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Technical Report

AD 640 100

STUDY OF MECHANIZATION IN DOD LIBRARIES AND INFORMATION CENTERS

BOOZ · ALLEN APPLIED RESEARCH INC.

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Technical Report

AD 640 100

STUDY OF MECHANIZATION IN DOD LIBRARIES AND INFORMATION CENTERS

Submitted to

Defense Supply Agency Defense Documentation Center Cameron Station, Virginia

by

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ABSTRACT

This report summarizes the on-site study of mechanization in DoD libraries and information centers. Included are presentations and evaluations on thesaurus building, file structure, input processing, serial control, selective dissemination of information, circulation control, equipments being used, recommendations on information retrieval systems, observations on organization, operation and application, and summaries on mechanization status, scope and size of collections, and COSATI subject area breakdowns. 76 facilities were visited; individual reports were generated for 35. Abstracts for the 35 reports and their DDC AD numbers are included.

TABLE OF CONTENTS

			Page <u>Number</u>
	ABST	'RAC'I'	iii
	INDE	X OF FIGURES	vili
	INDE	X OF TABLES	х
	INDE	X OF FACILITIES SURVEYED	xii
1.	INTR	ODUCTION AND SUMMARY	1 - 1
	1.	Purpose of the Study	1 - 1
	2.	Study Approach	1 - 2
	3.	Summary of Findings of the Study	1 - 4
		 Status of Mechanization Costs of Mechanization Effectiveness of Mechanization Major Problems 	1 - 4 1 - 9 1 - 1 4 1 - 20
	4.	Recommended Mechanization Guidelines	1 - 24
11.	INPU	JT PROCESSING	2-1
	1.	Acquisition and Screening	2-7
	2.	Descriptive Cataloging Techniques	2-8
	3.	Data Transcription and Editing	2-19
		 Data Transcription Data Editing 	2-19 2-20

a. Italian 💏 👘 🖓 👘

v

			Page <u>Number</u>
	4.	Computer Input Operations	2-22
	5.	Outputs	2-24
III .	CON	TROL SERIALS	3 - 1
	1.	Computer Mechanization of Serial Control	3 - 3
	2.	The EAM System of Serial Control	3-5
IV.	CIR	CULATION CONTROL	4-1
V.	THE	SAURUS GENERATION AND USE	5 - 1
	1.	Thesaurus Develorment and Use	5 - 2
,	2,	Thesaurus Characteristics	5-6
	3.	Examples of Thesaurus	5 - 8
VI.	FILI	E STRUCTURE	6 - 1
	1.	Serial File	6 - 2
	2,	Inverted File	6 - 4
	3.	File Elements	6 - 6
VII.	STO	RAGE AND RETRIEVAL	7 - 1
	1.	System Functions	7 - 1
	2.	Communication of the Request	7 - 1
	3.	Conversion of Data to Machine-Readable Form	7-3
	4.	File Search	7-9
	5.	Analysis of Retrieval Material	7-10

vi

i

			Page <u>Number</u>
6.	Com	parison of Retrieval Functions	7-16
	(1)	Search Query Formulation	7-16
	(2)	Computer Availability	7-22
	(3)	Combination of Queries for Processing	7 - 23
	(4)	Thesaurus Check by Computer	7 = 24
	(5)	File Processing and Information Retrieval	7-24
	(6)	Permuted and Coordinate Indexes	7 - 27
		E DISSEMINATION	8-1
OF	INFOR	MATION	
OF	·	MATION Detrick System	8 - 2
	Ft.	· · · · · · · · · · · · · · · · · · ·	8 - 2 8 - 5
1. 2.	Ft.	Detrick System SDI System	
1. 2.	Ft. FTD UIPME	Detrick System SDI System	8-5
1. 2. EQ	Ft. FTD UIPME Equi	Detrick System SDI System NT pment for Storage and Retrieval	8-5 9-1 9-3
1. 2. EQ	Ft. FTD UIPME	Detrick System SDI System NT	8-5 9-1
1. 2. EQ	Ft. FTD UIPME Equi (1) (2)	Detrick System SDI System NT pment for Storage and Retrieval Termatrex and Keydex	8-5 9-1 9-3 9-3
1. 2. EQ	Ft. FTD UIPME Equi (1) (2)	Detrick System SDI System NT pment for Storage and Retrieval Termatrex and Keydex The ACCESS System	8-5 9-1 9-3 9-3 9-9
1. 2. EQ	Ft. FTD UIPME Equi (1) (2) Equi	Detrick System SDI System NT pment for Storage and Retrieval Termatrex and Keydex The ACCESS System pment for Materials Processing Crossfiler	8-5 9-1 9-3 9-3 9-9 9-24

X. BIBLIOGRAPHY

10-1

••••

INDEX OF FIGURES

ſ

1 1 1 ₹**1**

		Page Number
		Carried Control of Co
۱.	Input Processing	2 - 2
2.	AMS Worksheet	2-11
3.	NWL Input Worksheet (Old System)	2-13
4.	SEG Input Worksheet	2-15
5.	APL Input Worksheet	2-17
6.	NWL Input Worksheet (New System)	2-18
7.	APL Edit Printout	2-21
8.	Control of Serials - Typical System Flow	3-2
9,	Picatinny Circulation Control System	4 - 4
10.	Redstone Circulation Control System	4 - 5
11.	Natick Circulation Control System	4-6
12.	Typical Retrieval System Flow	7 - 2
13.	NWL Query Worksheet	7;
14.	NPS Query Worksheet	7-5
15.	EA Query Worksheet	7 - 6
16.	APL Query Worksheet	7 - 7
17.	APL Search Output	7 - 1 1

viii

<u>ي</u>د

		Page Number
18.	NOL Search Output	7 - 13
19,	APL Search Output	7-15
20.	HDL Permuted Index	7 - 29
21.	REIC Coordinate Index	7-31
22.	General SDI System	8-3
23.	FTD SDI System	8-7
24.	Weekly Notification	8-9
25.	Computer Equipments in the Facilities Studied	8-10
26.	Storage Process - File Search System	9-15
27.	Coding Form - File Search System	9-16
28.	Index Card - File Search System	9-19
29.	Document Recording Format - File Search System	9-20
30.	Retrieval Process - File Search System	9-23
31.	IBM 870 System Outputs - Punched Cards	9-31
32.	1BM 870 System Outputs - Printout	9-32
33.	IBM 870 System Outputs - Purchase Order	9-33
34.	JBM 870 System Outputs - Letter	9-35
35.	1BM 870 System Outputs - Punched Cards	9-36
36.	IBM 870 System Outputs - System Request Record	9-37
37.	1BM 870 System - Flow Diagram	<u>9</u> -38

ix

.....

INDEX OF TABLES

		Page Number	 _
1.	Mechanization Štatus	1-5	-
2.	Input Processing Summary	2-5	-
3.	Mechanized Serials Control	3-7	
4.	Summary of Thesauri	5 - 3	
5 .	Storage and Retrieval	7 - 17	

3

1.267

APPENDICES

- A. COSATI SUBJECT CATEGORY BREAKDOWN OF THE FACILITIES STUDIED
- B. COPIES OF DD FORM 1473 FOR THE INDIVIDUAL FACILITY REPORTS
- C. DD FORM 1473 FOR THIS FINAL REPORT

LIST OF FACILITIES SURVEYED

The following is a listing of the 76 major technical libraries and information centers of the Department of Defense that were visited during the BAARINC survey, together with their location and abbreviations. They are listed in alphabetical order, by abbreviations where abbreviation was possible.

ABBREVIATION

FACILITY

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ACIC	Aeronautical Chart and Information Center Technical Library St. Louis, Missouri
AEDC	Arnold Engineering Development Center Tullahoma, Tennessee
AFCRL	Air Force Cambridge Research Laboratories Technical Library L. G. Hanscom Field Bedford, Massachusetts
AFFTC	Air Force Flight Test Center Technical Library Edwards AFB, California
AFIT	Air Force Institute of Technology Library Wright-Patterson AFB, Ohio
AFML	Aerospace Materials Information Center Air Force Materials Laboratory Wright-Patterson AFB, Ohio

ABBREVIATION

FACILITY

AFML	Ceramics & Graphite Information Center Air Force Materials Laboratory Wright-Patterson AFB, Ohio
AFOSR	Air Force Office of Scientific Research Washington, 25, D. C.
AFRRI	Armed Forces Radiobiological Research Institute National Naval Medical Center Bethesda, Maryland
AFWL	Air Force Weapons Laboratory Technical Library Kirtland AFB, New Mexico
AMC	Aeromedical Library USAF Aerospace Medical Center Brooks AFB, Texas
AMS	U. S. Army Map Service Library Bethesda, Maryland
APL	Applied Physics LaboratoryJohn Hopkins University Technical Library Silver Spring, Maryland
ARL	Aeronautical Research Laboratory Technical Library Wright-Patterson AFB, Ohio
ASDIRS	Army Study Documentation and Information Retrieval System Army Library The Pentagon Washington, D. C.

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ABBREVIATION	FACILITY
BAMIRAC	Ballistic Missile Radiation Analysis Center University of Michigan Ann Arbor, Michigan
BCIC	Binary Constitution Information Center IIT Research Institute Chicago, Illinois
BDIAC	Battelle-Defender Information Analysis Center Battelle Memorial Institute Columbus, Ohio
BUSHIPS	Bureau of Ships Technical Library 18th Street & Constitution Avenue, N. W. Washington, D. C.
CDC AA	U. S. Army Combat Developments Command Library Artillery Agency Administrative Division Fort Sill, Oklahoma
CDC CBR	USA CDC CBR Agency Documentary Library Branch U. S. Army Combat Developments Command Fort McClellan, Alabama
CPIA	Chemical Propulsion Information Agency Johns Hopkins University Applied Physics Laboratory Silver Spring, Maryland
DASIAC	Defense Atomic Support Agency Information and Analysis Center General Electric Company 816 State Street Santa Barbara, California 93102
DASA Field Command	Defense Atomic Support Agency Field Command Library Sandia Base Albuquerque, New Mexico

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ABBREVIATION FACILITY DASA Headquarters Defense Atomic Support Agency Headquarters Library The Pentagon Washington, D. C. DELSIE Defense Logistics Studies Information Exchange Army Logistics Management Center Fort Lee, Virginia DISC Defense Industrial Supply Center Technical Library 700 Robbins Avenue Philadelphia, Pennsylvania DMIC Defense Metals Information Center **Battelle Memorial Institute** Columbus, Ohio DPG **Dugway** Proving Ground **Technical Library** Dugway, Utah EA Army Edgewood Research & Development Laboratory Edgewood Arsenal, Maryland EPIC Electrical & Electonic Properties Information Center Hughes Aircraft Company Culver City, California ERDL U.S. Army Engineer Research & Development Laboratories STINFO Division Fort Belvoir, Virginia FA Frankford Arsenal Library Philadelphia, Pennsylvania

ABBREVIA'TION

FACILITY

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FTD	Foreign Technolory Division Library Division	6
	Air Force Systems Command Wright-Patterson AFB, Ohio	
Ft. Detrick	Chemical Biological Laboratory Ft. Detrick, Maryland	-
Ft. Monmouth	Technical Documents Center Fort Monmouth, New Jersey	
HDL	Harry Diamond Laboratories Technical Information Office Washington, D. C.	-
IRIA	Infrared Information and Analysis Center University of Michigan Willow Run Laboratories Ann Arbor, Michigan	-
MEL	Navy Marine Engineering Laboratory Library Annapolis, Maryland	
MPDC	Air Force Materials Information Center 13919 West Bay Shore Drive Traverse City, Michigan 49684	
NAFI	Naval Avionics Facility Technical Library Indianapolis, Indiana	
NASL	Naval Applied Science Laboratory Technical Library U.S. Naval Base Brooklyn, New York	
Natick	Natick Laboratories U.S. Army Technical Library Natick, Massachusetts	
NAVUSL	Navy Underwater Sound Laboratory Library New London, Connecticut	

ABBREVIATION

FACILITY

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NCEL	Naval Civil Engineering Laboratory Technical Library Division Port Hueneme. California
NEL	Naval Electronics Laboratory Technical Library San Dicgo, California 92152
N MC	Naval Missile Center Technical Library Point Mugu, California
NODC	National Occanographic Data Center Washington, D. C.
NOL	Naval Ordnance Laboratory Library White Oak, Maryland
NOLC	U.S. Naval Ordnance Laboratory Library Corona, California
	Nondestructive Testing Information Analysis Center U.S. Army Materials Research Agency Watertown, Massachusetts
N00	Naval Oceanographic Office Library Suitland, Maryland
NOTS	Naval Ordnance Test Station Technical Information Department China Lake, California
NPRA	Naval Personnel Research Activity Technical Library San Diego, California
NPS	Naval Postgraduate School Library Monterey, California
NRDL	Naval Radiological Defense Laboratory Library San Francisco, California
NRL	Naval Research Laboratory Technical Information Office Washington, D. C.

ABBREVIATION

FACILITY

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NSMSES	Naval Ship Missiles Systems Engineering Station Technical Library Division Port Hueneme, California
NUWS	Naval Underwater Weapons Research and Engineering Station Library & Technical Information Division Newport, Rhode Island
NWL	Naval Weakpons Laboratory Technical Library Dahlgren, Virginia
OPTEVFOR	Operational Test & Evaluation Force Technical Library U. S. Naval Station Norfolk, Virginia
Picatinny	Picatinny Arsenal Technical Library Dover, New Jersey
PLASTEC	Plastics Technical Evaluation Center Picatinny Arsenal Dover, New Jersey
RACIC	Remote Area Conflict Information Center Battelle Memorial Institute Columbus, Ohio
RADC	Rome Air Development Center Library Griffiss Air Force Base, New York
RC	Reliability Central Rome Air Development Center Griffiss Air Force Base, New York
Recon Central	Reconnaissance Applications Branch Reconnaissance Division Air Force Avionics Laboratory Wright-Patterson AFB, Ohio

ABBREVIATION	FACILITY
REIC	Radiation Effects Information Center Battelle Memorial Institute Columbus, Ohio
RSIC	Redstone Scientific Information Center Redstone Arsenal, Alabama
SEG	Systems Engineering Group Technical Information Reference Branch Research & Technology Division Wright-Patterson AFB, Ohio
TAC	Tactical Air Reconnaissance Center Shaw AFB, South Carolina
TPRC	Thermophysical Properties Research Center Purdue University West Lafayette, Indiana
USA MRA	Army Materials Research Agency Technical Library Watertown, Massachusetts
VESIAC	VELA Seismic Information & Analysis Center University of Michigan Ann Arbor, Michigan
	Technical Library, AFL 2302 Wright-Patterson AFB, Ohio
WVT	Benet Research & Engineering Laboratories Technical Information Services Office Watervliet Arsenal Watervliet, New York

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1. INTRODUCTION AND SUMMARY

1. PURPOSE OF THE STUDY

The purpose of this study was to obtain detailed information relating to the mechanized systems being planned, developed, and used within DoD technical libraries and information centers. The information gathered was to be organized, analyzed, and documented to provide a basis for the following:

- . Determination of the present status of mechanization in the subject facilities
- . Assessment of the costs and effectiveness of the information systems
- . Definition of significant developed and developing techniques and problem areas
- . Promulgation of the information to aid in the development and improvement of related systems.

In all, 76 facilities were studied during the period of this project. These are identified on pages x through xvii and their collection characteristics are described in Appendix A. Of these, 33 had significant mechanized systems in development or operation. Detailed information relating to the operation, the mechanized processes, program systems, files and routines, equipment used, future plans, and costs

of systems at individual facilities is separately documented in individual facility reports. Readers interested in the specific data collected at each of the significantly mechanized facilities are referred to these reports. Thirty-five individual facility reports have been published which include the 33 with mechanized systems as well as two nonmechanized facilities. (The latter were surveyed prior to the final decision regarding the reporting scheme.) Abstracts for each of the 35 reports appear in Appendix B. ---

Summarizations of the above information and analysis relating to the basic objectives of this contract are presented in this report. Throughout the report, abbreviations are used rather than complete names of the facilities surveyed. A glossary of the abbreviations appears on pages vi through xiii.

2. STUDY APPROACH

The study was conducted in three phases. Pilot Interviews, Data Collection, and Data Analysis.

Pilot Interviews in four libraries were completed in July 1965. The purpose of this phase was to establish a realistic and comprehensive survey procedure to insure adequacy of the information to be collected.

Interviews were conducted at the libraries at the Bureau of Ships, Ft. Detrick, Harry Diamond Laboratories, and Foreign Technology Division of the Air Force Systems Command. These were selected because of their proximity and relatively advanced degree of mechanization.

The Data Collection Phase began in July 1965 and continued for seven months. For this phase, the libraries and information centers were organized into 11 areas: Southeast: Southwest; Washington, D.C.; Boston; Columbus-Dayton, Ohio; Northern California; Ann Arbor-Suitons Bay, Michigan; Indianapolis-Chicago; New York-Philadelphia; Southern California; and, the Desert Region. Data were collected by two teams, each of which included a librarian and a computer specialist. Of the 76 facilities visited, 10 were DoD, 17 were Army, 26 were Navy, and 23 were Air Force. Facilities to be reported on in depth were selected on the basis of the degree of usage of computers or of novel application of other equipment. Each report was reviewed and approved by the facility concerned before publication.

Information analysis began in mid-December 1965 and continued for five months, the major activity being in the final two months. This final report of the project presents the results of the analysis and a summary of the information collected.

3. SUMMARY OF FINDINGS OF THE STUDY

(1) Status of Mechanization

Table 1 summarizes the mechanization status of the 33 facilities that have significant mechanized systems. Of these, six have relatively sophisticated overall program systems. These are BuShips (Ships System Command), FTD, Fort Detrick, APL, NOTS, and RSIC. Most of the facilities combine mechanized and manual operations. In almost every one of the 33 facilities, a mechanization improvement project was underway or planned.

It is notable that none of the facilities has developed novel programming techniques (e.g., automatic abstracting and indexing), and none has expressed the need or desire to do so. All are dependent upon proven and well-exploited software techniques.

Only one facility owned (leased) the computer it used (Mechanical Properties Data Center). It is significant to note, however, that facilities felt that the lack of control over equipment was the source of many of their problems. None used time-shared techniques; although TPRC has plans to do so, and Recon Central experimented for a while with a teletype communication link between human operators— one at the Central and one at the remote computer.

	Facility	Classified	Input			Serial	Circula-	SDI	Catalor	20	Acression List	List
Faculty	Report	Inventory	Processing	sing	Retrieval	Control	tien		Cards Book	300k	Comp	а -
a	Ad#	Control	Cards Paper	Paper			Control			Form		
				Tape								
AFIT	640-114		0					I			0# 0	
AMS	640-121		0		U						0	
APL	640-120		0		0			0	0		0	
	640-125		0		Manuel					0		
BAMIRAC, IRIA, VESIAC	640-130		0		c							
BDIC, DMIC, RACIC, REIC	640-113	0	0	0	Manuel							0
BUSHIPS	640-i03		0		0	0		0	0		0	
AFCRL	640-109	с.		0	n	n			0	5	n	0
DELSIE	640-118		0		0					0		
DISC	801-059		0						EAM		EAM	
EA	540-123		0		D	Р	۵ ,	a ,			с.	
EPIC	640-128		0		0						0	
LTD CT4	489-996		0	0	0		đ	0	0		0	
FORT DETRICK	640-102			0	0	0		0			0	
HDL	640-101		0		Manuel			¢	0		0	
MPDC	489-998		0		0							
MEL	640-117		IJ		U							
NAFI	640-126		0	0								
NATICK	640-104		0	0		0	0	4	0			0
NMC	640-111	Ч		0	ፈ					0	0	
NOL	540-122		0	0	0	ሲ	<u>д</u> ,		c	T		0
NUTS	489-395		0	0	0	Р			0		þ	Γ
NPS	₿40-110	ዋ		0	0				0		<u>а</u>	
NSMSES	540-112		0							0	0	Γ
NUWS	489-997	ፈ	0							۵.		
NHL	640-119		C		0		C		5		0	
PICATINNY	640-106	n	0		D	4	0	<u>с</u> ,			D	
PLASTEC	640-107		0									
RECON CENTRAL	<u>540-115</u>		0		0							
RSIC	<u>540-129</u>	D	0		U	0	0	d.	0	4	d	
ISEG.	489-099		0					0	0		0	
TPRC	<u> </u>		0		0			_				
Reliability Central	640-116		<u>د</u>		Ч						0	

Key: O = Operational P = Planned U = Under development or in testing # = Discontinued

Mechanization Status <u>Table # 1</u>

Seven of the facilities stored their thesauri in computer memory and used them for automatic error control and/or code conversion for natural language input. Only three found links and roles to be worth the added programming complexity.

Eighteen facilities stored their search files in an inverted form (e.g., a file ordered by accession numbers) and four in the direct form (e.g., a file ordered by descriptors). Searching a direct file can be a long procedure since the file must include a record for each acquisition in the library. Each of these records must be searched in serial sequence to determine if it has the desired combination of descriptors. An invertea file, on the other hand, has one record for each descriptor and, therefore, is only as long as the descriptor thesaurus. Furthermore, a search can be confined to only those descriptors of interest. Searching this latter type of file, however, requires a more sophisticated program (see Section VI, "File Structure"), but the total search time can be much shorter. For this reason, the use of direct files in mechanized searching is unusual, although direct files are often used after an inverted file searci. in order to obtain bibliographic information relative to the retrieved accession numbers.

Two kinds of retrieval system philosophies which employ a direct file search were encountered. One (e.g., NPS) is a

two-tape file scheme wherein an abbreviated file (accession number vs. coded descriptors) is actually searched while a second detail file is driven in synchronism. When a selection is made on the abbreviated file, the printout is developed from the detail file . including the reference, bibliographic information, and abstract. The second approach (e.g., APL) is based on a unit-record concept in which each record carries detailed information describing the document. The primary advantage of both approaches is that the retrieved information is printed out in detail (e.g., with bibliographic data and abstracts) immediately without a secondary operation being required.

Four of the facilities (all information centers) have mechanized files of data that can be manipulated and reordered in the process of retrieval. The retrieved outputs of these are actually specific answers to specific questions. All of the other systems studied retrieve only document references.

Four facilities have developed SDI systems. Four produced or were planning permuted indexes that were to be available to the user. Two information center complexes, the University of Michigan group (IRIA, VESIAC, and BAMIRAC) and the EPIC, are planning or are involved in generalized information retrieval

programs that serve a multitude of facilities. (These generalized programs represent a considerable cost economy, since a single program development can be used by several facilities. The generalized program approach can make the difference between being able to justify and afford a mechanized search process, and having none at all.) 아무 도로 아이 한 같이 봐요.

Almost all of the libraries complained of a poor understanding of library problems on the part of the programmers, and, in general, the programmers criticized the librarians for not understanding the potentials and limitations of computer applications. Poor communications between librarian and programmer can be blamed for many of the system development problems experienced. Some of these problems manifested themselves only after the system was operating and improvements more difficult to undertake. For example, Boolean search capabilities were sometimes designed into the retrieval program with severe, although unintentional, limitations. One such limitation was the inability of the program to relate both the AND and the OR operators. Also, the capability for search complexability often seemed far more sophisticated than necessary to satisfy the actual user's needs.

In their relationships with programmers, the information certers had much less difficulty than did the libraries. This can be attributed to two conditions:

The centers' staffs were usually more technically oriented and had a meaningful understanding of computer technology. They were able, therefore, to communicate with the programmer on his terms. (We encountered no programmers who could communicate with the librarian on his terms.)

Some centers (e.g., TPRC and MPDC) maintained a staff member who had the ability to program.

It would appear that unless the libraries found themselves in a similar position, they would continue to suffer the consequences of poor communication.

We believe that a more businesslike approach to the programmer and an effective cost control program will reduce this problem as well as several others related to the development of mechanized systems. The following sections present these aspects in greater detail.

(2) Costs of Mechanization

In almost every library studied, cost information on system development was either not available, of questionable reliability, or not comprehensive. In addition, there was an almost universal

lack of concern about development costs on the part of the librarians when these costs were not associated with manpower billets or hardware purchases. Information center operators, conversely, were generally very concerned about costs and maintained detailed records of current operating costs, although even in these cases the historical development costs were usually not available. Ē

The lack of cost information appears to be the result of one or more of the following factors:

- Time is generally made available to a library on a computer that it does not own and, often, the library is not charged for the time used.
- In some cases, programming has been done in house at no cost to the library and with no records kept of man-hours expended.
- In other cases, programming was done by contractors who performed many services in addition to programming for the library, and the library programming costs were not separable from other costs.
- The historical operating costs for the premechanized manual system are not usually available for comparison.
 - For those libraries with developing mechanized operations, the costs are mingled with other library activities, including use of the old system (card catalog, etc.), which the new system has not yet replaced.

We feel that incomplete cost records and insufficient concern about cost versus usefulness and value is probably the most detrimental influence to the development of many of the systems encountered. We believe that this criticism is valid in the majority of systems studied.

Reference to the individual facility reports will reveal a number of examples of the acquisition of a system which proved useless and had to be abandoned, or which was only marginally successful and later required extensive modifications. The survey data clearly indicate some cases in which a program of mechanization was initiated and pursued simply because it was the "thing to do". Several of these systems seemed remarkably able to operate and to expand in the vacuum of a nearly complete absence of considerations of user needs.

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A sensible attention to the elements of system development and operating costs, as well as to the resulting system effectiveness (including satisfaction of user needs), is essential if the above situations are to be avoided. For this reason, we have included a discussion of pertinent cost factors in the following paragraphs.

1. The purpose of assembling cost information is to measure how resource consumption compares with resource allocation. The allocation is usually specified by a budget, which, in turn, should reflect the judgement of management concerning the relative value of each activity. This value judgement should include intangibles as well as tangibles. Applied to mechanized processes, this means considering and including the value of such elements as increased timeliness, flexibility, and quality; broader and/or deeper search capability; greater file detail; increased user satisfaction; etc. The elements of value (both tangible and intangible) used in determining budgetary allocation should be the same ones used in measuring the operating systems effectiveness. This provides a two-way check -- budget versus cost and expected value versus actual effectiveness.

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2. As the cost information is accumulated, it should be compared to the budget. The budget should be subject to revision based upon the changing availability of resources and the changing view of the value of the system elements as derived from measures of performance effectiveness. (See the following Section on Effectiveness of Mechanization). Ideally, this approach will lead to the selection of the most

desirable courses of action while minimizing the effects of unwarranted optimism or undue pessimism. It should also permit a more sensible and orderly consideration of future developments such as service demand variations, new techniques, expanding and contracting missions, etc., and should permit the formation of a basis for coordination with other organizations (e.g., purchasing and computer programming groups).

3. Examples of elements that make up the overall cost of mechanized processes are:

- Library staff salaries (relative to the mechanized process)
- . Materials cost
- . Equipment purchase or rental cost
- . Equipment space requirements
- . Maintenance charges
- . Computer time
- . Programming cost (even if not charged to the library)
- . Cost of contractor services
- . Cost of acquiring new skills

These cost elements should be assembled and related to various units of the mechanized operation, such as cost of maintenance and update lists, cost per acquisition, per item cataloged, per search, per dissemination, etc. These figures will permit a cost analysis of the mechanized processes in terms of budget and, combined with the operation statistics, a determination of cost effectiveness. Finally, these figures can be maintained from year to year to develop a historical cost basis for comparisons, decisions regarding future allocations, staff alterations, and changes in service emphasis. -

(3) Effectiveness of Mechanization

The following considerations have precluded a quantitative determination of the effectiveness of the systems studied:

- Factors of effectiveness for information systems have not been generally agreed upon. (The National Science Foundation and ATLIS are currently conducting studies toward this end.)
- The facilities which have mechanized processes that formerly were manual have generally not attempted to compare the two except in superficial ways.

Examples of factors that do carry effectiveness information and that should be used as a basis for evaluating the effectiveness of mechanized information schemes are:

> Through-put characteristics, including response time for retrieval requests. (This is the actual time from

receipt of request to delivery of the answer--not just processing time.)

- Types, nature, frequency of inputs and outputs
- . Cataloging rate
- . Resource requirements, such as manpower needs, operator skill level, space, layout, etc.
- . Number of files stored in the computer and materials on the shelves
- . File capacity, level of detail, and breadth of subjects
- . File organization
- . File load
- . File updating time
- . Error rate
- . Interarrival time of various demands upon the system, such as requests to catalog and retrospective search requests
- . Backlog of requests
- . Cataloging backlog
- . Number of users accommodated by the process
- . Number of requests
- . Number of queries adequately satisfied
- Recall and relevance of search output.
- . User satisfaction

These measures should be taken for worst, average, and best

cases, and then compared to management expectations and user needs.

The following comments characterize the qualitative evaluation of effectiveness as assigned by the facilities' staff to their own mechanized systems:

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 Work measurement and standard time data studies on the efficiency of the system used at the Picatinny Arsenal Technical Library indicate that the mechanized circulation system is more efficient than the previous manual one,
 e. g., the overdue portion of the system is considered five times more efficient.

In terms of hours per unit, the new system averages 0. 15 hour per item for keypunching, sorting, pulling from shelves, preparing for mail, discharging and refiling returns, and processing on the computer. The old system averaged 0. 18 hour per item. This represents a significant saving when the number of annual transactions is considered. The number of library personnel needed to handle circulation functions was reduced by two with the introduction of the computer-based system.

