issue, perhaps voluminous materials should be converted to CD-ROM even if they are not used frequently.

Document Updates/Revisions. If periodicals or other documents that are routinely updated or revised will be accessed on CD-ROM, a publishing schedule must be drawn up and implemented to provide for the most efficient and effective production of CD-ROM updates. A determination as to the desired frequency of the update process must be made. For instance, will conversion of current editions of periodicals occur quarterly, semi-annually, or annually? A decision should also be made regarding segregation or combining files on CD-ROM discs according to frequency of update. For instance, will documents that are revised monthly be stored on the same disc? And will archival documents be stored on separate discs?

Efficient Use of CD-ROM Storage Space/Distribution. As to what should not be accessed on CD-ROM, since CD-ROM is a read only medium, data that must be manipulated or updated frequently are not a candidate for this technology. As a general rule, information that does not exceed 10 megabytes of memory should not be transferred to CD-ROM format. A single CD-ROM disc can store up to 650 megabytes of information, so consideration should be given to what

data would be an efficient use of the vast storage space on a CD-ROM disc. Also, data that only reside in one location and do not need to be accessed by many users from different locations are not a candidate for CD-ROM.

3.2.3 Targeting the End User

One of the first decisions that must be made before selecting and implementing a CD-ROM system is to determine who will access the system. Targeting the end user involves determining how many people will access CD-ROM at any one time (both patrons and staff); how many locations other than MCRC will need to access the information stored on CD-ROM; and identification of end user computer skills.

3.2.3.1 Number of Users

Determining how many people will access CD-ROM will enable decisions to be made regarding the configuration of system components or equipment. First, estimate how many users will access the CD-ROM system per day, per week, or at any one time. A suggested approach would be to start with only a couple of workstations with the expectation that user demand will dictate how many workstations are necessary. Estimate how many users will need to access a particular database at any one time. CD-ROM technology can provide multi-user access to data via multiple workstations networked together. A network that includes CD-ROM capability would enable several users to conduct concurrent searches on the same CD-ROM database. A stand-alone workstation will allow only one user at a time to access CD-ROM, regardless of the number of drives interfaced. Therefore, if there is only one copy of a popular CD-ROM database, patrons may have to wait to use it.

3.2.3.2 Number of Locations

The next decision that must be made concerns determining who, other than MCRC patrons, will access the system. If other personnel at Marine Corps Base, Quantico or at distant field sites require access to the information stored on CD-ROM, how will they gain access? Will they access the system via network, or will they be provided a duplicate of the CD-ROM database? If a network scenario is chosen, will it be intended for use within the MCRC only or will users who are off-site and at field locations be part of the system? Since both on-line costs and access time increase for distant users of networks, it may be that providing duplicate CD-ROMs to be used on stand-alone workstations at those locations is more efficient and economical. (See Section 3.2.4, Equipment Considerations, for more on the pros and cons of a networked system.) Once the decision has been made concerning what will be stored on CD-ROM and who will access the data, this information can be used to determine how many duplicate discs need to be produced based on user demand.

3.2.3.3 Identify End User Computer Skills

Once the users of the CD-ROM system are identified, consideration must be given to their level of computer skills and, for those patrons who may have no computer knowledge, their receptivity to the system and their willingness to learn it.

The CD-ROM system must be designed and set up to attract patrons to use it. The more user friendly the system is, the more likely it will be used. (Many of the decisions regarding user friendliness are made when designing the database; see Section 2.3.4, Production/Publishing.) For instance, providing an optional mouse (vice a standard keyboard) as a device for navigating through the database will increase the system's usage by a variety of personnel with different skill levels. Identifying user computer expertise will enable further decisions to be made regarding user training (see Section 3.2.7, Staff/User Training).

3.2.4 Equipment Considerations

Once the external resources regarding CD-ROM have been investigated and the MCRC has determined the databases and the end users of the system, the MCRC should have the information needed to conduct an effective evaluation of equipment/system requirements. Equipment considerations include target platform identification to include processor, operating system, memory and graphics requirements, CD-ROM disc and floppy disk drive requirements, and data retrieval concerns. The utility of networked vs. stand-alone systems and the use of terminals vs. PCs are some basic equipment considerations.

3.2.4.1 Network vs. Stand-alone

There are many factors to consider before deciding on the configuration of a CD-ROM system. One of the most basic issues is whether to use stand-alone workstations or a networked system. With stand-alone workstations, every user must have a full set of resources located at the station--a fully equipped computer, a CD-ROM drive, and all CD-ROM discs to be read. Networked stations rely on remote resources, so an individual user station may consist only of a computer workstation with connection to the network and its centralized resources. Two classes of networks are in general use: local-area networks (LAN), which connect stations in a relatively small area (typically within a building or a cluster of buildings) using dedicated cable or wiring; and wide-area networks (WAN), which connect stations separated by up to thousands of miles using modems and telephone lines or radio carriers. Although LANs are limited in the distance they can cover, their data transfer rates are roughly a thousand times faster than WANs and modems--typically 10 million bits per second (bps) instead of 9,600 bps--and they are better suited to moving very large blocks of data such as digitized images.

It usually costs more to implement a network system than stand-alone workstations. However, the decision to network is one of economy of scale. If many users must share the same CD-ROM resources, then over time, a network system may be more cost effective. Some of the advantages and disadvantages of both types of systems are discussed below.

Multiple Copies of Commercial Titles (Databases). A stand-alone CD-ROM workstation requires a PC and at least one CD-ROM drive. This arrangement may be satisfactory if there are only a few users and system availability is not a problem. But if there are insufficient workstations to accommodate all users during peak periods, this may not be desirable. Adding more CD-ROM drives to the single-user workstation might provide the user with more flexibility; however, the additional drives will not alleviate the problem of too many users and too few systems. A similar problem exists with single copies of a much used database. If there is only one copy of a popular database, patrons may have to wait to access it. Multiple copies of a

commercially available database could be purchased. However, this may be prohibitively expensive depending on the cost of the database and the number of quantities required. (If CD-ROMs are produced in-house, the cost per copy is very small and would not be a consideration.)

A network configuration would consist of a central database of (possibly) many CD-ROM discs (accessed either through many interconnected drives or through a "jukebox" drive) with user terminals networked to the database. A network that allows users to share CD-ROM resources would require only one copy of the CD-ROM database. (Although, if too many users try to access a single disc on the network at the same time, the system's response time will be degraded.) Commercial titles produced for network use generally cost more than the same titles when produced for stand-alone systems. However, since only one copy of the title would be needed for the entire network, this cost would have to be compared with the cost of multiple copies for stand-alone use. Some vendors may give a discount for multiple copies purchased in large quantities.

Library Staff Time. Another consideration before deciding on the system configuration is the library staff time involved in assisting patrons. If patrons are allowed to insert and remove the CD-ROM discs and computer floppy disks (for downloading) at a stand-alone workstation, the library staff would have to sign out the discs and, possibly, distribute blank floppies. Locked drives could be installed on the workstations so that patrons never handle the discs. This procedure could reduce damage, breakage, and unauthorized removal of the discs; however, the library staff would have to change the discs whenever the patron required access to a new database. An estimation of how much staff time would be expended on this activity would have to be based on the number of users and their requirements for accessing multiple databases. A network system would require less library staff time in assisting patrons with inserting and removing discs because the CD-ROM drives would have to be loaded only once. (See Section 3.2.6.2, Printing and Downloading Data.)

Drive Problems. If the CD-ROM drive fails on a stand-alone workstation, only that station is affected. Other workstations at the facility will still be operational. But if the CD-ROM drive fails in a network, all users of the network will likely be affected; no one could access the databases resident on the inoperable drive. In an ideal situation, the network would have other unused drives available and the database could be transferred to a still-operational CD-ROM drive.

Retrieval Time. Retrieval time is based largely on the capabilities of the system, for example the speed of the microprocessor. Networks are affected by the number of users. Retrieval time can be slowed simply by having many users simultaneously accessing the system. Since information requests are queued in a network system, system response time can also be adversely affected if many users attempt to access the same database simultaneously or print material on a community printer.

If the network includes off-site users, it must be remembered that both on-line costs and access time increase for remote users. Rather than having off-site users accessing a network, it may be more cost effective to provide those users with stand-alone workstations and individual copies of the CD-ROM discs.

3.2.4.2 Terminals vs. PCs

The ability of the patron to download information must be a consideration when determining hardware requirements for workstations.

Terminals. Computer terminals do not contain floppy disk drives. The use of terminals is more efficient and cost-effective if patrons will not be permitted to download, if downloading will be performed by a staff member, or if the MCRC will utilize a network. In situations in which data will be retrieved from a central location, the need for separate CD-ROM disc drives at each workstation is eliminated. Terminals and keyboards would be the only equipment required. However, it is important to consider the type of terminal required to support the system. Terminals must be compatible with the display requirements (e.g., VGA, ASCII) of the CD-ROM titles.

PCs. If patrons will be allowed to download data stored on CD-ROM to floppy disks, each workstation will need the hardware to support this capability (single or double disk drives for 5 1/4" and/or 3 1/2" disks). Allowing patrons to download data may reduce the costs and time associated with printing data, especially if large amounts of information are to be downloaded. If PCs will be utilized, the following factors must be considered.

Internal vs. External Drives. Computer floppy disk drives can be either internal or external to the computer's chassis. Internal drives require no desk space, but they do require an empty 5 1/4", half-height drive bay in the computer. (Usually, installing an internal drive is simply done by adding the appropriate board and controller to the system and then slipping the drive into the bay rack.) External drives take up desk space but do not require an inside drive bay. Most external drives do require an internal controller board. (Some hook up to a parallel port, but these are usually expensive and slow in performance.) The choice between these types of drives will depend on price and the amount of space at each workstation. If existing equipment is to be used that does not have drive bays available, external drives will need to be purchased. If new equipment will be purchased, drive bays for internal CD-ROM drives (and other options) should be considered.

Low vs. High Density Disk Drives. Whether internal or external, consideration must also be given to the capability of the floppy disk drive for storing and accessing information. High density 5 1/4" disk drives allow the user to store 1.2 megabytes of data per disk (1.4 megabytes for 3 1/2" disk drives), while 360 kilobytes of information can be stored on a low density 5 1/4" disk drive (720 kilobytes for 3 1/2" disk drives). High density disks allow the user to store more information per disk, which may be desirable if the patron must download a large amount of information.

However, high density disks will not read on low density drives.

Hardware/Software Requirements. PCs, whether used as stand-alone workstations or networked, should meet Multimedia PC (MPC) criteria. MPC is the emerging standard and many commercially available CD-ROM programs are designed to run on MPC-compatible systems. In order to be MPC compatible, a PC must include a sound board, a CD-ROM drive, a 20-megabyte hard drive, VGA graphics card, VGA monitor, and a 386+ microprocessor. Software

requirements may vary slightly but generally include DOS version 3.3 or higher, Microsoft Windows version 3.0, and Multimedia Extensions 1.0.

3.2.5 Setting Up CD-ROM Work Areas

In designing and setting up a CD-ROM work area within a library, consideration must be given to location, furniture selection and placement, access to staff assistance, and access to CD-ROM titles.

Since it may be difficult to purchase all necessary workstations up front, the space designated for a CD-ROM work area should be one that allows more workstations to be added as the demand increases. The work space itself should be large enough to accommodate a desk for each workstation, tables for printers, and extra chairs for staff assistance. Work surfaces should be large enough to accommodate a PC with keyboard, a CD-ROM drive, and possibly, a printer.

