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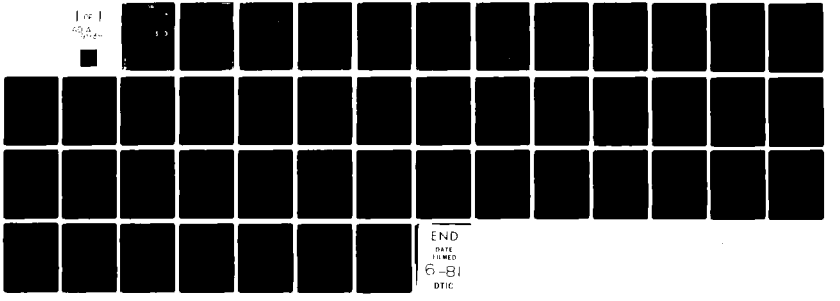

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DAVID W. TAYLOR NAVAL SHIP RESEARCH AND DEVELOPMENT CENTER

Bethesda, Maryland 20084

DATA COLLECTION OF AND RECOMMENDATION FOR THE TECHNICAL DOCUMENT STORAGE AND RETRIEVAL SYSTEM AT SHIPS PARTS CONTROL CENTER (SPCC)

by

Ruey Chen

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COMPUTATION, MATHEMATICS AND LOGISTICS DEPARTMENT
DEPARTMENTAL REPORT

April 1981

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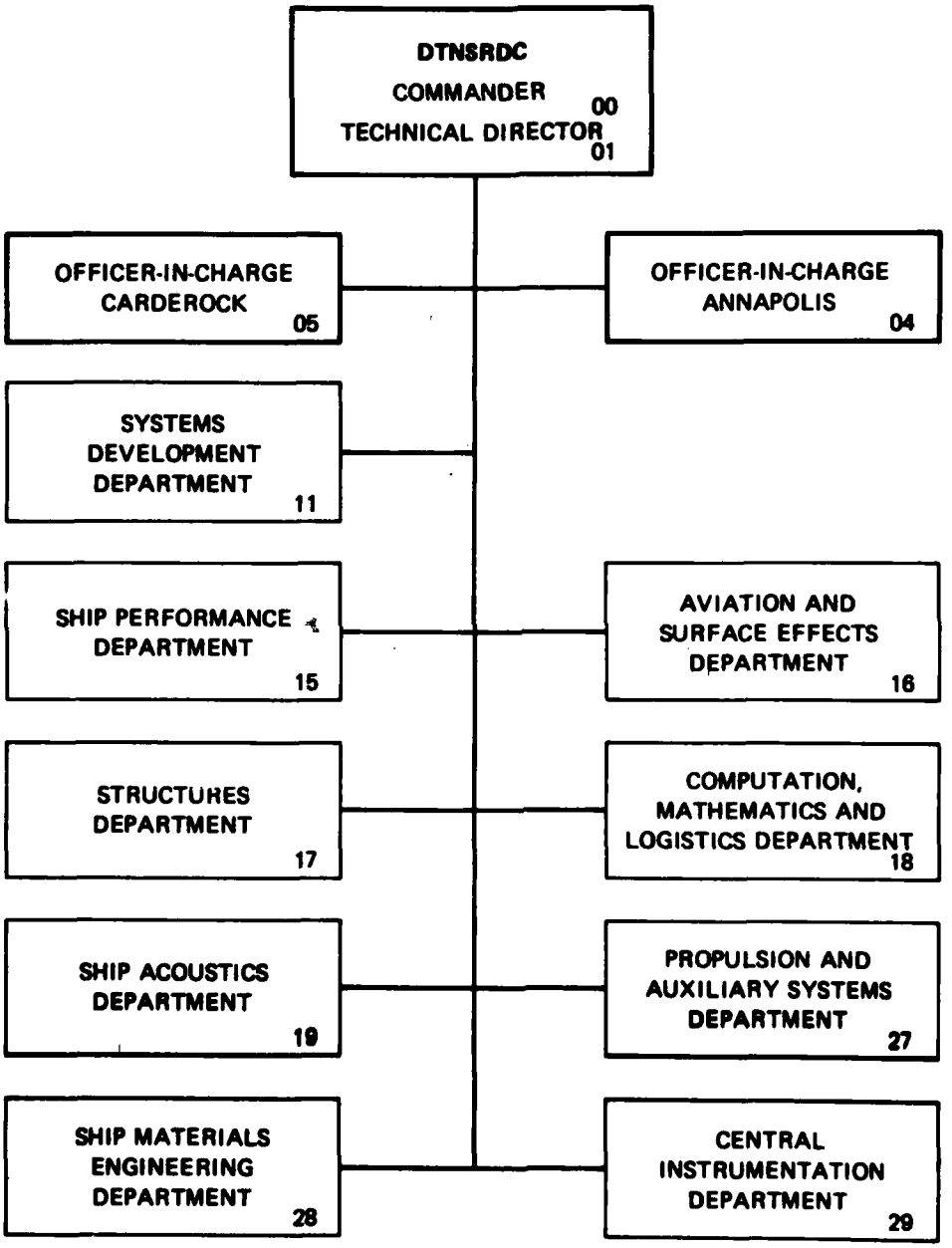

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The Navy Ships Parts Control Center (SPCC) is designated as the Navy's inventory control point for ship maintenance parts and has the responsibility for projecting requirements and procuring materials for the types of parts which SPCC manages. To support this mission, the Technical Data Support Section, Code 5652, of SPCC has the responsibility for maintaining more than seven million aperture cards of technical documents. The overwhelming size

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of the document files, increasing demand for documents, and cumbersomeness of manual retrieval and refile procedures and inadequate equipment combine to create an extremely difficult to control situation. Based on a comprehensive review of the overall situation at SPCC, current technology and future trend of technology development, a recommendation has been made to start converting the microfilm-based manual technical document files at SPCC to an optic-based automation storage and retrieval system in three phases.