2. Since the introduction of mechanized processing, the Technical Information Reference Branch has been able to produce a regular semimonthly accessions list with no

increase in effort or manpower. In the eight years preceding mechanization, the Branch was able to produce manually only 56 such lists. Besides the accessions list, the computer also produced, in its first run, 4,700 catalog cards in 11 minutes. Normally, 30 days would have been required to type these cards, with additional time required for proofreading, correcting, and arranging them in file order.

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3. The U. S. Naval Postgraduate School Library expressed satisfaction with the mechanized system in regard to retrieval relevancy, retrieval recall, and usefulness of the end product. The mechanized system conserves the time of the professional staff. They now devote about 10 to 15 minutes each to 300 student requests per month. Formerly, 1-1/2 hours would have been required for professional assistance with a manual search. The mechanized, versus manual, literature search saves about 500 manhours per month of the students' time.

4. The Air Force Materials Laboratory Library Staff found that, during searches, the new system caused a reduction of irrelevant information of over 56 percent and incurred less than a 5 percent loss of relevant information. 5. The library staft at the Redstone Scientific Information Center has praised its Alpha project as having made possible a greater volume of library service at a saving in staff time. In 1962, before mechanization began, less than 4,000 of a potential 20,000 patrons used the Library. A staff of 67 was required to serve these users. In 1965 there were 8,300 users, while the staff had been decreased from 67 to 43 members, with no increase in overall workload on the staff. - 14 C

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6. The Infrared Information Analysis Center personnel believe that the operation of their center has been improved by mechanization. Last year, with mechanization, they were able to answer five times as many requests as before. Prior to going on full-time computer use, IRIA personnel required two to three days to prepare a bibliography for a visitor. The time now required averages one and one-half hours, and bibliographies have been produced in as short a time as 45 minutes.

7. In 1964, the Foreign Technology Division Library conducted a controlled experiment on a data base of 100 documents. The computer search based on 30 user profiles retrieved an average of 85 documents. The manual searches

yielded 45 documents. Of those 45, about 15 percent, or seven documents, had been missed by the computer search. Relevance levels were 58 percent on the computer search and 63 percent on the manual search. It was also discovered that many users were glad to get an excess of material.

8. The Thermophysical Properties Research Center has found that most retrieval queries can be answered by manual reference to the Retrieval Guide or by consulting with one of the staff members. Furthermore, the Director believes that, at present, he can perform a search faster manually than by machine. This is with reference to the total real cycle time, which includes all the time consumed between the asking of the question and the receipt of the information by the requester. This condition exists because the total system is small as yet, and because the number of retrievals is only about 50 per year (not considering the publication of TPRC's Retrieval Guide which amounts to a retrieval of its entire file).

9. All four of the information centers at the Batelle Memorial Institute consider that their manually produced and searched files of extracts are preferable to a computerized

system. They point out that up to 80 percent of questions can be answered by direct reference to the extract files alone. In addition, a user of the files is automatically "referred" to other positions of the files by other clue words underlined on the cards he is using. A user who makes a personal visit to the centers, usually on a very tight air-travel schedule, has immediate access to the information itself, not merely to bibliographic citations. Furthermore, the subject specialists who deal with telephone queries often can answer questions on the spot by reference to the files. On the other hand, additional mechanization of the Center's printed outputs would be considered desirable for time-saving features where it is economically advantageous. ne os se score en la planta de la

(4) Major Problems

The following paragraphs express the problem areas that were of concern to and reported by staff members at the facilities surveyed:

1. Computer Service

None of the libraries studied owns or leases computers; therefore, they are forced to rely on other organizational groups for computer services. As a result, computer

service is often erratic and sometimes may become unavailable for extended periods of time. In one case, erratic service led to overdue notices being two weeks late. In another case, the replacement of a facility's computer required the library to return to manual methods until its programs were converted on a second-priority basis.

2. Motivation

In some cases a library initiated a program of mechanization not so much because it was needed or desired by the users but because the computer facility had computer time and programmers available. Even under these conditions, computer usage by the library usually remains on a secondpriority basis. Also, because of poor communications between the programmers and the library staff, the library's needs and the programmers' areas of responsibility have not been clearly delineated prior to the development of the computer programs. This has led to extended delays in processing (such as six months to produce an accessions list by computer compared to three weeks by manual methods).

3. Changeover

Bringing a storage and retrieval system into operational use is greatly complicated by the problems of file conversion. Computer searching is effective only if a substantial part of the file to be searched is accessible to the computer. However the creation of machine files, particularly for the whole card catalog, often initially exceeds the resources available to the libraries, and the file conversion process may have to be stretched out over a long period. Thus, a library may have to operate two systems; the old system, using card catalogs. etc., and the mechanized system, for which capability is built gradually over a period of several years. This experience can be frustrating and discouraging to both the user and the scarcher.

4. SDI

The facilities that use SDI systems have unique problems. The most difficult problem observed in developing an SDI system is the proper maturation of the interest profile. Often, this difficulty is not given adequate attention, with the result that participants soon become discouraged by the flood of irrelevant information and the lack of desired information. Experience has shown that in the area of

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profile development there is no substitute for patient, painstaking work on the part of both the profile developer and the participant.

Problems have also been experienced in the choice of methods used to notify SDI system participants of citations selected for their attention. Individuals may be unwilling to cope with the filing problems associated with distributing a single notification card per selected citation. Problems of this sort must be identified and eliminated, or the participant may lose interest in the system.

5. Staffing

Information facilities consider themselves to be understaffed for the job expected of them. Some of the difficulty in bringing a mechanized process into operation can be attributed to insufficient staff for organizing the system and preparing material for computer input.

6. Organization

The facilities reporting to research and development staff management generally feel that they have much better management support for their efforts toward mechanization (as well as their other activities) then do those reporting to administrative management.

4. RECOMMENDED MECHANIZATION GUIDELINES

The experiences of many of the facilities studied suggest the following guidelines for those now planning mechanized processes:

Clearly establish the goals to be achieved by mechanization.
 Examples of these are the following:

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- Increased service
- . Faster service
- . More search flexibility
- . Greater search scope
- . Lower personnel costs
- . Fewer personnel required.

(2) Determine whether or not these goals can be achieved more economically by other methods than by mechanization--c.g., by improvements to the existing manual system, or by obtaining equipments such as EAM punched card machines for processing and relatively inexpensive devices for retrieval such as the "peek-a-boo" systems. This type of equipment can be owned and controlled by the information facility; thus, many potential problems are avoided.

(3) Determine the feasibility of computer processing and whether or not such an approach will really achieve the desired goals.

(4) If computer processing is to be attempted, consider how this can be done with a minimum of interference to the present service. As much as possible, plan to use the existing formats and schemes. Also, plan the system so that in event of computer nonavailability for extended periods, or loss of computer services altogether, the library operations will not be paralyzed. Specifically, maintain man-machine convertible files such as punched cards to back up the machine memory and use input and output formats that can also be created and handled manually.

(5) Determine with as much depth as practicable the way in which the conversion to the new system will affect the existing operation. Identify potential problem areas such as personnel retraining, user education, organization adjustments, communications arrangements, space preparations, the new system/old system parallel operation period, etc. Develop realistic plans for handling each of these.

(6) Begin the system development with a careful analysis of the existing system. This analysis may indicate areas that

could be eliminated or modified substantially, particularly in view of the different capabilities of the mechanized process Very useful aids for this type of analysis are flow charts which detail each operational function along with workload figures and the individual responsible for performing the function. ₩....

(7) The mechanized process development should proceed based on the analysis and (ideally) with full mutual understanding between the librarian and the programmer of what is to be accomplished. This aspect of development was one of the most poorly handled in the system studied during this project. The potential for costly errors and lost time inherent in a breakdown of the understanding is clearly extensive. To avoid such a situation, be particularly contain that the computer program developers understand what is to be done and that there is no serious obstacle to good communications, such as the political environment, terminology problems, too many other jobs with higher priority, etc. One good beginning is to obtain a written statement of work and a work schedule from the program developers.

(8) Start conversion to mechanization with a relatively small part of the system that can continue to function manually during the development phase. (An example of this is the production

of a book catalog or catalog cards.) A planned approach will permit the developing of experience and confidence before the difficult major development tasks are attempted.

(9) Be sure that the system planners are aware of the cost and effort required to convert 'he system's manual records to machine records: for example, to what extent information on each catalog card will have to be keypunched to create a computerized retrieval file.

(10) Do not start the program development until it is reasonably certain that time and resources will be available to complete it.

(11) Create and follow a cost budget that realistically reflects the anticipated value of the developing system as well as the available resources. Record costs as they accumulate, including reasonable estimates for those services that are supplied "free". Relate these costs to:

- The cost budget
- . Costs of the old system
- . Effectiveness of the new system

Modify the cost budget and direct the available resources to those areas that the above analysis indicates will yield the greatest return in terms of the goals established in step (1) above

(12) As the system implementation phase is entered, collect and maintain operational statistics such as:

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- query handling frequency and characteristics
- . user characteristics

- . number of queries per user and/or user type
- . frequency of use of use of each thesaurus term
- . frequency of use of each file record
- . peak demand periods
- file update frequency and characteristics

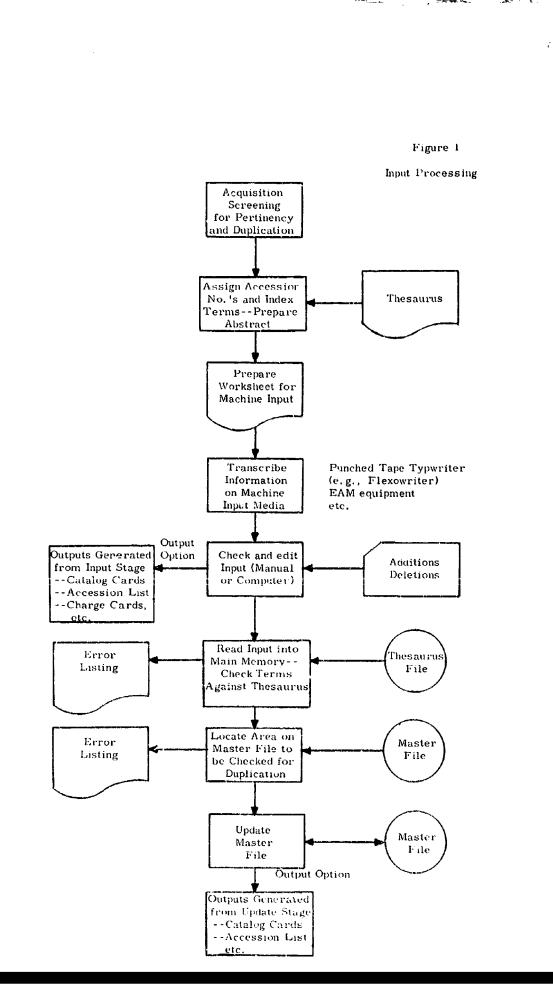
Most of these can be acquired by the computer program during its normal operation. An analysis of operational statistics will provide a current quantitative basis for performing system improvement modification as well for developing effectiveness estimates.

II. INPUT PROCESSING

For the purpose of this section, we have defined input processing of documented information as the functions that take place from acquisition to establishment of the information in the retrieval system. The important functions are as follows:

- Acquisition
- Screening for retention and circulation
- Cataloging/indexing
- Transcription to machine-readable media
- Verification and other forms of error control
- Output of input data in various formats.

A representative process is presented in Figure 1. Acquisitions are first screened to eliminate duplication and to insure pertinency. Using the thesaurus previously established for the facility, cataloging is then accomplished. Machine inputs are next prepared. A variety of alternatives exist at this stage which are described in detail later in this section.



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As shown in Figure 1, the generation of output formats (e.g. catalog cards, accessions lists, etc.) can occur at either of two stages in the process:

- They can be produced as a byproduct of off-line input preparation (card punching, tape punching, etc.). Examples of this approach are found in the systems of NOL and NWL.
- They can be produced as a byproduct of file updating runs. Examples of those using this approach are NOTS, FTD, and Fort Detrick.

Table 2 is a summary of the mechanization status of input

processing at the various information facilities studied.

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Table 2 Input Processing Summary

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1. ACQUISITION AND SCREENING

The receipt of a document initiates a number of administrative procedures such as filling out receipts, separating and establishing separate control for classified documents, separating the documents from interlibrary loan sources, checking for duplications, and separating requested reports from those received on automatic distribution. Those identified as user-requested usually have some form of distribution sheet attached to the document identifying the requester. When NWL changed over to the IBM 870/7030 system, however, they made provision to have the document forwarded to the requester before submitting it to subject analysis.

For the purpose of creating a record in the computer master file, it is usually necessary to provide only the title, author, date, classification, and source. Later, after the document has been returned to the library, the more time-consuming job of subject analysis may be performed to develop the descriptors and the abstract. This information can then be added to complete the document's record in the Master File. Most information facilities add to their collection all reports received on distribution, with little or no screening, since distribution is usually based on their areas of interest. Some facilities, however (e.g., HDL, NOL, BAMIRAC, IRIA, and VESIAC) maintain a careful screening process, primarily accomplished by the information facility staff. In some of these cases, selected members of the scientific staff also perform an evaluation of some of the reports.

2. DESCRIPTIVE CATALOGING TECHNIQUES

Cataloging worksheets of a variety of forms were found to be almost universally used for assembling the data for transcription onto the input media. Of this class we have identified two basic types.

The first type has all or most of the repetitious information and information field identifiers pretyped on the form. Blank space is left for the variable information. This type can be further divided into the following kinds of worksheets:

> A worksheet that in total is designed to correspond in exact format to an EAM card that will be prepared from it. Figure 2 gives an example of this type as used by AMS.

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A worksheet that is arranged so that the data entered on each line of the worksheet corresponds to the entry to be punched on one entire card. Figure 3 gives an example of this type as used by NWL in its original system (IBM 7090). Figure 4 shows a similar worksheet used by SEG.

A worksheet that lists the required data or refers to areas in the document for the data. This type of sheet does not contain any instructions or column guides for punching the EAM card. Figure 5 gives an example of this type as used by APL.

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The second basis type of worksheet contains a minimum of information but provides information that is not immediately obvious from the document. Figure 6 shows this type of worksheet, which is used by NWL in its new system (IBM 870/7030). In this example, the worksheet is used only to list descriptor data.

Descriptive cataloging, preparation of abstracts, and subject analysis are then performed, in varying order, and this information is also entered on the worksheets. Some facilities attempt to reduce the amount of information to be entered on the worksheets by referencing data in the report itself (e.g., title, author, abstract, etc.) rather than copying these data on the worksheets. The APL Document Library uses this scheme, although the input data sheet contains sufficient space for the Library's entry, should one be necessary. The NOTS Library marks important data on the title pages of a report,

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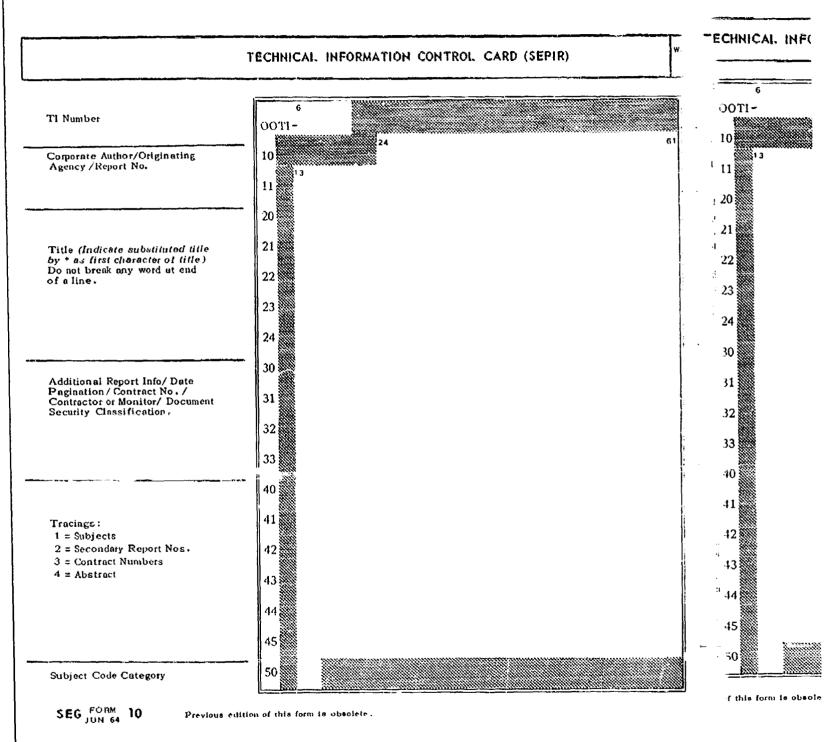
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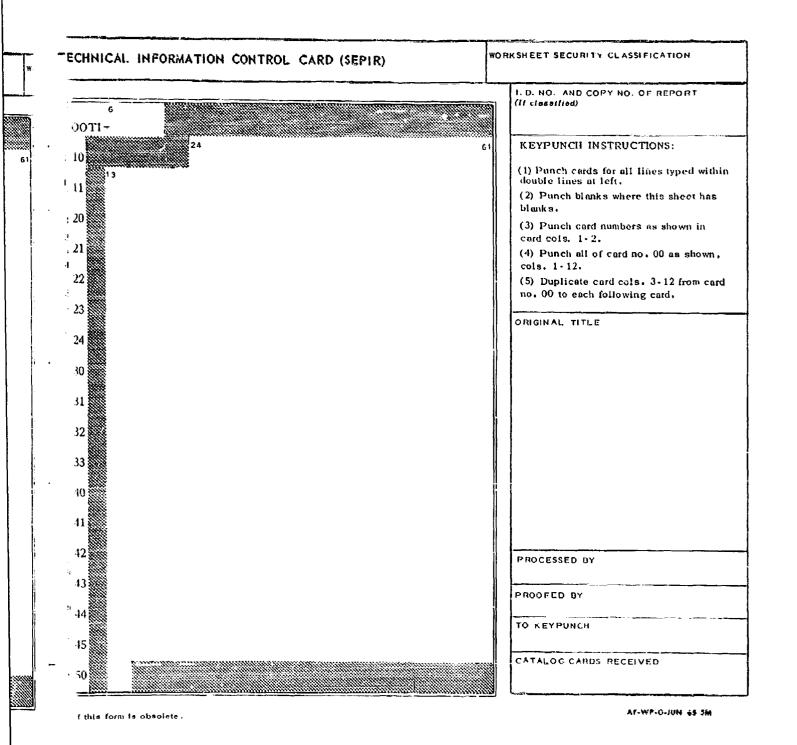
### FIGURE 4

### SEG Worksheet

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G Worksheet



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APL Worksheet

THE JOHNS HOPKINS UNIVERSITY APPLIED PHYSICS LABORATORY DOCUMENT LIBRARY

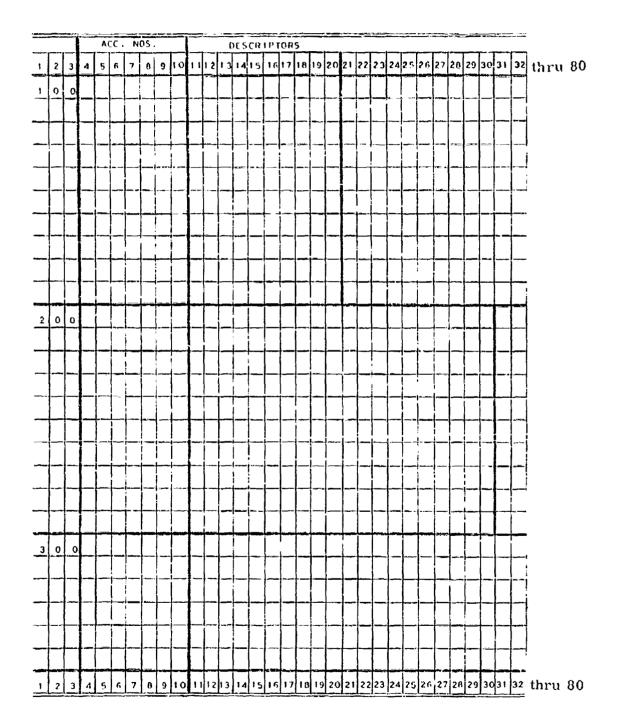
APL Document Library Form Ho II ITEV, MAY 1984

INFORMATION RETRIEVAL SYSTEM PRELIMINARY INPUT FORM

ACCESSIONS No.	### Ch		
		** (2)	
SOURCE			
REPORT		AD No	** (4)
TITLE & AUTHOR		PERIOD COV	/ERED
FAGES	DATE	CONTRACT No	**
ABSTRACT			**
DESCRIPTORS		· · · · · · · · · · · · · · · · · · ·	
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### NWL Worksheet (New System)

TECHNICAL LIBRARY DESCRIPTIVE WORKSHEET Nºw-Nal-5070/21 (9-65)



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and the indexer supplies descripted data on a tracing slip. The object of these shortcuts is (1) to cut down on processing time by relieving catalogers of unnecessary duplication, and (2) to clearly present the data to the keypunch operator.

### 3. DATA TRANSCRIPTION AND EDITING

### (1) Data Transcription

The media employed for transcription of the input data into machine-readable format are as follows:

- Panched cards (e.g., NWL, APL, SEG)
- Paper tape (e.g., FTD, NPS, Ft. Detrick)
- Combination of 1 and 2 above (e.g., NOTS, NOL).

In both the examples noted for 3 above, the indexing descriptor data resulting from the subject analysis are separately prepared for the system. Even in the cases in which only one input medium is employed, the indexing is accomplished separately by a specialist.

### (2) Data Editing

The input data are then proofed and edited by obtaining a listing and checking the data against the worksheets. Some libraries obtain the listing by using a reader/printer. (SEG uses an IBM 407.) Others first convert the data onto magnetic tape and then obtain a listing of the data. (NWL uses an IBM 1401 as an off-line processor for card-to-tape and tape-toprinter operations.) Almost all, however, convert the data onto magnetic tape before the update run and obtain an editing printout of the data as they exist on the magnetic tape. One exception to this is NPS, who edit with their original paper data input tape. At the end of the taped update run, a list of the changes or additions is produced.

The APL Library employs a specially constructed editing printout to facilitate the location of errors. The printout, which is shown in Figure 7, consists of 100 spaces to each line, divided into 10 columns of 10 characters. Each line is also numbered vertically. This system permits the editor to locate the character number on the tape without tediously counting each character across the line to identify the error. In systems that permit replacement of a single character of an item in a record, when the record length is significant, this method

0691327621 0 1	5 * UNEY OF SEUTHAMPTO N. ENGLARI D. R-143. JRL-FN-6 0-176.° AF COMBINATIO M OF 01YGF 2 \$150N WITH EXPERIMENTIAL RESULTS FOR ALR FROM GENER AL ELECTRI C RESEARCH LABORATOR (BRAFAXIN /1960/FEAR /74555/ACC /U/10EAL/G 45/D1550C1 AFT0M/HYPF RSONEC/MOZ ZLE/FLOM/A 100M/GYVEW /RECOMBINA TTOM/ARROD THAMEC/MEA TING/MYPER SOMEC/HOZ ZLE/FLOM/A 100M/GYVEW /RECOMBINA TTOM/ARROD THAMEC/MEA TING/MYPER SOMEC/FLOM /GAS/FLOM/FLUM RECHANIC/NO NEGULIERI UM/FLOM/RE SULTS ARE PRESENTED FRUM CALCU LATIONS ON THE FFEC NATTON ON THE FLOW OF AN IDEAL DISSOCIAT ING CAS TH ROUCH A HY PERSONEC WITH DATA FROM SHORE TUBER SULLITATION ON ALR 2 USED FROM A RED NGTH DATA FROM SHORE TUBER SULLITATI VE AGREEME AT R PUBLISME D OF THE G ARCH LABORA ACTON SHOLETTS . OUNLITATI VE AGREEME AT IS FOUND D BELWEEM EXPERIMENT & RESULTS .
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4 1234567890	SEUTHANDTO EXPERIMEN /1960/TEAR /860/12180 Mequiler Mequiler Mequiler Meta FROM Dala FROM Alor FOR AL RESULTS
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Sample of an editing printout, showing numbered spaces and lines for the convenience of an editor.

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# FIGURE 7 APL Edit Printout

measurably reduces the editing time. On the other hand, the special structure of the printout makes it more difficult to read, thus slowing down the editor and increasing the probability of missing an existing error.

The following four general methods of error correction were encountered:

- Replacement of a single character of an item or term within a record le.g., APL)
- Replacement of a term within a record (e.g., BUSHIPS SHARP-LARC)
- Replacement of an entire subgroup of data within a record (e.g., NWL)
- Replacement of an entire record (e.g., NOL).

In general, it was observed that the longer the record, the more likely it was to find a finer level of replacement (e.g., a single character) employed,

### 4. COMPUTER INPUT OPERATIONS

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As indicated in the block diagram for input processing, Figure 1, the descriptors assigned to describe the input are generally checked manually at the beginning of the process. New descriptors are sometimes generated or some newly generated descriptors may be rejected at this point. Even old ones may be discarded or modified in the checking process. Most systems employ this early manual check as well as an additional check of a computer printout of the update (input) tape for the thesaurus or master dictionary. A third method of checking is the automatic comparison of input terms by the update program against the thesaurus file in memory (e.g., Ft. Detrick).

APL has demonstrated an effective way to use the computer to assist in input checking. After the new accessions data have been entered on the work tape, the tape is run off against the master dictionary. As a result of this run, a printout is obtained of all descriptors used that are not in the master dictionary. The listing is then analyzed to determine which are incorrect and which are actually new descriptors. The errors are corrected by one of the four general methods previously described. New descriptors that are accepted must then be added to the thesaurus. This is accomplished in much the same way that the new documents work tape is created. Worksheets are filled out, and the new descriptors are transcribed into machinereadable format on EAM cards. The cards are checked, and the descriptors are converted to magnetic tape where they are used to directly update the thesaurus file (e.g., NWL) or to update the thesaurus file in conjunction with the document file maintenance run (e.g., NOL).

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The number of EAM cards used to represent a document was found to vary quite extensively. The number used depends on such factors as whether natural language or coded descriptor terms are used, how many descriptors may be used, and whether or not the document record contains bibliographic data, abstracts, etc. In the original NWL system, where a maximum of 35 descriptors was allowed per document, a maximum of 10 cards (of 4 basic types) per record existed. In the new NWL system, there are 8 types of input cards, which can result in over 400 cards being input for a single document record. In the BUSHIPS SHARP-LARC System, the bibliographic file used 6 basic cards with up to 9 extensions each for a range of 6-60 cards per record. The subject matter file, which allowed 30 cards per link, could have a range of 1-700 cards per record. The SEG system has one card for each line on the worksheet, a maximum of 19 cards. Solute Includes & Constant Annual Reserved

### 5. OUTPUTS

Outputs were obtained in one of three ways:

- As a byproduct of preparing the input data
- As a result of computer processing
- By combination of the two above

An example of the first output method is provided by NOL, which produces charge cards, catalog cards, and an accessions list as a byproduct of data preparation. The descriptive cataloging of the reports is performed on a programmed Flexowriter that is coupled to a keypunch. The processing renders temporary catalog cards on a multipart paper form, punched charge cards, and a punched paper tape. Once a week, the daily punched paper tapes are printed out on the Flexowriter to produce offset-press paper masters. The accessions list and permanent catalog cards on card stock are then produced from the offset master. NOL and NPS also input the paper tape to the information retrieval system to generate a bibliographic file which is used in conjunction with the document file during retrospective searches. It should also be noted that the NWL Library, in their new system (IBM 870/7030), has switched to obtaining their catalog cards and accessions list as a byproduct of input processing rather than by computer processing as was previously done.

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The BUSHIPS LARC, NOTS, and SEG are examples of the second type, i.e., those systems that obtain their catalog cards and accessions lists from the computer. SEG obtains them by processing the input tape. The BUSHIPS LARC system obtains them from the updated master tape. This requires specifically retrieving from the master tape each item to be printed.

The main advantage in producing these items on the computer is the ability to reformat and reorder the data as needed. Also, obtaining the catalog cards and accessions list as a byproduct of the input data (e.g., NWL 870 system) can result in cards being filed sooner and accessions lists being distributed more frequently. The main disadvantage is the need for computer time and a possibly higher cost per item obtained. - मेहे : ह

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APL and Ft. Detrick are examples of the third method of obtaining outputs. Both produce the catalog cards during input preparation and obtain their accessions lists from the computer. Ft. Detrick, which collects the descriptive cataloging data on paper tape, passes the tape back through the Programmatic Flexowriter to obtain the required number of catalog cards. APL produces 3 x 5 cards on the Synchrotape machine and duplicates the required number of copies. Ft. Detrick is planning to eliminate its card catalog in favor of a printout in book form. There would be one book for each filing method previously used in the card catalog (e.g., author, title, etc.). Other libraries are using or planning to use the book form .e.g., Redstone Arsenal, NSMSES). The main advantage given for this type of catalog is that in large facilities, the catalog books can be distributed throughout. The utility of the library to the user is thus presumably increased.