The work space should be planned so that CD-ROM units are not adjacent to exterior windows because extraneous light can cause glare on the computer screens, making viewing difficult. If this is not possible, glare-reducing screen overlays can be purchased that are both effective and inexpensive. Printers shared by library patrons should be located on separate printer tables. To eliminate distractions to other library patrons, laser printers, "quietized" dot matrix printers with sound baffles, or ink jet printers should be used. Laser printers emit much less noise than dot matrix printers, although laser-quality printouts should not be required in the library setting. Dot matrix printers can use entire boxes of continuous-feed (fan-fold) perforated paper at a time; they may be preferable in some circumstances because they require less attention from operators. Ink jet printers are nearly as quiet as laser printers and can use continuous-sheet paper, but are slow and are suited only to low-quantity printing applications. A printer table with a slot in the top for continuous-sheet paper feeding is recommended for dot-matrix or ink-jet printers.

The work area and workstations should be designed so that everything the patron needs to use the system is at his fingertips. This will reduce any inconveniences or frustration by the patrons. Reference tools should be available to all workstations. Instructional materials or databases that supplement on-screen directions for accessing the CD-ROM system and conducting searches should be available. This information, along with CD-ROM database catalogs, can even be posted in the work area to reduce the amount of assistance needed from library staff. If patrons will be handling the CD-ROM titles, they must be readily available, although a system must be established for checking out, handling, and returning the discs.

The physical location of the work area must be close to library personnel so that they may assist with loading discs, conducting searches, downloading, and printing. If patrons will access CD-ROM titles through library staff, the titles must be located near or within the work area.

3.2.6 Establishing Operating Procedures

Operating procedures should be established to ensure optimal use of any CD-ROM system. The specific procedures developed should be based on decisions made regarding the amount of patron access to the system and the type of CD-ROM system installed. These decisions can include: determining whether patron access to CD-ROM systems and discs will be restricted,

selective, or open; determining whether CD-ROM discs will be allowed to circulate; identifying whether certain CD-ROM discs contain limited access materials that will require the discs to be controlled (such as classified or other sensitive information); and determining whether CD-ROM hardware will consist of stand-alone workstations, networked systems, or a combination of both (see Section 3.2.4, Equipment Considerations). Based on these decisions, operating procedures and guidelines for patron use of the system must be established for controlling and managing discs, printing and downloading data from CD-ROM discs, providing staff assistance, and establishing patron time limits per workstation.

3.2.6.1 Disc Management

The goal of disc management is to ensure the continued operability, security, and accountability of CD-ROM discs. The amount of patron access will play a large part in establishing disc management guidelines. For example, some CD-ROM drives can be locked so that users cannot remove discs. This prevents unauthorized handling and ensures the security of the disc (particularly desirable for limited-access discs). However, limited patron access will also require that library staff load new discs when patrons wish to view another disc, potentially tying up the staff and inconveniencing patrons.

For limited patron access, it will also be necessary to specify procedures for retrieving discs for patron use and tracking the location of discs being used by patrons. If patrons will have access to discs, the operating procedures should reflect decisions regarding whether patrons must sign for discs they use within the MCRC, procedures for checking out and returning discs, any restrictions on the number of discs a patron can access or check out at a time, requirements for handling discs properly, and patron financial responsibility for discs that have been damaged or lost.

Operating procedures must also be established for cataloging, storing, and inventorying discs. Decisions must be made regarding: how CD-ROM titles will be incorporated into the MCCAT system; how discs will be cataloged; where, in relation to the CD-ROM work area, the discs will be stored; and what the procedures or schedule will be for adding new CD-ROM titles to the system.

Disc management operating procedures will also be dependent on the type of CD-ROM system in place. Networked systems can reduce patron handling of discs. However, MCRC staff will then be responsible for loading and changing discs.

If duplicate discs will be sent to off-site or field locations, procedures must be established for method of distribution. Controls must be in place to ensure prompt distribution and the replacement of discs that are damaged or lost.

3.2.6.2 Printing and Downloading Data

One of the benefits of a CD-ROM system is the capability of the user to print data and download information from a CD-ROM disc. Particularly for libraries and similar research facilities, this capability can be readily exploited. However, it is essential to ensure that operating procedures are established to prevent abuses to the system by patrons or staff. In order to make

optimum use of these capabilities, decisions are needed with regard to restrictions, if any, on the types and/or amount of data which may be printed or downloaded and whether patrons will be charged a fee to print or download data.

Operating procedures must enable staff and/or patrons to operate the printers properly and identify maintenance requirements, particularly if staff members will be responsible for performing basic maintenance such as replacing ribbons or paper. Paper usage must be carefully monitored to avoid excessive or unnecessary printing which may tie up the system and increase operating costs. This may be accomplished by limiting the amount of printing time per patron or charging the patron per page or article/citation. If a printing charge will be implemented, procedures for the method of payment must also be determined. A log-on code can be developed to track printing, downloading, and system time. Whatever method is used, it should be outlined in detail in the operating procedures.

Procedures to regulate downloading of data must also be very detailed with regard to the amount of data that are permitted for downloading, and whether or not patrons will be able to download to floppy disks. If the decision is made against downloading, computer terminals rather than PCs with disk drives should be purchased. If downloading is permitted, consideration must be given to establishing a fee for downloading and how the fee will be calculated and charged to the patron. Operating procedures must also be developed with regard to any restricted data that cannot be printed or downloaded.

3.2.6.3 Staff Assistance

The operating procedures for staff assistance must be clear to all staff members as well as to patrons of the CD-ROM system. Based on the amount of patron access, staff responsibilities for patron use of CD-ROM will vary. The staff should understand their responsibilities regarding response to patron requests for discs, loading discs at patron workstations, instructing patrons on the use of the system, assisting with or conducting searches, downloading or printing data, and monitoring patron use of the system. Decisions should also be made regarding the need for dedicated staff personnel, whose only function is to assist patrons in using CD-ROM and managing the CD-ROM system. This requirement may be necessary for CD-ROM systems located in restricted areas or when the data accessed is sensitive, classified, or archival.

3.2.6.4 Patron Time Limits

To ensure that all patrons have equal opportunity to use the CD-ROM system, the operating procedures may need to include requirements regarding patron time limits on the system. Procedures should be established to track and monitor patron use of the system. The time limit can be inclusive to cover search, review, printing, and downloading; or time limits could be established separately for each procedure. If patrons can download data to a floppy disk, there should be other computer systems set up so patrons can edit and manipulate data while not tying up a CD-ROM system.

The MCRC may also wish to consider establishing in addition to first-come, first-serve workstations, CD-ROM workstations that are dedicated for quick turnaround use or long-term use. For example, certain workstations may have posted time limits of 15 minutes per patron. These

workstations may be useful for patrons who know the specific information they are looking for, or wish to conduct a short abstract or citation search. Other workstations may have posted time limits of an hour, to be utilized by patrons conducting extensive searches or when printing or downloading data. Long-term use stations may require that the patron call ahead to schedule time on the system.

3.2.7 Staff/User Training

If the MCRC adopts a CD-ROM system for use in its new facility, decisions regarding staff and patron training will be required. Staff training should include management of the system for physically storing and controlling patron access to CD-ROM discs, operation and maintenance of the equipment, how to access individual titles (search functions, as well as the user interface, may be different for each title); and how to conduct searches in a CD-ROM environment. Decisions concerning how and when this training should take place must also be answered. Before any training program is designed, it is essential to consider how the introduction of a new technology may impact the staff. The implementation of CD-ROM along with the integration of other new or existing automated systems may increase the staff's perceived level of stress, anxiety, and confusion and make the staff resistant to learning and utilizing the system effectively. To ensure that training is successful, the development and implementation of any staff training should incorporate the following:

- Ensure all staff members are included in the planning and implementation phases of the CD-ROM system to enable them to learn about the system and how it will be utilized. Staff members should also be provided with a forum to discuss ideas, voice concerns, and ask questions. This input may provide valuable insight when designing the training program.

- Ensure all staff members receive training on the CD-ROM system, even if not all staff members will utilize the system as frequently as others. Consideration should be given to those situations in which staff members principally involved with the system may not be available.

- Ensure training is conducted so that it does not interfere with the staff's other duties. This will help eliminate distractions and allow the staff to focus on learning the system. Training may be scheduled before or after normal working hours, or the library can be closed during the time that training is conducted.

- Provide ample time for staff members to practice utilizing the CD-ROM system. Training should include as much hands-on time as possible to enhance the effectiveness of training, improve transfer of learning, and allow the staff to become comfortable with the system at their own pace.

- Training should be developed in a building block process. Basic information should be presented first, and instruction should not proceed to new topics until all staff members completely understand the information presented to that point.

- Training aids and supporting materials should be developed and included in the training package. This information should be designed so that the staff can refer to it when needed. Each staff member should receive a set of these materials.

Patron training should also be well thought out. The timeliness and comprehensiveness of the training program can do much to reduce any intimidation or the frustration some patrons may feel when introduced to new technology. Elements of patron training should include general parameters and use of equipment for reading, printing and downloading data, general CD-ROM search techniques, and handling or check out of discs.

Probably the biggest area for patron training involves conducting searches. Research studies on CD-ROM use in libraries have found that users generally do not take full advantage of system search capabilities. This leads to users printing out many articles because they did not narrow their search topic, due to their lack of knowledge concerning CD-ROM searches. There is more to conducting a search than entering search terms and displaying the results on the computer screen. Many types of searches exist from basic to very complex. Patrons should receive training in all types of searches so that they may utilize the sophisticated search features of a CD-ROM retrieval program to refine their searches of literature and reference materials and to reduce paper costs associated with printing.

Consideration should be given to whether the library staff should teach patrons how to use the CD-ROM system or whether other types of training materials or methods should be used. Methods to teach patrons how to access the system and conduct searches include a written instructional manual or user's guide, an on-line tutorial, an interactive CD-ROM training application, workshops, or through staff assistance.

If the MCRC decides to publish CD-ROMs in-house, personnel will require training in those areas where production will take place: instructional design, database programming, scanning, quality assurance, indexing, etc. It is estimated that one to three days of formal training and two weeks of familiarization with CD-ROM database techniques would be required. Decisions will need to be made concerning which staff members to train, where and how the training will take place, and the schedule for initial and/or follow-on training.

3.2.8 Commercially Available Titles

Today, many CD-ROM titles are commercially available from many vendors. Vendors publish an exciting array of titles including standard periodicals, reference materials, government documents, on-line services, multimedia educational programs and learning tools, photograph and graphics collections, and maps and atlases.

3.2.8.1 System Requirements

Before purchasing any discs from a vendor, it is important to determine, from the specific manufacturer, what the minimum system requirements are for reading the discs. The following questions should be asked of the vendor: What type of PC is required (IBM-compatible or Macintosh)? How much random access memory (RAM) is necessary? What version of DOS is required? What type of CD-ROM drive should be used? What type of graphics card and monitor (EGA or VGA) are required?

3.2.8.2 Standardized Format

Another area of inquiry concerns the standard used in formatting the CD-ROM disc. When purchasing CD-ROM titles through commercial vendors, it is important to ensure the discs are formatted to the ISO 9660 standard. Most discs produced since the start of 1992 are formatted in the international standard, ISO 9660, making the discs compatible with most CD-ROM drives now on the market. If discs have not been formatted to this standard, there is no guarantee that they will be readable on any particular CD-ROM drive. If the disc is not available in ISO 9660, it will important to determine whether the disc will be readable on the system the MCRC has acquired, prior to the title being purchased.

3.2.8.3 User Interface/Indexing and Retrieval Program

Before purchasing any CD-ROM title, it should be previewed, if possible. Many CD-ROM vendors make sample discs available for just this purpose. Some vendors provide sample discs for a nominal fee, while others provide them at no charge; some vendors will loan out a disc for a period of time, while others will send out sample discs that the customer can retain. There is wide variability in commercial titles with respect to their user interface and indexing and retrieval programs. How the title appears on the computer screen (readability, use of color, screen layout) and how the content of the title is presented and organized (user friendliness) can vary dramatically among vendors. For any facility that provides CD-ROMs for public access, the assumption should be made that the computer literacy of its patrons will vary greatly. Therefore, it will be important to purchase CD-ROM titles that are as user friendly as possible. Any title that may be purchased as part of the MCRC's holdings should be previewed with the following in mind:

Visual Display. The visual display should be easy to read, with colors that are not harsh or hard on the eyes. The print should be easily distinguishable from the background so that the user will not have to strain to read the text (for instance, red text on a black background). The choice of colors should also facilitate legibility on monochrome displays, in case a color display is not available (e.g., in a portable system with an LCD flat-panel display).