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ABSTRACT

The Navy Ships Parts Control Center (SPCC) is designated as the Navy's inventory control point for ship maintenance parts and has the responsibility for projecting requirements and procuring materials for the types of parts which SPCC manages. To support this mission, the Technical Data Support Section, Code 5652, of SPCC has the responsibility of maintaining more than seven million aperture cards of technical documents. The overwhelming size of the document files, increasing demand for documents, and cumbersomeness of manual retrieval and refile procedures and inadequate equipment combine to create an extremely difficult to control situation. Based on a comprehensive review of the overall situation at SPCC, current technology and future trend of technology development, a recommendation has been made to start converting the microfilm-based manual technical document files at SPCC to an optic-based automation storage and retrieval system in three phases.

1. INTRODUCTION

The Navy Ships Parts Control Center (SPCC) is designated as the Navy's inventory control point for ship maintenance parts (including hull, electrical, electronic, mechanical components, navigation system, conventional weapons and ammunition) and has the responsibility for projecting requirements, procuring material and directing its distribution to satisfy present and future requirements for the types of parts which SPCC manages.

To support this mission, the Technical Data Support Section (TDSS, Code 5652) of SPCC has the responsibility of receiving and maintaining a large quantity of technical documents and providing designated users with copies of these documents when requested.

TDSS performs an essential and important function within SPCC and for other DOD agencies. The effective operation of the technical document reference service is essential for responsive and coordinated procurement activities at SPCC and other DOD agencies.

Although TDSS appears to be doing the best possible job under current circumstances, the overwhelming size of the document files, increasing demands for documents, the cumbersomeness of manual retrieval and refile procedures, and inadequate equipment combine to create an extremely difficult to control situation. A comprehensive review of the overall situation and operation at TDSS was considered necessary as a first step in an effort to improve its effectiveness through automation alternatives. The David W. Taylor Naval Ship Research and Development Center was requested by the Naval Supply Systems Command to manage the task as an R&D effort under the Automated Graphic Sciences (AGS) program.

A baseline study of the operation of TDSS and users' requirements at SPCC was determined to be necessary. Sterling Systems, Inc., was awarded a contract in June 1979 to conduct the study. The final draft report received in Oct 1979 was found useful; however, inaccurate and insufficient data were found in the report. Subsequently, additional data verification and collection efforts were conducted by SPCC, DTNSRDC, and Sterling System personnel. Appendix A contains the summary of those data collection activities. The final report[1*] by Sterling Systems, Inc., with corrections and addenda, was received in June 1980.

Based on the data collected at SPCC, visitations to other technical document depositories, and an extensive search of current technologies of mass storage, optical scanning, data compression, etc., a recommendation has been made to start converting the microfilm-based manual technical document files at SPCC to a optic-based automation storage and retrieval system. It is believed that the industry has the technology and capability to integrate a large optic-based technical document storage and and retrieval system. Commercial availability of such a system at a cost-effective level will probably take several more years. Therefore, the recommendation will be implemented in three phases as described in Section 5 of this report. The immediate effort is to start developing a technical document index information automation system described in Section 5.1.1.

*A complete list of references is given on page 30.

2. HIGHLIGHTS OF DATA COLLECTION

The highlights of data collection recorded here are the combination of the results of reference [1] and additional data collection efforts done by Steve Coyle and Lois Crabb of SPCC, and Ruey Chen of DTNSRDC.

Document files maintained by TDSS are divided into Active File and Inactive File. The Active File includes approximately 5,209,000 aperture cards; it grew in size by about 13 percent in CY79. The Inactive File is composed of documents filmed prior to 1974 and mounted on non-standard aperture cards. All requested documents retrieved from the Inactive File are converted to the standard format and filed in the Active File. The Inactive File contains approximately 2,200,000 aperture cards and is converting to Active File at a rate of approximately 5 percent a year.

The TDSS receives and processes annually an average of more than 400,000 technical documents (a document contains an average of approximately 2.21 aperture cards) or over 900,000 aperture cards. Of these, about 380,000 are updates and duplicates, therefore 623,000 aperture cards were added to the Active File in CY79, including 94,809 from the Inactive File. The documents are composed of engineering drawings and specifications. The documents are received from Navy Hardware System Command, SPCC Operations Divisions, and DOD technical document depositories.

Requests for documents are received from SPCC Divisions, government vendors, and DOD agencies, including the Defense Logistics Agencies. In addition to routine internal and external requests, TDSS supported the Purchase Division (Code 370) and Technical Division (Code 380) of SPCC in the

preparation of an estimated 18,500 bid sets for procurements in CY79. The bid sets operation required TDSS to duplicate about three million aperture cards in CY79, an increase of the previous year. These and other highlights of data collection are shown below. More detailed information can be found in Appendix A.