### III. CONTROL OF SERIALS

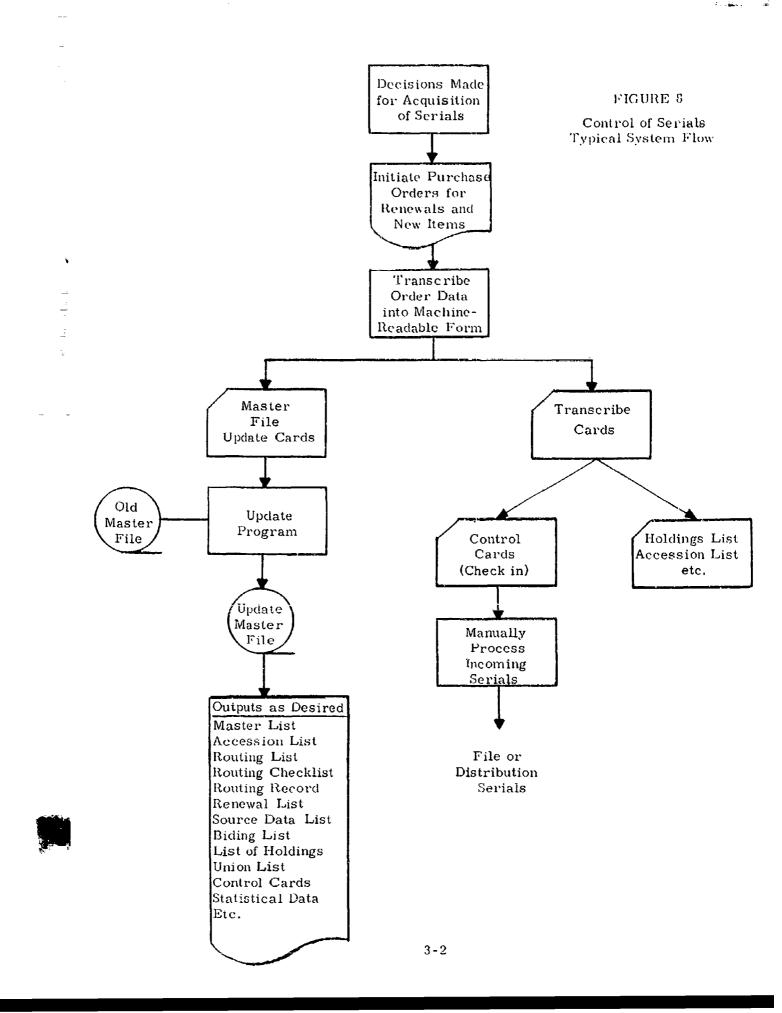
The main objective expressed by those developing mechanized serial control programs is the alleviation of the manual tasks associated with inventory control, ordering, and distribution. The mechanized programs are also typically planned to provide the tools for the publication of journal and serial holdings and the retrieval of cost, use, and other statistical data. The block diagram of Figure 8 depicts the two general types of mechanized serial control systems encountered during the survey.

The first type of system makes extensive use of the computer. All data pertinent to serials (title, source, and procurement data, publication frequency, renewal frequency, expiration date, number of copies that the library reviews, cost, routing data, binding information, etc.) are stored in a master file that is used to produce all required listings, routing sheets, and receipt control cards.

The second type is a more limited but more cheaply implemented and operated system that utilizes only EAM equipment. In this system, necessary data are kept on EAM cards which are used to process incoming serials and to generate holdings lists, renewal lists, etc. by means of a reader/printer.

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### 1. COMPUTER MECHANIZATION OF SERIAL CONTROL

Three installations, Ft. Detrick, Redstone Arsenal, the BUSHIPS, make extensive use of the computer in their control of serials. Others, like APL and NPS, maintain a master tape or master card deck and use the computer to print out a list of holdings.

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The computerized serial control system begins with the decision to subscribe to a new serial or to renew an existing subscription. All the required data on a serial are entered on a worksheet and forwarded for processing. The data are keypunched, checked, and converted to magnetic tape, which is then used to update the master file of serials. The master file is then used to produce the various outputs indicated in the system diagram of Figure 8.

To control the receipt of serials, Ft. Detrick and Redstone Arsenal produce monthly a set of cards for those serials anticipated in the following month. As each item is received, the card for that item is pulled, batched with other similar cards, and inputed to the computerized master file of serials to record the transaction and to update the holdings record, binding record, etc. The remaining cards at the end of the period then serve to generate claiming notices. Ft. Detrick also uses the data recorded on the transaction cards to publish a monthly accessions list. The BUSHIPS system, which is in a transition stage, does not employ control cards. For each serial, all the routing slips required for the

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period are printed out. The remaining routing slips form the basis for notifying the suppliers of shortages. Redstone Arsenal and Ft. Detrick also use computer-generated routing lists to control distribution. At Redstone, routing assignments for every copy of a serial are determined at computer run time. Users are not permanently assigned to a given copy number.

Redstone Arsenal prints out the periodical master file monthly and semiannually produces a list of holdings. BUSHIPS prints out the master file but does not produce a list of holdings. Ft. Detrick, Redstone, and BUSHIPS, conversely produce a list of holdings but do not print out the masterfile. All three, however, print out a renewals list that indicate those serials due to expire. Redstone Arsenal produces the periodicals list five months in advance of the expiration date, and the BUSHIPS list is categorized into renewals required in two, three, and four months. After the decision to renew has been made, Redstone produces a verification list of titles to be renewed and new titles to be ordered. As an aid in placing orders, Ft. Detrick produces a separate serial supplier list containing all logistical data required for ordering. Both Ft. Detrick and Redstone Arsenal produce binding lists.

The following paragraphs describe serials outputs that are unique to particular information facilities.

BUSHIPS produces and circulates a routing checklist twice a year that shows those periodicals the Library has available for internal routing to various Bureau Divisions, Branches, and offices for their review and study. The user checks titles he wishes to receive regularly. BUSHIPS also produces a Routing Code Record, a listing that accounts for every copy of the periodicals being received and indicates the Bureau codes to which they are being routed.

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Ft. Detrick produces a monthly First Copies List for new periodicals that gives title, issue, and date. This list is used for receipt reports and subscription payments.

Redstone Arsenal produces a monthly list of claims, by vendor, showing items not received, a yearly printout of foreign periodicals, and a monthly list showing the total active files and number of actual subscriptions by journals, services, and newspapers.

### 2. THE EAM SYSTEM OF SERIAL CONTROL

The type of system in which the periodical collection is maintained on EAM cards was encountered at HDL and Natick.

At HDL, four decks are produced, three decks of which contain one card for each title. The first deck is arranged alphabetically by title and is used for the list of holdings. The second deck is arranged

by expiration date and includes the full renewal record. The third deck is arranged by source record for renewal purposes. The fourth deck contains a card for each issue of each volume expected throughout the year. These are then arranged by month, and, upon receipt of the issue, the card is pulled and used as a circulation record. Cards remaining at the end of the month are used as a basis for claiming. At Natick, the serials are checked in on a Kardex file, and missing issues are reordered. The EAM cards are used to generate a master list of serials, a renewal list, a binding list, and a current titles checklist that is utilized by the user to check items to be continued.

Table 3 summarizes the mechanization status of serials control and outputs produced by information facilities for which individual reports have been written.

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Binding	LIST	×							×		••••	×				×	
Renewal	List		;			X	l		×	×		X				х	
Accession	List	×				×			×			×					
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Juipine	EAM		X		×					×		×		×		×	
Equipment	Com- puter	×	×		×	×	71 bay		×		×					×	
	Library	AFCRL	FITA	AFML	APL	BuSHIPS	DISC	FTD	Fort Detrick	HDL	MEL	NATICK	NMC	SdN	PICATINNY	RSIC	

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## IV. CIRCULATION CONTROL

Mechanized circulation control systems were operational in three of the facilities studied (Picatinny Arsenāl, Redstone Arsenāl, and Natick) and under development in one (NSMSES).

The functions typically included in these systems are as follows:

- Overdue item identification and production of recall notices
- . Inventory list production

- . Listings of items charged to a given borrower
- Listings of the circulation status and statistics of items.

Flow charts describing the operating systems of Picatinny, Redstone and Natick are presented in Figures 9, 10, and 11. The system planned for NSMSES uses circulation cards which are a product of the descriptive cataloging of technical reports. These cards are utilized manually as book slips. Picatinny and Redstone Arsenals keep their files on magnetic tape and use the computer to maintain the files and to produce circulation control lists. Natick, with a cheaper equipment complex, keeps the information on punched cards and uses a sorter and reader/printer to produce recall notices.

Comparing the Redstone and Picatinny systems, the flow diagrams of Figures 9 and 10 show that Picatinny begins by requiring the requester to fill out a library request card. The card is then checked by the librarian, who adds any additionally required information to the card (e.g., accession number of a particular report) and then has it keypunched. Redstone keeps prepunched cards in its books; these are duplicated, and the borrower's identification and the date due are added. Picatinny punches the data on the card before finding out whether or not the item is on the shelf and then must route the card to the keypuncher again to record whether the item has been put into circulation or should be marked for reserve. Redstone does not utilize reserve cards or keep reserve information in its system. a second as the public of the second se

Both Redstone and Picatinny produce two circulation lists, one arranged by call number of item and the other by borrower identification (Redstone by borrower's name, Picatinny by borrower code number). Picatinny also produces a reserve list and individual monthly statements informing the user of items charged out to him.

NSMSES has under development a punched-card-oriented system for control of circulation. The intended system operation is as follows:

A manual record of all documents borrowed during a 24-hour period will be kept by the clerk at the checkout point. This will show the Julian date for that day, the accession number of the document, and the serial number and department number of the borrower.

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When a document is returned within 24 hours, the charge will be deleted by scratching through the entry in the record. At 4:00 p.m. each day, the checkout record for the previous 24 hours will be picked up and taken to the data processing group to be put on EAM cards. The next morning, two cards for each transaction will be filed manually, one by employee badge number and one by document accession number.

As documents are returned, the cards will be removed from the file. A 30-day loan or control period is assumed. Cards will be sorted mechanically each day by Julian date, and the data processing group will make a weekly sort for overdues and will print out in triplicate a list showing accession number, borrower's number, and department number.

## FIGURE 9

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# Picatinny Circulation Control System

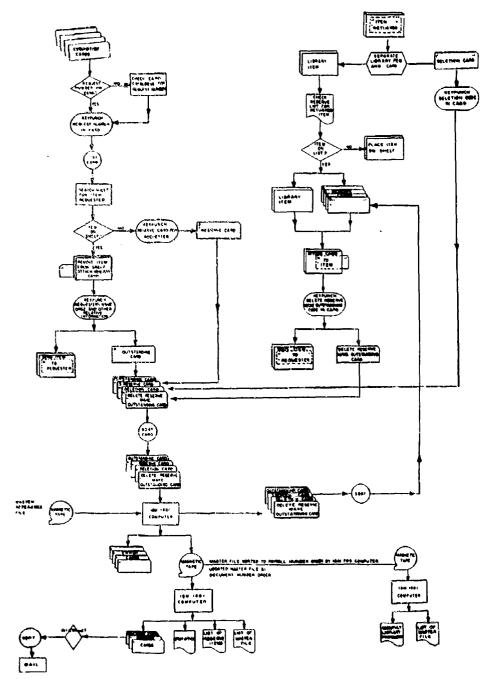
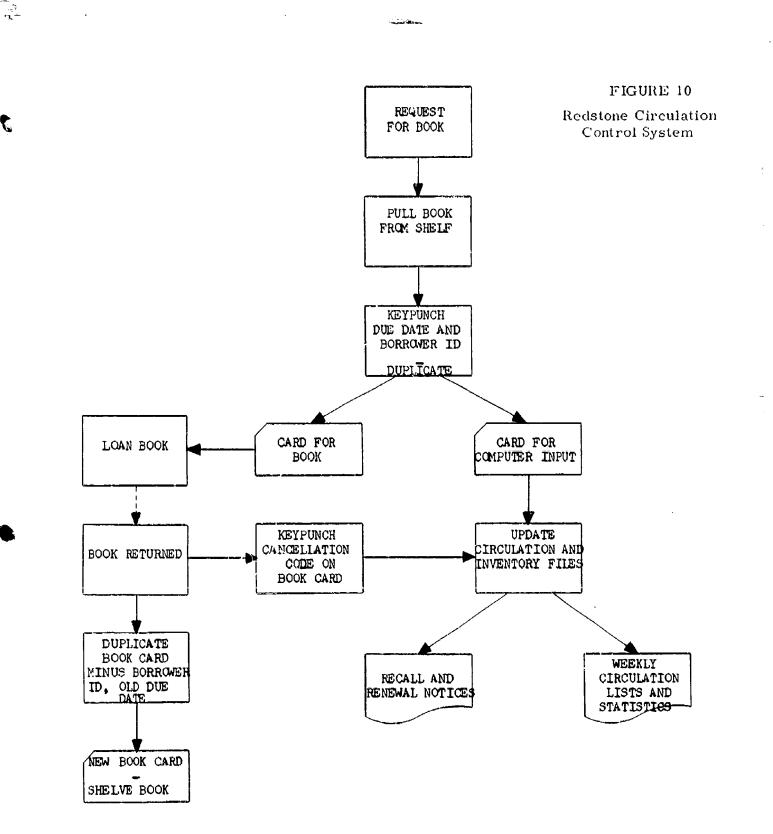
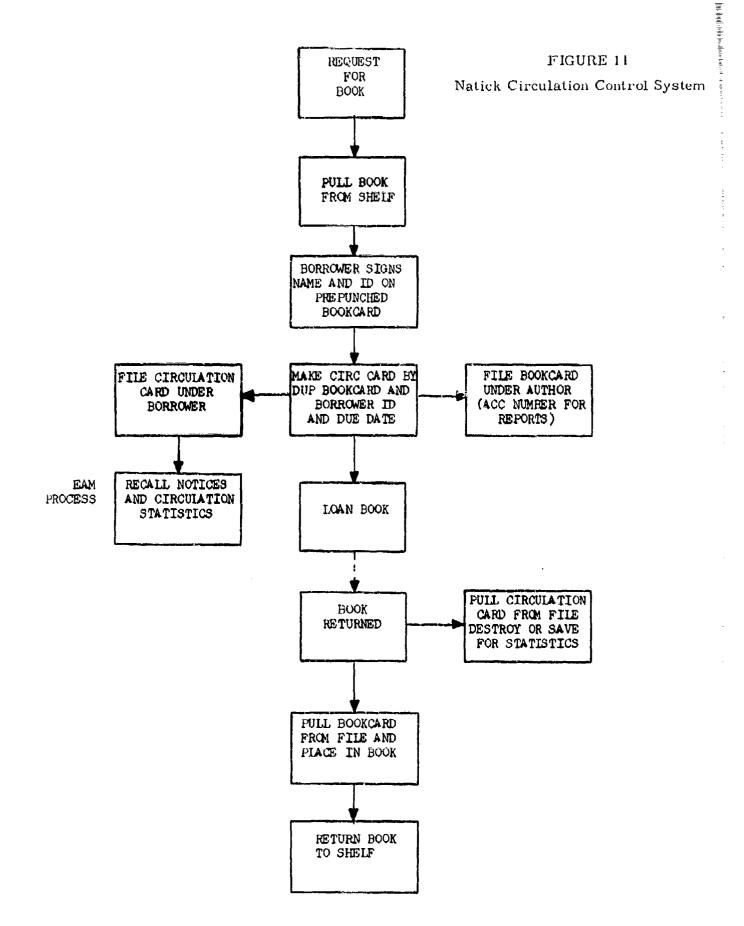


Figure 1: Circulation control flow chart



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#### V. THESAURUS GENERATION AND USE

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In all of the mechanized systems studied a vocabulary "thesaurus" was utilized for subject indexing. The thesauri encountered varied from a simple alphabetic listing of subject terms to complex generic structures (hierarchical) with scope notes, cross references, and "see" and "see also" references. Some of the thesauri encountered were for manual use only, even though computer techniques were used. Others were stored in the computer memory where they were used for the automatic assignment of codes and for detecting errors in input updating and search query formats.

Indexers and reference and retrieval staffs of the information facilities are the principal users of thesauri. In these instances, the user or search requester approaches the reference or retrieval staff with his problem, and the staff member consults the thesaurus for the terms to use in query formulation.

In contrast to this procedure, the permuted and coordinate indexes are examples of a sort of thesaurus that has been developed primarily for the use of the information requester. The purpore of these indexes is usually to permit the user to develop his own search query and to perform his own search without having to work through the retrieval staff member.

A wide variety of thesauri were encountered in this survey. A summarization of the more significant types is presented in Table 4, and these are further discussed in this section.

#### 1. THESAURUS DEVELOPMENT AND USE

In the development of a vocabulary thesaurus, the facilities studied in this survey typically accumulated their initial terms from material being cataloged. In some facilities, however, these terms were added to a vocabulary base consisting of portions of the DDC and/or the EJC thesauri. In either case, this somewhat uncontrolled accumulation of terms soon required the establishment of controls restricting the addition of new terms and implementing a review of existing terms and their meanings. Scope notes and cross-references were also introduced, and terms were grouped and segregated into various structures. This general pattern was not unusual even in the cases of facilities that based their thesauri on those of DDC and EJC, such as Recon Central, NUWS, and NAFI.

In many instances, the facilities found the exclusive use of generalized thesauri, such as DDC's and EJC's, to be unsuitable for their needs because of variations in term meanings and a lack of sufficient detail in their fields of interest. (For example, one who deals with strategic information might consider satellites as a

Facility	Number	Arrangement	Codes	Links
	of terms	of terms		Ro
AFML	10, 000	Hierarchical	Numeric	Link
APL		Hierarchical	Alphabetic	Not l
ASDIRS	600	Hierarchical	Not Used	Not l
BuSHIPS		Hierarchical	Alphabetic	Both
Defense Logistics Studies Information Exchange	2, 000	Hierarchical	Not Used	Not U
Edgewood Arsenal	9, 500	Hierarchical	Numeric	Links
FTD	7, 000	Hierarchical	Not Used	Not U
Fort Detrick	10, 000	Hierarchical	Not Used	Not L
IRIA	140	Hierarchical	Alph. &Num.	Not U
Naval Missile Center		Hierarchical	Not Used	Not U
Naval Ordnance Lab	22, 000		Alphabetic	Not U
Non-Destructive Testing Information Center	400	Alphabetic	Numeric	Not U
Naval Posigraduate School	8, 000	Alphabetic	Alphabetic	Nume
NSIMSIES		Alphabetic	Not Used	Not L
NUWS		Hierarchical	Not Used	Not
Naval Weapons Laboratory	3, 000	Alphabetic	Alphabetic	Not U
RACIC		Hierarchical	Numeric	Not U
Recon Central	8, 000	Alphabetic	Numeric	Not U
REIC	18, 000	Hierarchical	Numeric	Not l
PLASTEC		Alphabetic	Numeric	Not U

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## SUMMARY OF REPRESENTATIVE THESAURI

и 15	Codes	Links and/or Roles	Scope Notes	Used in Computer Memory	
125 1750 - 1	Numeric	Links	Used	Yes	
	Alphabetic	Not Used	Used	No	
e	Not Used	Not Used	Not Used	No	
C	Alphabetic	Both	Used	No	
	Not Used	Not Used	Not Used	Nö	
6	Numeric	Links	Not Used	No	
	Not Used	Not Used	Used	Yes	
e	Not Used	Not Used	Not Used	Yes	
e	Alph. & Num.	Not Used	Used	No	
e	Not Used	Not Used	Used	No	
e C	Alphabetic	Not Used	Not Used	Yes	
	Numeric	Not Used	Not Used	No	
C.	Alphabetic	Numeric	Not Used	No	
i	Not Used	Not Used	Not Used	No	
i (	Vot Used	Not Used	Used	No	
le	Alphabetic	Not Used	Not Used	Yes	
se.	Numeric	Not Used	Not Used	No	
e.	Numeric	Not Used	Not Used	No	
SC	Numeric	Not Used	Not Used	No	
e e	Numeric	Not Used	Not Used	No	



political-geographical entity, while another might think of it only as an orbiting object in the astronomical sense ) These two shortcomings are the primary reason for the lack of enthusiasm about efforts to develop a common, comprehensive thesaurus.

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Thesauri were developed by contract, by the information facility's staff, or by technical specialists in the specific subject areas. Examples of contract-developed thesauri may be found at NSMSES, Edgewood Arsenal, Ft. Detrick, and Dugway Proving Ground. (One thesaurus was developed by a contractor to serve both Edgewood and Dugway.) In the majority of the libraries surveyed, the library staff itself generated the thesaurus. Technical specialists were employed in thesaurus development by most of the information centers.

Only two of the facilities studied had utilized a thesaurus developed by another facility. NWL originally adopted NOL's thesaurus of descriptors and codes, and NAFI combined the BUSHIPS SHARP listing with several others as a basis for its own thesaurus.

The introduction and use of scope notes with a thesaurus was generally thought to be an important development, particularly as a system grows. Scope notes assist in identification of the exact term to use in indexing and in formulating a query for mechanized retrieval. If a thesaurus is to be stored within the computer's memory, however,

the scope notes may take up an uneconomical amount of space. Some facilities (e.g., NOTS) avoid this problem by including in the mechanized thesaurus a cross-reference to scope notes actually contained in a manual card file.

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## 2. THESAURUS CHARACTERISTICS

Generally, the thesauri surveyed were hierarchical term lists arranged by subject categories. Some also had the terms arranged alphabetically. (Among facilities that use the hierarchical type of thesaurus are APL, FTD, Ft. Detrick, Defense Logistics Studies Information Exchange, Edgewood Arsenal, Dugway, BUSHIPS, and AFML.) Facilities with large collections of information on weapon systems or chemistry usually have larger thesauri than other facilities because individual identifiers, compounds, etc., are included in the system.

Activities using permuted indexes usually substitute these for thesauri, although "see" and "see also" references are often built into these indexes (e.g., HDL, OPTEVFOR).

The majority of the thesauri studied were stored on punched cards and were not maintained in computer memory. Most of the facilities that store the thesaurus in the computer memory do so for two reasons:

(1) To detect errors in term usage as it appears in the computer input format in file updating and search routines. In this case, the computer automatically compares the incoming terms to the stored thesaurus and, if an invalid or misspelled term appears, it is printed out in an error listing.

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(2) To automatically assign codes to the input terms for computer manipulation. This feature relieves the system operators from working in other than the natural language form of the terms. Besides assigning the codes, the computer also automatically decodes the terms if they are to be listed in the output after processing.

The depth of indexing for both manual and computer-based systems generally ranges from 4 or 5 terms per document to 25 to 30 terms; however, some facilities in the chemistry field used 80 to 130 terms for some documents (e.g., Edgewood Arsenal). In AFML's system, fewer than 4 or 5 terms are assigned to each document. Above this number, the computer automatically posts to higher terms in the structure.

There has been a trend away from the use of codes to represent thesaurus terms, except when assignment and translation of codes is done automatically by the computer.

Standard subject headings are used in the technical libraries in the cataloging of books and indexing of periodicals. In the information analysis centers, where portions of books or individual periodical articles are indexed, descriptors are used.

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Links are used at BUSHIPS, AFML, and Edgewood Arsenal and are considered valuable. Roles have been dropped at the facilities that used them (BUSHIPS and AFML) because of lack of utility. (In the Wright-Patterson and DuPont studies, it was found that the use of roles actually decreased the possibility of retrieving certain documents.)

Some of the facilities (e.g. Edgewood Arsenal) perform statistical reviews of term usage to eliminate unnecessary words and to substitute new terms with narrower meanings for overworked terms.

#### 3. EXAMPLES OF THESAURUS

Table 4 (page 5-3) summarizes significant characteristics of a representative sample (21 facilities) of the thesauri encountered in the survey. Detailed information on these thesauri may be found in the individual facility reports and as follows:

(1) Bureau of Ships

BUSHIPS has applied the EJC method in the development of their thesaurus. In the course of thesaurus development, they also considered the FROLIC method as proposed for the David Taylor Model Basin but decided that the EJC method provided a comparable indexing depth and flexibility without the complexity of FROLIC.

The descriptors in the BUSHIPS thesaurus are used in the form of seven-character alphabetic codes. The thesaurus is arranged hierarchically and includes synonyms and scope notes.

The thesaurus is maintained on the computer, where it is used to detect input errors.

#### (2) Recon Central

Recon Central uses a keyword listing of 8,000 descriptors consisting primarily of single words with a few double- and triple-word descriptors. Each descriptor is assigned a fourdigit numerical code which is used to identify the descriptor in storage and retrieval operations. The keyword list is made up partly of FTD, DDC, and NASA keywords. The descriptors were selected independently of the actual document collection; therefore, some of them may not yet apply to any of the present collection. The thesaurus is not maintained in computer memory.

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## (3) Infrared Information and Analysis Center

A Dictionary of IRIA Category Numbers has been established which consists of approximately 140 descriptors in hierarchical arrangement. Each descriptor is assigned a three-digit code for storage and retrieval processes. Also, a <u>Dictionary of Code Words</u> has been compiled which includes alphabetic codes, words, scope notes, and meanings. The code words are assembled into compound descriptors of a maximum of three words and are used to describe the content of the document being indexed. The usage of the code words within the document being indexed is defined by the category numbers.

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IRIA's thesaurus is not maintained in computer memory.

## (4) Naval Ordnance Laboratory

NOL uses a thesaurus of descriptors with alphabetic codes, the latter made up of four-letter combinations. Early plans to use links were abandoned. It was found that a larger number of compound terms were needed than were originally anticipated to keep improper selections to a minimum. There are 22,000 descriptor codes in the thesaurus; 7,500 of these are for subjects, and the remainder cover equipment, trade names, projects, geographical locations, corporate authors, and other areas. The

maximum length of the descriptor list is limited by the size of the computer memory to 32,768 words.

The thesaurus is maintained on the computer and is used to detect input errors.

#### (5) Defense Logistics Studies Information Exchange

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> The Exchange set out to develop a glossary of indexing terms acceptable to all DoD agencies. The DoD definition of logistics was used as a basis for the glossary, which is now structured to five hierarchical levels.

Originally, no limit was placed on the number of terms, and no restrictions were placed on the terms to be used. Now, however, terms must be selected from the glossary, and new ones may be added only after careful consideration. Early in 1965, a detailed study was made of the glossary, and nearly all second-level terms were eliminated. Terms that receive only occasional usage will be studied for elimination. Currently, there are about 2,000 terms; definitions will be added in the future.

## (6) <u>Army Study Documentation and Information Retrieval</u> Service

ASDIRS originally based their thesaurus on the ARMITERM thesaurus. Term definitions are being added as the thesaurus

develops. There are currently 600 terms in the thesaurus; on the average, 10 to 15 terms are assigned to each document. The thesaurus is not maintained in computer memory.

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#### (7) Air Force Materials Laboratory

The AFML thesaurus was established on the basis of terms derived from documents in the indexing process. Twelve or thirteen terms are assigned to each document. Synonymous terms were placed under the same machine codes from the beginning of development. However, in a study performed at AFIT, roles were found inferior in utility to links. The use of links showed a reduction of irrelevant information by over 56 percent, while incurring less than 5 percent loss of relevant information. The AFIT study recommended the dropping of roles at AFML.^{*} While compound terms are used freely, only one link per term is listed.

The use of many specific terms, especially in organic chemistry, had increased the thesaurus to between 45,000 and

* Complete results of this study are given in An Evaluation of Links and Roles Used in Information Retrieval, AD606192, Technical Documentary Report No. ML TDR 64-152 July 1964, AF Materials Laboratory RTD, AFSC, Wright-Patterson Air Force Base, Ohio.

50,000 terms To control this expansion, a fragmentation system was developed for organic chemistry and other specific areas that resulted in a reduction in the thesaurus to 10,000 terms.

The thesaurus has a hierarchical arrangement and uses numeric codes and scope notes.

A version of the thesaurus, consisting of a basic file of valid descriptor terms with numeric codes, is maintained on the computer to correct input errors.

#### (8) Nondestructive Testing Information Center

The Center uses an alphabetical listing of 400 terms which is available for manul tuse by indexers and information requesters. Terms are added as the need arises.

#### (9) Applied Physics Laboratory

APL followed the free vocabulary approach until June 1965, when terms in use were reviewed for inclusion in a formal thesaurus. The thesaurus is about one-third complete and upon completion will have two sections: an alphabetical listing of terms (nonhierarchical) including their meanings, synonyms, alphabetic codes, use information, and related terms; and a list of field structures with a modified COSATI listing of categories.

## (10) Foreign Technology Division

FTD's thesaurus is arranged hierarchically in 56 subject areas. It is maintained on the computer, where it is used for checking input errors. Scope notes are included in the thesaurus, although these have been reduced by about 15 percent. COSATI subject categories are used in information dissemination and accessions listings.

## (11) Ft. Detrick

The thesaurus, which was developed under contract, was an empirical development resulting from a search of the open literature, the document index process, and interviews with Ft. Detrick staff members. The thesaurus has been published in three parts. Part 1 is a complete listing of descriptors with codes, in hierarchical arrangement; there are up to nine descriptors in a hierarchy. Part 2 is a condensation of Part 1. Part 3 is a straight alphabetic listing of all descriptors with codes. There are approximately 10,000 descriptors. The thesaurus is maintained in computer memory and is used for detecting input errors.

## (12) Naval Postgraduate School

NPS's file of descriptors is maintained on punched cards, and new descriptors are added as necessary. There are 8,000

terms in use at present. Alphabetical listings of terms are used together with a uniterm code number.