Organization of Material. The material on the disc should be organized in such a way that the user can quickly identify how to navigate through the disc and readily access information. This is accomplished primarily through menu screens, help screens, screen design, search structures, operational controls such as "hot buttons" or function keys, and written instructions. These features should be easy to understand and enable the user to quickly identify what to do to access the system, move through the document, conduct a search, retrieve information, print, download, or exit the system. Information should be organized on the CD-ROM disc in a logical sequence and the menu should allow quick access to its contents. Help screens should be easy to access, understand, and exit. The size, type, and color of text and the use of bolding, italics, and underlining should be consistent throughout the document. Function keys should be consistent throughout the document to avoid confusion. For example, if the F1 function key is designated as the "page forward" key on one screen of a title, it should not be designated as the "exit" key on another screen. It is also desirable that the location of these keys be consistent so the user does not have to search for them to maneuver through the document.

Content. The content of the title should be easy to understand and at a reading level appropriate for most patrons. Written instruction should be simple and brief, avoiding the use of highly technical wording.

3.2.8.4 Stand-alone vs. Networked System

Before purchasing any discs from commercial vendors, consideration must be given to the type of CD-ROM system or systems which will be acquired. Some vendor titles are designed to run only on stand-alone systems that require a separate disk drive to run the install program off of a floppy disk. Other vendor titles are available with the install program on the CD-ROM disc, thus requiring no additional equipment to read the CD-ROM. There are also titles that are either compatible with single workstations or local area networks.

Additionally, the cost of a commercial title may be higher if its use is designed for a network. Generally, a vendor will ask a customer about the disc's intended purpose. This is because the vendor will lose money if a customer purchases a title to be accessed by multiple users at one time, as opposed to selling that customer multiple copies of the same title for use at many stand-alone workstations.

3.2.9 Planning for the Future

It is never too early to begin planning for the future, particularly when designing a new CD-ROM system. To make the best use of CD-ROM technology, thought should be given to the MCRC's future as well as current needs for storing, accessing, and distributing information. Because CD-ROM is a relatively new field, technological improvements are being made every day. Investments in today's technology must be weighed against the possibility of their being outmoded in the near future, thereby requiring further investments to keep current. With these considerations in mind, a CD-ROM system should be designed so that it is flexible to take advantage of technological advancements and respond to future MCRC requirements.

As with standard computers, future CD-ROM upgrades will always be just around the corner. Wherever possible, equipment should be purchased that can be upgraded for future enhancements. For instance, CD-ROM drives in today's market provide faster access to data and improved data transfer rates; future models will operate even more efficiently. In addition to faster retrieval of data, these improvements will allow better playback of animation and motion video. Newer equipment and services appear on the market daily, so whatever is purchased today must be planned for integration with new improvements and enhancements of the future.

Today's commercial titles are not standard in their indexing structure and user interface. This requires users to learn a new retrieval method for each title. New standards for electronic publishing, indexing, interface, and multimedia are being developed and will soon be available (See Section 3.3.2.11, Emerging Standards). When implemented, these standards should result in the development of commercial titles that are much more user-friendly. The acquisition of commercial titles should be planned on a schedule that can best take advantage of these emerging standards.

In summary, while CD-ROM technology makes many applications available today, even greater possibilities for its use are just ahead.

3.3 Use of CD-ROM Vendors

CD-ROM vendors can be grouped into three broad categories: publishing/production vendors perform all or specific steps required for CD-ROM production; equipment vendors sell the equipment necessary to produce CD-ROM or to read CD-ROM; titles vendors sell commercial off-the-shelf CD-ROMs that contain reference materials, educational packages, various periodicals, etc.

3.3.1 Considerations for Choosing a Vendor

When choosing a vendor for any one of the steps of CD-ROM production, for equipment or software purchases for reading CD-ROM, or for the purchase of commercial titles, careful planning and thought must be given to the decision. Vendors provide a variety of services, have varying levels of capability and stability, and charge wide-ranging prices. Although equipment and software purchased for use in the MCRC will probably be made in bulk or through a government agency, newspaper and magazine articles, and advertisements are a good source for some initial individual research. These sources of information provide an overview of the prices, services, equipment, and software available. Visits to local CD-ROM dealers, chain stores, computer stores, and discounters are another way to obtain some initial information. However, when refining the search and selecting a CD-ROM vendor, the following factors should be considered:

Reliability. With new applications for CD-ROM technology being developed every day, CD-ROMs are becoming more popular and the market is expanding with vendors selling a variety of equipment, software, and services. All of these vendors promise to deliver a reliable product or service and, because of the rapid growth of the CD-ROM field, not all vendors will be able to do so. That is why it is critical to check a vendor's reliability and customer satisfaction status before entering into an agreement. For instance, does the company specialize in CD-ROM or is that an area recently acquired? How long has the company been in business, particularly in CD-ROM technology? Can the vendor produce the phone numbers and addresses of satisfied customers? Before selecting a vendor, these questions must be answered. References should be contacted to learn about the vendor's performance in terms of quality of product, meeting the customer's needs, adherence to CD-ROM standards, and timeliness of delivery. The vendor's financial stability should also be checked. Does the vendor have the resources to deliver what it promises? Does it have sufficient capital to keep up with current technology? Many publishing vendors require a considerable up-front investment---as much as 50% down, 25% at acceptance of design, and 25% on delivery. Young or small companies may not be able to deliver an acceptable product or service or may lack sufficient financing and go out of business before completing a contract. Recouping an initial investment could be very difficult under those circumstances.

Ability to Demonstrate Products/Services. When choosing a vendor, insist on demonstrations, especially of software programs. Most companies can provide floppy disks that emulate their CD-ROM software. Demonstrations will help ensure that the program fulfills the vendor's promises and that it meets technical and usability requirements.

Customer Satisfaction. Before selecting any vendor, it is important to ask for the names, phone numbers, and addresses of previous customers. These companies or individuals should be contacted to get information about the vendor. The following questions should be asked: Was the customer happy with the vendor's services or products? Was product quality good? Were delivery schedules met? Was a representative readily available for consultation when necessary? Would the customer use that vendor again? If possible, the product(s) the vendor supplied to the customer should be reviewed.

Licensing/Royalty Fees. Almost all vendors charge a licensing fee for use of their indexing and retrieval software programs. Many also charge a royalty fee on the duplicate discs made from each title produced using that software. This applies to both use of the software in-house and the vendor's use of this software to produce titles. Some vendors claim to have no royalty fees and use terms such as annual "retrieval license" for per-disc charges. But whatever the term, most vendors charge some form of licensing/royalty fees for the use of their software. The only way to avoid this cost is to program indexing/retrieval software in-house. Licensing/royalty fees are charged in various ways:

- A royalty fee is paid per disc produced. This fee can range from $5 - $130 per disc depending on the number of duplicates made (e.g., $5/disc for 5000 duplicates or $130/disc for 100 duplicates).

- A flat rate is paid for a minimum of 100 duplicates or a higher flat rate for unlimited duplicates. This rate can range from $6,000 - $12,000.

- A flat rate is paid for each CD-ROM title produced using the software, regardless of the number of duplicates. This rate can range from $750 - $10,000. This fee may decrease for each additional title produced.

- A flat one-time fee is paid for indexing and retrieval software use with no limit on the number of titles and duplicates created. This fee is usually about $30,000 - $60,000. This fee covers the cost of the software and its licensing.

Costs. CD-ROM is still a relatively new technology with new vendors entering the market constantly. In order to capture new customers, many of these companies will negotiate prices aggressively. Therefore, there is a wide range of prices for CD-ROM services and equipment. For instance, because CD-ROM drives are standardized, the buyer can shop for the best price. Although generally directed toward individuals rather than organizations like the USMC, many companies now offer package deals that enable the purchase of a drive together with one or more currently available titles. If the titles are ones the MCRC desires, this can be a very economical way to purchase drives and CD-ROM discs. However, keep in mind that the price of drives reflect performance. For instance, products offering rapid retrieval time and/or a faster transfer rate will generally cost more than those drives with less desirable capabilities. Opt for drives with the best retrieval time and transfer rate.

On-going Vendor Relationship. When periodicals or other materials that are updated frequently are produced in the CD-ROM medium, an on-going relationship may be established with a vendor. That is, the vendor will produce the initial CD-ROM and at regular intervals (e.g.,

quarterly, semi-annually, annually) produce additional CD-ROMs to capture current editions or issues of the material. This on-going work and its frequency are factored into price negotiations and normally result in a lower cost for the purchaser than if he began negotiations anew each time an updated CD-ROM was to be produced.

3.3.2 CD-ROM Production

Production of CD-ROM is a time-consuming, complex process. It requires time, money, and personnel with expertise in instructional design, information retrieval, medium transfer, computer programming, etc. Decisions must be made regarding whether to work with a publishing vendor or to make the time, training, and equipment investments that would enable in-house production of CD-ROMs. This section will present the considerations for planning CD-ROM in-house, the equipment involved, and the use of vendors for each step of CD-ROM production.

3.3.2.1 Step 1 - Design

In-house Staff. To design a database, in-house staff must have expertise in instructional design so that they may select an appropriate indexing and retrieval software package (if one is not developed in-house) appropriate to the delivery platform chosen, the database, and the skill level of the targeted end users of the system. It is recommended that an indexing and retrieval software package be purchased from a vendor, particularly if many CD-ROMs will be published by the USMC. Organizations with Instructional Systems Development (ISD) background and experience can be consulted to assist in the design of a user friendly database that makes effective use of colors, screen layout, menu, on-line tutorial (optional), and function key structure.

Equipment. No equipment is required in the design phase.

Vendor. Many vendors provide consulting services concerning the CD-ROM design process, although most do not have a background in ISD. As a result, the databases they create can be difficult to navigate through. The cost of such service would depend on the extent of the effort.

3.3.2.2 Step 2 - Data Conversion to an Electronic Medium

In-house Staff. Data conversion--via keyboard entry, image scanning, and/or OCR scanning--can be performed in-house with the appropriate equipment. However, some expertise in data conversion is required, and all three methods are labor intensive (although image scanning is more time consuming than text scanning). The selection of a sophisticated OCR software package for scanning text that produces few errors is important, especially if the work is done in-house. The scanning process will require skill in the use of specialized equipment and, if images are scanned, possibly graphic arts. Cost as well as the pros and cons of staff experience and available time should be weighed in making a determination for converting data in-house or using a vendor's services.

Equipment. A PC (386, 33 MHz or better with 640 RAM) or mainframe system computer with a large external hard drive of at least 640 megabytes of memory is necessary to store

the database and enter the data via the keyboard. In addition, a scanner is needed for the transfer of source materials (graphics or text) to a magnetic medium. External hard drives range in price from about $1,600 (680 megabytes) - $2,500 (1.2 gigabytes). A flatbed scanner should be used; they can range in price from $1,000 - $6,000, depending on features and the amount of software included. Hand-held scanners should not be used because, with a scanner head width of 4", they are generally designed for graphics and clip art and not 8 1/2" by 11" documents. However, hand-held scanners are useful for scanning archival documents that require special handling or rare books that cannot be taken apart so their pages can be placed flat on a flatbed scanner. Hand-held scanners range in price from $100 - $500 and their image conversion resolution is not as high as a flatbed scanner's.

If text is being transferred, OCR software is needed. OCR software can range in price from $300 - $1,000, depending on its sophistication for recognizing characters and producing fewer errors. Consideration should be given to these higher-end OCR software packages even when their costs exceed other packages because their benefits in terms of fewer errors may outweigh the costs incurred.