• Size of aperture card file (30 Dec 1979)		7,409,000
- Active file	5,209,000	
- Inactive file	2,200,000	
• Growth of Active File (aperture cards)		623,000
• Requests made		219,900
- Counter	128,400	
- Bid-set	18,500	
- External	73,000	
• Requests retrieved		165,400
- Counter (76%)	97,600	
- Bid-set (100%)	18,500	
- External (68%)	49,300	
• Aperture cards retrieved		542,665
- Counter	215,696	
- Bid-set	163,540	
- External	163,429	
• Copies reproduced		3,111,164
- Aperture cards	2,900,664	
- Paper	210,500	
• Drawing revisions in the Active File		65.1%

- Drawing size distribution in the Active File
  - Specifications and parts list (Size A) 15.0%
  - Drawings 85.0%
    - Size A 36.2%
    - Size B 16.3%
    - Size C 11.9%
    - Size D 12.8%
    - Size E 11.0%
    - Size F and up 11.8%
- Distribution of incoming documents
  - Paper 29.5%
  - Roll film* 31.0%
  - Aperture cards 39.5%
- Quality of the incoming document
  - Paper
    - Good 53.0%
    - Fair 39.0%
    - Poor 8.0%
  - Image of aperture card and roll film
    - Good 29.0%
    - Fair 45.0%
    - Poor 26.0%

*Roll film converted to aperture cards by SPCC

- Quality of the aperture card image in the Active File

Good	31.0%
Fair	52.0%
Poor	17.0%

- Incomplete information on aperture cards 20.0%

- Personnel complement (Dec 1979) 24

3. ALTERNATIVES

With the increasing numbers of technical documents and the number of requests received by TDSS, it is evident that the manual method of handling technical documents is marginal. In CY79, the growth rate of the technical documents in the active file was more than 13 percent (623,000 aperture cards) per year. The requests for the documents stored have been increased considerably in recent years. Without substantial improvement of the facilities and operations, TDSS will experience increased demands to exceed its current storage and retrieval capabilities. In addition, the problems inherent in a manual system, such as file security, file integrity, slow retrieval, etc., have been aggravated as the file size became larger and larger.

Several existing electromechanical aperture card storage and retrieval systems appear to be able to resolve many of the problems with manual methods and improve response time over the current manual method. However, the conversion of all five million aperture cards in the Active File to this type of device is unjustifiable for the following reasons:

. Low retrieval rate -- a study described in Appendix A showed that the number of aperture cards retrieved in CY79 averaged about 10 percent of the total of five million aperture cards stored in the Active File, so that, if all the aperture cards had an equal chance of retrieval, then the expectation that an aperture card might be retrieved would be once in every ten years. However, it is believed that some aperture cards are requested more often than others.

. High initial system cost -- estimates show that the initial system cost is over $1.00 for each aperture card automated. Therefore, it would cost over five million dollars for the initial system investment, excluding substantial conversion costs.

. Poor to fair image quality -- as seen in the previous Sections, over 17% of the images in the Active File are poor, and over 52% of the images are of fair quality. Image conversion may not be warranted for 69% of the images in the Active File.

. High maintenance cost -- due to the quality of the aperture cards and the complex and intricate electro-mechanical devices used, installed systems have shown that breakdowns and maintenance have proven to be a major and costly factor in very large systems.

. Additional equipment costs -- the growth rate of the Active File is over 13 percent (623,000) per year. The criteria for purging aperture cards from the Active File have not yet been established. Consequently, new equipment will have to be added to accommodate the additional documents.

Another alternative is to identify a certain portion (perhaps 10 to 20 percent) of the Active File that have sufficiently high access rates and place only that portion in an electromechanical storage device. By doing this, the response time would be improved and the labor needed to operate the system would be reduced. However, estimates show that the labor savings would not be great enough to justify the initial system and conversion costs. In addition, 80 to 90 percent of the aperture cards will continue to be stored in the manually operated power file. The problems of file integrity, file security, etc., remain unsolved.

The suggestion of converting aperture cards to microfiche format is considered impractical and unacceptable for the following reasons:

- Each aperture card is considered to be an individual or "unit record." An individual aperture card can be revised, replaced, duplicated and distributed without affecting or disturbing other aperture cards or drawing images.[2] Further, when making duplicates the recipient would get many more images than needed unless special costly marking was done at the time of duplication.

- Due to the fact that 69 percent of the aperture cards in the Active File are judged to be only fair or poor, image conversion would further downgrade the quality of the file to an unacceptable level.

- The cost of the conversion would be prohibitively high.

The proposed long range solution is to convert the image of aperture card files to digital data stream and to store digital data in a mass storage device for retrieval. Detail of this alternative is described in the next section.

4. A PROPOSED SOLUTION

In recent years, the advancement of mass storage and laser scanning technologies[3,4,5] suggests the feasibility of implementing[6] an automated system for the storage, retrieval and transmission of technical documents. Documents would be converted into the digital data stream by the use of high resolution laser scanners and this digital data would be stored in mass storage system. Figure 1 shows the major components of the proposed automation system.

The on-line mass storage device is the core of the whole system. Other technologies such as scanning and data compression are already known and are available commercially in other application areas. The commercial availability of a complete system appears to have halted for lack of large appropriate mass storage devices.

Surveys of current technology[3,4,5] indicate that optical storage (video disk) technology has potential as a viable, realistic, and near-term solution to large mass storage needs. To describe an E-Size drawing in digital form at an adequate level of resolution requires approximately 80 x 10^6 bits of data. With a 40:1 data compression ratio,[6] the data stored per drawing can be reduced to 2 x 10^6 bits. A mass storage of 1.4 x 10^{13} bits would provide enough capacity for storing seven million engineering drawings. However, the successful production of a cost-effective optical mass storage facility is probably several years away.