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## (13) U. S. Naval Underwater Weapons Research and Engineering Station

A thesaurus is being developed. In the meantime, DDC's thesaurus and COSATI listings are being used.

#### (14) U. S. Army Natick Laboratories

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DDC's thesaurus is used in conjuction with Natick's own subject authority file.

#### (15) Plastics Technical Evaluation Center

PLASTEC uses a maximum of eight precoordinated terms per document. An alphabetical printout of previously used terms forms the thesaurus. New terms may be added as necessary. Terms are coded for information storage and retrieval.

When a term is used in more than 25 documents, precoordinated term groups are created to reduce term usage and to increase specificity. Coordinated terms are connected by a hyphen and arranged in the printouts by the first term of the pair. The higher-order term, which is generally a property or useoriented term, is placed first in the pair. A list of style rules has been developed to assist toward consistent indexing. PLASTEC's thesaurus is not maintained in computer memory.

### (16) Naval Missile Center

NMC uses DDC's thesaurus, with added terms as required. A maximum of five descriptors is assigned to each document. A printout of descriptors used in any one year is made as desired. The NMC's thesaurus is not maintained in computer memory.

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#### (17) U. S. Naval Ship Missiles Systems Engineering Station

The keyword thesaurus used by NSINSES is NAVWEPS DD 24650, 2nd edition, prepared for NSMSES by a contractor who will continually revise the thesaurus. A keyword may consist of several words; since such groups may not fit into the space available, the thesaurus contains abbreviations for them derived from the actual documents and from MIL-STD-12B.

A keyword listing is printed monthly from the master file of the retrieval system. (There is no separate thesaurus maintained on the computer.) A maximum of four keywords may be assigned to a document.

## (18, 19) Battelle Memorial Institute--Radiation Effects Information Center, Remote Area Conflict Information Center

Clue words underlined on extract cards are the basis of Battelle's indexing system. These clue words are not subject headings or keywords from a pre-established thesaurus but are words

which, in the opinion of the specialist or scientist performing the review, provide the best clues to the content.

REIC's clue word list contains about 18,000 words at present, and about 1,000 new terms are being added each year. They are numerically keypunched on EAM cards, coded, and filed by hand in a card file that is manually updated continuously as new clue words are reflected. Filing of the cards is by code number.

Each clue word used in RACIC's files is keypunched on an EAM card. Also punched on cards are card sequence number, a clue word classification number, and the higher-order hierarchical clue word file into one of the following six general subject areas: biological science, chemistry, electronics and communication, mobility, social studies, and weapons. RACIC is experimenting with a coordinate index of clue words with accession number crossreferences established by links.

#### (20) Edgewood Arsenai

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A word list of 12,500 terms was reduced by a contractor to 9,500. The basic thesaurus was developed during two nonconsecutive one-year contracts. In the first contract, an attempt was made to remain compatible with the DDC thesaurus, but this approach resulted in 40,000 terms including identifiers. The thesaurus

has been reduced to a compilation of terms used at Dugway as well as edgewood. Additions are generated from indexing. Based on use frequency counts, infrequently used terms have been dropped, and words used very frequently are reviewed for further breakdown. correct contraction of the

The thesaurus is not maintained in the computer memory. A hierarchical format is used. Links are used although they are not considered worthwhile on the 35,000 items now in the collection. The Library believes they might be helpful when the collection grows to around 100,000 items.

#### (21) Naval Weapons Laboratory

The NWL thesaurus, containing 2,500 to 3,000 descriptors and approximately 3,000 identifiers, was based originally on NWL's four- to six-letter code listing. New terms are reviewed for potential importance. Codes are being dropped, and natural language will be used in NWL's second-generation systems. A computer printout of descriptors and descriptor codes is made as required. The thesaurus is maintained in computer memory to detect input errors.

#### VI. FILE STRUCTURE

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Two general classes of files were encountered: serial and inverted. The great majority of facilities studied utilize the inverted file in their search process and then resort to a serial file, often offline on punched cards, to print bibliographic information corresponding to retrieved accession numbers.

In the serial (direct) file, all information relating to documents is stored in an ordered sequence, usually by alphabetic or numeric characters (accession number, LC number, etc.). Access to all information pertinent to a specific document is gained by locating in mass storage the block containing the correct unique identifier (accession number, etc.).

In the inverted file, such as the traditional card catalog of authors or subjects, items are filed in batches under the subject headings, descriptors, or authors. There are also various combinations of these basic file structures that have been developed in specific cases.

The selection of file structure is critical to a library's operation. File structure can greatly influence the following:

File maintenance effectiveness

Retrieval effectiveness

- Staffing needs
- . Growth capabilities
- . Resource requirements.

Simpler and cheaper file updating and maintenance is generally possible with a serial file structure. Updating information can be sorted by accession number and the appropriate file information blocks located and updated in simple sequence. Maintenance of inverted files is more complex, since the updating information pertaining to an accession numbered entry must be entered under each term to which the entry is indexed. However, file search is generally much faster using the inverted file. hi aliga i gan dhonoo

#### 1. <u>SERIAL FILE</u>

The common method of searching a serial file is to examine it record by record and to check for the presence of the required des riptor or descriptor combination assigned to each document. In its simplest form, the criterion for rejection of an item is the absence of at least one of the required descriptors.

The chief drawback to this method is that, although the probability that any given item in the file will be relevan to the query is quite small, every item in the file must, nevertheless, be examined. The factors that make this exhaustive approach at all practicable are the high processing speed and memory capability of the computer. These characteristics permit the combining of a number of queries so that only one pass through the file is needed for the several queries.

A scheme is employed at NOL which reduces the amount of file that must be searched. In NOL's approach, document records are grouped serially in a rough sort by common characteristics, and these characteristics are identified by a binary code. NOL's strategy is to separate extraneous material as quickly as possible and then to screen promising material at finer and finer levels of discrimination until only relevant material remains. The method is based on comparison of data in the single field of binary digits making up the grouping code and rejection of the unwanted items on a statistical basis.

The essential feature of this method is the assignment of a random pattern of bits (1's and 0's) to each descriptor in the dictionary. The number of 1's placed in each pattern is adjusted to be proportional to the discriminating power of the descriptor. Terms with a high frequency of occurrence offer little selectivity, so drey are encoded with relatively few 1's, and vice versa. The pattern for the totality of descriptors that have been assigned to one particular document is formed by superposing the patterns for each individual descriptor. Similarly,

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the pattern assigned to the batch (up to six documents per batch) is formed by superposing the patterns for each document. The query patterns are formed in a similar manner.

During a search, each of the batches is successively compared with the list of query patterns. Unless the binary field of the batch code contains a 1 in every position where the query has a 1, it will be rejected. If a match occurs, then the next level of screening is performed, which is to compare the code of each of the documents in the batch against the query pattern. Again, only those documents that pass this screening go on to the next level, which is to compare the individual query terms against the document terms. Thus, the final result is a list of just those items that are pertinent to the query and no others.

The extent to which the above variation overcomes the input/ output limitations imposed by the series file structure was not quantitatively determined by the survey. This technique, however, when combined with strategic storage of records based on frequency of use of descriptors, could result in significant savings of computer time.

#### 2. INVERTED FILE

The usual method for searching an inverted file is to first determine all of the accession numbers that pertain to each descriptor and second to determine if a given accession number appears the proper number of times to satisfy the Boolean criteria (AND, OR, NOT operators). The result of such a search is a list of accession numbers which must then be related manually or automatically to another file (a serial file) to obtain corresponding bibliographic information, abstracts, etc. The latter file is usually maintained on EAM cards or other media external to the computer in order to avoid using a large amount of memory space for what is usually only a printing operation. The Ft. Detrick search scheme is typical of this type of approach.

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The main disadvantage of searching only the inverted file is that it limits the search to descriptors. Other items of interest, such as bibliographic information, keywords in the abstracts, titles, etc., cannot be searched automatically. The solution for this is to increase the variety of files, but this approach complicates the programming and the system operation. A particularly difficult situation arises when several different types of information facilities are compelled by economics to utilize the same general retrieval program. Examples of this situation are the University of Michigan analysis centers (IRIA, VESIAC, and BAMIRAC) and the Electronic Properties Information Center. EPIC has rejected the use of inverted files for its generalized retrieval program planning because of the lack of versatility in search

criteria.

## 3. FILE ELEMENTS

Another aspect of file structure, which affects computer search and update time and compactness of the files, is whether or not the document file should contain subject data (descriptors), bibliographic data, and abstracts. The APL Library is an example of a system that stores all three together for each document. NWL in its original system included subject and bibliographic data and in its new system is adding abstracts. NPS and NOL exemplify libraries that maintain separate subject and bibliographic files. In these systems, the bibliographic file is only searched for documents that were called out during the search run on the subject file. FTD maintains a coded subject file whose search output lists the document numbers of the hits obtained. While the approaches varied, most of the facilities studied believed that, at the minimum, bibliographic data should be included in the search output.

## VII. STORAGE AND RETRIEVAL

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### 1. <u>SYSTEM FUNCTIONS</u>

The basic functions of a mechanized retrieval system are defined,

for the purpose of this analysis, as follows:

- . Communication and refining of the request
- . Conversion of the request to machine-readable form
- . File search
- . Analysis of retrieved material
- . Preparing the response and communicating it to the requester.

The block diagram of Figure 12 depicts a typical retrieval system flow.

### 2. COMMUNICATION OF THE REQUEST

Initially, the request for information is phrased in the user's language. The question may be transmitted verbally or in written form and may be formulated with or without the assistance of an information facility staff member. In most facilities surveyed, however, the assistance of a member of the facility staff is usually employed in formulating requests for information. The staff member analyzes the request, discusses it with the requester, and finally structures the query or queries into the most suitable form.

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#### TYPICAL RETRIEVAL SYSTEM FLOW FIGURE 12

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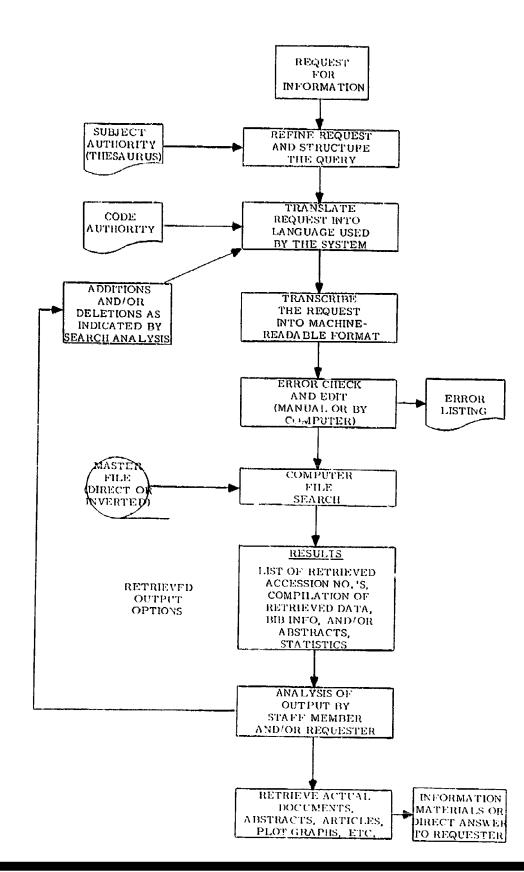
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The formulation of a query commonly involves the filling out of a query worksheet. One such worksheet (NWL) is presented in Figure 13. This one allows the actual question to be entered on the form. Most worksheets require only the subject descriptors and qualifying information (e.g., limits on date of publication of pertinent documents), as shown in Figure 14 (NPS), or are tailored for machine data conversion (Edgewood--see Figure 15). The refined question is entered on the worksheet using subject descriptors, qualifiers, a link and role relationship, logical operators, etc. A thesaurus is generally used at this stage to obtain the correct terms for translating and for checking for synonyms, abbreviations, etc.

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### 3. CONVERSION OF DATA TO MACHINE-READABLE FORM

Before the query data can be entered onto some standard input media, such as punched cards or paper tape, a formatting step is usually necessary. Although some facilities (e.g., NPS) have arranged to use a portion of the query formulation worksheet (see Figure 14), the majority require a new worksheet (the program coding sheet) as shown in Figure 16. In some cases, the staff searcher and query coder are different members of the staff, with the latter being more familiar with the mechanized system.

### FIGURE 13

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NWL Query Worksheet

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# FIGURE 14 NPS-Query Worksheet United States Naval Postgraduate School MONTEREY, CALIFORNIA

MACHINE INFORMATION RETRIEVAL APPLICATION TECHNICAL REPORTS and CLASSIFIED MATERIALS SECTION 12ND P88 73 (1-66)	United States Naval Postgraduate Sobool MONTEREY, CALIFORNIA
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Document Search Request (STINFO) FIGURE 15

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PROGRAMMER J. P. CUMMINGS

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The Johns Hattins University APPLIED PHYSICS LABORATORY

: 7090 SYSTEM blic Coding Form

FIGURE 16 APL-Query Worksheet

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After coding, the query is punched onto cards or paper tape, checked for errors, and then applied to the computer for conversion to magnetic tape. Commonly, a printout of the query data as they appear on tape is obtained for checking and editing.

4. <u>FILE SEARCH</u>

The computer may now check each query for validity (format, consistency, etc.), check the descriptors against the master dictionary (thesaurus), and combine the queries of a class into one integrated search which is then used to examine all the records in the master file. The conclusion of the file search is usually an output tape containing the retrieved data, which is then taken off-line for listing. The off-line step is used to avoid tying up the computer for a simple print operation of a bulk file of, say, EAM punched cards containing detailed bibliographic information. (Types of files and associated retrieval schemes were discussed in Section VI of this report, File Structure.)

The output data are formatted in as many ways as there are retrieval systems. Only one installation, FTD, reported making any extensive analysis of user requirements in determining the quantity, type, and format of the output data. In general, the following types of output listings are produced:

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- A summary list containing the number of hits found for each query (see Figure 17)
- A coded list that contains the accession numbers of all hits found for each query and may also contain other coded data (see Figure 18)
- A list that contains bibliographic data for each accession number listed and sometimes additional information such as abstracts, descriptors, etc. (see Figure 19)

A list of numerical data.

5. ANALYSIS OF RETRIEVED MATERIAL

Regardless of the form of the retrieved output, the staff searcher or the user must analyze the information in order to determine its relevance. This task becomes quite difficult if the retrieved output form contains only a listing of codes or accession numbers. In such a case, the card catalog must be searched, or the document itself must be analyzed--a time-consuming process. Thus, from the standpoint of the analyst and user, a search output should also consist of titles and, if possible, abstracts. This sort of listing permits a browsing process that is an efficient version of that done in a card catalog.

If a searcher feels that the information he desires is not in the output obtained due to too-restrictive search or improper query, or if too much data have been produced because the query was too general, be can rephrase the question and search the file again. A mechanized

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FIGURE 17

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APL- Search Output

SUBMARY OF RESULTS

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DENTIFICATION	MAXIMUM	OF HITS
JPC.1	0	1983
JPC+2	0	0
J2C+3	0	130
JPC 4	0	585
JPC.5	0	306
JPC+6	0	183-
JPC.7	0	502
190.8	o	971
J9C+9	0	1060]
JPC.10	0	734
JPC - 11	n	18841
J-1C.12	0	9591
JPC+13	0	180
J°C.14	0	2261
JPC.15	0	1471
100.10	0	5531
JPC.17	0	10761
320.13	0	1421
J*C. 19	0	5141
J6C • 50	0 -	45881
190.21	0	8471
JPC . 22	0	3591
197.1	999	231
520.1	900	181
5 0.2	200	21
52043	200	391
3/ 1+1	200	24
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OUTPUT 1 - ACCESSION

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FIGURE 19

APL-Search Output

105789 UNCLASSIFIED

POLYTECHNIC INSTITUTE OF BRUJKLYN, DEPARTMENT OF AEROSPACE EN-GINEEKING AND APPLIED MECHANICS. RPT. PIBAL+R-615, AFOSR-64-1786.

A MUMENT METHOD FOR COMPRESSIBLE LAMINAR BOUNDARY LAYERS AND SOME APPLICATIONS, BY P.A. LIBBY AND H. FUX. SEPTEMBER 1964., AF-AFOSR-1-63.

AN INTEGRAL METHOD BASED ON MOMENT TECHNIQUES AND ESPECIALLY USEFUL FOR COMPRESSIBLE LAMINAR FLOWS IS PRESENTED. THE DESCRIPTING PARTIAL DIFFERENTIAL EQUATIONS ARE FIRST TRANSFORMED TO THE LEVY-AND THEN CONVERTED TO INTEGRAL CONDITIONS WITH NU LEES VARIABLES TO THE THE M POWER AS A WEIGHING FACTOR. A TECHNIQUE FOR HANDLING THE VARIATION IN TRANSPORT PROPERTIES WHICH EXPLICITLY ARISES FOR M GREATER THAN O IS DESCRIBED. THE RESULTANT EQUATIONS ARE APPLIED FOR M = C, 1 WITH THE COMMONLY EMPLOYED FOURTH AND FIFTH DEGREE POLYNOMIAL PROFILES FUR VELUCITY AND STAGNATION ENTHALPY. THE DISTINCT CLASSIFICATION OF SIMILAR AND NUNSIMILAR FLOWS WITHIN THE SAME ANALYTIC FRAMEWURK IS EMPHASIZED. THE ANALYSIS IS APPLIED TO VARIETY OF FLOWS FOR WHICH MORE ACCURATE RESULTS ARE AVAILABLE Δ AND IS FOUND TO YIELD SATISFACTORY RESULTS IN MOST CASES. THERE-FORE, THE PRESENT METHOD IS CONSIDERED TO IMPRUVE SUMEWHAT THE CUNVENTIONAL INTEGRAL METHOD (M=D) WITHOUT EXCESSIVE LABOR. (AU-THOR).

/+LIBBY/+FUX/1964/YEAR/105789/ACC/U/≃AF-AFOSR-1-63/.PT9/ /COMPRESSIBLE/LAMINAR/BOUNJARY/LAYER/MOMENT/TECHNIQUE/FLUID/ME-CHANIC/INTEGRAL/SULUTION/TECHNIQUE/WALL/EXTERNAL/FLOW/CONDITION/ NONSIMILAR/FLOW/AL-FLUID/ system in which only minutes are required to rephrase a question encourages the repetition of in-depth searches until the desired information has been obtained. A manual system would soon discourage both the user and the reference librarian.

6. COMPARISON OF RETRIEVAL FUNCTIONS

The following paragraphs compare the functions encountered in the retrieval systems surveyed. Table 5 summarizes this comparison.

(1) Search Query Formulation

The basis for formulating a search query is the specification of descriptors which may be related with the Boolean connectives AND, OR, NOT, EQUAL, etc. The use of connectives appears to be the most confusing aspect of mechanized retrieval. The range and usage of logical and pseudological operators varies widely from no usage (excluding the intrinsic AND requiring all descriptors to be included for a match), as in the NPS system, to the approximately eight connectives utilized by APL. APL is very consistent in their use of connectives, although this tends to cause errors in coding.

NWL uses an AND/OR key in which the descriptors on any one query card are all AND related, and AND/OR relationships may exist between cards. However, this query technique is limited

Key: C=Card Catalog P=Planned

LIBRARY	Stora	ige Equip	ment	Docu	nber of ments in		tions per		Mo	ies per onth
	Com-				val System	Total	Current	Expected	Current	Expected
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		Sensed								
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AMS Repromats	_			110, 000						
APL	x			18K	8K					
ASDIRS	ļ	X	X	ļ						
BATTELLE	Manu	al Card	File				·			Į
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CAMERIDGE	X				L					
Defense Logistics	x			6 K	1,5K					
Info. Exchange										
DISC			<u>X</u>	600BKS						
Edgewood	X		<u> </u>	35K	•••••	 	_25%			
EPIC	X					ļļ				
Fort Detrick	x									
FTD	x			40K	60K-70K	 				
HDL	X		<u> </u>			┣────┤				
Mechanical Prop. Data Center	x		<u>x</u>							
Naval Postgrad School	х		х	25K	≤ 5K	300			25	
NOL	x			70K	20K				200	
Non-Destructive	+									
Testing Center		x								
NOTS	x		x	66K			25%			
PICATINNY	x			7K		<u>├</u>				
PLASTEC	x			7K		├───╂				
REDSTONE			- · ·							
TPRC	x		<u> </u>							
University of Mich.						┝───╊				
Info. Centers	x		x							·

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Best Available Copy



Table 5 Storage and Retrieval

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Expected		Natural	Used for Input Checking	Inverted		Catalog C/B	Acc. List	Charge Cards		Acc# and Code	Sear Biblio- graphy	Abstr.	Des					
		x	X		x	-c	x			x	<u>x</u>	x	x					
	<u>x</u>	x		X		В	x		x	x	x x	x						
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to a total of three cards. Thus, where lengthy descriptors are used (provision is made for "type 3" descriptors, which are 21 to 40 characters in length) so that only one or two descriptors may be entered on a single card, multiple queries for the same question must be made up in order to employ the logical operators. The following table indicates the usage of the AND/OR key to satisfy the relationships expressed between the cards.

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Condition	a second se	<u>Keypun</u>	ching* Card 3		
One Card only	0				
Card 1 AND Card 2	1	1	-		
Card 1 OR Card 2	0	0	-		
Card 1 AND Card 2 AND Card 3	1	1	1		
Card 1 AND Card 2 OR Card 1					
AND Card 3	1	0	0		
Card 1 OR Card 2 OR Card 3	0	0	0		
Card 1 AND Card 2 OR Card 3	1	1	0		

Other information facilities (e.g., FTD and Ft. Detrick) also use "MUST" terms. A "MUST" term must appear with one or more of the other terms requested in order to qualify as a hit.

A one (1) signifies a punch, zero (0) means leave blank, dash (-) means not applicable

FTD also uses "qualifiers" in the retrieval program. A requester can "qualify" a query by date, country, classification, type of document, number of term hits, and others.

Ft. Detrick combines its "MUST" relationship with such qualifiers as all documents having x or more of the set of descriptors listed in the query. In general, the following types of search questions may be accommodated by the computer program for retrieving document references contained in Ft. Detrick's Retrospective Search File:

- (AEC, ... n)--a request for all documents having all descriptors, A and B and C, etc. (maximum of 20) appearing together
- (X, D, E, F, ..., n)--a request for all documents having x or more (maximum of five) of D, E, F, etc., appearing together. For example, if x is given by the requester as 2, then the request is for at least two of D, E, F, etc. (i.e., D and E, or D and F, or E and F, or D and E and F)
- . (-I, J,...n)--a request for documents <u>not</u> having descriptors I or J or n appearing
- (-x, K, L, M,...n)--a request for documents not having x or more (maximum of five) of K, L, M, etc., appearing together as in the second item above.

The above criteria may be assembled together as desired, but only in an AND relationship. For example, the specification (A and B and C) AND (2 of D, E, or F) is allowable, but (A and B and C) OR (2 of D, E, or F) is not allowed in a single search. The latter specification would require two independent searches, the first excluding the second specification, and the second excluding the first. Note that multiple searches, since they are recorded independently, may result in redundant selections.

Edgewood Arsenal employs three Boolean operators: AND, BUT NOT, and OR. The last may be used with only two terms. However, the operators are not applied until the end of the file search. That is, the search produces accession numbers that relate to all descriptors without regard to the operators. The queries are then reconstructed to determine what Boolean relationships exist in each query, and the output file is evaluated and edited against these relationships.

Performing this operation at the end of the search, however, requires assembling and then working with another file, which adds more input/output time to the process. Systems such as Edgewood's are normally input/output limited; i.e., tape-handling time far exceeds the time required for the computer to process the data, and the computer must then sit idle while inputing or outputing the next record to or from tape. Consequently, considerable time is spent in producing and working with a tape of document hits, many of which must now be discarded. Two tests of the Edgewood system operation have shown that approximately

9 and 11 hours have been required for search runs of 60 and 89 questions, respectively. This ratio is greater by a factor of approximately 10 than that of most other systems encountered.

Discussions with the programming staff at the Arsenal have indicated that the main problem was the program requirement for extensive repetition of data associated with the reformatting of the search question. It is expected that rewriting this part of the program will result in a time saving of 40 to 65 percent. However, although this is a considerable improvement, the running time is still greater than that being achieved by most others. A contributing factor may be the computer--a Honeywell 400-which is a medium-speed, small-core machine.

It should be noted that only 15 percent of the document collection of approximately 25,000 is presently included in the file. To handle the enire collection, a new system approach may be necessary, especially if a more powerful computer is not available.

(2) <u>Computer Availability</u>

The availability of computer time, and consequently the response time for a search, varies widely. At NOL, computer time is made available daily during prime hours. At APL, searches are normally accomplished overnight but at times must be extended

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to two days because of unavailability of computer time; at NPS it takes two days for a requester to receive his bibloigraphy. Lack of computer time availability and the low priority assigned to the Library is causing Redstone Arsenal to think in terms of weekly searches when it inaugurates its technical documents retrieval system. TPRC is installing a radio-teletype circuit with the computer area located several miles away. TPRC's opinion is that much more time is spent in mailing and processing a request, delivering and receiving materials to and from the computer, and communicating the answer than is spent in computer running time,

(3) Combination of Queries for Frocessing

As a part of their programming technique, all installations combine queries into one search list, so that a file can be searched in one pass. However, the number of queries that can be combined in a single search operation varies from a low of 10 on one file at FTD to 5,000 descriptor/role pairs on the BUSHIPS SHARP-LARC System. The most common limit is around 50 queries. In most retrieval programs, the combined and reformatted queries list is held in core during file scanning; therefore, core limitation was the most quoted response to the question of what determined the size limitation of the search.

(4) Thesaurus Check by Computer

An additional item found in many search runs was a check of the coded or natural language descriptors in the query against the thesaurus. Because an incorrect descriptor (either erroneously spelled or coded or nonexistent) would normally prevent any document from responding to the query, such a check is a valuable part of a search run. The limited number of evaluations conducted on existing retrieval systems reveal that a relatively high number of errors occur at facilities where descriptor codes are used (e.g., BUSHIPS Project SHARP--Evaluation of Indexing Procedures and Retrieval Effectiveness, NAVSHIPS 250-200-3). This is one of a number of factors that prompted a switch to natural language by BUSHIPS and NWL in their new systems. The use of natural language decreases input errors and is also more amenable to computer error detection techniques, particularly because a coding error often produces another valid (although incorrect) code,

(5) <u>File Processing and Information Retrieval</u>

One of the few areas of agreement encountered during the survey is the need to provide the requester with something more than a list of accession numbers that satisfy the query. A typical method is to provide bibliographic data as part of the search output for each query. Some, such as Edgewood Arsenal, do not as yet

provide bibliographic data. The only output data currently available to the requester are the accession numbers of the documents found.

Ft. Detrick maintains an abbreviated bibliographic file that contains the title and author (corporate and personal) for each document. This file is used to add bibliographic information to the list of retrieved accession numbers following the output of the retrospective search run.

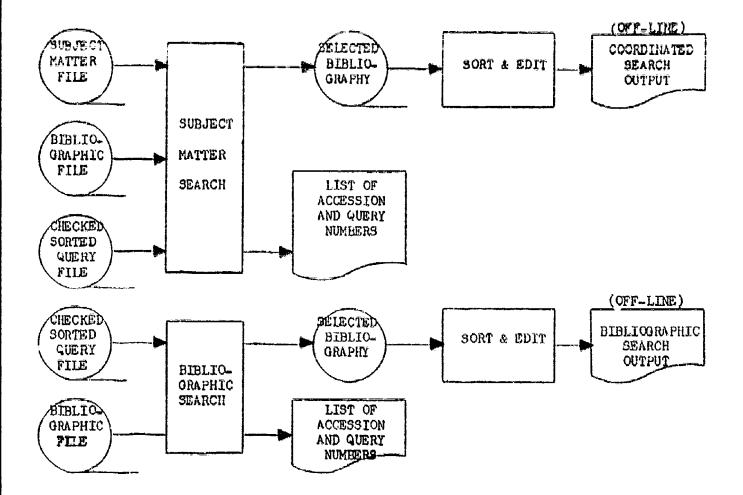
NOL has added a more inclusive bibliographic file to its original system, which includes title, source, author, date, number of pages, and contract number. As yet, this file does not contain entries for all documents in the subject file; therefore, two outputs are produced. First, a coded output is produced which contains the query data, accession numbers of hits, agency, date, classification, and the four most important descriptor codes for each hit (see Figure 18). Then the output file is run against the bibliographic file, and a combined output is produced containing query data and bibliographic data for each hit for which data exist in the bibliographic file.

The APL system, on the other hand, provides accession number, full bibliographic information, abstract of the document, and all associated descriptors for each selection (see Figure 19).

An option is also available that limits the number of selections to be printed out. Each document entry in APL's serial file contains all data pertinent to it.

Another difference being employed by APL is a scheme by which it is possible to obtain the number of hits that would be generated for a query without getting a printout of the hits. By using this scheme, it is possible to phrase a query on various levels to determine the amount of data available before asking for the actual data. The benefits of this are partially undermined by the loss in time, since it is now necessary to wait for the next time the computer is available in order to obtain the document data desired.