Vendor. Vendors charge around $1 - $2 per page to enter data via keyboard. Vendors charge similar rates for OCR text scanning, usually with a minimum charge of about $45 and a discount on a high volume of work. Vendor prices for OCR scanning will vary depending on accuracy, volume, and the amount of markup in the original material. Image scanning costs vary from $.60 - $3.50 per page, again depending on volume and amount of cleanup required.

Whether this step is performed in-house or by a vendor, it is recommended that microfiche not be planned for direct conversion because the technology still does not really exist for doing this. Information on microfiche will require conversion to paper format before it can be converted, unless the original source tape is available for use.

3.3.2.3 Step 3 - Quality Assurance

In-house Staff. Checking the accuracy of data once it has been scanned can be performed in-house with basic word processing and computer skills. However, it is a very labor-intensive process; the greater the number of errors resulting from the data entry or scanning process, the more time will be required to clean up the files. Again, the consideration for performing this in-house is based on whether staff can dedicate sufficient time and the necessary attention to detail to the effort.

Equipment. PC(s) or mainframe computer and word processing software are needed to edit the data files for quality assurance.

Vendor. Quality assurance may be performed by a data conversion service vendor, although not all vendors do this. The cost of having an outside vendor perform this step may depend on both the length and the content of the document. Documents containing multiple text fonts, foreign language text, special text characters or symbols, or captioned figures may cause unusually large numbers of conversion errors. In addition, documents containing special characters, abbreviations, handwritten annotations, or specialized military terminology may be beyond the capability of an outside vendor to proofread for accuracy and may require a knowledgeable specialist for checking. Keep in mind that if a vendor is used, they have to be solely

relied on to assure an error-free database. If a vendor performs quality assurance, it is generally included in the price for data conversion. When selecting a data conversion vendor, make sure this question is asked.

3.3.2.4 Step 4 - User Interface and Indexing

In-house Staff. Since this is the developmental step that results in either a user-friendly, appealing research medium or one that is cumbersome or dreary to use, the importance of using experts for designing the user interface and indexing the material cannot be overemphasized. Whether the indexing program is designed in-house or a vendor's indexing program is used, the expertise of an instructional designer who can set up search structures and organize data files is essential. It is recommended that a commercially produced indexing and retrieval software package be used. However, many commercial indexing programs are not user friendly, possibly making computer programming expertise required. It is recommended that any indexing program be reviewed prior to purchase to determine its user friendliness for authoring and if the software has clear instructions documenting how to use it.

Indexing a database requires defining the data type, describing the data, and structuring the data for retrieval by providing specifications for the kind of output to be applied. Depending on the type of data (e.g., text, graphics), software should be chosen that supports the DoD recommended standards for formatting data (see Section 3.3.2.11, Emerging Standards).

Indexing can be a time-consuming process. One recommended method of estimating the staff hours required for indexing is to divide the number of megabytes in the source file by four. Thus, a 400 megabyte database would require about 100 hours to index. With regard to performing this step in-house, staff expertise and time demands as well as the cost of the indexing software package need to be considered. And again, consultation with an ISD-experienced contractor is recommended.

Equipment. An IBM-compatible PC (386 or better with 640K RAM, 33MHz) or a mainframe computer and an external drive with a temporary storage capacity three to five times the size of the source database are needed to index the database. The amount of storage space needed will depend on the type of data format, for instance, full text information or fielded databases. Full text information (e.g., books or other standard documents) requires less temporary disk space. Fielded databases (e.g., spreadsheets) require much more. As an example, if the database is 300 megabytes of text information, 900 megabytes of temporary disk space would be needed for the indexing process. If that 300 megabyte database were fielded information, perhaps 1500 megabytes of memory may be needed. An external hard drive with this memory capacity will cost about $2,500. If sufficient disk space is not available, it is possible to index in sections and save each section to magnetic tape. The finished, indexed product will require about 50% more disk space than the original source file; that is, a 400 megabyte database will increase in size to 600 megabytes. An indexing and retrieval software package is needed to structure the database. If in-house personnel do not have computer programming experience, a commercial indexing and retrieval software should be purchased. There are many software packages commercially available that have a variety of capabilities and features. Once the package is purchased, indexing may be performed in-house. The choice of an indexing and retrieval software package is a critical step: the package should be user friendly and must fit all needs without having unnecessary and costly

extras. Such software packages generally cost $1,000 - $4,000, with the higher cost reflecting the program's search capabilities and ability to automatically find and correct errors. Vendors also charge additional licensing and/or royalty fees for use of their software, which can run up to $30,000 for a flat fee in addition to a royalty fee paid per title, depending on duplication volume. (See Section 3.3.1, paragraph Licensing/Royalty Fees, for more detailed information.)

Vendor. Vendor prices for indexing can vary dramatically from $10,000 - $100,000 (not counting licensing and royalty fees), depending on the sophistication of the search system and the amount of data to be processed. (A vendor should be able to provide a price estimate based on these factors.) Just as selection of an indexing and retrieval software for in-house use is critical, it is also important when using a vendor to ensure that the indexing method used by the vendor meet MCRC requirements in terms of search and retrieval capabilities, user friendliness, etc. The decision to use a vendor to index data must be made by considering how many discs will be indexed currently and in the future. If the user wishes to publish many CD-ROMs, it may be quicker and more cost-effective to purchase a software package and to index the material in-house with the assistance of an ISD consultant.

3.3.2.5 Step 5 - Transfer of Source Data to Magnetic Medium

In-house Staff. If the vendor chosen for mastering does not accept the medium that now contains source data (e.g., computer floppy disks, hard disk), the data must be transferred to an acceptable magnetic medium. This can be performed in-house; basic computer skills and knowledge of the magnetic medium chosen are required. Again, the availability and experience of staff and the cost of necessary equipment are prime considerations in deciding whether to perform this step in-house.

Equipment. A 670-megabyte (minimum) external hard drive, magnetic medium hardware (e.g., 9-track tape or 8mm data cartridge drive) and tapes or cartridges are required. External hard drives range in price from about $1,500 to $2,500 for 680 megabytes and 1.2 gigabytes capacity, respectively. Nine-track tape drive prices are in the $5,000 range and 8mm data cartridge drives are about $3,000. Tapes cost about $16 each; data cartridges about $100 each. If it is necessary to convert data, it is important to note that four to five 9-track tape reels are required to hold the data on one CD-ROM disc; 8mm data cartridges can hold the equivalent data of about three and a half CD-ROMs.

Vendor. There are many service vendors who will transfer data from computer floppy disks to a magnetic medium. On average, for transfer from floppy disk to magnetic tape, vendors charge about $40 per floppy disk (plus the cost of the magnetic tape if the customer does not supply it). Again, it is important to remember that one CD-ROM disc can hold up to 1,500 low density floppy disks. Therefore, using a vendor for this step can become quite expensive if a large volume of data needs to be transferred. However, almost all mastering facilities now accept external hard drives as a data input medium, so it may not be necessary to transfer source data stored on floppy disks.

3.3.2.6 Step 6 - Premastering

In-house Staff. This step involves converting the database into CD-readable files (formatting block address, headers, and sync pattern), logically placing the files on the disc (ISO 9660), and inserting error detection and correction codes into the database. The CD-ROM reader then uses these codes for accurate retrieval. Some vendors offer premastering software packages for in-house use. Again, the user friendliness of these software programs varies. Premastering is a relatively fast process, requiring five or so hours. However, because of the resources required, it is probably not cost effective and it is not recommended to perform this step in-house.

Equipment. IBM compatible PC (386 or better) or a mainframe computer, desktop encoder/recorder system (sometimes called a write-once system), write-once discs, and premastering software program. Write-once systems currently cost about $30,000 and the discs range from $30 - $80 each. However, new, less expensive (approximately $12,000) equipment and software that outputs the premastered data to a high capacity tape cartridge has just become available in the commercial market. Premastering, whether done in-house or by a vendor, uses CD-ROM disc space. Error detection and correction codes take up 144 bytes of disc space for each kilobyte of the database.

Vendor. Many vendors premaster data at flat prices ranging from $250 - $750. Others charge about $125 per hour, with an average time required of two to five hours. Prices will vary depending upon the input medium (e.g., computer hard drive, magnetic tape or cartridge). A vendor should be selected who will format the database to the ISO 9660 standard. This price is usually included in the premastering cost, although some vendors charge an additional fee.

3.3.2.7 Step 7 - Checking the Search Structure for Proper Retrieval (CD-ROM Simulation)

In-house Staff. Following premastering, the vendor will send a check disc to the client for quality assurance. The check disc simulates the CD-ROM disc so the client can access the software and perform searches to make one final check of the product's accuracy before the final master disc is pressed. This quality assurance step requires time and expertise in search structure and retrieval methodology.

Equipment. PC or mainframe computer and a CD-ROM reader are needed to run the check disc.

Vendor. It is not recommended that a vendor perform this step because it is up to the client to determine if the program performs satisfactorily.

3.3.2.8 Step 8 - Mastering and Duplication

Master Disc. Mastering must be performed by a vendor. It requires very specialized, costly equipment and a specialized environment. However, as CD-ROM technology gains wider industry acceptance, it is conceivable that within five years equipment capable of producing CD-ROM master discs will become commercially available and feasible for individual users to acquire. Turnaround time for mastering can range from 15 days to same day service, with prices increasing

for faster delivery time. Prices are generally about $800 for 15-day turnaround to $2,900 for one-day turnaround. The price may also vary based on the input medium, so this should be checked out before a vendor decision is made.

Vendor Selection. When selecting a vendor for the mastering process, the following considerations are important: What types of input media does the vendor accept? Does the company have an integrated manufacturing line (pressing, checking for errors, labeling and packaging performed in one continuous line)? Ask the vendor about his error and rejection rates and see figures if possible.

Storage. Many vendors include one year's storage of the CD-ROM master disc and input media as part of their service. The storage service generally includes one free remastering if failure of the master disc occurs during storage. Additional storage time costs about $200 per year. A reorder charge may range from about $200 for a 15-day turnaround to about $300 for 3-day turnaround. About 50 replicas are generally included in this price. Some vendors waive the reorder fee and charge only for the discs duplicated.

Duplication. Duplication of discs after mastering involves a similar time range for delivery; prices are sometimes tied to the mastering charges. Generally, replicas cost about $2 per disc. The price decreases with volume and increases for fewer copies or faster delivery time.

Labeling and Packaging. Most vendors include one or two color labeling and bulk packaging in their mastering and replication prices. The labels are printed from positive, color-separated film. Additional colors in the labels can cost from $30 - $100 per color. For disc packaging, most vendors use the clear-plastic "jewel box," costing about $.35 per box. For $.10 to $.15, each disc can be packaged in an envelope, a clear plastic bag, or a cardboard sleeve.

3.3.2.9 Other Considerations for In-house Production

Staff. Probably the most important consideration for in-house production of CD-ROMs is the availability of adequate staff. This means not only numbers of persons, but their ability to dedicate sufficient time to the project(s), their having or obtaining the expertise required, and the relative permanence of staff members with that expertise.

Staff Training. Vendors offer various software programs to aid in CD-ROM production; free training is provided with a small number of these programs. Some vendors also offer training workshops and seminars on CD-ROM production; and there are both commercial and academic programs in some disciplines. Vendors must be contacted to find out more about these services. (Section 3.3.2.10, Other Considerations for Using Vendors for Production, describes representative vendor software programs.)

Quantity of CD-ROMs to be Produced. In-house production of one or two CD-ROMs would not be economically feasible unless all required resources--staff expertise, time, equipment--were already in place. However, if a large number of CD-ROMs will be produced and production will continue indefinitely, initial investments in equipment, software, and training may prove to be less costly than repeated purchases from vendors.