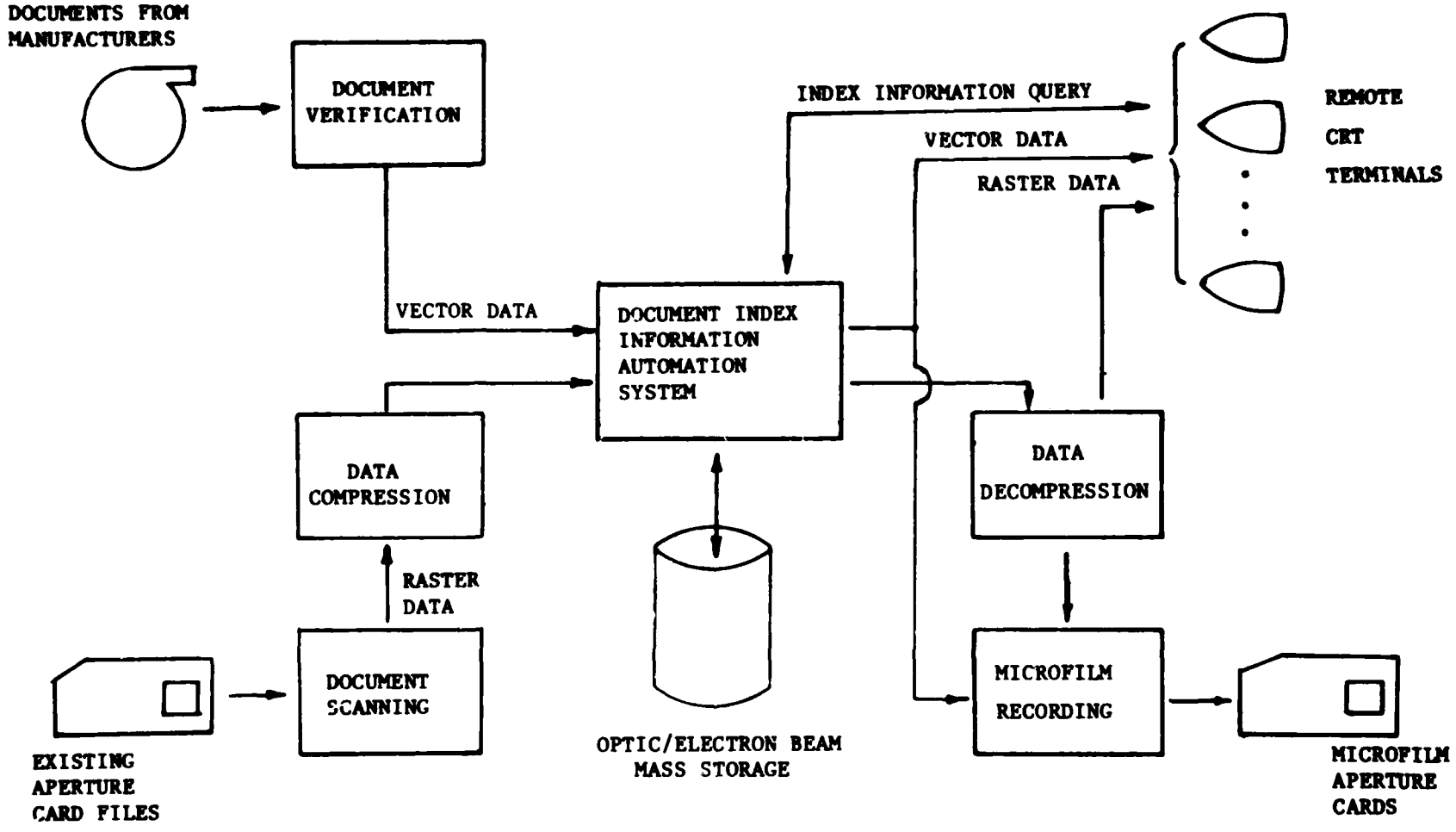

Figure 1 - Major Components of the Proposed System

The need for even larger rapid access data storage has resulted in considerable interest in electron, beam-addressed, storage. Both electron (writing) and ion (reading) beams are suitable for addressing because of their ease of deflection and small spot sizes. They appear to have a high packing density (10^{12} bits/in^2), an improvement over optical recording densities of three orders of magnitude. The electron/ion beam technology, which is quite attractive, is not yet sufficiently developed for implementation in a commercial archival system in the near future. They are best suited for technical document storage and retrieval in the long run.

A Source Sought Solicitation (Appendix B) was prepared and appeared in Commerce Business Daily on June 5, 1980. Favorable responses have been received from industry.

4.1 SYSTEM REQUIREMENTS

The proposed system should be designed to fulfill the following requirements and is based on a 50% increase in file size and usage as todays requirements. (See Appendix A.)

- The system should be capable of producing a digital data stream in either vector or raster format to represent engineering drawings of various sizes; performing data compression techniques on the digital data to reduce it to the most compact form; storage of the resulting information in an on- or off-line storage system will provide for remote retrieval of the drawings.

- The input devices should be capable of processing incoming drawings at an average rate of 3000 drawings per day. The two types of input, vector data generated by manufacturers and raster data generated through data compression from microfilm, are forwarded to mass storage.

- With the drawings stored in compact digital form, the system should be able to handle at least seven million drawings in its on-line storage. Provisions will be made to place older and less used documents in a off-line mode if required.

- Output from mass storage is decompressed and forwarded for microfilm recording or visual display.