Some libraries separated subject matter and bibliographic files, as was briefly discussed in Section VI, File Structure. Adaptations of this method are employed by NPS and BuShips. In these systems, the bibliographic file is mounted along with the subject matter file. As hits are scored on the subject matter file, the bibliographic file is stepped to the same accession number of the hit, and the bibliographic data are simultaneously recorded. In addition to this coordinated search, the BuShips system allows for an independent search on the bibliographic file if this is desired. The simplified block diagram below depicts the new BuShips retrieval system.



(6) Permuted and Coordinate Indexes

1. Permuted Indexes

In a permuted index, titles of documents are listed in alphabetic order by title keyword, each title bring listed as many times as there are keywords in it. In order to prevent words of no index value from being listed, a predetermined group of words of this class (e.g., applications, work, the, to, etc.) are set in the computer program for permutation suppression. Permuted indexes are produced and used at HDL and SEG, and one is in development at NAFL.

HDL's index publication, known as the ABC Dictionary. is printed from an updated master tape file of titles and/or concept statements. The latter are assigned to each document processed by staff analysts and are based on the use of important keywords. A sample page from the Dictionary is shown in Figure 20.

Copies of the Dictionary are maintained in the Library for manual reference by both users and library staff. The Dictionary provides a means for searching the document file. The user scans the Dictionary for the desired term or terms (in much the same way he would scan a card catalog arranged by subject terms) and obtains desired document reference codes from it.

2. <u>Coordinate Indexes</u>

A coordinate index is a listing of keywords (descriptors) with corresponding document references such as accession numbers. The searcher looks through the index for the accession numbers that appear under all of the keywords he wishes to "coordinate". A sample search would be

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ALE	292		ALYSIS OF PHASE DISTORIION+ CONTROL NO FA TAMAISISTOR Alastation constructions of paretizations and of the	-FREQUENCI CURVERSALIUM OF UNITATIONALISION AND UNITATION AND UNITATI	TRETTON IN BILANCED AND UNBUL ANCED CLASS-AB PUSH-PULL	I ITY EDUATION FOR DIFFERENT TYPES OF FRANSISTOR YOLIAGE	ARD AND RE	EL-0100ES+ = MEGATIVE-RESISTANCE	PERFORMENCE OF PARAMERAIC-DEUDULS+ 1N ZUIVEL DEODES FOUTUREDEDEDE	A STOCKING THE STAND AND AND TO THE STOCKING THE STOCKING THE STAND AND AND AND AND AND AND AND AND AND	DEVICE AND ANALYSIS OF FB NEGATIVE	HIGH-FREQUENCY-TRANSISTUR F9, PNZ AS ESCILLATOR OR	FAEE-SUNNING AND PULSE	ENT OF TRANSISTOR* PARAMETERS AND EQUIVALENT-CIRCULT FOR	PUT = CONSTANT SEMPERATIONE UNE-TRANSISTOR	POHER-SUPPLY, CHEPPINE DSCILLATOR AND TUVED	0%5%68+ =	CE () 80+03 = 0.11 - 0.11 - 0.10 - 0.10 - 0.10 - 0.11 - 0.	DIAD OF TOTAL CONTOURNEY	ELEC FROCARDE	HALL-EFFECT PJLTIPLEER USING FELUBACK	UNDUSTAILL PREPAREDUESS-STUDY. FOR DEVICE T. FBX.3	PHASE-SENSITIVE S-STAGE TRAUSISTOR HOXDOVKE-IVPE AC	TATES AND	CONTRACTOR OF AN ANALOSIS OF ANALOSIS OF ANALOSIS OF AN ANALOSIS O		TENPERATURE-STABILIZATION+ CF IRANSISTOR	DESIGN OF A COMPUTENTIA AND TAMENTA DISIRIEULEU	DESIGN CF RESISSANLE-LOUFLED INAVISSISSANLED INAVISSIS	INTERPOLATION CONTRACTOR INTO A CONTRACT INTO A CONTRACT ON A CONTRACT O	- THREE-STACE CASCADED	1 1 1 1 1 1 1 1 1 1 1 1 1 1 1 1 1 1 1

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HDL Permuted Index

<u>ultrasonic</u> welds in <u>missiles</u>, i: which the searcher would select those accession numbers that appeared under all three keywords. Coordinate indexes are produced and used by REIC at Battelle, by NOTS, and by NSMSES. An example of REIC's list is shown in Figure 20. This list is printed twice, and both copies are bound together in one volume. This is a convenient arrangement which permits the searcher to simultaneously look at two terms, one for each list, to determine if an accession number appears under both.

A mechanized form of coordinate index uses cards with drilled-holes and a means for optical sensing commonly referred at as the "peek-a-boo" system (e.g., the Termatrex system of USAMRA and the Keydex system of Recon Central). This system utilizes plastic cards, each representing an index term from the thesaurus. Each document number that carries the index term is represented by the position of a hole in the card. Documents are retrieved by superimposing the index term cards for all terms in the query, observing the coincident holes, and then reading the X and Y coordinates of the holes.

FIGURE 21 REIC-Coordinate Indes

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Each card can handle a 100 x 100 matrix and therefore has a capacity for 10,000 documents. The advantages of this system are its relative simplicity, quick availability, and comparatively low cost. In addition, reading errors are reported to be rare. ſ

VIII. SELECTIVE DISSEMINATION OF INFORMATION

The basic purpose of a Selective Dissemination of Information (SDI) system is to discriminately inform users of new acquisitions in their areas of interest by means of the same basic principle used in retrospective searches, i.e., search by subject content. By previously establishing the user's subject interests (referred to as a user profile) and applying these to the subject description of new accessions, specific new arrivals of potential interest to the user can be identified. The user can then be advised of, or have routed to him, only those items that are relevant to his indicated areas of interest. In addition, the facility can accumulate statistics for its SDI operation that will form the basis for the following:

- A better understanding of information needs of the various jobs
- . A better definition of the areas of research
- . A method of identifying individuals with mutual or similar interests

Four of the installations studied had SDI systems in operation. These were Ft. Detrick, HDL, APL, and FTD. Two other SDI systems were in various stages of development at BUSHIPS and SEG. The systems used at Ft. Detrick and FTD will be described as representative of the group.

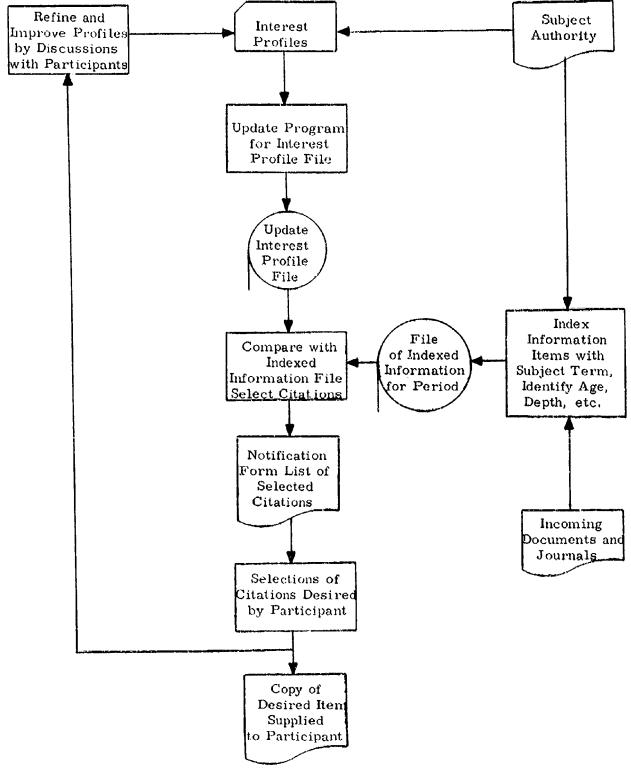
Figure 22 presents a generalized flow chart of an SDI system applicable to both Ft. Deterick and FTD. The significant aspects include the following:

- . The interest profiles
- . A means for updatin the interest profiles to keep them current and responsive
- . A means of subject-indexing incoming materials compatibly with profile development
- . A mechanized means for comparing profiles with the new material index terms
- . A notification and/or circulation scheme
- Provision for feedback to maintain the viability of the system and the satisfaction of the user.

1. FT. DETRICK SDI SYSTEM

At Ft. Detrick, each participant develops and submits his own interest profile. The profile consists of the participant's name and address, up to 10 languages of interest, and any number of subject interests, using up to 400 medical subject tags to describe an interest. This profile may be updated at any time with additions, changes or deletions. In order to refine the participant's interest profile so that a useful selection of citations can result from it, the Information Division spends a considerable amount of time in personal conference with the individual and in keeping records of what notifications he

FIGURE 22 Selective Dissemination of Information System



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received, what he wanted, and why. The success of the SDI system as measured by the satisfaction of the user appears to depend heavily upon such personal treatment. -

The profile interest tags of all users are run against a tape of medical citations specially prepared for Ft. Detrick by the National Library of Medicine. The result is a printout on 3 x 5 cards of selected citations for each user.

The selection of citations employs a system of "weights" in which "weighted" numbers are assigned to each of the user's profile interest tags. In the descriptor tag versus profile interest tag match in a citation, the preassigned weights of the matched tags are summed. If the sum equals or exceeds 10 (a program constant), then the citation is listed for the individual's attention. Certain tags may be listed as MUST OR NOT, and, in this case, the indicated action is taken without regard for weight. If a match is found and the tag is a MUST, the citation will be selected regardless of weights or percent of matches. If a match is found and the tag is a NOT, the citation will be bypassed. The NOT operation overrides all other considerations, including the MUST.

Formerly, the MAY method was also a selection option, but it is no longer used because of its relatively poor discrimination. The MAY method determines the citation descriptor tag versus profile interest tag match as a percent of either the total number of descriptor

tags per document or profile tags per individual, whichever is less, and compares this percentage to a percentage factor that has been predetermined by the participant. If a percent figure higher than this factor results, then the citation is listed for the participant's attention.

Once a citation has been selected on the basis of a particular interest, it will not be matched against any other interests for the same participant. Thus, the notification cannot be selected twice. (If a participant's entire profile contains more than 400 tags, it is possible to make more than one selection of a citation, since in this case the program would make a second search of the citation file and would not keep track of citations selected during the first search.) Should a citation meet the selection criteria for only one interest of a participant, only the tags of the interest causing selection will appear on the notification card.

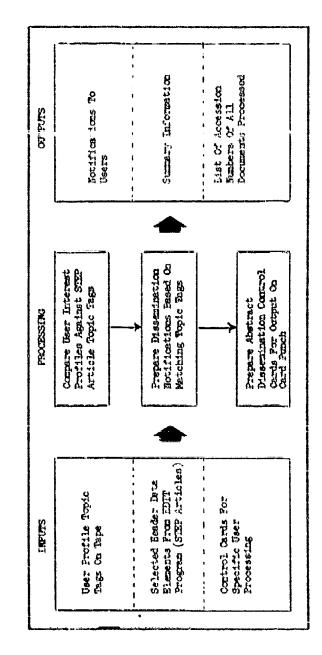
2. FTD SDI SYSTEM

Selective dissemination of information at FTD is performed by two methods. In the first method, a group of accessions lists supplied monthly make up the notifications. Separate accessions lists are produced for each subject area, and the user is sent those lists for the subject areas indicated in his profile. In the accessions list, the data under each subject are grouped by input type, which enables the

user to rapidly select and use only the information that is of value to his present work. The level of information contained in the accessions list includes accession number, title, author, source, descriptors, and references. The second method shown in Figure 23 is concerned with the dissemination of information by the FTD system, better known as the Central Information Reference and Control (CIRC) System. All of CIRC's dissemination is semiautomatic (i. e., it is computer supported) and depends upon the existence of very specific and very detailed user profiles. The user profile is a list of topic tags, or descriptors, that describes the scope of a user group's interest. All dissemination is based upon unit profiles. It was discovered that individual profiles contained duplication and that it was more economical to have a profile serve a unit rather than an individual. Such a unit may be comprised of from two to ten individuals working on closely associated subject areas. From experience, it was found that a unit profile averaged approximately 1,000 precoordinated topic tags. The system has been running for about one year and is currently serving approximately 70 user groups throughout the United States.

Semiautomatic dissemination at FTD is accomplished in several ways. One is profile-controlled notification. This method is used for

FIGURE 23 FTD SDI System



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users who prefer to be kept aware of information that is responsive to their areas of interest but do not wish to have the actual materials automatically sent to them. These people receive a notification once a week that consists of the bibliographic level of information on each article that came into CIRC which fits their use pattern and which is responsive to their profile.

Other users prefer proxy dissemination, in which case they receive the abstract or extract of each document responsive to their profile. Some users prefer to receive both, because the notification is easy to screen and the proxies are useful as references.

It was found necessary to provide each user group with a control for volume and specificity. These user groups vary from just a few people to dozens of people, so that the capability to assimilate raw data varies considerably. The machine criteria that determine what shall be sent to a specific user can be varied by a clip level in the program, and a different setting can be applied for each user group. With respect to specificity, there is a feedback program, primarily automatic, which makes small demands on the users on a routine basis.

Figure 24 presents an excerpt from a weekly notification. Note that an asterisk appears after some of the topic tags. This informs the user that the article was called to his attention because these topic

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tags occurred in his profile ("sounding rockets" and "stmospheric sampling"). If the user so desires, these topic tags may be deleted from his profile, or other topic tags may be added.

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FIGURE 24 Weekly Notification

Before June 1965, notifications were prepared on standard printout paper. However, since that time a change has been made to card stock (one card per notification) which provides the recipient with notifications that can be filed in a standard, manual file box under the indicated subject headings. This new method facilitates retrospective scarching of materials selected for the user by the seminutomatic dissemination program.

There is a quarterly, automatic review of a user's profile. The machine prints out the user's profile, and next to each word a number is printed that indicates how many times that word was useful in obtaining an article for the user. Although accurate data could not be acquired, the cost of SDI systems is obviously high. Whether this can be justified in terms of reduced effort on the part of the user and higher relevance and increased quantity of material disseminated is highly questionable. User satisfaction with SDI systems appeared to vary widely. È

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IX. EQUIPMENT

This section discusses several mechanical aids, other than computers, encountered during the field surveys that are used for retrospective searching and information materials processing. This is not, however, a comprehensive review of available equipments. Such general reviews may be found in the sources listed in the bibliography section.

Included in the discussion of each equipment is a detailed description of its application and some of the special advantages and disadvantages experienced. In addition, a summary of computer equipments employed by each facility in their mechanized processes is given in Figure 25.

Since the devices relate primarily to either retrospective search functions or materials processing functions (e.g., catalog card production), the following section organization has been established:

Equipment for Information Storage and Retrieval

Termatrex and Keydex ACCESS Filesearch

FIGURE 25

Summary of Computer Equipments Used by Surveyed Facilities

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Facility	Computer Type			
AFCRL	1BM 7044, PDP-1			
AFIT	IBM 1401			
Army Map	Univac 1004, Honeywell H-800			
ASDIRS	IBM 1401, 7090			
APL	1BM 7094, 7040			
BATTELLE	CDC 3400			
BuSHIPS	IBM 7094, LARC			
Lifense				
Logistics	RCA 501			
DISC	Univac 1004			
Edgewood	Honeywell 200			
EPIC	Honeywell 200, G.E. 635			
FTD	1BM 7094, 1401			
Fort Detrick	Univac SS II-90			
Harry Diamond	IBM 7094			
Materials	NCR 301			
Mechanical Properties				
Data Center	IBM 1440			
MEL	IBM 1401			
NAFI	Burroughs 280, G.E. 225			
NATICK	G. E. 225			
Naval Missile Center	IBM 7094, 1401			
Naval Post Craduate				
School	CDC 1604			
NOL	IBM 7090			
NOTS	IBM 7094			
NSMSES	IBM 705, 1401			
NWL	IBM 7090, 1401			
Picatinny	1BM 7090, 1401			
PLASTEC	Honeywell 1401			
Redstone	IBM 7010, 1401, 1460			
SEG	IBM 7094, 7044			
TPRC	IBM 7094			
Un. of Mich. Info.				
Center	IBM 1401			

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Equipment for Materials Processing

Crossfiler EDITOR-I IBM 870 Document Writing System

1. EQUIPMENT FOR INFORMATION STORAGE AND RETRIEVAL

(1) <u>Termatrex and Keydex</u>

1. General Description

The Termatrex¹ and Keydex² systems belong to a class of equipment that utilizes coordinate indexing techniques via the "peek-a-boo" method of visual term coordination. In the visual coordination method, one vocabulary term is assigned to each of any number of term cards. These cards are made of tough flexible plastic material about 9-5/8 x 11-1/2 in size. On each card, holes are drilled in identifiable positions to represent information references (e.g., accession numbers) that relate to the specific term. A term

¹ Jonker Business Machines, Inc., Gaithersburg, Md.

² McBee Systems a Division of Litton Industries, Athens, Ohio

card has space for 10,000 references, each of which may be uniquely identified by using a grid overlay to determine the vertical and horizontal coordinates. Thus, one such system has a capacity of 10,000 information sources, although this limit can be increased simply by adding more independent card files. the first state of a first state of the first state

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To retrieve information from the system, the user selects cards corresponding to his desired index vocabulary terms and superimposes them all together over a card-sized light source. If a reference contains all of the selected terms, its representative holes on the term cards will coincide, permitting light to shine through. Coordinates of the lighted holes, then, identify the retrieved references. A search might proceed as in the following example:

Assume a search is to be made for information concerning the utlrasonic testing of welds in missiles. Three cards are selected: "Ultrasonics," "Welds," and "Missiles." The "Ultrasonics" card contains holes representing all of the information sources dealing with ultrasonics in the system; "Welds," all the information concerning welds; and

"Missiles," all information concerning missiles. By overlapping "Ultrasonics" and "Welds," the light shines through only at those locations that identify documents which contain information on both ultrasonics and welds--probably in the relationship of ultrasonic testing of welds. Note that references dealing with only one of the terms are excluded. By overlapping "Missiles" on top of the preceding two cards, only those references pertaining to ultrasonic testing of welds in missiles coincide and are therefore selected. Further refinements are possible. Steel welds in missiles can be selected by simply adding the card for "Steel." "Ultrasonics" can be replaced by "X-Ray" for search in another direction, and so forth.

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Two or three minutes are said to represent a typical time for conducting a search.

Both the Termatrex and the Keydex equipments consist of a precision drill and a file of plastic cards containing special identifying features such as tabs, colors, and edge notches. Holes are made in the cards with the precision drill, which

is movable on two axes to the appropriate coordinates.

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Coordinates are determined by a 100 x 100 grid. Accession number 1427, for example, corresponds to a hole in the 15th row and the 28th column. A warning device may be included with the drill to reduce errors resulting from out-of-sequence drills. Color filters may be used to indicate, for example, abstracts (green) and classified documents (red) by drilling holes in the filter card corresponding to all documents that do not apply. Thus, if a document is classified, no hole exists for it in the filter; light shining through coincident term card holes and the filter card appears red.

The Termatrex and Keydex systems differ in one significant feature. Termatrex term cards are filed in some pattern and located in the file by means of the tab on each card. Keydex term cards, on the other hand, do not have tabs, are usually filed randomly, and are located in the file by means of passing a needle through the margin holes in the fashion of the well-known McBee Keysort process. With both Termatrex and Keydex equipments, it is possible to obtain peripheral equipment such as optical readers that will automatically punch EAM cards or paper tape, automatic term card punches that operate from EAM card readers

and thus copy EAM punched cards, gang punches for reproducing several identical term cards simultaneously, etc.

As stated earlier, the capacity of a complete system is 10,000 information source references corresponding to an equal number of hole positions on each term card. In order to accommodate a larger number of references, as many card file systems are necessary as there are multiples of 10,000 references. Term cards belonging to up to 10 different systems may be identified by a scheme of punching the edge of the card in a specified position. This, however, does not relieve the user of the necessity of conducting separate searches in each system; that is, cards from one system cannot be intermingled with cards from another system for a common search.

The chief advantage of the visual coordination system derives from its characteristic of immediate visual identification of holes belonging to references containing coinciding terms. However, the drilling process and the later determination of the coordinates of drilled holes have been reported to be tedious and error-prone processes if many holes are involved and if the only aid is the grid overlay.

2. Application

A Termatrex system is used by the Nondestructive Testing Information Analysis Center.

Recon Central has developed a retrieval system based upon the Keydex equipment with two files of term cards. The information sources are usually in the form of document abstracts which are stored on unpunched aperture cards. The system provides a search requester with lists of retrieved abstract accession numbers with corresponding document titles, and, if desired, enlarged copies of the selected microfilm chips. The system consists of the Keydex equipment and peripheral equipment including an automatic term card reader and an EAM card reader, both of which are capable of operating a Programmatic Flexowriter for printouts. The EAM cards are used to provide title information corresponding to the retrieved information source code numbers from the term cards. $\| (\alpha + (1 - \beta + \beta)) \|$

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3. Cost

<u>Termatrex System</u>: The Nondestructive Testing Information Analysis Center purchased their Termatrex equipment in 1961 for \$3, 600.

Keydex System: Recon Central purchased their Keydex equipment and the peripheral equipment in 1961 and reported the costs as follows:

Friden Programmatic Flexowriter Automatic Keydex Card Reader \$20,000 EAM Card Reader

Keydex System \$ 9,500 Miscellaneous Copiers and Viewers

4. Comments

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Recon Central is generally pleased with the operation of its system and has pointed out that it represents about one-tenth the investment of a fully computerized system giving the same performance. The Central has further commented that the system as presently constructed meets the main requirements of getting information into the hands of the requester in time to be useful; i.e., full response time is less than one week.

Other forms of the "peek-a-boo" system have been developed using different term card formats (including EAM card formats), but a discussion of these is beyond the scope of this report.

(2) The ACCESS System

1. General Description

Recon Central is currently considering an alternative system that can be used in coordinate index applications,

ACCESS Corp., 4632 Paddock Road, Cincinnati, Ohio

called the ACCESS System. This system utilizes cards that are edge-notch-coded and provided with magnetic tabs. In the selection process, an operator presses keys on the system's calculator-size console corresponding to a set of terms to be coordinated. When all of the term codes have been entered, the system's selector automatically raises a tray of cards to contact an energized electromagnet and then lowers the tray, leaving all of the cards attached to the electromagnet. The previously selected keys then cause rods to press down on the cards, pushing away all cards not having corresponding notches (i.e., coordinated terms). The rejected cards fall back into the tray, and the selected cards may be removed for identification.

The ACCESS System has three basic units: a keyboard console, a card notching device which is controlled from the keyboard, and a selector unit. The selector holds a tray of about 1,350 cards; up to 100 selectors may be operated simultaneously from the console. There is no

limit to the number of trays and therefore no limit to the number of cards. The searching of one tray takes only about as long as it takes to press the selection keys.

The cards have 65 coding sites on each of two edges. Only one edge may be searched at a time. The sites may be arranged in fields, and up to 13 decades (0.9 for each decade) of digits may be encoded on an edge.

To use the system for coordinate index searches, one card is prepared for each document. Since only the edge is used in the system, the body of the card could also contain, for example, a film chip or an abstract plus bibliographic information. The coding of terms on the card can be done by using the console keyboard to automatically notch the cards, with the notching pattern for each term dependent upon the number of terms in the thesaurus.

The maximum number of terms assignable to each document determines the term capacity of the term thesaurus. This is because of the limited number of position sites on the card for coding terms. For example, if a maximum of 65 terms, er document were to be assigned,

then each term would have to correspond to each site, yielding a thesaurus maximum of 65 terms. If, however, only four terms were to be assigned to each source, then 1,000 terms would make up the thesaurus. This is apparent from the earlier statement that 13 coded decades were available on an edge. These can be divided into four groups (for the four terms assigned) of three decades each. Since a three-decade group will permit numbers from 000 to 999, 1,000 term variations are possible. A typical application of this system would probably not require as many as 65 term assignments but would probably need more than four. anga tarta ngeolaligik

2. Cost

The price for the ACCESS System has been quoted at less than \$1,800. Many variations of system use besides coordinate index searches are possible. Using the system for coordinate index searches is one of the less flexible arrangements. If only one code per card were required, for example, a trillion code permutations would be possible.

3. Comments

The chief advantages of the system are the random filing of cards, the simple techniques of preparing the cards, and the unlimited file capacity. Since the cards are searched

on the basis of notches, no order is required, and refiling time is nearly eliminated. The card notching is a simple mechanical operation compared to the drilling of visual coordination cards, and it can be done automatically from the keyboard. The file capacity does not have a limit, the maximum being only whatever the user is willing to store. Furthermore, the trays do not have to be kept separate, and cards from different trays can be intermingled.

The chief limitation of the system with regard to coordinate index searches is the inverse dependency of term thesaurus capacity upon the maximum number of terms to be assigned to an information source.

(3) <u>Filesearch</u>*

1. General Description

The Filesearch is a system that stores documentary information on 35-mm film, along with indexing codes, and that has the capability for later retrieval of the information based on a single term query or a query composed

*

The descriptive material in this section is largely composed of extracts from <u>The Filesearch System</u>, a general information manual by FMA, Inc., Washington, D. C.

of terms related by AND, OR, and NOT connectives. The system consists of three elements, as follows:

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- A Recording Unit that photographs documents and their indexing information adjacent to one another on reels of photographic film.
- A Retrieval Unit that searches the Index codes on the file with an optical scanner and locates the desired information via comparison registers.
- A Flexowriter that is used to prepare the input forms with indexing information.

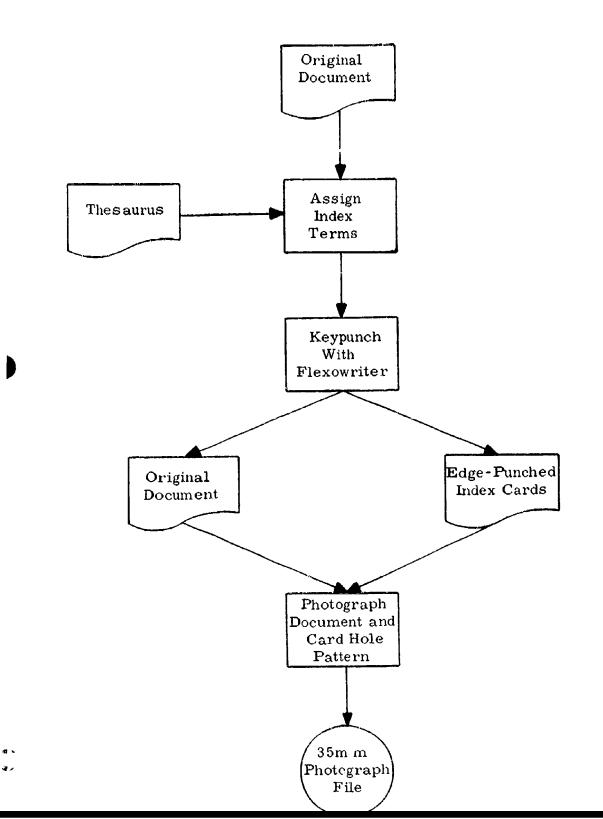
Figure 26 illustrates the operation of the system.

The operational functions are identified as follows:

- Indexing
- Keypunching
- Recording
- Retrieval
- File Structuring.
 - (1) Indexing

The indexing process consists of reviewing the document and assigning a set of descriptive words or numbers to it. These may vary from a single accession number to an assortment of terms giving

Storage Process -- Filesearch System



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information about such things as the document's date, classification, and subject. The indexing terms may be numeric (e.g., Part No. A72-4521B). Indexing terms may be of varying length, may be assigned in random order, and may be used in any quantity. and a set of a solution of the second se

Index terms are entered on a coding form, each preceded by a special letter that identifies the type of term (e.g., date or contract number). Thus, the date January 24, 1927, might be written D12427, while a contract number appears as C12427.

These characters may be preprinted on the coding form as in the example in Figure 27. Some other special characters used are the parenthesis sign, which indicates the beginning of indexing information for one document, and the slash or virgule, which is used for descriptors exceeding six characters in length.

(2) Keypunching

Indexing information from the worksheet is punched on an edge-punched card using a Flexowriter.

FIGURE 27 Coding Form - File Search System

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		<u>811111</u>	
	FMA, INC		

An illustration of one of these cards is given in Figure 28. Six bits on the card represent each alphanumeric character, and a seventh bit is used for checking for odd parity.

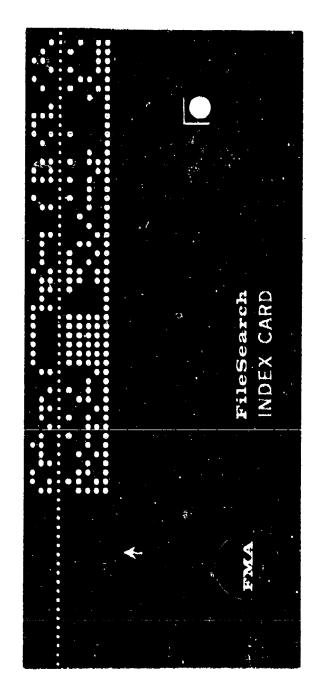
(3) <u>Recording</u>

The document to be recorded is placed below the Recording Unit viewer, and the edge-punched card is inserted into a slot in the unit's control panel. The document is then photographed page by page simultaneously with the hole pattern appearing on the edgepunched card. Figure 29 is an illustration of the resulting format on 35-mm film. The viewer holds up to 200 feet of film which will record up to 6, 400 pages on one reel.