CD-ROM Market. Whether CD-ROM production is performed in-house or by a vendor, consider that there may be a market for any CD-ROMs produced by the Marine Corps and some of the initial investment costs may be recouped with sales of these CD-ROMs to commercials sources. Working with a CD-ROM publishing vendor may mean receiving a royalty rather than getting all of the profits; however, with a limited or small budget, this may be the way to get started.

3.3.2.10 Other Considerations for Using Vendors for Production

Many vendors carry comprehensive software and equipment packages designed for use within various stages of CD-ROM production. Their usability, reliability, and prices vary greatly, and as stated in preceding paragraphs, licensing and royalty fees usually apply. The following are vendor descriptions of representative software/hardware packages.

- A package with all the hardware needed to prepare data for mastering, including data formatting and replication. Off-the-shelf software is used with this package. It enables a manager to create a CD-ROM check disk and includes a data cartridge drive, data cartridge tapes, data formatting standards, a CD-ROM for mastering and 100 CD-ROM replicas. Its cost is about $2500.

- Another package offers premastering hardware, text and simulation software, and a hard drive. It enables a manager to create a comprehensive index, premaster data, and do tests and simulations. Its cost is about $4,800.

- Several vendors also offer CD-ROM publishing packages that include the hardware (write-once system and discs) and software for ISO formatting, simulation and testing, and premastering. These packages are currently priced at about $30,000 and the discs range from $30 to $80 each. However, less expensive (approximately $12,000) equipment is expected to be on the market shortly.

- A multimedia resource program provides "how to" information on design, management, data preparation, programming, premastering and manufacturing techniques. It includes demos of various off-the-shelf tools and sample applications. Its cost is about $300.

- Vendors also offer customized presentations on the application of SGML, optical retrieval and hypermedia.

Many vendors perform the various CD-ROM production steps as part of a package. For instance, many vendors who offer premastering services include ISO formatting, and production of a check disc at the same time. Some mastering facilities perform premastering, ISO formatting, and production of a check disc also. The exact costs for these services should be determined before selecting such a vendor.

3.3.2.11 Emerging Standards

There are many emerging standards that govern or may govern the production and publishing of CD-ROM. As potential producers entering the market, Marine Corps personnel must be knowledgeable of these standards and be able to adopt them as they become available or as they

are updated. Because this is a new field, the standards will continue to be developed and revised. Their progress should be followed so that when decisions have to be made, the Marine Corps is informed on all fronts.

There is no standard indexing and retrieval system used by all publishers of CD-ROM. In fact, every CD-ROM publisher has its own proprietary software. There is no standard user interface among commercial titles. The screen design is different, the function keys are different, and the search capabilities may be different. Each time a new title is accessed it will take some time and, possibly, frustration to learn the new interface. Currently there are three organizations developing a standard user interface:

CD-RDx. A standard has been proposed entitled Compact Disc Read Only Data Exchange (CD-RDx) that will create a standard data/user interface allowing users to browse any commercially available title without having to learn the vendor's particular user interface. When working with a variety of titles produced by many different vendors, it is difficult to access and search the data because different search and retrieval programs are used to set up the database. Therefore, different function keys are used to scroll, select, print, and exit the database. CD-RDx would permit a user to read and display the data independent of the search and retrieval software the vendor used to index the data on disc.

CD-CINC. Compact Disc Consistent Interface Committee (CD-CINC), a committee under the Special Interest Group on CD-ROM Applications and Technology (SIGCAT), has proposed an approach for ensuring the agreement and implementation of specific user interface characteristics. Identify basic functions and assign common keys to specific functions, this committee goal is to recommend standards to publishers so their products have a universal standard, making using them easier.

CAIS. The CD-ROM Index Architecture Specification (CAIS) group is working on a solution to the user interface problem that promotes interchangeability in CD-ROM applications. They are developing a new index architecture that would standardize the structure of indexing. Currently a CD-ROM publisher uses their proprietary indexing/retrieval software which are inseparable. With the CAIS solution all CD-ROM publishers would use the same indexing structure and the end user would select the best retrieval software for their needs that accepts this standard.

The most inclusive set of standards regarding the interchange of digital technical information is the Department of Defense Computer-aided Acquisition and Logistics Support (CALS) initiative. The intent of CALS is to create and use shared data, eliminate duplication of data, and improve processes. CALS covers file format standards for specific data types: text, image, and audio/video (multimedia). Standard Generalized Markup Language (SGML) is the standard for the exchange of text data. SGML is a set of rules for defining markup language. A markup language identifies text or sections of text and specifies what processing functions should be performed on them (e.g. tab settings, paragraphing). Markup allows data to be stored, searched, and accessed because it specifies information the computer needs to perform these functions. The SGML standard is universal so that a text file using SGML can be read by any SGML-compliant software. There are CD-ROM authoring tools available to format a text file using SGML markup.

An example of a CALS-based imaging system is the Navy's Engineering Data Management Information and Control System (EDMICS). The EDMICS project involves scanning over 100 million drawings and 500,000 related technical documents and storing them on optical disc for access at over 40 Navy sites. Up to 250 workstations per site will be able to access the data. Another example of CALS use is the Joint CALS (JCALS) effort where over $750 million will be spent to connect DoD sites in order to share data. Another effort taking advantage of CALS standards is the tri-service Interactive Electronic Technical Manuals (IETM) effort. An example of an IETM is a portable PC-based job aiding system which is used on the flight line by aircraft engine mechanics. The database includes weapon system information using SGML so that it can be accessed by multiple applications and is presented in a consistent manner.

CALS is documented in MIL-HDBK-59A, "Military Handbook - Department of Defense Computer-Aided Acquisition and Logistics Support (CALS) Program Implementation Guide." (Specific guidelines regarding the acquisition of digital training products are provided in section 50.5 of Appendix B.) Specifications and standards which are considered part of CALS and may apply to the development of Marine Corps CD-ROM include:

MIL-M-28001, Markup Requirements and Generic Style Specifications for Electronic Printed Output and Exchange of Text (SGML)

MIL-D-8510, Preparation of Drawing, Undimensioned, Reproducibles, Photographic and Contact MIL-M-28002, Requirements for Raster Graphics Representation in Binary Format

MIL-D-28003, Digital Representation for Communication of Illustration Data: CGM Application Profile

MIL-STD-1379D, Military Training Programs

These standards are applied during the indexing stage of CD-ROM production. The first of these standards, SGML, governs the markup of text files. Data must be marked up to identify keywords for searches and the automatic construction of indices and cross-references. The next three standards govern the file structure and identification for graphics files. One of the most challenging tasks during indexing is the assignment of descriptions to graphics and still images. It is difficult to determine which of the "1,000 words" to use to best describe a picture so that it may be readily accessed and retrieved by the user. These graphics standards provide parameters for describing graphics files. The last standard, MIL-STD-1379D, governs the interactive courseware (ICW) development process and products. Whether CD-ROM production is performed in-house or by a vendor, these standards must be considered when designing the document and incorporated into the final product during the indexing step.

3.3.3 Reading CD-ROM

There are many equipment vendors available to sell the equipment necessary to read CD-ROM.

CD-ROM Drives. All that is needed to read CD-ROM is a CD-ROM drive hooked up to an IBM-compatible PC. Today, CD-ROM discs are standardized and will play on any

commercially available drive. This is definitely to the buyer's advantage. However, prices usually reflect performance. Rapid access time for retrieval and a high transfer rate of data from the CD-ROM drive to the PC are qualities of good performance, including smoother playback of video and animation. These factors should always be considered when selecting a drive. An access time of 300-340 milliseconds and a transfer rate of 150,000 bits per second are preferable. Further, the drive should be network accessible (Local Area Network) and be capable of hookup by a Small Computer System Interface (SCSI). (Most drives on the market meet these requirements.) Internal drives range in price from about $500 - $650, while external drives are generally more expensive and range from about $620 - $800.

Multiple Disc Drives. Drives are also available with a cartridge that holds six CD-ROMs. The discs are changed automatically within the drive, with the time required for the disc change varying from as low as 700 milliseconds to about 7 seconds depending on the model. Access time for retrieval also varies. Up to seven of these drives can be daisy chained, thereby allowing 42 discs to be automatically accessed by the system of drives. These cartridges can be locked in place so that a user cannot remove a disc from the drive. Price of such a drive range from $1,000 - $1,300 and may require the addition of an IBM interface ($100), a SCSI interface ($100), and ethernet cable for the daisy chain ($75).

Portable Drives. Portable drives, to be interfaced with laptop computers, cost about $500. Laptop computers with internal CD-ROM drives are not yet widely available. Some portable ("luggable") computers can accommodate internal CD-ROM drives.

Software. Also, depending on the retrieval methodology selected for the CD-ROMs, specific software may be required, including Windows and its supporting programs. Many PCs on the market today are preloaded with Microsoft Windows, MS DOS, and include a mouse. Purchased separately, Windows software is now available for under $100, with supporting programs ranging from $250 - $500.

3.3.4 Commercial Titles

There are many vendors today who publish off-the-shelf titles for commercial use. These titles cover a great range in price and cover the spectrum of educational tools, reference materials, periodicals, multimedia, graphics, clip art, music, etc. Many large newspapers and magazines as well as on-line services are now commercially available on CD-ROM.

The many titles available provide the user with a variety of options for research and entertainment. This variety may allow the user to purchase a particular title rather than produce a CD-ROM (e.g., titles include encyclopedias, government documents, military terms and acronyms, bibliographies, maps, U.S. history and wars, language tutorials, medical sciences, environmental data, and standard reference and literary works). Any library or research facility should look into these sources before setting out to publish their own CD-ROM because the CD-ROM discs may already be on the market and available for purchase. Many vendors will send a catalog of their titles on request.

One drawback to using commercially available titles, however, is the lack of standardization in retrieving the data. This occurs because companies producing the titles use many

different indexing methods. Consequently, function keys used to access the data, screen colors, and the degree of user friendliness vary from title to title. Though most CD-ROM titles contain a menu describing the use of function keys to navigate through the data, it still may be confusing to the user who is accessing different titles. Also keep in mind that many vendors produce titles without the aid of an instructional designer to provide expertise about screen layout and search structures. Producing CD-ROM discs in-house can ensure a standardized indexing and retrieval structure that is user friendly and efficient. The best bet may be to test or view the vendor's products before purchase.

3.4 General Implementation and Maintenance

3.4.1 Timeframe, Scope, Budget

The timeframe and cost for implementing a CD-ROM system will vary depending on the state of the source data (e.g., paper, computer disk, microfiche, film, video, magnetic tape), the quantity of data, and the vendors used for various stages of the CD-ROM production. (Detailed costs and timeframe for CD-ROM production are presented in Section 3.3, Use of CD-ROM Vendors.) However, as the technology for CD-ROM improves and evolves, the associated costs and timeframe for production and implementation will change to reflect the advances in hardware, software, and vendor services.

3.4.2 Maintenance Considerations

With any technology or hardware, there are maintenance requirements that must be considered. Maintainability concerns include design factors to be considered before CD-ROM system installation and maintenance strategies to be followed after installation.

3.4.2.1 Design for Maintainability

Design decisions made before system installation can ensure that the system is maintainable for years after it is installed. Basic guidelines for a multi-user CD-ROM information retrieval system include:

Modularity and Interchangeability. A system built from many interchangeable modules is inherently more reliable and maintainable than a system based on a single central device, as long as the rest of the system can continue to function if one module fails. An information retrieval facility based on a network, with PCs or other compatible computers exchanging data on the network, meets this goal. PCs can be added, repaired, or replaced as necessary without disabling the system as a whole.

Vendor Independence. A key to long-term maintainability is freedom from dependence on a single vendor. Use of interchangeable parts is of primary importance. Rather than committing to a single vendor of computer hardware, CD-ROM drives, or development software, a sounder strategy is to make sure that any hardware or software used in the system is compatible with multi-vendor standards for operation. This will help ensure that even if the vendor of a component used in the system goes out of business or discontinues the product, a replacement from another vendor will be available.