- The system should provide for retrieval of the drawings in two ways:

  - Users should be able to retrieve specific drawings for viewing on suitable display terminals. The terminal must be capable of allowing the operator to view the entire drawing and also be

able to select an area of the total drawing for enlarged display. The system should be able to handle an average total of 1300 random requests per day from up to 48 such terminals, while maintaining an average response time of under 10 seconds from on-line storage and five minutes from off-line storage. The off-line storage requests can be processed on a background mode. The system will also allow the users to prepare bid set procurement packages on-line.

- Another mode of retrieval is for bid set requests to be outputted on 35 mm aperture-card recorders at an average rate of 17,500 per day. The microfilms so generated will have resolution qualities equal to or better than that specified in MIL-M-9868.

4.2 INPUT (See Figure 1.)

4.2.1 Computer-aided Drafting

The computer-aided drafting capability is primarily used to generate new technical documents by the manufacturers. This device is primarily used to visually check incoming documents in the vector-alphanumeric type format before putting them in mass storage.

4.2.2 Microfilm Scanning

The basic purpose of the microfilm scanner is to translate the microfilmed drawings into a digital stream. This is generally done by sub-dividing the image into small pixels, translating the optical density of each pixel into digital form, and transferring the resulting digital data after compaction to mass storage devices.

For the scanning, a laser scanner can be used which can scan or record an aperture card containing an E-size (36" x 48") drawing in 12 seconds with resolution of over 200 LP/mm. A technical document can be sufficiently described digitally by approximately 8×10^7 bits of data.

4.2.3 Data Compression

The laser scan of imagery at very high resolution generates a great deal of digital information. Fortunately, most of the data derived from the scanner is redundant and need not be stored or transmitted. Data compression needs to be applied to the digitized drawing data produced by the microfilm scanning device to reduce the storage requirements and to decrease the transmission time. Compression ratios of 40:1 or more have been achieved on engineering drawings.[6]

4.3 DOCUMENT INDEX INFORMATION AUTOMATION

The document index information automation is primarily a software system designed to facilitate rapid retrieval of documents from mass storage, to maintain document access statistic data, to help in preparing bid set procurement packages, to enforce security, to support remote CRT terminal inquiries, to maintain and purge document files, to keep cost accounting, and prepare other file management reports etc. Each technical document stored on the mass storage system will have an associated data record in a magnetic disc storage (approximately 300 to 500 megabyte capacity) for controlling document reproduction, maintaining statistics, etc.

This portion of the system is independent of the document storage system, except for the document addresses which serve as links between document index information automation and document storage system. The document information automation system is required immediately and has been given top priority. Details are discussed in Section 5.

4.4 OPTICAL MASS STORAGE

The essential part of the optical mass storage technology is to store digital data on a modular removable optical disc with high density (10^8 ~ 10^9 bits/in^2) and an access time compatible with magnetic disc devices. Data is recorded with a track-to-track spacing of 2 μm which allows a total capacity of approximately 2×10^{10} bits per 12 in disc. Multiple optical disc controllers can be made which store 700 discs with a total potential capacity of 1.4×10^{13} bits. This is enough to store seven million technical drawings.

4.5 OUTPUT

The majority of output is to satisfy two basic needs: (1) remote users' needs which would be met by CRT visual display; and (2) bid-set packages preparation which would be computer-generated microforms.

4.5.1 Remote Terminals

The CRT terminals, located at the user's sites, allow users to query the document index file, preview the documents, verify data, make copy requests, and prepare bid packages.

4.5.2 Computer Output Microfilm (COM)

COM is used to record drawing images on the 35 mm microfilm which can be mounted into aperture cards.

5. RECOMMENDATIONS

The following recommendations are made which, it is believed, will improve the productivity of file operations. (See Figure 2.)

There are three phases:

- To enhance the overall effectiveness of the current operation in specified areas.
- To advance the current technologies of optic/electron based storage systems and to facilitate the conversions of microfilm-based files to optic/electron-based mass storage files.
- To convert the technical document file on the aperture cards to a optic/electron beam-based mass storage system whenever such a system becomes available at a cost-effective level, and to require that incoming documents be submitted in vector format.