(4) Retrieval

A request for information is indexed using the same format as for documents. The request index terms are keypunched on an edge-punched card and inserted in a slot in the retrieval unit. The holes in

FIGURE 28 Index Card - File Search System



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FIGURE 29 Document Recording Format - File Search System

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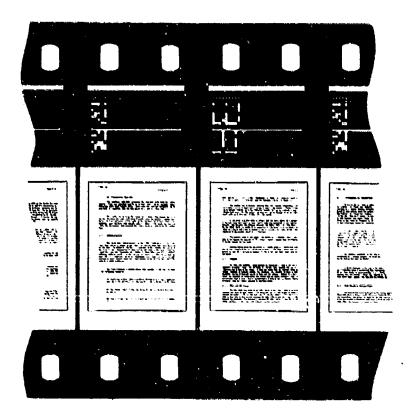
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the card are optically read and converted to electrical pulses, which are stored in a set of comparison registers.

A film reel is mounted on the Retrieval Unit, and the film is optically read. The pulses from the reading process are compared with the request criteria in the comparison register, and the reel is stopped each time a correspondence occurs. The comparison registers may be associated with one another by AND, OR, and NOT connectives and may be required to function in the following three different ways:

> To match the code on the film exactly with that of the request

To accept code on the film that falls between limits (e.g., all documents after June 1, 1963 and before June 1, 1964)

To function in continuity with one another so that a descriptor that begins in one register can be continued into the next (for terms larger than seven characters).

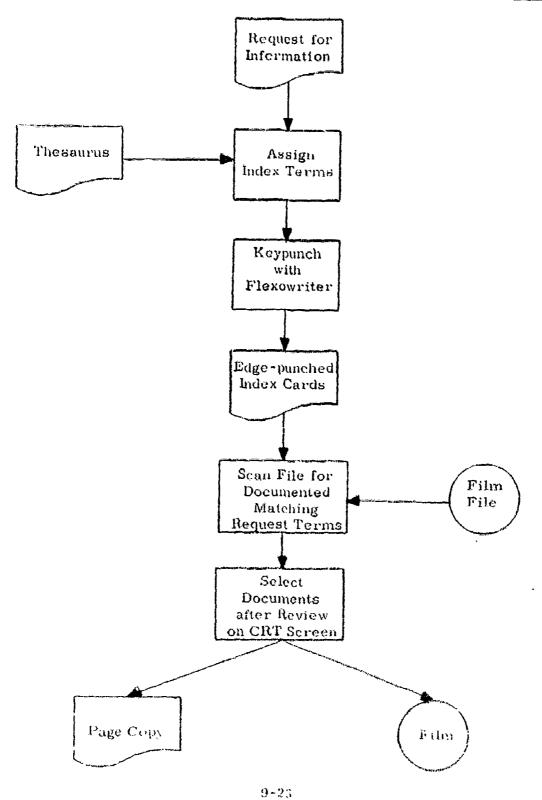
A simple request that illustrates these operations is one for all documents dealing with electrooptical companies that make lasers, excluding pulsed <u>January 1, 1960 and January 1, 1964</u>. The association indicates how the request terms are to be logically connected with one another: the functions indicate how the registers are to compare the code from the film with that of the request. Figure 30 illustrates this process.

Any of the search descriptors can be dropped from the search by turning off the corresponding register switches. Thus, if a search does not produce a hit, it can be made more general by cancelling one or more descriptors.

The system provides for categorical searches by coding a "superdigit" character (typed as an asterisk). This will preclude a comparison with corresponding characters read from the film. Thus, all documents on physics can be retrieved by searching on QC***** or all on Optical Instruments by searching on QC 373**. Another example is the ease of searching when using an author's name where the spelling is questionable, such as Millar, Muller, or

FIGURE 30

Retrieval Process -- Filescarch System



Moller. Such a request would be coded M*LL*R and AND-ed with other descriptors. 5

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(5) File Structuring

The system has the capability of searching a reel of randomly sorted material by any element of their index code, thereby producing a new structured file from the old. In this fashion, the results of a search can be recorded on a reel of tape automatically.

2. EQUIPMENT FOR MATERIALS PROCESSING

(1) Crossfiler

1. General Description

The crossfiler is a solid-state digital processor capable of performing the following functions: (1) catalog card record multiplication on punched paper tape which can be used to produce a set of catalog cards with segregated entry headings, and (2) tape duplication.

The first function is completed by detecting headings that will be used for each card in a set from a punched paper tape record of a catalog card. After each heading is punched

out on a secondary tape, it is followed by a reproduction of the complete card record. Thus, for one card record input, the Crossfiler punches out the representation of a complete set of cards with appropriate headings formatted at the top of each card in the set.

To perform the second function, the Crossfiler simply reads the input tape and simultaneously punches out a duplicate.

The Crossfiler consists of the following:

- An optical bidirectional paper tape reader, which has a reading speed of 110 characters per second
- A mechanical paper tape punch with a punching speed of 110 characters per second.
 - Processor digital logic.

There is no memory in the Crossfiler. It generates by scanning, detecting, and punching the detected information; it then reverses the input tape to the beginning of the record, and reads the record again and punches out the complete record information.

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2. Application

The Crossfiler was designed and built by the Itek Corporation for the Technical Library of the Air Force Cambridge Research Laboratory. Rather than purchase a computer, the Library had the Crossfiler developed because of its relatively cheaper cost (\$25,000 compared to \$100,000) at the time of development. However, this large cost difference no longer exists, and the Library will phase out the Crossfiler after the necessary computer programs are developed. ակիրել եպետություն

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The Library applies the Crossfiler output tape to a Programmatic Flexowriter to produce catalog cards, charge cards, card pockets, and an accessions list and then stores the paper tape record for a future book catalog to be produced by computer. A significant feature of the system is its use of a natural language format with nontyping characters rather than codes to define information fields.

3. Cost

The following chart presents a cost analysis of the use of the Crossfiler at the Cambridge Library.

COST ANALYSIS OF CROSSFILER-PRODUCED CARD SETS*

Percentage of total Crossfiler processing capacity	100%	50%	25%
Total number cards produced in 1 year	806,400) 403, 200	201,600
Total number of card sets produced in 1 year	115,200) 57,600	28, 800
Machine cost per card	. 3	, 6¢	1.2¢
Final cost of machine-produced cards	12.3	12.6¢	13.2¢
Final cost of machine-produced card sets	82.7¢	86.7¢	90.9¢
Percentage of total Crossfi processing capacity	ler	12.5%	6.25%
Total number cards produc in 1 year		100, 800	50,400
Total number of card sets produced in 1 year		14,400	7, 200
Machine cost per card		2.4¢	4. <u>8</u> ¢
Final cost of machine-prod cards	luced	14.4¢	16.8¢.
Final cost of machine-prod card sets	luced	99.3¢	\$1.16

* Figured on using a Crossfiler exclusively for card set production. Based on a \$25,000 machine cost and 10-year depreciation. Extracted from: <u>Automating Cataloging Functions in Conventional</u> <u>Libraries</u>, Paul J. Fasana, Itek Corporation published in Library Resources and Technical Services, Volume 7, Number 14, Fall 1963.

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(2) EDITOR-I

The EDITOR-I is a small digital data processor that has a two-character memory buffer, a character counter, and a high-speed tape reader and punch. It has two significant capabilities, as follows:

> A Flexowriter may be connected through the buffer, permitting a two-character delay between the pressing of the key and the punching of the character. Thus, if the word <u>data</u> was to be punched on the tape, the <u>d</u> and <u>a</u> would be keyed but would be stored in the Editor without any corresponding action to the tape. When the <u>t</u> is keyed, the <u>d</u> would then be taken out of storage and punched on the tape. This delay permits an operator to correct character errors that are immediately detected.

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For editing, a paper tape may be mounted on the high-speed reader, and the location of a previously noted error may be typed in the unit's console. The Editor will then advance at 500 words per minute to the error position, meanwhile copying the correct material on a new tape. When it reaches the error, it will stop and permit the operator to enter the correct information from the Flexowriter keyboard. It can then be instructed to proceed to the next error.

The control console has the following three sets of

keys on it:

Set 1 - Copy, Insert, Delete, Justify
Set 2 - Line, Word, Character, Sentence, Paragraph, Record

Set 3 - 1, 2, 3, 4, 5, 6, 7, 8, 9, 10, 20, 30

The selection <u>Copy 9 Lines</u> would cause, for example lines of the old tape to be reproduced followed by a stop for the operator to insert new or corrected information.

(3) IBM 870 Document Writing System

1. General Description

The IBM 870 Document Writing System is a wired program, punched-card-oriented system which permits the printing of several programmed outputs simultaneously with card-punching or card-reading. It also has provision for punched tape input. Possible outputs for library applications are as follows:

- Orders
- . Order status reports
- . Claim notices
- . Receipt and checkin
 - Cataloging forms

- Book pockets and labels
- . Shelf list cards
- . Announcements and notifications
- . Circulation control forms
- Statistics.

The system consists of an IBM 836 Control Unit and an IBM 866 nontransmitting typewriter. A second typewriter may be connected to the Control Unit for simultaneously typing in a different format. The Control Unit contains a card reader/punch and a tape reader and will produce an output from any combination of keyboard, punched cards, and punched tape inputs. A second card punch may also be connected to the Control Unit. Auxiliary equipment often used with the 870 System are the 082 Sorter and/or the 085 collator. nder istendung

Figures 31 through 33 illustrate three output forms that are produced simultaneously on the 870 System using keyboard input. These outputs consist of a set of punched cards, an order record, and a purchase order. Figures 34 through 36 illustrate

FIGURE 31

IBM 870 System Outputs Punched Cards

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SEPTEMBER 29, 1965 LOWDERMILK BOOK STORE 715 12TH ST., N W	WASHINGTON, DC	010TK6575 .W6 101 WOODWARD, PHILIP M. 201 1 PROBABILITY AND INFORMATION THEORY.	202136P. 351MACMILLAN, NEW YORK 701RADAR 702PROBABILITIES 703INFORMATION THEORY		

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270 	ouran 1	WOODWARD, PH. PROBABILITY /	WOODWARD, PHILIP M. PROBABILITY AND INFORMATION THEORY.	THEOR	Χ.	2 11 1	⁷⁴⁶⁶ 5 - 00	
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FIGURE 33 IBM 870 System Outputs Purchase Order three other outputs--a typed letter, punched cards, and a request record. The cards and request records were produced at the particular stage in the typing of the letter when the information requested was specified.

Figure 37 illustrates a system flow for an application of the 870 System. This system may be characterized by the following general procedure:

- After processing a request, the order clerk selects the prepunched cards pertaining to the vendor to be used from a file of vendors' cards.
- (2) The clerk next selects an order card, order memo card, author card, title card, shelf list card, and source card. These are placed in the order given behind the vendor card. All of these latter cards are blank except for a card identification code prepunched in column 75 of each card.
- (3) All of these are sent to the keypunch operator, who punches each of the cards with information taken from the original request form. (Some of the information is automatically duplicated from one card to the next.)
- (4) The order memo card is then filed, and the shelf list card is removed to be held until after the purchase order is written.

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Rand Corporation 1700 Main St. Santa Monica, California

Gentlemen,

The IBM Washington Systems Center is interested in obtaining a copy of the following publication which we believe you may be able to supply. The publication is

BELLMAN, R. E. KALABA, R. E. A NOTE ON NONLINEAR SUMMABILITY TECHNIQUES IN INVARIANT IMBEDDING. RAND RM3397PR FEB 63

This item is needed by our Systems Engineers in connection with their current projects. We would appreciate your assistance in sending us this publication, invoicing us for any charges due or suggesting another source for this material.

Thank you for your consideration.

Sincerely yours,

IBM Washington Systems Center Library

DCE,esz

FIGURE 34 IBM 870 System Outputs Letter

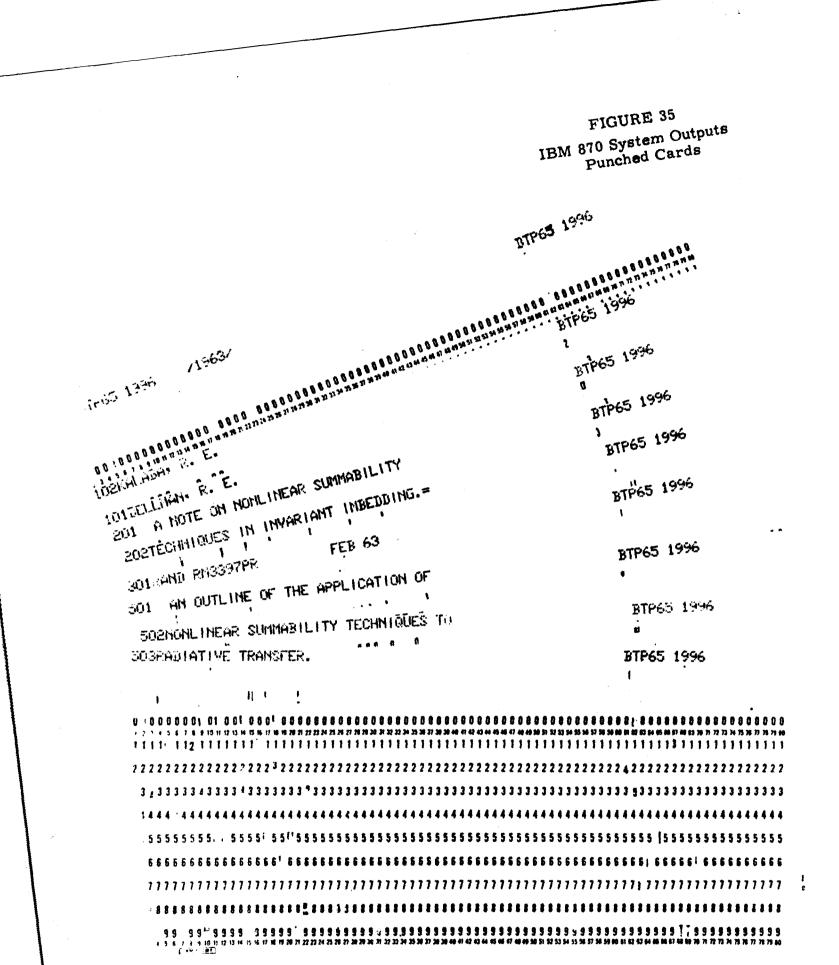


FIGURE 36 IBM 870 System Outputs System Request Record

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100	$bt_{\hat{\nu}}$ 65 1996 1963	btp65 1996	1996
	BELLMAN, R. E.	BTP65 1996	1996
	KALABA, R. E.	BTP65 1996	1996
	A NOTE ON NONLINEAR SUMMABILITY	BTP65 1996	1996
ע יי ע יי	TECHNIQUES IN INVARIANT IMBEDDING.	BTP65 1996	1996
501 502 503	RAND RM3397PR FE 63 AN OUTLINE OF THE APPLICATION OF NONLINEAR SUMMABILITY TECHNIQUES TO RADIATIVE TRANSFER.	BTP65 BTP65 BTP65 BTP65	1996 1996 1996

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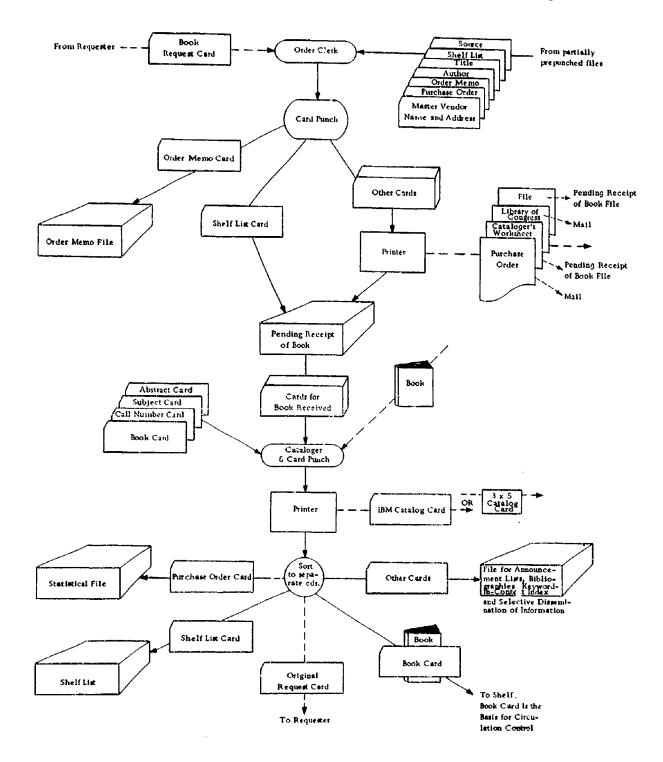
<u>.</u>

FIGURE 37 IBM 870 System Flow Diagram

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- (5) The remaining cards are read by the 870 Control Unit to produce the purchase order and other desired formats as indicated. Cards are then filed by vendor and order date.
- (6) When an order is received, the cards are pulled from the vendor file. The order is checked in against the purchase order card.
- (7) The received orders are then sent to the cataloger, who prepares a worksheet of usual cataloging information. The worksheet, blank book, call number, subject heading, abstract cards, and the cards of step 6 are all sent to the keypunch operator.
- (8) Call number, number of copies received, and cost are added to the purchase order card and are automatically duplicated on the shelf list card. From the shelf list card, the title, call number, author, and accession number are duplicated onto the book card. Call number and accession number are duplicated into the call number card, which is also manually punched with the number of subject headings assigned and the number of catalog cards to be printed. The subject heading cards and abstract cards are manually punched with the necessary information.
- (9) Catalog cards are then printed using a programmed format for 3 x 5 cards.
 (LC cards are not to be used.) For this printing, the subject, author, title, source, call number, and abstract cards are used. These cards are then used for special output listings such as SDI notification and KWIC indexes.
- (10) The various cards are filed, completing the process.

A detailed description of the IBM 870 Document Writing System may be found in the following publication:

The IBM 870 Library Administrative Processing System for Federal Government Libraries and Special Information Repositories, published by IBM, Technical Publications Department, White Plains, N.Y. 10601.

2. Application

The Mechanical Properties Data Center employed the IBM 870 System prior to the installation of its present computer system.

3. Cost

The Center experienced the following monthly rental charges for its 870 System and some of its auxiliary equipment:

834	Control Unit	\$ 124
866	Typewriter	35
101	Electronics statis- tical machine	275
026	Keypunch	60
083	Sorter	112

X. BIBLIOGRAPHY

The following bibliography is divided into six sections. The first section covers DoD information systems other than the Defense Documentation Center (DDC). The second has references concerning or published by DDC. The third section lists references concerning Government information systems other than those of DoD.

The remaining three sections list additional bibliographies, directories of libraries and information centers, and general references to mechanization processes in libraries.

Bibliographies of publications relating specifically to the facilities studied may be found in the individual facility reports.

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Biological/Medical Science	11	7	19	10	6	18
Chemistry	22	15	10	20	17	8
Earth Sci. / Oceanography	8	14	16	9	9	16
Electronics/Electr. Engr.	29	12	9	30	11	6
Energy Conversion (non-propulsive)	2	8	13	2	6	13
Materials	14	17	11	16	16	10
Mathematical Sciences	21	21	4	16	22	5
Mech., Indus., Civil and Marine Engineering	13	17	11	12	17	11
Methods and Equipment	9	18	13	8	18	30
Military Sciences	9	15	16	9	11	16
Missile Technology	19	10	11	20	9	9
Navigation, Comm., De- tection/Countermeasures	13	12	11	9	13	19
Nuclear Sci. / Technology	14	18	12	13	18	16
Ordnance	9	11	14	9	11	14
Physics	27	13	6	25	15	5
Propulsion/Fuels	9	11	14	9	11	14
Space Technology	13	14	15	11	13	15



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<u>Appendix A-1</u> Distribution of Facilities by COSATI Subject Category

Subject	by COSATT Subject Category										
RELA MEER OF FACILITIES AND RELATIVE SIZE OF COLLECTION											
Periodicals Technical Reports Unclassified Classi											
									Classifie		
Ma	<u>)r</u>	Major	Medium	Minor	Major	Medium		<u>Major</u>	Medium	Minor	
1.	• •	13	6	17	13	8	17	11	6	17	
		3	0	7	3	0	9	3	0	10	
		6	10	9	6	3	10	5	5	13	
-		7	9	15	6	12	15	5	12	12	
+	• •	7	13	10	3	12	10	2	9	8	
		10	6	18	9	8	17	7	9	11	
		20	17	8	19	15	11	17	13	8	
		9	9	16	?	10	15	7	9	15	
2"		30	11	6	29	13	6	25	14	5	
<u>+</u>		2	6	13	6	6	16	6	4	15	
	•••	16	16	10	18	17	9	13	18	5	
<u>†</u>		16	22	5	16	18	9	11	14	9	
1		12	17	11	9	17	16	7	16	12	
1		8	18	30	12	18	11	11	14	8	
<u> </u>		9	11	16	15	7	15	17	7	11	
2		20	9	9	21	13	6	23	11	6	
		9	13	10	15	10	10	19	11	5	
1		13	38	16	14	18	12	12	19	10	
		9	11	14	16] 4	7	16	12	8	
2		25	15	5	23	19	5	21	16	4	
-		9	11	14	9	18	12	9	16	10	
1		11	13	15	14	14	13	11	15	12	



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Appendix A-2

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This section contains the COSATI Subject Category breakdowns of the collections of most of the facilities visited. Breadkdowns are not incleded for those facilities whose collections consist primarily of specialized data.

COLLECTION OF THE DASA INFORMATION AND ANALYSIS CENTER 816 STATE STREET SANTA BARBARA, CALIFORNIA

BOOKS PERIODICALS	REPORTS, Uncl REPORTS, Class			
COSATI SUBJECT CATEGORIES		als		nical orts
1 - Largest Aspect	Books	Periodicals		
2 - Middle Aspect		erio	Uncl.	Class.
3 - Smallest Aspect		ட் 		
Aeronautics				
Agriculture				
Astronomy/Astrophysics				
Atmospheric Sciences				
Behavioral/Social Science				
Biological/Medical Science			3	
Chemistry			3	
Earth Science/Oceanography				
Electronics/Electrical Engineering				
Energy Conversion (non-propulsive)				
Materials				
Mathematical Sciences			[
Mech., Indus., Civil & Marine Eng				
Methods and Equipment				
Military Sciences				
Missile Technology				
Navigation, Comm., Detection/ Countermeasures				3
Nuclear Science/Technology			1	1
Ordnance				
Physics			3	3
Propulsion/Fuels		[
Space Technology				

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COLLECTION OF THE ARNOLD ENGINEERING DEVELOPMENT CENTER TECHNICAL LIBRARY TULLAHOMA, TENNESSEE

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BOOKS <u>19.470</u> PERIODICALS <u>8,069</u>		PORTS, : PORTS,		72,000
COSATI SUBJECT CATEGORIES		cais		nical orts
1 - Largest Aspect 2 - Middle Aspect 3 - Smallest Aspect	Books	Periodicals	Uncl.	Class.
Aeronautics	1	1	1	1
Agriculture				
Astronomy/Astrophysics				
Atmospheric Sciences	1	1	1	1
Behavioral/Social Science				
Biological/Medical Science				
Chemistry	3	3	3	3
Earth Science/Oceanography				
Electronics/Electrical Engineering	1	1	1	1
Energy Conversion (non-propulsive)	2	2	2	2
Materials	2	2	2	2
Mathematical Sciences	2	2	2	2
Mech., Indus., Civil & Marine Eng	3	3	3	3
Methods and Equipment	2	2	2	2
Military Sciences				
Missile Technology	1	1	1	1
Navigation, Comm., Detection/ Countermeasures				
Nuclear Science/Technology	2	2	2	2
Ordnance				
Physics	2	2	2	2
Propulsion/Fuels	1	1	1	1
Space Technology	1	1	1	1

AIR FORCE FLIGHT TEST CENTER TECHNICAL LIBRARY EDWARDS AFB, CALIFORNIA

BOOKS ______

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REPORTS, Unel. REPORTS, Class.

COSATI SUBJECT CATEGORIES		als		nical orts
 1 - Largest Aspect 2 - Middle Aspect 3 - Smallest Aspect 	Books	Periodicals	Uncl.	Class.
Aeronautics	1	1	1	
Agriculture				
Astronomy/Astrophysics	3	3	3	
Atmospheric Sciences	3	3	3	
Behavioral/Social Science	1	1	3	
Biological/Medical Science	3	3	3	
Chemistry	1	2	3	
Earth Science/Oceanography	3	3		
Electronics/Electrical Engineering	1	1	3	
Energy Conversion (non-propulsive)		3	3	
Materials	3	2	3	
Mathematical Sciences	1	3	3	
Mech., Indus., Civil & Marine Eng.	1	2	3	
Methods and Equipment	3	3	3	
Military Sciences	3	3		
Missile Technology	3	3	3	
Navigation, Comm., Detection/ Countermeasures	3	3	3	
Nuclear Science/Technology	3	3	3	
Ordnance	3	3	3	
Physics	1	2	3	
Propulsion/Fuels	3	3	2	
Space Technology	2	3	2	

PEFENSE LOGISTICS STUDIES INFORMATION EXCHANGE ARMY LOGISTICS MANAGEMENT CENTER FORT LEE, VIRGINIA

BOOKS	REPORTS, Uncl. REPORTS, Class.			
COSATI SUBJECT CATEGORIES		als		nical orts
1 - Largest Aspect	Books	Periodical		
2 - Middle Aspect		eric	Uncl.	Class.
<u>3 - Smallest Aspect</u>				
Aeronautics	3.	3	3	3
Agriculture				
Astronomy/Astrophysics				
Atmospheric Sciences				
Behavioral/Social Science	1	1	2	2
Biological/Medical Science	3	3	3	3
Chemistry				
Earth Science/Oceanography				
Electronics/Electrical Engineering	3	3	2	2
Energy Conversion (non-propulsive)				
Materials				
Mathematical Sciences	2	2	1	1
Mech., Indus., Civil & Marine Eng				
Methods and Equipment	1	1	1	1
Military Sciences	3	3	2	2
Missile Technology				
Navigation, Comm., Detection/ Countermeasures				
Nuclear Science/Technology				
Ordnance	3	3	2	2
Physics				
Propulsion/Fuels	3	3	3	3
Space Technology	3	3	3	3

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AIR FORCE OFFICE OF SCIENTIFIC RESEARCH WASHINGTON, D. C.

BOOKS <u>10-272</u> PERIODICALS <u>338</u>		PORTS, PORTS,		30,000
COSATI SUBJECT CATEGORIES 1 - Largest Aspect		cals		nical orts
 2 - Middle Aspect 3 - Smallest Aspect 	Books	Periodicals	Uncl	Class.
Aeronautics	1	1]	
Agriculture				
Astronomy/Astrophysics	1	1	1	1
Atmospheric Sciences	3	3	3	3
Behavioral/Social Science	2	2	2	2
Biological/Medical Science	3	3	3	3
Chemistry	2	2	2	2
Earth Science/Oceanography	3	3	3	3
Electronics/Electrical Engineering]	l	1	1
Energy Conversion (non-propulsive)	3	3	3	3
Materials				
Mathematical Sciences	2	2	2	2
Mech., Indus., Civil & Marine Eng.				
Methods and Equipment				
Military Sciences				
Missile Technology				
Navigation, Comm., Detection/ Countermeasures				
Nuclear Science/Technology	2	2	2	2
Ordnance			 	
Physics	2	2	2	2
Propulsion/Fuels	2	2	2	2
Space Technology	1	1]	1

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AIR FORCE MATERIALS LABORATORY WRIGHT-PATTERSON AFE, OHIO

BOOKS PERIODICALS	REPORTS, Uncl. REPORTS, Class.				
COSATI SUBJECT CATEGORIES		cals		nical orts	
 Largest Aspect Middle Aspect Smallest Aspect 	Books	Periodical	Unct.	Class.	
Aeronautics					
Agriculture		یں ہوتا ہوتا پر انہوں کرت ا ہوتا ہوتا ہوتا ہوتا ہوتا ہوتا ہوتا ہوت			
Astronomy/Astrophysics					
Atmospheric Sciences					
Behavioral/Social Science					
Biological/Medical Science					
Chemistry			1		
Earth Science/Oceanography					
Electronics/Electrical Engineering					
Energy Conversion (non-propulsive)					
Materials			1		
Mathematical Sciences					
Mech., Indus., Civil & Marine Eng					
Methods and Equipment			3		
Military Sciences					
Missile Technology	_				
Navigation, Comm., Detection/ Countermeasures					
Nuclear Science/Technology					
Ordnance					
Physics			1		
Propulsion/Fucls					
Shace Technology					

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AIR FORCE INSTITUTE OF TECHNOLOGY WRIGHT-PATTERSON AFB, OHIO

BOOKS <u>75,000</u> PERIODICALS <u>1,250 titles</u>		PORTS, PORTS,	Uncl Class	25.000
COSATI SUBJECT CATEGORIES 1 - Largest Aspect	Books	Periodicals	Technical Reports	
2 - Middle Aspect 3 - Smallest Aspect			Uncl.	Class.
Aeronautics	l	l	l	1
Agriculture	3	3	3	·
Astronomy/Astrophysics	2	2	2	
Atmospheric Sciences	2	2	2	
Behavioral/Social Science	2	2	2	2
Biological/Medical Science	3	3	3	
Chemistry	3	3	3	3
Earth Science/Oceanography	3	3	3	
Electronics/Electrical Engineering	1	1	1	
Energy Conversion (non-propulsive)	2	2	2	
Materials	2	2	2	
Mathematical Sciences	1	1	1	
Mech., Indus., Civil & Marine Eng	1	1	1.	
Methods and Equipment	2	2	2	
Military Sciences	3	3	3	
Missile Technology	1	1	1	
Navigation, Comm., Detection/ Countermeasures	2	2	2	
Nuclear Science/Technology	1	1	1	
Ordnance	2	2	2	2
Physics	ì	1	ł	1
Propulsion/Fuels	1	1	1	
Space Technology	1	1	1	1

COLLECTION OF THE AECRNAUTICAL RESEARCH LABORATORY TECHNICAL LIBRARY WRIGHT-PATTERSON AFB, OHIO

BOOKS PERIODICALS

REPORTS, Uncl. REPORTS, Class.