Standards. Another key to long-term system maintainability is the use of standards that are now being internationally recognized (see Section 3.3.2.11, Emerging Standards, for more information on standards). Important standards and interface protocols include:

- ISO 9660. Adherence to this CD-ROM disc format standard ensures that discs and drives produced by different manufacturers will be compatible with one another.

- SCSI. Most high-performance disc drives use the SCSI high-speed parallel data interface scheme, which is an international standard supported by hundreds of vendors. However, some low-price, low-performance drives use proprietary interfaces, supported by one (or at most a few) vendors. The low initial cost of these drives may be attractive, but the rapid turnover of products in the PC industry practically guarantees that any drive based on a proprietary interface will not be maintainable in two or three years. Replacing a proprietary drive with one that uses another interface standard will require not only new compatible hardware, but new computer system software to control the hardware. A disc drive that uses the SCSI interface can be replaced by a similar drive from another manufacturer with a minimum of expense and effort.

Network. If a networked computer system is appropriate, use of a standard hardware and software scheme will improve the long-term maintainability of the system. The PC industry supports several networks that are standardized at the lowest (hardware-oriented) levels (called the Physical Layer and Data Link Layer of definition). The most widespread and best supported PC network is Ethernet on coaxial cable, with other contenders being Ethernet on other media, IBM Token Ring network, and the extremely fast (and very expensive) Fiber Distributed Data Interface (FDDI) network. Software from several vendors operates with these networks, including Novell Netware, Microsoft LAN Manager, and Banyan Vines. For the sake of long-term compatibility, 50-Ohm coaxial Ethernet with Novell Netware is probably the minimum risk.

Computer. Computers called "PCs" have various levels of performance and can run different types of software, depending on the processor chip they use. PCs based on the 8088 and 80286 chip are quickly becoming obsolete, and cannot run the latest generation of software. The minimum risk solution for future hardware and software maintainability is a computer system based on the 80386 or 80486 processor chips. Computer boards based on the ISA (IBM AT-bus) or EISA (Extended ISA) hardware bus would take advantage of industry-wide hardware support.

3.4.2.2 Maintenance Strategies

Hardware and software maintenance, system administration, and continued CD-ROM production can be handled by several strategies. These strategies are not mutually exclusive.

Vendor Support. Most PC hardware and software products include three months to one year of warranty support. In addition, extended maintenance service is usually available from vendors at the various levels of responsiveness and cost. In general, these services are applicable only to commercial products rather than site specific software and hardware configuration maintenance.

Some vendors provide same-day on-site service on a per-call basis. In this instance, the vendor sends a repair technician on call from the user. This service generally has a high cost per

repair, but is only provided on an as-needed basis. It would be difficult to budget for this type of vendor arrangement. Same-day on-site service can be covered by an extended warranty or service plan. This service has a relatively high cost per repair compared to other warranty plans, but usually provides the best service and should only be justified by critical need. Some vendors provide next-day on-site service covered by extended warranty or a service plan. This service has a slower vendor response time, with correspondingly lower costs. Another service provided by vendors is a customer-assisted return service (depot maintenance). In this arrangement, on-site personnel (users or third-party support) diagnose a problem and send the faulty components to the manufacturer or the repair/supply depot for repair or replacement. This is usually the most cost-effective vendor maintenance plan if qualified maintenance personnel are available on site.

Contractor Logistics Support. On-site support personnel can be supplied by a contractor who specializes in this service. This maintenance strategy can be applied to the following areas:

- Support of standard hardware. The advantages of this strategy include continuity of service, single point of responsibility, knowledge of specialized requirements and configurations, and immediate response to problems. System operation can be ensured by repairs utilizing either vendor depot maintenance or on-site spares.

- Configuration management. Although hardware and software products will be standard, they will be put together in a configuration that will be unique to the installation and that will change with time as the system evolves. One or more system administrators will be required to keep track of the system as a whole. These can be either government personnel or contractors. In practice, continuity of expertise is usually easier to achieve with contractor personnel.

- Software maintenance. Software does not "break," but it is subject to updating as bugs are discovered and new capabilities are added. Updates have to be installed by qualified and trusted personnel. If unqualified personnel are in a position to alter critical software and databases, the potential for harm is very large.

General Preventive Maintenance. Preventive maintenance with a CD-ROM system will be that of a standard computer system. The MCRC staff can perform preventative maintenance by: cleaning monitor screens regularly, keeping keyboards free of dirt and dust, handling and storing CD-ROM discs with proper care, ensuring no food or liquid is allowed in the CD-ROM work area, keeping printers free of dust and dirt, changing printer ribbons/cartridges regularly, and ensuring all electrical equipment is plugged into surge protectors.

3.4.3 Conclusions and Recommended Approaches

In light of the existing resources available to MCRC, the best approach for integrating CD-ROM technology may be to implement CD-ROM as a complement to the On-line Books system.

On-line Books, currently in place at CDPA, is a central database of reference material stored on WORM discs (see Section 2.2.6.2 for a description of the On-line Books system). WORM technology allows data to be written locally to a disc. Data written to a WORM disc cannot

be edited or erased, but new data can be added until the disc is full. WORM discs are ideal for storing many iterations of data, thus providing an historical audit trail of information. WORM technology is ideal for applications such as On-line Books where many people need to access a single optical disc containing the latest or most current version of a document.

WORM technology, although similar to that of CD-ROM, is more cost effective where only one optical copy of the data is required. Since WORM discs are not mastered for duplication, a WORM disc is cheaper to produce than a master CD-ROM disc. However, if a WORM disc must be duplicated, additional specialized equipment and resources are required, and each WORM disc copy costs as much as the master disc. A master CD-ROM disc, on the other hand, is expensive to produce but many duplicates can be made inexpensively. Today's technology does not allow a CD-ROM disc to be updated. For revisions to or new issues of publications and documents, a new master CD-ROM must be produced at a considerable cost. (Technology for writing over CD-ROM discs is rapidly developing, but is not likely to be cost-effective in the foreseeable future.)

These differing characteristics of WORM and CD-ROM technology make them complementary. The On-line Books system is a central database of reference materials that can be continuously revised to reflect up-to-the-minute information. For users not connected to the network for On-line Books or for material that needs wide distribution and only the latest version, CD-ROM technology is an efficient and effective alternative to On-line Books. On-line Books can currently be accessed from distant locations established on the network via modem. However, access and response time with modems increases as the distance to the user increases, making the retrieval of data slow or difficult. The degradation in response time will also affect real time viewing of graphics and video. In fact, full motion video is difficult if not impossible to achieve over a network. If a user requires access to large quantities of data, the bandwidth of the modem will not support the transfer of this data. It would take over 25 days to send the information contained on a single CD-ROM disc over a network. There is also an additional fee associated with modem use that increases, the more time the user spends accessing the database. Therefore, it is recommended that the database resident on a WORM disc in the On-line Books system be downloaded to a magnetic medium and sent to a vendor for mastering and duplication of CD-ROM discs. The mass produced CD-ROM discs can then be distributed to users around the world. In this way, information can be collected and stored efficiently and still be distributed in a cost-effective manner. It is possible that the On-line Books database will need to be processed in some way (e.g., ISO formatting or work on the indexing/retrieval system) to make it most suitable for CD-ROM. Since CDPA houses and controls the On-line Books system, this activity may be able to provide insight regarding the integration of the On-line Books system with CD-ROM to take advantage of their complementary features.

It is further recommended that MCRC contact other organizations at Quantico and within the Marine Corps that have CD-ROM experience before making any major decisions in the selection and implementation of a CD-ROM system (see Section 3.2.1, Capitalizing on Available Resources). Activities such as CDPA that have performed in-house design and production of CD-ROM can be a valuable resource to MCRC in its CD-ROM production. MCCTA, whose function is to provide technological direction and support for automated information systems, is another essential resource to tap. Establishing a liaison with MCCTA can put MCRC into the CD-ROM information loop, thus keeping current on CD-ROM applications Corps-wide to identify products/

efforts that might be integrated with MCRC's system. Being in the loop can preclude duplication of effort and provide MCRC the benefit of "lessons learned" by other organizations. Activities throughout the Marine Corps are capitalizing on CD-ROM technology and the MCRC should be a part of the effort, not separate from it.

One final consideration is to view the integration of CD-ROM into the Marine Corps as a long-term investment that appropriately plans for the Marine Corps's future needs. Entering the CD-ROM production arena is a costly venture, but it is one that can prove to be very cost effective over the long run. CD-ROM is very economical for storing large volumes of data that must be distributed to many users. Sound decisions must be made regarding what information will be published on CD-ROM, for instance, to ensure that only information that must reside in many locations for use by many users is published.

If a decision is made that MCRC will produce a number of CD-ROM titles, it is recommended that the design and development be performed in-house. Because of the resources required, it is recommended that premastering and mastering be conducted by outside vendors. To support in-house production, initial investments should be made to acquire equipment and software designed for the long term. An important advantage of CD-ROMs is investment protection; they are not an expensive fad that will be discarded in a couple of years. The CD-ROM format is stable and standardized by ISO 9660. This standard is supported by many vendors and while CD-ROMs may gain additional capabilities and standards in the years ahead, future systems will be downward-compatible with present ones. Therefore, the important considerations in equipment and software purchases are, first, to capitalize on existing equipment by upgrading systems to meet the needs for CD-ROM, and second, ensure interoperability and interchangeability. Equipment that will not be outmoded by future enhancements, equipment that can be upgraded and added to, are the best choice for a CD-ROM system. Equipment and software purchased should be compatible with ISO 9660 and should be designed for SCSI interfaces.

While an MCRC CD-ROM system will most likely be set up for PCs, it need not be limited to them in the future. The same CD-ROMs that can be read by PCs can be read by other types of workstations and computers. And different types of computers can be interfaced on a single network. PCs in an information retrieval network designed with inter-changeable modules can be added, repaired, or replaced without disabling the system as a whole.

Because of the capability to upgrade a CD-ROM system to take advantage of future technology advancements, today's investment in the hardware and software required to produce CD-ROMs in-house and to operate a state of the art retrieval system is an investment in the future of the system.

Appendix A

Survey Questionnaire

Survey Questionnaire

NAME _____ DATE _____

TITLE/FUNCTION_____

- What is your current role in the library?
- What will your function be in the Research Center?

I. Target Audience

1. Who uses the library for research?

2. What is their experience level with computers?

3. How many people currently conduct library researches?

4. Who will be accessing the proposed CD-ROM data retrieval system?

5. Will library staff conduct computer searches?

II. Current Equipment

1. What type of equipment do you currently have (film/fiche readers, computers, card catalogs)?

2. Is the available equipment adequate for data retrieval needs?

3. How many users would you like to see utilize a data retrieval system at any one time?

4. How many work stations do you foresee in the future?

5. Do other data retrieval systems (e.g., CDPA "jukebox") exist that can or should be integrated with the proposed system for the Research Center?

III. Source Data

1. What data would the Marine Corps like to readily access at the Research Center?

2. Is there a need for graphics, digitized pictures or photos, video, and/or audio?

3. What library references are used most frequently?

4. What format is data currently in?

5. If data is on computer files, what is its software format?

6. How many titles (number of discs) do you want to access on a regular basis?

7. Will there be a need to transfer more data to CD-ROM discs in the future?

IV. Process for Retrieving Data

1. Is there a standard data retrieval process for conducting research? What are the steps?

2. Are computers used in the retrieval process currently?

3. How long does a standard search take using the current retrieval process?

4. How comprehensive and effective is the search?

5. What is the motivation, acceptance, and knowledge of Marines to use the current retrieval process?

6. What are the strengths and weaknesses of the current retrieval process?

7. What other systems have you heard of for conducting data retrieval?

V. Storage Capabilities

1. What is the amount of your holdings at present?

2. What are your storage capabilities at the Research Center?

3. How long do you hold onto hard copy of materials?

4. How are materials stored if not on hard copy?

5. How long does it take to get hard copy converted into another medium?

VI. Research Center Goals

1. What are the major goals the research center is seeking to achieve?

2. Will field sites interact with the Research Center to conduct on-line data retrieval?

3. Are there other locations in the USA that will provide the same type of service as the Research Center?

4. Who will decide what data is stored on CD-ROM?

Appendix B

Glossary of Terms

Glossary of Terms

ASCII - American Standard Code for Information Interchange.