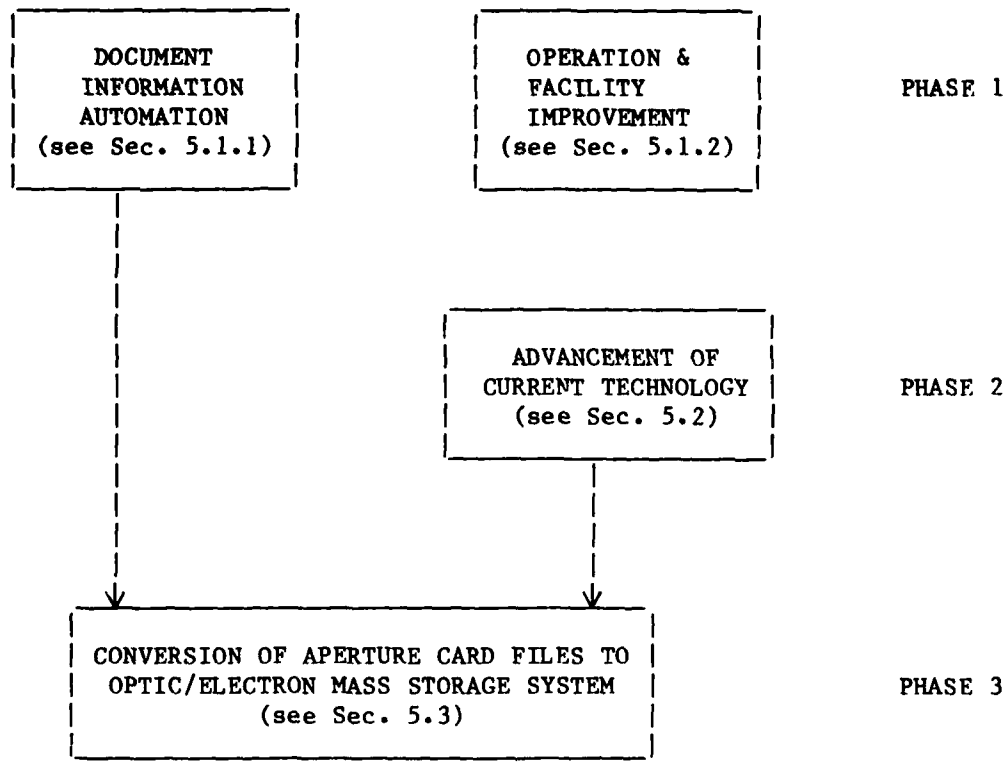

Figure 2 - Recommendations and Implementation for Technical Document Storage and Retrieval System

5.1 ENHANCEMENT OF THE CURRENT OPERATION

5.1.1 Document Index Information Automation System

The current aperture card index file contains index information for all aperture cards in the Active File. This index information is reproduced on microfiche and updated once a month to add new incoming documents to the file. When a technical document is requested, a manual look-up is made on the microfiche index file to determine whether the aperture card is, in fact, in the Active File. This manual look-up process is tedious and slow. The other drawbacks are:

- The index file is not available for external users. In CY79, 63 percent of the requests for documents were by external users.
- The index file does not include other vital information such as usage account, creation data, bid-set linkage, etc. The lack of usage data makes systematic file purging impossible.
- The microfiche index file is updated only once a month. Sometimes, therefore, technical documents are available from the file, but are not shown on the microfiche index file.

It is proposed to automate the index information referring to all the documents in the Active File and to collect usage data on each document. This system would utilize a mini-computer and remote CRT terminals. The automated index data file would be stored on a magnetic storage device.

This index data file would contain a record for each document. If the document is part of a bid-set, a linkage references the appropriate entry in the bid set file. Each record (or document) should contain the following items of data:

- Document number
- FSCM number
- Document description
- Revision level
- Number of sheets in document
- Number of aperture cards
- Record creation date or revision data
- Date document entered
- Security/access word
- Document address (file location)
- Document access count
- Last access date
- Document status (missing, out-of-file, etc.)

Remote terminals would be provided at all the principal internal user sites. This document information automation system should also be accessed by remote external users through telephone dial-up connections.

The advantages of such a document information automation system would be:

- The user would be able to obtain suffficient information on each document at his desk and could request documents from the terminals without filling out a request or walking to a file counter. The current manual microfiche index file verification effort and manual processing of document requests would be

eliminated. Thus, the document request and retrieval process can be expedited.

. The document information system would provide sufficient information on each document so that many unnecessary requests (including requests for hard copy documents) could be reduced or eliminated.

. The document information system will reduce the number of aperture cards and the amount of time the aperture cards are out-of-file.

. The system could queue the requests and periodically print out a pre-sorted list of requests for the file operator. This would allow the file operators to more efficiently access the aperture card files in numerical order rather than use the inefficient random access method presently utilized.

. Since the system would keep historical information on document access, that information would be used to periodically purge the file. This usage data collection feature would be able to promptly supply management with user statistics.

. The document information system would also contain a bid-set chaining subfile for each of the more frequently used bid-sets. The user could prepare his bid-set package through the remote terminal. Bid-set package preparation can also be greatly simplified through the assistance of this computer software.

. The incoming documents could be available to the users as soon as they were put on the file.

. When the aperture card files are to be converted to an automated mass storage system, this proposed Document Information Automation Software will be the controlling portion requiring no additional work.

5.1.2 Operation and Facility Improvements

Recommendations to immediately facilitate the overall performance of specific current operations and facilities are given below:

- Because the growth rate of the active file is more than 10 percent a year, and external requests have increased considerably in recent years replacement of the worn-out and outdated equipment by more advanced equipment can substantially increase overall efficiency. Additional Diebold horizontal files and aperture card duplicators are needed.

The major items of equipment needed are listed below.

Diebold horizontal files

High-speed aperture card duplicator

Aperture card collators

Aperture card sorter

Aperture card key punches

Aperture card viewers

- Approximately 47 percent of the incoming paper copies and 71 percent of incoming aperture card and roll films received at TDSS has some qualitative defects that affect the readability of the documents. TDSS should implement a quality inspection procedure for all incoming documents before entering them into the active file. Documents having qualitative defects should be returned to the manufacturer for replacement by better quality documents.

. In CY79, 210,500 (average 810/day) paper copies were made from aperture cards by counter requests. Most of the paper copies were made for document verification purposes. Paper copy duplication processes are slow and expensive (4 cents for an aperture card duplication cost vs 35 cents for a paper copy). Until the automated document information is installed, it is suggested that more aperture card readers be made available at principal users' sites to restrict or minimize the number of paper copy reproduction requests. Aperture cards can, for the most part, fulfill this function and are relatively inexpensive.

. An estimated 24 percent of internally requested documents was not available from the existing file. Some of the non-available documents were ordered from vendors or from other Navy technical document depositories. In FY79, an estimated 11,803 documents were ordered. It is assumed that a certain amount of the non-availability of documents is due to a miss-file (out of sequence). An out-of-sequence checking procedure should be done at least once a year for both the active and inactive files by using collators that will sort out the out-of-sequence aperture cards.