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COSATI SUBJECT CATEGORIES		cals	Technical Reports	
1 - Largest Aspect 2 - Middle Aspect 3 - Smallest Aspect	Books	Periodicals	Uncl.	Class.
Aeronautics	2	2	2	
Agriculture				
Astronomy/Astrophysics				
Atmospheric Sciences				
Behavioral/Social Science				
Biological/Medical Science				
Chemistry	1	1	1	
Earth Science/Oceanography				
Electronics/Electrical Engineering				
Energy Conversion (non-propulsive)				
Materials				
Aathematical Sciences	1	1	1	
Mech., Indus., Civil & Marine Eng				
Methods and Equipment				
Military Sciences				
Missile Technology				
Navigation, Comm., Detection/ Countermeasures				
Nuclear Science/Technology				
Ordnance				
Physics	1	1	1	
Propulsion/Fuels				
Space Technology	3	3	3	

COLLECTION OF THE U. S. ARMY MAP SERVICE LIBRARY BETHESDA, MARYLAND

BOOKS PERIODICALS	REPORTS, Uncl. REPORTS, Class.				
COSATI SUBJECT CATEGORIES		cais		onical orts	
1 - Largest Aspect 2 - Middle Aspect	Books	Periodical	Uncl.	Class.	
3 - Smallest Aspect		<u>д</u>			
Aeronautics	1	1	1	1	*
Agriculture	1	1	1	1	*
Astronomy/Astrophysics	2	2			*
Atmospheric Sciences	1	1			*
Behavioral/Social Science	1	1			¥
Biological/Medical Science	1	1			*
Chemistry	1	1			*
Earth Science/Oceanography	3	3	3	3	
Electronics/Electrical Engineering	1	1			*
Energy Conversion (non-propulsive)					
Materials	1	1			*
Mathematical Sciences	1	1.			
Mech., Indus., Civil & Marine Eng.	1	1			*
Methods and Equipment	2	2			
Military Sciences	3	3			
Missile Technology	1	1			*
Navigation, Comm., Detection/ Countermeasures	1	1			*
Nuclear Science/Technology	1	1			*
Ordnance					
Physics					
Propulsion/Fuels					
Space Technology	1				

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* The Total of all these subjects represent less than 15% of our total Library holdings.

COLLECTION OF THE U. S. ARMY COMBAT DEVELOPMENTS COMMAND LIBRARY ARTILLERY AGENCY ADMINISTRATIVE DIVISION FORT SILL, OKLAHOMA

BOOKS	
PERIODICALS	

REPORTS, Uncl. ______ REPORTS, Class. _____

COSATI SUBJECT CATEGORIES	Books	cais	Technical Reports	
 Largest Aspect Middle Aspect Smallest Aspect 		Periodicals	Uncl.	Class.
Aeronautics			3	3
Agriculture			3	3
Astronomy/Astrophysics			3	3
Atmospheric Sciences			2	2
Behavioral/Social Science				
Biological/Medical Science			2	2
Chemistry			3	3
Earth Science/Oceanography			3	3
Electronics/Electrical Engineering			2	2
Energy Conversion (non-propulsive)			3	3
Materials		<u></u>	2	2
Mathematical Sciences			2	2
Mech., Indus., Civil & Marine Eng			2	2
Methods and Equipment			1	1
Military Sciences			1	1
Missile Technology			1	1
Navigation, Comm., Detection/ Countermeasures			1	1
Nuclear Science/Technology			2	2
Ordnance			1	1
Physics			2	2
Propulsion/Fuels			2	2
Space Technology			3	3

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COLLECTION OF THE USAF AEROSPACE MEDICAL CENTER AEROMEDICAL LIBRARY BROOKS AFB, TEXAS

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	BOOKS PERIODICALS			Uncl. Class.	
	COSATI SUBJECT CATEGORIES		cals	ທ Technical Reports	
	1 - Largest Aspect 2 - Middle Aspect 3 - Smallest Aspect	Books	Periodicals	Uncl.	Class.
	Aeronautics	2	2	2	2
	Agriculture		<u></u>		
	Astronomy/Astrophysics	1	1	1	1
	Atmospheric Sciences	2	2	2	2
	Behavioral/Social Science	2	2	2	2
	Biological/Medical Science	1	1	1	1
	Chemistry	1	1	1	1
	Earth Science/Oceanography 3				
	Electronics/Electrical Engineering	1	1	1	1
	Energy Conversion (non-propulsive)				
	Materials				
Biometrics	Mathematical Sciences	1	1.	1	1
	Mech., Indus., Civil & Marine Eng.			•	
	Methods and Equipment	3			
	Military Sciences				
	Missile Technology				
	Navigation, Comm., Detection/ Countermeasures				
	Nuclear Science/Technology	1	1	1	1
	Ordnance				
	Physics	1	1	1	1
	Propulsion/Fuels				
	Space Technology	1	1	l	1

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COLLECTION OF THE ARMY STUDY DOCUMENTATION AND INFORMATION RETRIEVAL SYSTEM ARMY LIBRARY THE PENTAGON WASHINGTON, D. C.

REPORTS, Uncl. BOOKS PERIODICALS REPORTS, Class. Technical COSATI SUBJECT CATEGORIES Periodicals Reports 1 - Largest Aspect Books Waxk. CLARS. 2 - Middle Aspect 3 - Smallest Aspect Aeronautics Agriculture Astronomy/Astrophysics Atmospheric Sciences Behavioral/Social Science 2 Biological/Medical Science Chemistry Earth Science/Oceanography Electronics/Electrical Engineering Energy Conversion (non-propulsive) Materials Mathematical Sciences Mech., Indus., Civil & Marine Eng. Methods and Equipment Military Sciences 1 Missile Technology Navigation, Comm., Detection/ Countermeasures Nuclear Science/Technology 2 Ordnance Physics Propulsion/Fuels Space Technology

COLLECTION OF THE AERONAUTICAL CHART AND INFORMATION CENTER TECHNICAL LIBRARY SECOND AND ARSENAL ST. LOUIS, MISSOURI

BOOKS ----PERIODICALS

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REPORTS, Uncl. _______

COSATI SUBJECT CATEGORIES		als	Technical Reports	
1 - Largest Aspect 2 - Middle Aspect 3 - Smallest Aspect	Books	Periodicals	Uncl.	Class.
Aeronautics	3	1	3	
Agriculture				
Astronomy/Astrophysics	1	1	1	
Atmospheric Sciences	3	3	3	
Behavioral/Social Science	1	2	2	
Biological/Medical Science	3	3	3	
Chemistry				
Earth Science/Oceanography	1	1	1	
Electronics/Electrical Engineering	2	1	2	
Energy Conversion (non-propulsive)				
Materials	3	3	3	
Mathematical Sciences	2	2	2	
Mech., Indus., Civil & Marine Eng	3	2	3	
Methods and Equipment	2	2	2	
Military Sciences	2	2	2	
Missile Technology	1	1	1	
Navigation, Comm., Detection/ Countermeasures	3	3	3	
Nuclear Science/Technology	3	3	3	
Ordnance				
Physics	2	3	2	
Propulsion/Fuels	3	3	3	
Space Technology	1	1	1	

COLLECTION OF THE HARRY DIAMOND LABORATORIES TECHNICAL INFORMATION OFFICE WASHINGTON, D. C.

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BOOKS <u>20,100</u> PERIODICALS <u>700</u>		REPORTS, REPORTS,		
COSATI SUBJECT CATEGORIES		als		nical orts
1 - Largest Aspect	Books	dic		
2 - Middle Aspect		Períodical	Uncl.	Class.
3 - Smallest Aspect		ሲ		
Aeronautics	3	3	3	3
Agriculture				
Astronomy/Astrophysics	3	3	3	3
Atmospheric Sciences	3	3	3	3
Behavioral/Social Science	2	2	2	2
Biological/Medical Science	3	3	3	3
Chemistry	2	2	2	2
Earth Science/Oceanography	3	3	3	3
Electronics/Electrical Engineering	1	1	1	1
Energy Conversion (non-propulsive)	1	1	1	1
Materials	2	2	2	2
Mathematical Sciences	1	1	1	· 1
Mech., Indus., Civil & Marine Eng.	2	2	2	2
Methods and Equipment	2	2	2	2
Military Sciences	1	1	1	1
Missile Technology	1	1	1	1
Navigation, Comm., Detection/ Countermeasures	1	1	1	1
Nuclear Science/Technology	1	1	1	1
Ordnance	1	1	1	1
Physics	1	1	1	1
Propulsion/Fuels	3	3	3	3
Space Technology	2	2	2	2

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COLLECTION OF THE U. S. ARMY EDGEWOOD RESEARCH & DEVELOPMENT LABORATORY TECHNICAL LIBRARY EDGEWOOD ARSENAL, MARYLAND

BOOKS PERIODICALS

REPORTS, Uncl. REPORTS, Class._____

COSATI SUBJECT CATEGORIES		als		nical orts
1 - Largest Aspect 2 - Middle Aspect 3 - Smallest Aspect	Books	Periodicals	Uncl.	Class.
Aeronautics	3	3	3	3
Agriculture	3	3	3	3
Astronomy/Astrophysics	3	3	3	3
Atmospheric Sciences	2	2	2	2
Behavioral/Social Science	2	2	2	2
Biological/Medical Science	1	1	1	1
Chemistry	1	1	1	1
Earth Science/Oceanography				
Electronics/Electrical Engineering	2	2	2	2
Energy Conversion (non-propulsive)	2	2	2	2
Materials	1	1	1	1
Mathematical Sciences	1	1	1 .	1
Mech., Indus., Civil & Marine Eng.	2	2	2	2
Methods and Equipment	2	2	2	2
Military Sciences	1	1	1	1
Missile Technology	2	2	2	2
Navigation, Comm., Detection/ Countermeasures	3	3	3	3
Nuclear Science/Technology	2	2	2	2
Ordnance	2	2	2	2
Physics	1	1	1	1
Propulsion/Fuels	2	2	2	2
Space Technology	3	3	3	3

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COLLECTION OF THE U. S. ARMY RESEARCH & DEVELOPMENT LABORATORIES STINFO DIVISION FORT BELVOIR, VIRGINIA

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BOOKS	REPORTS, Uncl. <u>37.24</u> REPORTS, Class. <u>15.96</u>				
COSATI SUBJECT CATEGORIES		aì s		echnical Reports	
1 - Largest Aspect	Books	Periodicals	<u></u>		
2 - Middle Aspect		erio	Uncl.	Class.	
3 - Smallest Aspect		<u>д</u>			
Aeronautics					
Agriculture					
Astronomy/Astrophysics					
Atmospheric Sciences					
Behavioral/Social Science					
Biological/Medical Science	3	3	3	3	
Chemistry	2	2	2	2	
Earth Science/Oceanography	1	1	1	1	
Electronics/Electrical Engineering	1	1	2	1	
Energy Conversion (non-propulsive)			1	1	
Materials	1	1	1	1	
Mathematical Sciences	3	3	3 ·	3	
Mech., Indus., Civil & Marine Eng.	1	1	1	1	
Methods and Equipment					
Military Sciences					
Missile Technology					
Navigation, Comm., Detection/ Countermeasures					
Nuclear Science/Technology		2	1	1	
Ordnance			1	1	
Physics	2	2	2	2	
Propulsion/Fuels					
Space Technology			3	3	

COLLECTION OF THE FOREIGN TECHNOLOGY DIVISION LIBRARY DIVISION AIR FORCE SYSTEMS COMMAND WRIGHT-PATTERSON AFB, OHIO

BOOKS 10,000 PERIODICALS 90,000

REPORTS, Uncl. 170.000 REPORTS, Class. 120,000

COSATI SUBJECT CATEGORIES		2 S IS	Technical Reports	
1 - Largest Aspect 2 - Middle Aspect 3 - Smallest Aspect	Books	Feriodicals	Uncl.	Class.
Aeronautics]	2	2	2
Agriculture	3	3	3	3
Astronomy/Astrophysics	1	2	3	3
Atmospheric Sciences	2	2	2	2
Behavioral/Social Science	2	2	3	3
Biological/Medical Science	3	3	3	3
Chemistry	2	2	2	2
Earth Science/Oceanography	2	3	2	2
Electronics/Electrical Engineering	1	1	1	1
Energy Conversion (non-propulsive)	2	2	1	1
Materials	2	2	2	2
Mathematical Sciences	2	2	3	3
Me 🗄 , Indus., Civil & Marine Eng	1	3	3	3
Methods and Equipment	3	3	2	2
Military Sciences	2	3	1	1
Missile Technology	1	3	1	1
Navigation, Comm., Detection/ Countermeasures	2	2	1	1
Nuclear Science/Technology	2	2	1	1
Ordnance	3	3	2	2
Physics	1	1	2	2
Propulsion/Fuels	1	1	1	1
Space Technology	1	1	1	1

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COLLECTION OF THE UNITED STATES ARMY COMBAT DEVELOPMENTS COMMAND TECHNICAL LIBRARY FORT MCCLELLAN, ALABAMA

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BOOKS PERIODICALS			Uncl. Class.	
COSATI SUBJECT CATEGORIES		cels		nical orts
 Largest Aspect Middle Aspect Smallest Aspect 	Books	Periodicals	Uncl.	Class.
Aeronautics		and the system of the second secon	3	3
Agriculture			3	3
Astronomy/Astrophysics			3	3
Atmospheric Sciences			2	2
Behavioral/Social Science				
Biological/Medical Science			2	2
Chemistry			3	3
Earth Science/Oceanography			3	3
Electronics/Electrical Engineering			2	2
Energy Conversion (non-propulsive)		1	3	3
Materials	**************************************		2	2
Mathematical Sciences			2	2
Mcch., Indus., Civil & Marine Eng			2	2
Methods and Equipment			1	1
Military Sciences			1	1
Missile Technology			1	1
Navigation, Comm., Detection/ Countermeasures		-T.).E.1	1	1
Nuclear Science/Technology			2	2
Ordnance			1	1
Physics			2	2
Propulsion/Fuels			2	2
Space Technology			3	3

COLLECTION OF THE JOHNS HOPKINS UNIVERSITY APPLIED PHYSICS LABORATORY CHEMICAL PROPULSION INFORMATION AGENCY SILVER SPRING, MARYLAND

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BOOKS PERIODICALS		PORTS, PORTS,		
COSATI SUBJECT CATEGORIES		cals		nicāl orts
1 - Largest Aspect 2 - Middle Aspect	Books	Periodicals	Uncl.	Class.
<u>3 - Smallest Aspect</u>		بنا <u></u>		
Aeronatics			2	2
Agriculture				
Astronomy/Astrophysics			3	3
Atmospheric Sciences			1	1
Behavioral/Social Science				
Biological/Medical Science			2	2
Chemistry			1	1
Earth Science/Oceanography			3	3
Electronics/Electrical Engineering			3	3
Energy Conversion (non-propulsive)			1	1
Materials			1	1
Mathematical Sciences	a de la casa de la cas Internet de la casa de la Internet de la casa de	and the second		
Mech., Indus., Civil & Marine Eng		17*** 7 ********************************	2	2
Methods and Equipment			1	1
Military Sciences			2	2
Missile Technology			1	1
Navigation, Comm., Detection/ Countermeasures			3	3
Nuctear Science/Technology			3	3
Ordnance			1	1
Physics			2	2
Propulsion/Fuels			1	1
Space Technology			1	1

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BOOKS <u>11.000</u> PERIODICALS <u>280</u>		PORTS, PORTS,		65.000
COSATI SUBJECT CATEGORIES 1 - Largest Aspect		dicals		nical orts
2 - Middle Aspect	Books	Periodical	Uncl.	Class.
3 - Smallest Aspect Aeronautics				
Agriculture				
Astronomy/Astrophysics				
Atmospheric Sciences				
Behavioral/Social Science				
Biological/Medical Science				
Chemistry	1	1	1	1.
Earth Science/Oceanography	2	2	2	2
Electronics/Electrical Engineering	1	1	1	1
Energy Conversion (non-propulsive)	2	2	2	2
Materials	2	2	2	2
Mathematical Sciences	2	2	2	· 2
Mech., Indus., Civil & Marine Eng.	1	1	1	1
Methods and Equipment	2	2	2	2
Military Sciences	3	3	3	3
Missile Technology				
Navigation, Comm., Detection/ Countermeasures	2	2	2	2
Nucle- Science/Technology	3	3	3	3
Ordnance				
Physics				
Eropulaion/Fuels	2	2	2	2
Space Technology				

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1 - Largest Aspect 2 - Middle Aspect 3 - Smallest Aspect	Books	Periodicals	Uncl.	Class.
Aeronautics	1	1	1	1
Agriculture				3
Astronomy/Astrophysics	1	1	2	3
Atmospheric Sciences	1	1	1	3
Behavioral/Social Science	3	3	2	3
Biological/Medical Science	3	3	3	3
Chemistry	3	3	2	3
Earth Science/Oceanography	1	1	3	3
Electronics/Electrical Engineering	1	1	1	1
Energy Conversion(non-propulsive)	3	3	3	3
Materials	2	2	1	2
Mathematical Sciences	1	1	2	· 3
Mech., Indus., Civil & Marine Eng	2	2	3	3
Methods and Equipment	3	3	3	3
Military Sciences	3	3	3	2
Missile Technology	1	1	2	1
Navigation, Comm., Detection/ Countermeasures	1	1	1	1
Nuclear Science/Technology	2	2	1	2
Ordnance	3	3	2	2
Physics	1	1	1	1
Propulsion/Fuels	1	1	2	1
Space Technology	1	1	l	2

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COSATI SUBJECT CATEGORIES	Books	als		Technical Reports	
1 - Largest Aspect 2 - Middle Aspect 3 - Smallest Aspect		Periodicals	Uncl.	Class.	
Aeronautics					
Agriculture					
Astronomy/Astrophysics					
Atmospheric Sciences			<u> </u>		
Behavioral/Social Science	3	3	3	3	
Biological/Medical Science					
Chemistry	2	2	2	2	
Earth Science/Oceanography					
Electronics/Electrical Engineering	3	3	3	3	
Energy Conversion (non-propulsive)	3	3	3	3	
Materials	1	1	1	1	
Mathematical Sciences	2	2	2 ·	2	
Mech., Indus., Civil & Marine Eng	1	1	1	1	
Methods and Equipment	1	1	1	1	
Military Sciences	2	2	2	2	
Missile Technology	1	1	1	1	
Navigation, Comm., Detection/ Countermeasures	3	3	3	3	
Nuclear Science/Technology	3	3	3	3	
Ordnance	1	1	1	1	
Physics	2	2	2	2	
Propulsion/Fuels	3	3	3	3	
Space Technology	2	2	2	2	

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BOOKS <u>40,000</u> PERIODICALS <u>1,100</u>				<u>20_000</u> 3,000
COSATI SUBJECT CATEGORIES		als	ूल Technical सु <u>Reports</u>	
1 - Largest Aspect 2 - Middle Aspect 3 - Smallest Aspect	Books	Periodical	Uncl.	Class.
Aeronautics	3	3	3	3
Agriculture				
Astronomy/Astrophysics	2	3	3	3
Atmospheric Sciences	2	3	2	2
Behavioral/Social Science	3	3	3	3
Biological/Medical Science	3	3		
Chemistry	1	2	2	3
Earth Science/Oceanography	2	3	2	
Electronics/Electrical Engineering	1	1	1	1
Energy Conversion (non-propulsive)	2	3	3	3
Materials	2	3	1	2
Mathematical Sciences	1	2	2	3
Mech., Indus., Civil & Marine Eng.	2	3	3	3
Methods and Equipment	3	3		
Military Sciences	3	3		2
Missile Technology	3	3		2
Navigation, Comm., Detection/ Countermeasures	3	3	3	1
Nuclear Science/Technology	3	3	3	2
Ordnance				3
Physics	1	1	1	1
Propulsion/Fuels				
Space Technology	3	3	3	3

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Propulsion/Fuels

Space Technology

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2 - Middle Aspect 3 - Smallest Aspect	Books	Periodicals	Uncl.	Class.
Aeronautics	3	3	3	3
Agriculture	1	1	1	1
Astronomy/Astrophysics				
Atmospheric Sciences	2	2	2	2
Behavioral/Social Science	3	3		
Biological/Medical Science	1	1	1	1
Chemistry	2	2	2	2
Earth Science/Oceanography	3	3	3	3
Electronics/Electrical Engineering	3	3	3	3
Energy Conversion (non-propulsive)				
Materials	3	3	3	3
Mathematical Sciences	2	2	3.	3
Mech., Indus., Civil & Marine Eng.	2	2	3	3 `
Methods and Equipment	3	3	3	3
Military Sciences	3	3	1	1
Missile Technology	3	3	3	3
Navigation, Comm., Detection/ Countermeasures	2	2	2	2
Nuclear Science/Technology	3	3	3	3
Ordnance	2	2	3	3
Physics	2	2	0 2	2
Propulsion/Fuels	3	3	3	3
Space Technology	3	3	3	3

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BOOKS PERIODICALS	REPORTS, Uncl REPORTS, Class			
COSATI SUBJECT CATEGORIES		ais	Tech Rep	nical * orts
1 - Largest Aspect	Books	dic	Ğ.	
2 - Middle Aspect		Periodicals	Uncl.	Class.
3 - Smallest Aspect		<u>ď</u>		
Aeronautics			1	
Agriculture				
Astronomy/Astrophysics			3	
Atmospheric Sciences			2	
Behavioral/Social Science				
Biological/Medical Science				
Chemistry			3	
Earth Science/Oceanography				
Electronics/Electrical Engineering			1	
Energy Conversion (non-propulsive)				
Materials			3	
Mathematical Sciences			3 .	
Mech., Indus., Civil & Marine Eng			3	
Methods and Equipment			3	
Military Sciences			1	
Missile Technology	*		1	
Navigation, Comm., Detection/ Countermeasures			1	
Nuclear Science/Technology				
Ordnance			3	
Physics			2	
Propulsion/Fuels			3	
Space Technology			2	

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REPORTS, Uncl. ______ REPORTS, Class. _____

COSATI SUBJECT CATEGORIES		cals	nical * orts	
1 - Largest Aspect 2 - Middle Aspect 3 - Smallest Aspect	Books	Periodicals	Uncl.	Class.
Aeronautics				
Agriculture				
Astronomy/Astrophysics				
Atmospheric Sciences				
Behavioral/Social Science	·			
Biological/Medical Science				
Chemistry			3	
Earth Science/Oceanography				
Electronics/Electrical Engineering				
Energy Conversion (non-propulsive)				
Materials			1	
Mathematical Sciences			•	
Mech., Indus., Civil & Marine Eng.			3	
Methods and Equipment			2	
Military Sciences				
Missile Technology			3	
Navigation, Comm., Detection/ Countermeasures		Aller		
Nuclear Science/Technology				
Ordnance				
Physics			3	
Propulsion/Fuels				
Space Technology			3	

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BOOKS PERIODICALS	REPORTS, Uncl. REPORTS, Class.			
COSATI SUBJECT CATEGORIES		als		nical orts
1 - Largest Aspect 2 - Middle Aspect <u>3 - Smallest Aspect</u>	Books	Periodical	Uncl.	Class.
Aeronautics	۱	1	1	1
Agriculture				
Astronomy/Astrophysics	2	2	2	2
Atmospheric Sciences	2	2	2	2
Behavioral/Social Science	2	2		
Biological/Medical Science	2	2	3	3
Chemistry	2	2	3	3
Earth Science/Oceanography	2	2		
Electronics/Electrical Engineering	2	2	2	2
Energy Conversion (non-propulsive)	2	2	2	2
Materials	2	2	2	2
Mathematical Sciences	2	2	3	3
Mech., Indus., Civil & Marine Eng	3	3		
Methods and Equipment	3	3	3	3
Military Sciences	2	2		
Missile Technology	1	1	1	1
Navigation, Comm., Detection/ Countermeasures	2	2	2	2
Nuclear Science/Technology	3	3	3	3
Ordnance	3	3		
Physics	2	2	2	2
Propulsion/Fuels	1	1	1	1
Space Technology	1	1	1	1

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BOOKS PERIODICALS

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COSATI SUBJECT CATEGORIES		als		Technical Reports *	
1 - Largest Aspect 2 - Middle Aspect <u>3 - Smallest Aspect</u>	Books	Periodicals	Uncl.	Class.	
Aeromautics	3		3		
Agriculture					
Astronomy/Astrophysics	2	2	2		
Atmospheric Sciences	3	3	3		
Behavioral/Social Science					
Biological/Medical Science	3	3	3	<u></u>	
Chemistry	3	3	3		
Earth Science/Oceanography					
Electronics/Electrical Engineering	1	2	2		
Energy Conversion (non-propulsive)					
Materials	3	3	3		
Mathematical Sciences	1	2	3 .		
Mech., Indus., Civil & Marine Eng.	2	2	1		
Methods and Equipment	3	3	3		
Military Sciences	3		1		
Missile Technology			1		
Navigation, Comm., Detection/ Countermeasures			2		
Nuclear Science/Technology	2	2	1		
Ordnance	3	3	2		
Physics	1	2	2		
Propulsion/Fuels	3	3	2		
Space Technology	2	2	2		

* Unclassified and classified reported together.

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COSATI SUBJECT CATEGORIES		sls	n Technica a Reports		
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Aeronautics			2		
Agriculture			3		
Astronomy/Astrophysics			3		
Atmospheric Sciences		landara an anna an an anna an an an an an an a	2		
Behavioral/Social Science			2		
Biological/Medical Science			1		
Chemistry			1		
Earth Science/Oceanography	1		3		
Electronics/Electrical Engineering			1		
Energy Conversion (non-propulsive)			2		
Materials			2		
Mathematical Sciences			2 ·		
Mech., Indus., Civil & Marine Eng			1		
Methods and Equipment			2		
Military Sciences			1		
Missile Technology			3		
Navigation, Comm., Detection/ Countermeasures			1		
Nuclear Science/Technology			З		
Ordnance			1		
Physics			2		
Propulsion/Fuels			3		
Space Technology			3		

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* In the form of Extract Cards.

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COSATI SUBJECT CATEGORIES 1 - Largest Aspect	Books	Periodicals	Technical Reports	
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Aeronautics				
Agriculture				
Astronomy/Astrophysics				
Atmospheric Sciences				
Behavioral/Social Science		74 0012 492 (1999) (1996) (1996)	<u></u>	
Biological/Medical Science				
Chemistry	2	2	2	8
Earth Science/Oceanography				
Electronics/Electrical Engineering	2	2	2	2
Energy Conversion (non-propulsive)				
Materials	1	1	1	1
Mathematical Sciences				
Mech., Indus., Civil & Marine Eng				``````````````````````````````
Methods and Equipment	l	1	1	1
Military Sciences	3	3	3	3
Missile Technology			an an fair an	
Navigation, Comm., Detection/ Countermeasures	میں اور اور میں میں اور	ار میگرد. استان از این از این	- المراجع من المراجع م المراجع من المراجع من ال	
Nuclear Science/Technology	2	2	2	2
Ordnance	1	1	1	1
Physics	2	2	2	2
Propulsion/Fuels	2	2	2	2
Space Technology		an a far i gaig se productive de la compa		

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1 - Largest Aspect	Books :			
2 - Middle Aspect		Periodicals	Uncl.	Class.
<u>3 - Smallest Aspect</u>		<u>Å</u>		
Aeronautics	3	3	3	3
Agriculture		L		
Astronomy/Astrophysics				
Atmospheric Sciences				
Behavioral/Social Science	3			
Biological/Medical Science				
Chemistry				
Earth Science/Oceanography				
Electronics/Electrical Engineering	1	1	1	1
Energy Conversion (non-propulsive)				
Materials				
Mathematical Sciences	2		2 .	2
Mech., Indus., Civil & Marine Eng	2	2	2	2
Methods and Equipment				
Military Sciences	2	2	2	2
Missile Technology	1	1	1	1
Navigation, Comm., Detection/ Countermeasures	1	1	1	1
Nuclear Science/Technology	2	2	2	2
Ordnance	1	1	1	1
Physics	r	2	2	2
Propulsion/Fuels				
Space Technology	2	2	2	2

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COSATI SUBJECT CATEGORIES 1 - Largest Aspect	XIES S B S		1	nical orts
2 - Middle Aspect	Books	Periodicals	Uncl.	Class.
3 - Smallest Aspect		<u>µ</u> ,		
Aeronautics				
Agriculture	1	1	1	1
Astronomy/Astrophysics				
Atmospheric Sciences				
Behavioral/Social Science	1	1	1	1
Biological/Medical Science	1	1	1	1
Chemistry	1	1	1	1
Earth Science/Oceanography	1	1	1	1
Electronics/Electrical Engineering	3	3	3	3
Energy Conversion (non-propulsive)				
Materials	1	1	1	1
Mathematical Sciences	2	2	3 .	3
Mech., Indus., Civil & Marine Eng	2	2	2	2
Methods and Equipment	3	3	3	3
Military Sciences	3	3	3	3
Missile Technology				
Navigation, Comm., Detection/ Countermeasures				
Nuclear Science/Technology	1	1	1	1
Ordnance	3	3	3	3
Physics	1	1	1	1
Propulsion/Fuels	3	3	3	3
Space Technology	2	2	2	2

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BOOKS <u>30.000</u> PERIODICALS <u>760 ti</u> tle				<u>120,000</u> 80,000
COSATI SUBJECT CATEGORIES		ls	Technical Reports	
1 - Largest Aspect	Books	Periodicals	nep	<u>onts</u>
2 - Middle Aspect		rio	Uncl.	Class.
3 - Smallest Aspect		Pe		
Aeronautics				
Agriculture				
Astronomy/Astrophysics				
Atmospheric Sciences				
Behavioral/Social Science	3	3		
Biological/Medical Science				
Chemistry	1	1	3	3
Earth Science/Oceanography	3	3	3	3
Electronics/Electrical Engineering	2	2	1	1
Energy Conversion (non-propulsive)				
Materials	3	3	2	
Mathematical Sciences	3	3		
Mech., Indus., Civil & Marine Eng.	1	1	1	1
Methods and Equipment				
Military Sciences	2	2	3	3
Missile Technology				
Navigation, Comm., Detection/ Countermeasures	2	2	1	1
Nuclear Science/Technology	3	3	2	2
Ordnance				
Physics	3	3	3	3
Propulsion/Fuels	3	3	3	3
Space Technology				

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REPORTS, Uncl. ____35.000____ REPORTS, Class.