Boolean - A type of data search (named after the mathematician George Boole) that allows the user to combine terms with AND, OR, and NOT to refine a search.

bps - bits per second. The unit of measure for serial transfer of data from one device to another.

byte - A group of 8 binary digits that a computer processes as a unit.

CALS - Computer-aided Acquisition and Logistics Support. Department of Defense set of standards for the interchange of digital technical information.

CD-ROM - Compact Disc Read Only Memory. Data can be stored on the disc and accessed but not edited. CD-ROM discs are read optically by a laser beam.

CDPA - Central Design and Programming Activity.

CGA - Color Graphics Array; has the lowest resolution quality.

Digital Data - Data in a form that can be manipulated by computer.

disc - Data storage medium based on optical technology.

disk - Data storage medium based on magnetic technology.

DVI - Digital Video Interactive. A high-end platform to provide full screen, full motion video from CD-ROM.

EGA - Enhanced Graphics Array; has a higher resolution quality than CGA, but a lower resolution than VGA.

Fielded Information - Data in a table or database format.

Gigabyte (GB) - A unit of measure equal to one billion bytes.

Hertz (Hz) - A unit of frequency equal to one cycle per second.

High Sierra - A standard for structuring or formatting files developed for CD-ROM, prior to ISO 9660, which may still be used by some CD-ROM publishers.

Hypertext - Writing or reading in a medium accessed in a non- sequential or non-linear fashion.

Image Information - Data which is treated by the computer as a graphic object. If text is present in the graphic, it will not be accessible for manipulation or searching.

ISO 9660 - The international standard for structuring or formatting files on CD-ROM. This standard enables CD-ROM discs to be read by any compatible CD-ROM drive.

ITS - Individual Training Standard.

Kilobyte (KB) - A unit of measure equal to 1024 bytes.

Local-Area Network (LAN) - A method of connecting computers, workstations, and other devices by wiring, coaxial cable, or fiber optic lines to allow them to share programs, data files, and other resources. Devices on a LAN are typically less than a mile apart, and transfer data at speeds of 1 million to 100 million bps.

Wide-Area Network (WAN) - A method of connecting computers, workstations and other devices by telephone lines, dedicated high-speed carriers, or satellite links to allow them to exchange data. Devices on a WAN can be a few miles or thousands of miles apart. They transfer information at speeds of 9600 to 1.5 million bps, with shorter distances and higher costs associated with higher speeds. On-line Books is an example of a WAN.

Mastering - The process in which data is etched on a glass or metal disc by a laser beam to become a stamp for replicating many CD-ROM discs.

Megabyte (MB) - A unit of measure equal to approximately one million bytes.

Megahertz (MHz) - A unit of frequency equal to 1,000,000 hertz.

MPC - Multimedia Personal Computer. A personal computer configured to create and work with multimedia applications.

ms -milliseconds.

OCR - Optical Character Recognition. Software that can convert text from an image format to ASCII text which can be read by a computer.

PC -Personal Computer.

PCX - A file format for graphics images.

Pixel - Picture element (dot) in a digitized image.

Premastering - A sub-task conducted in the mastering process which adds error code correction and error code detection to the data stream along with creating a physical image of the CD-ROM disc.

RAM - Random Access Memory.

Resolution - The number of dots per inch displayed on a screen layout; resolution is important for clear graphics and photographs.

SCSI - Small Computer System Interface. A standard interface hooking a computer and its various peripherals (e.g., printer, CD-ROM drive).

SGML - Standard Generalized Markup Language. The CALS standard for text data.

Stopword - A word that has been identified for elimination from indexing, such as "the," "of," etc.

TIFF - A file format for graphics.

Title - A published CD-ROM disc.

Textual Information - Data which can be read.

VGA - Video Graphics Array; has the highest resolution quality.

WORM - Write Once Read Many is a type of optical storage medium which can be written to locally.

Appendix C

Vendor List

Vendors

CD-ROM Drives

CD Technology	780 Montague Exprswy Suite 407 San Jose, CA 95131	408/443-8698 FAX: 408/432-0250
Chinon America Inc.	Information Equipment Division 660 Maple Ave. Torrance, CA 90503	800/441-0222 213/533-0274 FAX: 213/533-1727
Denon America Inc.	222 New Road Parsippany, NJ 07054	201/575-7810 FAX: 201/808-1608
Digital Equipment	Digital Dr, MKO1-2/E33 Merrimack, NH 03054-9501	800/344-4825
Genesis Integrated Systems	1000 Shelard Parkway Minneapolis, MN 55426	612/544-4445 FAX: 612/544-4347
Hitachi Home Electronics	1333 Lawrence Exprswy Suite 201 Santa Clara, CA 95051	408/249-1821 800/241-6558
Int'l Business Machines (IBM)	U.S. Marketing and Services, Dept. ZW1 1133 Westchester Ave. White Plains, NY 10604	800/426-9397 800/426-9402
JVC	19900 Huntington Beach Blvd. Suite I Huntington Beach, CA 92648	714/965-2610 FAX: 714/968-9071
Panasonic Industrial Company	50 Meadowland Parkway Secaucus, NJ 07094	201/348-7620
Mitsumi	4655 Old Ironsides Santa Clara, CA 95054	408/970-0700 FAX: 408/727-5337
Philips Consumer Electronics Co.	20720 S. Leapwood Ave. Suite A Carson, CA 90746	800/722-6224
Pioneer Communication of America, Inc.	600 E. Crescent Ave. Upper Saddle River, NJ 07458-1827	201/327-6400 FAX: 201/327-9379

Reference Technology	5775 Flatiron Pkwy. Suite 220 Boulder, CO 80301	303/449-4157 FAX: 303/442-1816
Samsung Information Systems America	3655 North First Street San Jose, CA 95134-1713	408/434-5400 FAX: 408/434-5653
Sony Corporation of America	Computer Peripheral Products Division 655 River Oaks Parkway San Jose, CA 95134	800/222-0878 408/944-4326
Toshiba America Information Systems	Disk Products Division 9740 Irvine Blvd. Irvine, CA 92718	714/583-3000

Other Optical Disc Drives/Systems

Filetek, Inc.	6100 Executive Blvd. Rockville, MD 20852	301/984-1542
Laser Magnetic Storage International	4425 Arrowswest Drive Colorado Springs, CO 80907	800/777-5674 719/593-7900 FAX: 719/593-4597
Sony Corporation of America	Optical Media Division Sony Drive Park Ridge, NJ 07656	FAX: 201/930-6806

Portable CD-ROM Computers

Devlonics n.v.	Prins Bisschopssingel 3500 Hasselt Belgium	32/11/27-54-34 FAX: 32/11/27-43-53
Scenario, Inc.	3 Bridge St. Newton, MA 02158	617/965-6458 FAX: 617/965-6460

Desktop CD-ROM and Multimedia Systems

Apple Computer	20525 Mariani Ave. Cupertino, CA 95014	800/538-9696
Commodore	1200 Wilson Drive West Chester, PA 19380	800/662-6442

Hitachi Home Electronics	Multimedia Systems 401 West Artesia Blvd. Compton, CA 90220	800/369-0422 FAX: 213/515-6223
Int'l Business Machines (IBM)	U.S. Marketing and Services, Dept. ZW1 1133 Westchester Ave. White Plains, NY 10604	800/426-9397 800/426-9402
Radio Shack	700 One Tandy Center Fort Worth, TX 76102	817/390-3300
Network/LAN		
3Com Corporation	3165 Kifer Road Santa Clara, CA 95052	800/638-3266
CBIS, Inc.	5875 Peachtree Industrial Blvd Bldg. 100/170 Norcross, GA 30092	404/446-1332
Meridian Data	5615 Scotts Valley Dr Scotts Valley, CA 95066	703/620-4200 FAX: 408/436-6816
Microsoft	16011 NE 36th Way Redmond, WA 98073	800/992-3675
Novell, Inc.	122 East 1700 South Provo, UT	800/526-5463 801/379-7660
Online Computer Systems Inc.	20251 Century Blvd Germantown, MD 20874	301/428-3700 800/922-9204 FAX: 301/428-2903
Sun Microsystems Inc.	2550 Garcia Ave. Mountain View, CA 94043	415/960-1300 FAX: 415/969-9131
Virtual Microsystems	1825 S. Grant SS Suite 700 San Mateo, CA 94402	415/573-9596 FAX: 415/572-8406
Image Scanners		
Abaton	Everex Systems 48431 Milmont Drive Fremont, CA 94538	800/628-3837 510/498-1111

Advanced Vision Research, Inc.	2201 Qume Drive San Jose, CA 95131	800/544-6243 408/434-1151
Chinon America Inc.	Information Equipment Division 660 Maple Ave. Torrance, CA 90503	800/441-0222 213/533-0274 FAX: 213/533-1727
Epson America	2780 Lomita Blvd. Torrance, CA 90505	800/922-8911 310/782-0770
Hewlett Packard	19310 Prune Ridge Ave. Cupertino, CA 95014	800/752-9000
Howtek	21 Park Ave Hudson, NH 03051	603/882-5200
Marstek	15225 Alton Parkway Irvine, CA 92718	714/833-7740
Microtek Lab Inc.	680 Knox Street Torrance, CA 90502	800/654-2160 310/321-2121
UMAX Technologies	3170 Coronado Drive Santa Clara, CA 95054	800/562-0311 408/982-0771
X-Ray Scanner Corp.	4030 Spencer Street Torrance, CA 90503	310/214-1900

Indexing/Retrieval

Data Conversion Lab	184-13 Horace Harding Expressway Fresh Meadows, NY 11365	718/357-8700 FAX: 718/357-8776
Dataware Technologies	222 Third St, Ste 3300 Cambridge, MA 02142	800/344-5849 617/621-0820
	2111 Wilson Blvd Ste 700 Arlington, VA 22201	703/243-0336
EPSIG	c/o OCLC 6565 Frantz Road Dublin, OH 43017-0702	614/764-6195 FAX: 614/764-6096
Ernst & Young	2000 National City Ctr Cleveland, OH 44114	216/861-5000

Exoterica Corp.	383 Parkdale Ave Suite 406 Ottawa, Ontario Canada K1Y 4R4	613/722-1700 FAX: 613/722-5706
I-Mode Retrieval Systems, Inc.	7 Odell Plaza Yonkers, NY 10701	914/968-7008 FAX: 914/968-9187
Knowledge Access International Inc.	2685 Marine Way Ste 1305 Mountain View, CA 94043	800/252-9273 415/969-0606
The Library Corp	Research Park Inwood, WV 25428	800/624-0559 FAX: 304/229-0295
Meridian Data	5615 Scotts Valley Dr Scotts Valley, CA 95066	703/620-4200 FAX: 408/436-6816
Nimbus Information Sys	Box No. 7427 Charlottesville VA 22906	800-782-0778
Online Computer	20251 Century Blvd Germantown, MD 20874	800/922-9204 FAX: 301/428-2903
Optical Media Int'l.	385 Alberto Way Los Gatos, CA 95032	408/395-4332 FAX: 408/395-6544
	180 Knowles Dr Los Gatos, CA 95030	408/376-3511 FAX: 408/376-3511
OWL Int'l, Inc.	2800 156th Ave SE Bellevue, WA 98007	800/344-9737 FAX: 206/641-9367
Retrieval Technologies	One Kendall Square Bldg 300 Cambridge, MA 02139	617/577-1574 FAX: 617/577-9517
Software Mart Inc.	4131 Spicewood Springs Suite I-3 Austin, TX 78759	512/346-7887 FAX: 512/346-1393
Synchronetic, Inc.	3700 Koppers St Ste 111 Baltimore, MD 21227	410/644-2400
Tesseract Technology	222 Cedar Ln, Ste 101 Teaneck, NJ 07666	201/907-0100x30 FAX: 201/907-0270