. It has been found that about 20 percent of the index files contain incomplete information. The current procedure for manual verification of document index information needs to be improved.

. Existing organization and job grade level limits staff development and contributes to a substantial turnover rate. The subsequent lack of experienced staff contributes to processing errors and delays.

5.2 ADVANCEMENT OF THE CURRENT TECHNOLOGIES

. Advancement of the technologies of automated document storage and retrieval:

The technologies of optic archival storage, high resolution scanning, and raster data compression are known and available, but they have not been integrated into a system for storing and retrieving technical documents. NAVMAT (0642) sponsoring a Manufacturing Technology project to design, develop, and install a pilot system at the Naval Ordnance Station* (Louisville, KY) for automated technical document storage and retrieval. More than two million dollars of FY82 funding has been requested. A steering committee was formed to oversee the project and Mr. Ruey Chen is currently a member of the committee. The successful implementation of this project will have a great impact not only on the technical document storage and retrieval system at SPCC but on other Navy installations and the micrographic industry.

. Requiring incoming documents to be received in aperture card format:

Approximately 29 percent of the incoming documents received are in paper form. The feasibility of requiring incoming documents to be received in aperture card format should be studied. All microfilm forms should be sealed to the aperture card rather than being inserted into a pocket-type aperture card. These aperture cards shall meet the requirements of MIL-M-9868.

*Contact point: Mr. D. McMahan, Code 80

. Graphics Exchange Specifications:

In recent years more and more technical documents are generated by computer aided drafting (CAD) tools, and the numerical description of technical documents is readily available in a vector format in the computer. Data exchange protocol will be needed for the transfer of such data. Reference [7] describes such work. Adaptation and standardization of graphics exchange specifications by DOD is recommended.

. Acceptance of the data of Technical Documents Generated by CAD Systems:

CAD systems generate data represented in vector format which is a more desirable data representation than raster-type data. The major advantages of vector-type data representation are the ease of document update or revision and less susceptability to data transmission error than when raster data is in compressed form.

In recent years the use of CAD systems to generate technical documents has increased significantly. It is suggested that a study be made of the feasibility of requesting and storing these valuable CAD generated vector-type data when it is available.

5.3 CONVERSION OF APERTURE CARD FILE TO THE OPTIC MASS STORAGE SYSTEM

The proposed system will require a contractor to implement an advanced technology system, including an optical disc storage device, laser scanner, and high resolution microfilm recorder. The system is designed to eliminate all manual effort in engineering-drawing storage, retrieval, reproduction and transmission which are done manually at the present time. This automated system will enable a user to request and review any engineering drawing and process other procurement functions from the CRT terminal at his desk.

The proposed automated system will provide the fol wing advantages in addition to labor reduction:

- The system will improve procurement administrative lead time by 2 to 3 days on the average.
- The system will improve engineering-drawing file-integrity which results in the ability to increase competitive procurement activities.
- The compactness and low cost of the optical storage media results in enhanced backup and recovery procedures for protecting the file against fire, flood, sabotage, and other forms of loss or destruction.
- The system will reduce the response time for handling external requests by other DOD agencies, such as the Defense Logistics Agencies.

The benefits of this automated system extend far beyond SPCC's application into other Navy and DOD engineering-drawing depositories, such as the Naval Ordnance Station, Louisville, KY, Naval Air Technical Services Facility, Philadelphia, PA, Naval Ship Weapons Systems Engineering Station, Port Hueneme, CA, the Naval Shipyards and Air Rework Facilities throughout CONUS, and the Defense Logistics Agencies. Large benefits can be expected not only from the reduced operational costs, but also from consolidating many large Navy and DOD engineering-drawing depositories into a centrally-managed system capable of electronic transmission to remote sites for file sharing. The use of the optic media provides a compact, digital data base that becomes the basis for central management and distribution of a mass engineering drawing data bank.

This system is also a complement to the on-going office automation project at SPCC in that procurement data can be automatically extracted from this Technical Drawing Automation System for input to the automated office system for processing and procurement-processing purposes.

Furthermore, the floor space for equipment can be reduced from current requirement of more than 4000 ft^2 to approximately 400 ft^2 or less for optic disc files.

ACKNOWLEDGMENTS

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APPENDIX A

SUMMARY OF DATA COLLECTION

GROWTH OF ACTIVE FILE IN CY 1979

ITEMS			DOCUMENTS*	APERTURE CARDS
INCOMING DOCUMENTS	HARD COPIES	29.5%	121,600	268,736
	ROLL FILMS	31.0%	127,600	281,996
	APERTURE CARDS	39.5%	162,900	360,009
	TOTAL		412,100	910,741
	REVISIONS & DUPLICATES		173,100	382,551
	ADDITIONS TO THE FILE		239,000	528,190
CONVERSIONS FROM THE INACTIVE FILE			42,900	94,809
TOTAL ADDITIONS TO THE FILE			281,900	623,000
FILE SIZE ON DEC. 30, 1978				4,586,000
FILE SIZE ON DEC. 30, 1979				5,209,000

*A document represents an average of 2.21 aperture cards.

DOCUMENTS REQUESTED & RETRIEVED IN CY 1979

		REQUESTS			DOC. PER REQ.	APERTURE CARDS RETRIEVED	COPIES PER DOC.	COPIES REPRODUCED	
		SUBMITTED	RETRIEVED					APERTURE CARDS	PAPER
INTERNAL	COUNTER	128,400	97,600	76%	1	215,696	1	38,825	210,500
INTERNAL	BID-SET	18,500	18,500	100%	4	163,540	16.5	2,698,410	
EXTERNAL		73,000	49,300	68%	1.5	163,429	1	163,429	
TOTAL REQUESTS SUBMITTED		219,900							
TOTAL REQUESTS RETRIEVED			165,400						
TOTAL APERTURE CARDS RETRIEVED						542,665			
TOTAL COPIES REPRODUCED								2,900,664	210,500

- Documents reordered: 11,083
- Percent of requests out-of-file: 2.5%

DRAWING SIZE AND CHARACTERISTIC DISTRIBUTION

SPECIFICATIONS								15%
ENGINEERING DRAWING	A	B	C	D	E	F & Up		85%
	36.2	16.3	11.9	12.8	11.0	11.8	100%	

N=1000

DRAWING REVISION DISTRIBUTION (ACTIVE FILE)

REVISIONS / %	UNREVISED	A	B	C	D	E & Up	TOTAL
DISTRIBUTION	34.9	21.4	15.6	8.4	5.2	14.5	100

N=1000

DRAWING AGE DISTRIBUTION (ACTIVE FILE)

PERIODS / %	70-79	60-69	50-59	PRIOR TO 50
DISTRIBUTION	47	38	8	7

N=850

QUALITY OF INCOMING DOCUMENTS

		DISTRI-BUTION %	OVERALL QUALITY		
			GOOD %	FAIR %	POOR %
HARD COPY	DIAZO	36	58	36	6
	SEPIOS	5	57	36	7
	COATED RL/WH	11	43	51	6
	PLAIN PAPER	48	52	39	9
	AVERAGE	100	53	39	8
APERTURE CARD	SILVER HALIDE	43	19	46	35
	DIAZO	57	36	44	20
	AVERAGE	100	29	45	26

N_H=306, N_A=150

QUALITY OF IN-FILE DOCUMENTS (ACTIVE FILE)

	DISTRI-BUTION %	OVERALL QUALITY		
		GOOD %	FAIR %	POOR %
SILVER HALIDE	41	21	54	25
DIAZO	59	37	51	12
AVERAGE	100	31	52	17

N=1000

QUALITY OF REPRODUCTION

QUALITY \ TYPE	%	APERTURE TO PAPER			APERTURE TO APERTURE		
		GOOD	FAIR	POOR	GOOD	FAIR	POOR
GOOD	ORIGINAL	100			100		
	REPRODUCTION	45	55		50	40	10
FAIR	ORIGINAL		100			100	
	REPRODUCTION		71	29		74	26
POOR	ORIGINAL			100			100
	REPRODUCTION			100			100

N=120

APPENDIX B

SOURCE SOUGHT SOLICITATION

The David W. Taylor Naval Ship Research and Development Center (DTNSRDC) is planning the procurement of an engineering drawing mechanization system aimed at the cost-effective performance improvement of the manual technical document (engineering drawings and specifications) storage, retrieval and duplication system currently at the Navy Ships Parts Control Center (SPCC), Mechanicsburg, PA.

SPCC is a Navy inventory control point for ship maintenance parts and has the responsibility for purchasing material to satisfy present and future needs.

To support this mission, SPCC maintains a large technical document file for use by activities at Mechanicsburg as well as other Navy and DoD agencies. This manual technical document storage and retrieval system has the following characteristics:

- The active file consists of 5.2 million 35 mm microfilm aperture cards stored in 25 rotary and elevator mechanical files (the average size of document consists of 2.2 aperture cards).
- The annual growth rate of the file is approximately 600,000 aperture cards.
- Approximately 65% of the engineering drawings stored are revisions.
- The file consists of approximately 15% of specifications and 85% of engineering drawings. The approximate break-down of the size of the engineering drawings are: size A, 36%; size B, 16%; size C, 12%; size D, 13%; size E, 11%; and size F and above, 12%.
- Preliminary investigation reveals that approximately 10%, among the 5 million aperture cards in storage, may have a higher retrieval rate.
- In 1979, approximately 500,000 aperture cards were retrieved and 3 million aperture card copies nd 200,000 paper copies were reproduced to satisfy users' requests.

Because of the ever-increasing workload at SPCC and the inherent problems associated with the manual technical document storage and retrieval systems, the new improved system must be capable of fulfilling the following requirements:

- The system must be able to manage up to 5 million engineering drawings and specifications, and provide growth potential to accommodate as much as 8 million engineering drawings and specifications.

- The storage medium may be the existing microfilm aperture cards, another format of microfilm or microfiche, or an electronic storage medium, such as optical disks. For any new medium, the techniques of document file conversion must be described and the cost of file conversion will be considered as a part of a cost/benefit tradeoff.

- The system must be capable of automatically recording and maintaining operational data of all the 5 million engineering drawings and specifications, such as access information, miss rate, etc.

- The system must have the capability to automatically retrieve and store all or a subset of the 5 million engineering drawings and specifications.

- Requests for retrieval of documents will be introduced through a keyboard from remote video display terminals.

- The system must be capable of automatically reproducing technical documents on 35 mm microfilm aperture cards, and of displaying the documents requested on remote video terminals.

This notice is not a request for proposals. Respondents will be notified of the results of the evaluation of the information submitted, qualified sources will be considered when requests for proposals are solicited. The closing date for submission of responses is 30 days from publication of this notice.

A summary of company experience in developing and delivering similar large-scale automation project systems is requested.

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