ISO Formatting Tools

Crowninshield Software	1105 Commonwealth Ave. Boston, MA 02215	617/787-8830 FAX: 617/787-3035
CSM Inc.	211 N. El Camino Real San Diego, CA 92024	619/944-1228 FAX: 619/942-5447
Elektroson	Veldersweg 25 5298 LE LIEMPDE The Netherlands	+31(0)4113-3021 FAX: +31(0)4113-2763
Meridian Data	5615 Scotts Valley Dr Scotts Valley, CA 95066	703/620-4200 FAX: 408/436-6815
Online Computer	20251 Century Blvd Germantown, MD 20874	800/922-9204 FAX: 301/428-2903
Reference Technology	5775 Flatiron Pkwy. Suite 220 Boulder, CO 80301	303/449-4157 FAX: 303/442-1816

SGML Information

Standards:	Dr. John Naim Optical Publishing Assn. PO Box 21268 Columbus, OH 43221	
CD-RDx Specification:	IHC Intelligence Community Staff PO Box 90828 Washington, DC 20090	
CD-ROM CAIS:	Capt. Larry Schankin Electronic Systems Div. Hanscom Air Force Base	617/377-2105
CD-CINC:	Fred Durr PO Box 828 College Park, MD 20740	301/243-0797
SGML Information:	Betsy Kiser EPSIG, c/o OCLC 6565 Frantz Road Dublin, OH 43017	614/764-6195

SGML Specification:	American National Standards Institute	212/354-3300
SIGCAT:	E.J. McFaul Chair, SIGCAT U.S. Geological Survey 904 National Center Reston, VA 22092	

SGML Authoring Tools

Avalanche Development	947 Walnut Street Boulder, CO 80302	303/449-5032
Dataware Technologies	222 Third Street Suite 300 Cambridge, MA 02142	617/621-0820
Oster & Associates	1220 Churchville Rd Bel Air, MD 21014	410/838-1908 FAX: 410/838-1913
Reference Technology	5775 Flatiron Parkway Boulder, CO 80301	303/449-4157

Paper vs. CD-ROM

OWL Int'l, Inc.	2800 156 Ave SE Bellevue, WA 98007	800/344-9737 FAX: 206/641-9267

Mastering

3M Optical Recording	3M Center Bldg 223-5N-01 St Paul, MN 55144-1000	715/235-5567/Tech 612/733-2142/Lit
JVC	19900 Huntington Beach Blvd. Suite I Huntington Beach, CA 92648	714/965-2610 FAX: 714/968-9071
Knowledge Access International, Inc.	2685 Marine Way Suite 1305 Mountain View, CA 94043	415/969-0606 FAX: 415/964-2027
The Library Corp	Research Park Inwood, WV 25428	800/624-0559 FAX: 304/229-0295
Meridian Data	5615 Scotts Valley Dr Scotts Valley, CA 95066	703/620-4200 FAX: 408/436-6816

Nimbus Information Sys	Box 7427 Charlottesville VA 22906	800/782-0778 FAX: 804/985-4625
On Line	20251 Century Blvd Germantown, MD 20874	800/922-9204
Optical Media Int'l.	180 Knowles Drive Los Gatos, CA 95030	408/376-3511 FAX: 408/376-3511
Retrieval Tech.	One Kendall Square Bldg 300 Cambridge, MA 02139	617/577-1574 FAX: 617/577-9517
Software Mart Inc.	3933 Spicewood Springs Suite E-100 Austin, TX 78759	512/346-7887 FAX: 512/346-1393
Digital Equipment Corporation	Digital Dr, MKO1-2/E33 Merrimack, NH 03054-9501	800/344-4825
Philips Consumer Electronics Co.	20720 S. Leapwood Ave. Suite A Carson, CA 90746	800/722-6224
Sony Corporation of America	Optical Media Division Sony Drive Park Ridge, NJ 07656	FAX: 201/930-6806

Data Conversion

Media Conversion	800 Roosevelt Rd Bldg D, Suite 106 Glen Ellyn, IL 60137	708/858-4566 FAX: 708/469-1277
Data Conversion Lab	184-13 Horace Harding Expressway Fresh Meadows, NY 11365	718/357-8700 FAX: 718/357-8776

Miscellaneous

Brodart Automation	500 Arch St Williamsport, PA 17705	717/326-2461 FAX: 800/999-6799
Cuadra Associates Inc.	11835 W Olympic Blvd Suite 855 Los Angeles, CA 90064	800/366-1390 FAX: 310/477-1078

Educorp Computer Svcs	7434 Trade St San Diego, CA 92121-2410	619/536-9999 FAX: 619/536-2345
The H. W. Wilson Co.	950 University Ave Bronx, NY 10452	212/588-8400 FAX: 212/590-1617
Winnebago Software Co.	457 E South St Caledonia, MN 55921	800/533-5430

Commercial CD-ROM Titles

Bell & Howell Company: ProQuest UMI		800-521-0600
Brittannica Software Inc.		415-597-5555
Bureau of Electronic Publishing, Inc.		201-808-2700
Cambridge Scientific Abstracts Compact Cambridge		800-843-7751
CD Consultants, Inc.	4404 Keswick Road Baltimore, MD 21210	410-243-2755
CD-ROM Professional	Journal	800-248-9581
CD-ROM, Inc., Software Titles Catalog/Vendor		303-231-9373
Compact Publications, Inc.		800-284-8353
DAK Industries Inc.	8200 Remmet Ave. Canoga Park, CA 91304	800-325-0800
Defense Mapping Agency		703-285-9195
Defense Technical Information Center Directorate of User Services		202-274-3848
Department of Commerce 'Technology Administration'; National Technical Information Service		703-487-4650
Dialog Information Services, Inc.		800-334-2564
Digital Data Library CD-ROM Software Vendor		703-648-9400

DSP Development Corp. DADISP/PRO Data analysis package	One Kendall Square Cambridge, MA 02139	617-577-1133
Earth Science Information and Sales Geological Survey		703-648-6045
Educorp Computer Services	7434 Trade Street San Diego, CA 92121-2410	800-843-9497
General Services Administration		202-501-3194
Highlighted Data, Inc.		703-533-1939
H. W. Wilson		800-367-6770
IHS DSI Standardization Services		703-830-3440
Information Spectrum, Inc.		703-845-3000
Interaction: CD-ROM & Optical		800-783-3ROM
Jane's Information Group, Inc.		703-683-3700
Journal of the American Society for Information Science (JASIS)		212-475-7700
Library Journal		212-463-6819
Mac's Place	8461 154th Ave NE Redmond, WA 98052	800-367-4222
Mead Data Central, Inc. NEXUS/LEXIS and MEDIS		202-857-8263
Meridian Data Inc.		408-438-3100
National Archives		202-501-6000
National Geographic Society		800-368-2728
National Information Services Corporation (NISC)		301-243-0797
National Institute of Building Sciences		205-289-7800

National Space Science Data Center, also under NASA	Code 933.4	301-286-6695
National Oceanic and Atmospheric Administration (National Environmental Satellite, Data, and Information Service		303-497-6215
NESEA	Code 2490	301-862-8436 or DSN: 326-3512
Nimbus Information System		804-985-1100
Online Computer Library Center, Inc. (OCLC)		614-764-6000
PhoneDisc U.S.A. or American Business Disk		800-284-8353 402-593-4593
Quanta Press, Inc. See Wayzata Technology Inc.		612-379-3956
Relax Technology	3101 Whipple Rd Union City, CA 94587	
Research Publications		800-444-0799
SIGCAT Info Line:		703-648-4452
Tiger Software	800 Douglas Entrance Suite 765 Coral Gables, FL 33134	800-666-2562
United Communications Group Periscope and Military Database		301-816-8950
University Microfilms Int'l ProQuest		313-761-4700
U.S. Army Publications and Printing Command (USAPPC)		DSN: 221-6262
U.S. Information Agency Library Systems Division		202-619-6709
U.S. Marine Corps Central Design & Programming Activity		703-640-2196

U.S. National Geophysical Data Center, NOAA E/GC	303-497-6571
Sony Publishers Data Service Corporation	408-372-2812
Telda Advanced Systems	215-667-0266 215-667-3088
The Software Outworks	415-883-3000
Wayzata Technology Inc. See Quanta Press, Inc.	218-326-0597

Partial Listing of Commercial CD-ROM Titles

Army Area Handbook Series: Countries of the World; U.S. History on CD-ROM (Bureau of Electronic Publishing, Inc.)

National Telephone Directory on Disc: East and West Editions; PhoneDisc U.S.A./The American Business Disk (Compact Publications, Inc.)

Digital Terrain Data Prototype (Defense Mapping Agency, DMASC)

Hazardous Material Control and Management; Hazardous Material Information System (Department of Defense)

DIALOG OnDisc (Dialog Information Services)
CD-RDx: DOS Prototype Disc: Version 3.11 (Director of Central Intelligence, Intelligence Community Staff)

Business Indicator Survey; COMLINE Bimonthly; Countries of the World; Digital Data Library; FEDLOG; SUPERBLUE; World Atlas; Word Cruncher; World Weather Disk (Digital Data Library)

GeoQuery 2.0: Geographic Information System (GeoQuery Corporation)

Federal Information Resources Management Regulation TC 90-1; Federal Acquisition Regulation FAC 90-2 (General Services Administration)

New Grolier Electronic Encyclopedia (Grolier Electronic Publishing)

Webster's Ninth New Collegiate Dictionary

DSI Standardization Services MILSPEC information on CD-ROM; DoD and Naval Instructions and Directives Services; DoD Adopted Industry Standards Service; NASA Documents; UK NATO Stock Numbers; GSA Source One Service; Environmental/Safety Library; INFONEWS (Information Handling Service)

Officers' Bookcase: Military Terms and Acronyms; Terrorist Group Profiles; The Aircraft Encyclopedia; The American Civil War; The Middle East Diary; The Reference Package: The CIA USA FACTBOOK; World Factbook and State Factbook; USA Wars: Korea; USA WARS: Vietnam; USA WARS: World War I; USA WARS: World War II (INTERACTION/Quanta Press, Inc.)

Science Citation Index: Cd Edition (Institute for Scientific Information)

The Orient: Demographic/Travel Information (Interoptica Publishing, Ltd.)

Electronic Library (Jane's Information Group)

Earth and Space Science: Challenger 51-L (Joint Educational Initiative)

Science and Technical Reference Set (McGraw Hill)

Random House Encyclopedia (Microlytics, Inc.)

Microsoft Bookshelf for Windows (Microsoft)

Consumer Reports on CD-ROM (National Information Services Corporation)

ProQuest Newspaper Abstracts on Disc; The Washington Post on Disc (ProQuest UMI)

CIA World Factbook: 1990 (Quanta Press/Wayzata Technology)

British News Index on CD-ROM (Research Publications)

DefenseNet (Teldan Advanced Systems, Ltd.)

CD-ROM version of Periscope/The Military Database (United Communications Group)

General Periodicals (University Microfilms International)

CD-1, Army Publications; CD-2, Army Forms (U.S. Army Publications and Printing Command)

CD-ROM Compendium; Digital Line Graph: 1:2,000,000 scale sectional maps of the National Atlas of the United States; Conterminous United States AVHRR Data Set (US&GS)

Wilson Business Abstracts (H. W. Wilson Company)

Appendix D

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