COSATI SUBJECT CATEGORIES		als		nical orts
1 - Largest Aspect 2 - Middle Aspect <u>3 - Smallest Aspect</u>	Books	Periodicals	Uncl.	Class.
Aeronautics	2	1	2	2
Agriculture				
Astronomy/Astrophysics				
Atmospheric Sciences				
Behavioral/Social Science				
Biological/Medical Science				
Chemistry				
Earth Science/Oceanography		1		
Electronics/Electrical Engineering	3	3		
Energy Conversion (non-propulsive)				
Materials				
Mathematical Sciences			•	
Mech., Indus., Civil & Marine Eng.				
Methods and Equipment	1	1	1	1
Military Sciences				
Missile Technology	2	2	2	2
Navigation, Comm., Detection/ Countermeasures	2	2	2	2
Nuclear Science/Technology				
Ordnance	1	1	1	1
Physics				
Propulsion/Fuels				
Space Technology	2	2	2	2

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BOOKS <u>16,000</u> PERIODICALS <u>600</u>		PORTS, FORTS,	Uncl Class,	<u>45.000</u> 15.000		
COSATI SUBJECT CATEGORIES	LI S		v Techr		nical orts	
1 - Largest Aspect	Books	Periodical	100	<u>,</u> ,		
2 - Middle Aspect		rio	Uncl.	Class.		
3 - Smallest Aspect		Pe				
Aeronautics	1	1	1	1		
Agriculture						
Astronomy/Astrophysics	1	1	1	1		
Atmospheric Sciences	1	1	1	1		
Behavioral/Social Science	3	3	3	3		
Biological/Medical Science	1	1	1	1		
Chemistry	1	1	1	1		
Earth Science/Oceanography	2	2	2	2		
Electronics/Electrical Engineering	1	1	1	1		
Energy Conversion (non-propulsive)	3	3	3	3		
Materials	1	1	1	1		
Mathematical Sciences	1	1	1	1.		
Mech, Indus., Civil & Marine Eng.	2	2	2	2		
Methods and Equipment	1	1	1]		
Military Sciences	1	1	1	1		
Missile Technology	1	1	1	1		
Navigation, Comm., Detection/ Countermeasures	3	3	1	1		
Nuclear Science/Technology	2	2	2	1		
Ordnance	3	2	1]		
Physics	1	1	1	1		
Propulsion/Fuels	1	1	1	1		
Space Technology	1	1	1	1		

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BOOKS <u>20.400</u> PERIODICALS <u>1.000</u>		PORTS, PORTS,		State of the local division of the local div
COSATI SUBJECT CATEGORIES		al s	Technical Reports	
1 - Largest Aspect	Books	Periodical	A.V.V.M	×
2 - Middle Aspect		erio	Uncl.	Class.
3 - Smallest Aspect		ਪੁੱ		
Aeronautics	3	3	3	3
Agriculture	3			
Astronomy/Astrophysics	3	3	3	3
Atmospheric Sciences	3	3	3	3
Behavioral/Social Science	1	2	3	
Biological/Medical Science	3	3	3	
Chemistry	2	1	1	1
Earth Science/Oceanography	3	3	3	3
Electronics/Electrical Engineering	2	1	1	1
Energy Conversion (non-propulsive)	3	3	3	3
Materials	1	1	2	1
Mathematical Sciences	2	3	2	2.
Mech., Indus., Civil & Marine Eng.	2	2	2	2
Methods and Equipment	2	2	2	2
Military Sciences	1	1	1	1
Missile Technology	1	1	1	1
Navigation, Comm., Detection/ Countermeasures	3	3	3	2
Nuclear Science/Technology	1	1	2	2
Ordnance	1	1	1	1
Physics	2	2	2	2
Propulsion/Fuels	3	3	2	2
Space Technology	3	3	2	2

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COLLECTION OF THE TECHNICAL INFORMATION REFERENCE BRANCH SYSTEMS ENGINEERING GROUP RESEARCH & TECHNOLOGY DIVISION WRIGHT-PATTERSON AFE, OHIO

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BOOKSREPORTS, Uncl.160,000PERIODICALSREPORTS, Class.40,000

COSATI SUBJECT CATEGORIES		als	Tech Repo	nical orts
1 - Largest Aspect 2 - Middle Aspect 3 - Smallest Aspect	Books	Periodical	Uncl.	Class.
Aeronautics			1	1
Agriculture				
Astronomy/Astrophysics			1	1
Atmospheric Sciences			1	1
Behavioral/Social Science			2	2
Biological/Medical Science			2	2
Chemistry			1	1
Earth Science/Oceanography			1	1
Electronics/Electrical Engineering			1	1
Energy Conversion (non-propulsive)			1	1
Materials			1.	1
Mathematical Sciences			1	1.
Mech., Indus., Civil & Marine Eng.			1	1
Methods and Equipment			1	1
Military Sciences			1	1
Missile Technolo			1	1
Navigation, Comm., Detection/ Countermeasures			1	1
Nuclear Science/Technology			1	1
Ordnance			1	1
Physics			1	1
Propulsion/Fuels			1	1
Space Technology			1	1

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COLLECTION OF THE TACTICAL AIR RECONNAISSANCE CENTER TECHNICAL LIBRARY SHAW AFB, SOUTH CAROLINA

BOOKS PERIODICALS	REPORTS, Uncl. REPORTS, Class.				
COSATI SUBJECT CATEGORIES		als	Technical Reports		
1 - Largest Aspect	Books	Periodicals			
2 - Middle Aspect		erio	Uncl.	Class.	
3 - Smallest Aspect		<u>Ĕ</u>			
Aeronautics	2				
Agriculture					
Astronomy/Astrophysics					
Atmospheric Sciences					
Behavioral/Social Science					
Biological/Medical Science	2				
Chemistry	2				
Earth Science/Oceanography	2				
Electronics/Electrical Engineering	2				
Energy Conversion (non-propulsive)					
Materials					
Mathematical Sciences	2		·		
Mech., Indus., Civil & Marine Eng.	2	2	2	2	
Methods and Equipment	2				
Military Sciences	2				
Missile Technology	2	2	2	2	
Navigation, Comm., Detection/ Countermeasures	2				
Nuclear Science/Technology	2				
Ordnance					
Physics	2				
Propulsion/Fuels					
Space Technology					

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COLLECTION OF THE RELIABILITY CENTRAL ROME AIR DEVELOPMENT CENTER TECHNICAL LIBRARY

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BOOKS PERIODICALS

REPORTS, Uncl. REPORTS, Class.

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COSATI SUBJECT CATEGORIES	Books Books Books	o Techn		
1 - Largest Aspect				
2 - Middle Aspect		en	Uncl.	Class.
3 - Smallest Aspect		ρ.,		
Aeronautics			· · · · · · · · · · · · · · · · · · ·	
Agriculture				
Astronomy/Astrophysics				
Atmospheric Sciences				
Behavioral/Social Science				
Biological/Medical Science				
Chemistry				
Earth Science/Oceanography				
Electronics/Electrical Engineering	1	1	1	1
Energy Conversion (non-propulsive)				
Materials				
Mathematical Sciences				•
Mech., Indus., Civil & Marine Eng.	3	3	3	3
Methods and Equipment	2	2	2	2
Military Sciences				
Missile Technology	2	2	2	2
Navigation, Comm., Detection/ Countermeasures	2	2	2	2
Nuclear Science/Technology		Sector Sector		
Ordnance				
Physics				
Propulsion/Fuels				
Space Tech. Jogy	2	2	2	2

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BOOKS PERIODICALS		PORTS, PORTS,			
COSATI SUBJECT CATEGORIES	or Tec d Re			hnical ports	
1 - Largest Aspeci	Books	Periodical	<u></u>		
2 - Middle Aspect		rio	Uncl.	Class.	
3 - Smallest Aspect		ф Ф		and the second	
Aeronautics	2	2	2	2	
Agriculture					
Astronomy/Astrophysics	2	2	2	2	
Atmospheric Sciences	2	2	2	2	
Behavioral/Social Science					
Biological/Medical Science					
Chemistry	2	2	2	2	
Earth Science/Oceanography	2	2	2	2	
Electronics/Electrical Engineering	2	2	2	3	
Energy Conversion (non-propulsive)					
Materials	3	}	3	2	
Mathematical Sciences	2	2	2	2	
Mech., Indus., Civil & Marine Eng.				·	
Methods and Equipment	2	2	2	2	
Military Sciences	2	2	2	2	
Missile Technology	2	2	2	1	
Navigation, Comm., Detection/ Countermeasures	2	2	2	2	
Nuclear Science/Technology	2	2	2	2	
Ordnance	2	2	2	2	
Physics	2	3	2	2	
Propulsion/Fuels	2	2	2	2	
Space Technology	1	2	1	2	

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COSATI SUBJECT CATEGORIES		2 5 1 1 1		nical orts		
1 - Largest Aspect	Books	eriodical	4000	<u> </u>		
2 - Middle Aspect		0irio	Uncl.	Class.		
3 - Smallest Aspect		<u>р</u> ,				
Aeronautics			3			
Agriculture	3					
Astronomy/Astrophysics	3					
Atmospheric Sciences	3	3	3			
Behavioral/Social Science	1	1				
Biological/Medical Science	1	1	1			
Chemistry	1	1	1			
Earth Science/Oceanography						
Electronics/Electrical Engineering	2	2	2			
Energy Conversion (non-propulsive)	2		2			
Materials	2	2				
Mathematical Sciences	1	1	1			
Mech., Indus., Civil & Marine Eng						
Methods and Equipment	2	2	2			
Military Sciences	3	3	3			
Missile Technology						
Navigation, Comm., Detection/ Countermeasures	3	a: Handa's - They be a second state	3			
Nuclear Science/Technology	1	1	1			
Ordnance						
Physics	1	1	1			
Propulsion/Fuels						
Space Technology	3		3			

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COLLECTION OF THE RADIATION EFFECTS INFORMATION CENTER BATTELLE MEMORIAL INSTITUTE COLUMBUS, OHIO

BOOKS PERIODICALS			DRTS, Uncl DRTS, Class		
COSATI SUBJECT CATEGORIES		s la	o Technic d Report		
1 - Largest Aspect 2 - Middle Aspect	Books	Periodicals	Uncl.	Class.	
3 - Smallest Aspect					
Aeronautics					
Agriculture					
Astronomy/Astrophysics					
Atmospheric Sciences	3	1	2		
Behavioral/Social Science					
Biological/Medical Science		<u> </u>			
Chemistry	3	2	2	2	
Earth Science/Oceanography		<u></u>			
Electronics/Electrical Engineering	3	1	1	2	
Energy Conversion (non-propulsive)					
Materials	3	1	1	2	
Mathematical Sciences		**************************************			
Mech., Indus., Civil & Marine Eng		<u></u>		· · ·	
Methods and Equipment	3	2	2		
Military Sciences		and a second set of the second s			
Missile Technology				2	
Navigation, Comm., Detection/ Counfermeasures					
Nuclear Science/Technology	3	2	2		
Ordnance					
Physics					
Propulsion/Fuels		2	2	2	
Space Technology					

COLLECTION OF THE PLASTICS TECHNICAL EVALUATION CENTER PICATINNY ARSENAL TECHNICAL LIBRARY DOVER, NEW JERSEY

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BOOKS <u>220</u> PERIODICALS <u>215</u>	RE	PORTS,	Uncl. Class.	7,500 700
COSATI SUBJECT CATEGORIES		als		nical orts
1 - Largest Aspect	Books	Periodicals		
2 - Middle Aspect		erio	Uncl.	Class.
3 - Smallest Aspect		<u>д</u>		
Aeronautics	2	2	2	2
Agriculture				
Astronomy/Astrophysics			_	
Atmospheric Sciences				
Behavio /Social Science				
Biological/Medical Science	3	3	3	3
Chemistry	2	2	2	2
Earth Science/Oceanography				
Electronics/Electrical Engineering	1	1	1	i
Energy Conversion(non-propulsive)				
Materials	1	1	1	1
Mathematical Sciences				
Mech., Indus., Civil & Marine Eng	1	1	1	1
Methods and Equipment	2	2	2	2
Military Sciences	3	3	3	3
Missile Technology	1	1	1	1
Navigation, Comm., Detection/ Countermeasures				
Nuclear Science/Technology	2	2	2	2
Ordnance	2	2	2	2
Physics	3	3	3	3
Propulsion/Fuels				
Space Technology	2	2	2	2

COLLECTION OF THE NONDESTRUCTIVE TESTING INFORMATION ANALYSIS CENTER U. S. ARMY MATERIALS RESEARCH AGENCY TECHNICAL LIBRARY WATERTOWN, MASSACHUSETTS

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COSATI SUBJECT CATEGORIES	Books	als		Technical Reports	
 Largest Aspect Middle Aspect Smallest Aspect 		Periodicals	Uncl.	Class.	
Aeronautics					
Agriculture					
Astronomy/Astrophysics					
Atmospheric Sciences					
Behavioral/Social Science					
Biological/Medical Science					
Chemistry	1	1	1	1	
Earth Science/Oceanography					
Electronics/Electrical Engineering	1	1	1	1	
Energy Conversion (non-propulsive)					
Materials	1	1	1	1	
Mathematical Sciences	1	2	3	3.	
Mech., Indus., Civil & Marine Eng.	3	3	3	3	
Methods and Equipment	3	3	3	3	
Military Sciences	2	2	2	1	
Missile Technology	3	3	3	3	
Navio ation, Comm., Detection/ Com. rmeasures					
Nuclear Science/Technology	i.	1	1	1	
Ordnance	3	3	2	2	
Physics	1	1	1	1	
Propulsion/Fuels	3	3	3	3	
Space Technology	3	3	3	3	

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COLLECTION OF THE NAVAL UNDERWATER WEAPONS RESEARCH AND ENGINEERING STATION TECHNICAL LIBRARY NEWPORT, RHODE ISLAND

BOOKS <u>10.000</u> PERIODICALS <u>345</u>			Uncl. Class.	
COSATI SUBJECT CATEGORIES		als	Technical Reports	
1 - Largest Aspect 2 - Middle Aspect	Books	Periodicals	Uncl.	Class.
3 - Smallest Aspect		Ъе		
Aeronautics		····		
Agriculture	}	-		
Astronomy/Astrophysics				
Atmospheric Sciences				
Behavioral/Social Science				
Biological/Medical Science				
Chemistry				
Earth Science/Oceanography	2	2	2	2
Electronics/Electrical Engineering	1	2	2	2
Energy Conversion(non-propulsive)	3	3	3	3
Materials	3	3	3	3
Mathematical Sciences			·	
Mech., Indus., Civil & Marine Eng	2	1	3	3
Methods and Equipment				
Military Sciences	3	1	3	3
Missile Technology	2	1	2	2
Navigation, Comm., Detection/ Countermeasures	1	2	1	1
Nuclear Science/Technology	2	2.	2	2
Ordnance	2	2	1	1
Physics	1	1	3	3
Propulsion/Fuels	3	3	3	3
Space Technology				

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BOOKS <u>9,500</u> PERIODICALS <u>467</u>		PORTS, PORTS,		44,000
COSATI SUBJECT CATEGORIES		Periodicals	Technical Reports	
1 - Largest Aspect	Books	dic		
2 - Middle Aspect		erio	Uncl.	Class.
3 - Smallest Aspect		ਖੁੱ		
Aeronautics	3	3	3	
Agriculture				
Astronomy/Astrophysics	3	3		
Atmospheric Sciences		3	3	
Behavioral/Social Science	3	3	3	
Biological/Medical Science	3		3	
Chemistry	3	3		
Earth Science/Oceanography	1	1	1	1
Electronics/Electrical Engineering	1	1	1	
Energy Conversion(non-propulsive)	3		3	
Materials	3	3	3	
Mathematical Sciences	2	2	2	
Mech., Indus., Civil & Marine Eng.	1	1	1	
Methods and Equipment	3	3	3	
Military Sciences	3	3	3	3
Missile Technology	1	1	1	1
Navigation, Comm., Detection/ Countermeasures	1	1	1	1
Nuclear Science/Technology	1	1	1	
Ordnance	2	2	2	2
Physics	1	1	1	1
Propulsion/Fuels	2	2	2	
Space Technology	3	3		

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BOOKS100,000_ PERIODICALS1,400_1it			Uncl Class	250.000	
COSATI SUBJECT CATEGORIES		als	প Technic রি <u>Reports</u>		
1 - Largest Aspect 2 - Middle Aspect 3 - Smallest Aspect	Books	Periodicals	Uncl.	Class.	
Aeronautics	3	3	3	3	
Agriculture					
Astronomy/Astrophysics	2	2	2	2	
Atmospheric Sciences	2	2	2	2	
Behavioral/Social Science					
Biological/Medical Science	3	3	3	3	
Chemistry	2	2	2	2	
Earth Science/Oceanography	2	2	2	2	
Electronics/Electrical Engineering	1	1	1	1	
Energy Conversion (non-propulsive)	3	3	3	3	
Materials	3	3	3	3	
Mathematical Sciences	2	2	2	2.	
Mech., Indus., Civil & Marine Eng	2	2	2	2	
Methods and Equipment					
Military Sciences					
Missile Technology	3	3	3	3	
Navigation, Comm., Detection/ Countermeasures	1	1	1	1	
Nuclear Science/Technology	2	2	2	2	
Ordnance	3	3	3	3	
Physics	1	1	1	1	
Propulsion/Fuels	3	3	3	3	
Space Technology	2	2	2	2	

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COSATI SUBJECT CATEGORIES		Periodicals	1	nical orts
1 - Largest Aspect	Books	odic		C 11
2 - Middle Aspect		eri	Uncl.	Class.
3 - Smallest Aspect		<u>д</u>		
Aeronautics	3	. <u>.</u>		
Agriculture	3			
Astronomy/Astrophysics	2			
Atmospheric Sciences	2			
Behavioral/Social Science	3			
Biological/Medical Science	1			
Chemistry	1			
Earth Science/Oceanography	2			
Electronics/Electrical Engineering	3			
Energy Conversion (non-propulsive)				
Materials	3			
Mathematical Sciences	2		· .	
Mech., Indus., Civil & Marine Eng	3			
Methods and Equipment				
Military Sciences	2			
Missile Technology	3			
Navigation, Comm., Detection/ Countermeasures	1			
Nuclear Science/Technology	1			
Ordnance				
Physics	1			
Propulsion/Fuels	3			
Space Technology	3			

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COSATI SUBJECT CATEGORIES		S I d		nical orts
1 - Largest Aspect	Books	Periodicals		<u> </u>
2 - Middle Aspect		rio	Uncl.	Class.
3 - Smallest Aspect		ੁੱ ਦ		
Aeronautics	1	1	1	1
Agriculture	3	3	3	3
Astronomy/Astrophysics	2	2	2	2
Atmospheric Sciences	2	2	2	2
Behavioral/Social Science	ì	1	1	1
Biological/Medical Science	2	2	2	2
Chemistry	1	1	1	1
Earth Science/Oceanography	1	1	1	1
Electronics/Electrical Engineering	1	1	1	1
Energy Conversion (non-propulsive)	1	1	1	1
Materials	1	1	1	1
Mathematical Sciences	1	1	1	l
Mech., Indus., Civil & Marine Eng	1	1	1	1
Methods and Equipment	1	1	1	1
Military Sciences	1	1	1	1
Missile Technology	1	1	1	1
Navigation, Comm., Detection/ Countermeasures	l	1	1	1
Nuclear Science/Technology	1	1	1	I
Ordnance	1	1	1	1
Physics	1]	1	I
Propulsion/Fuels	1	1	1	1
Space Technology	1	1	l	1

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2 - Middle Aspect 3 - Smallest Aspect		Peni	Uncl.	Class.
Aeronautics		3		3
Agriculture				
Astronomy/Astrophysics				
Atmospheric Sciences				
Behavioral/Social Science	1	1	1	
Biological/Medical Science		3	3	
Chemistry				
Earth Science/Oceanography		3		
Electronics/Electrical Engineering		3	3	
Energy Conversion (non-propulsive)				
Materials				
Mathematical Sciences	1	2	2	
Mech., Indus., Civil & Marine Eng.				
Methods and Equipment			3	
Military Sciences		2		1
Missile Technology				3
Navigation, Comm., Detection/ Countermeasures		3		1
Nuclear Science/Technology		3		3
Ordnance				<u> </u>
Physics				
Propulsion/Fuels	l			
Space Technology	L	3		

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COSATI SUBJECT CATEGORIES		cals	Technical Reports	
 Largest Aspect Middle Aspect Smallest Aspect 	Books	Periodicals	Uncl.	Class.
Aeronautics	1	1	1	1
Agriculture				
Astronomy/Astrophysics	3	3	3	3
Atmospheric Sciences	3	3	3	3
Behavioral/Social Science	2	2	2	2
Biological/Medical Science				
Chemistry	1	1	1	1
Earth Science/Oceanography	3	2	2	2
Electronics/Electrical Engineering	1	1	1	1
Energy Conversion (non-propulsive)				
Materials	2	2	2	2
Mathematical Sciences	1	1	1	1
Mech., Indus., Civil & Marine Eng	2	2	2	2
Methods and Equipment				
Military Sciences	2	2	2	2
Missile Technology	1	1	1	1
Navigation, Comm., Detection/ Countermeasures				1
Nuclear Science/Technology	3	3	3	3
Ordnance	l	1	1	1
Physics	1	1	1	1
Propulsion/Fuels	1	1	1	l
Space Technology	2	2	2	2

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COSATI SUBJECT CATEGORIES 1 - Largest Aspect		icals	Technical Reports	
2 - Middle Aspect 3 - Smallest Aspect	Books	Periodicals	Uncl.	Clāšs.
Aeronautics	2	3	3	3
Agriculture				
Astronomy/Astrophysics		3		
Atmospheric Sciences	3		3	3
Behavioral/Social Science				······································
Biological/Medical Science				
Chemistry	1	1	3	1
Earth Science/Oceanography	3	3	3	3
Electronics/Electrical Engineering	1	1	1	2
Energy Conversion (non-propulsive)				
Materials	2	2	2	2
Mathematical Sciences	1	2	3	·
Mech., Indus., Civil & Marine Eng			3	3
Methods and Equipment			2	2
Military Sciences	2		3	3
Missile Technology	3	3	2	1
Navigation, Comm., Detection/ Countermeasures	3	3	3	2
Nuclear Science/Technology	2	3	3	3
Ordnance	3	3	1	1
Physics	l	1	2	1
Propulsion/Fuels			3	2
Space Technology	3	3	3	3

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BOOKS PERIODICALS

REPORTS, Uncl. REPORTS, Class.

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COSATI SUBJECT CATEGORIES		als		mical orts
 Largest Aspect Middle Aspect Smallest Aspect 	Books	Periodicals	Uncl.	Class.
Aeronautics	2	2	2	
Agriculture				
Astronomy/Astrophysics	2	3		2
Atmospheric Sciences	2	3		2
Behavioral/Social Science	3	3		
Biological/Medical Science	3	3		
Chemistry	1	1	3	1
Earth Science/Oceanography	3			3
Electronics/Electrical Engineering	1	1	1	1
Energy Conversion(non-propulsive)	3		3	2
Materials	2	3	3	
Mathematical Sciences	1	1	1	
Mech., Indus., Civil & Marine Eng	l	1	2	2
Methods and Equipment	2		2	2
Military Sciences	3		1	1
Missile Technology	1	1	1	1
Navigation, Comm., Detection/ Countermeasures	1	2		1
Nuclear Science/Technology	2	2		2
Ordnance	2	3	2	2
Physics	1	!	1	1
Propulsion/Fuels	2		2	2
Space Technology	2	2		2

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BOOKS <u>100,000</u> PERIODICALS <u>over 600 in</u>		PORTS, PORTS,		
COSATI SUBJECT CATEGORIES		S C	Technical Reports	
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2 - Middle Aspect		0 L	Uncl.	Class.
<u>3 - Smallest Aspect</u>		<u>د</u>	 	
Aeronautics	3	3		3
Agriculture	3	3		3
Astronomy/Astrophysics	3	3		3
Atmospheric Sciences	3	3		3
Behavioral/Socia! Science				
Bielogical/Medical Science	2	2		2
Chemistry				
Earth Science/Occanography	1	1		1
Electronics/Electrical Engineering	2	2		2
Energy Conversion (non-propulsive)				
Materials				
Mathematical Sciences	2	2		2
Mech , Indus., Civil & Marin Eng				
Methods and Equipment	2	2		2
Military Sciences				
Missile Technology				
Navigation, Comm., Detection/ Countermeasures	3	3		3
Nuclear Science/Technology	3	3		3
Ordnance				ļ
Physics	3	3		3
Propulsion/Fuels				
Space Technology	3	3		3

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COSATI SUBJECT CATEGORIES 1 - Largest Aspect	Licals		Technical Reports		
2 - Middle Aspect 3 - Smallest Aspect	Books	Periodicals	Uncl.	Class.	
Aeronautics	1	1	1	l	
Agriculture	3		3	3	
Astronomy/Astrophysics	1	1	1	1	
Atmospheric Sciences	1	1	2	2	
Behavioral/Social Science	2	2	2	2	
Biological/Medical Science	2	2	2	2	
Chemistry	3	3	3	3	
Earth Science/Oceanography	1	1	1	1	
Electronics/Electrical Engineering	1	1	1	1	
Energy Conversion(non-propulsive)	3	3	3	3	
Materials	2	2	2	2	
Mathematical Sciences	1	1	1	1	
Mech., Indus., Civil & Marine Eng.	2	2	2	2	
Methods and Equipment					
Military Sciences	3	3	3	3	
Missile Technology	1	1	1	1	
Navigation, Comm., Detection/ Countermeasures	2	2	2	2	
Nuclear Science/Technology	3	3	3	3	
Ordnance	3	3	3	3	
Physics	1	1	1	1	
Propulsion/Fuels	2	2	2	2	
Space Technology	1	1	1	1	

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COLLECTION OF THE U. S. NAVAL CIVIL ENGINEERING LABORATORY TECHNICAL LIBRARY FORT HUENEME, CALIFORNIA

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BOOKS PERIODICALS		PORTS, PORTS,		
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The Technical Library has developed a unique semimechanized process for the production of catalog cards, charge cards, card pockets, and accessions lists, and a machine-readable punched paper tape record for a future computer-produced book catalog. This system was originally based on a special purpose digital processor, called the Crossfiler, which multiplies catalog card records, inputed on punched paper tape and supplies entry headings for each of the copies. Actual printing is done on a Flexowriter. The Library recently began employing the PDP-1 computer to perform this task and has phased out the Crossfiler. A periodical control system is being developed utilizing the Laboratory's IBM 7044 computer. The library plans to convert its paper tape records to magnetic tape for computer production of a book catalog and computer-run retrospective searches.

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The Army Map Service (A^{MS}) Library uses a Univac 1004 computer to produce map accessions lists and bibliographies from punched cards containing printed text. Also data on a Map Reproduction (Repromat) File are punched onto cards and transferred to magnetic tape on a Honeywell H-800 computer. This tape is used to produce a high-speed printout of the Repromat Tabulation semiannually and a monthly listing to update the semiannual tabulation. It is felt that the mechanized Repromat File system should be modified in a number of ways for greater efficiency.

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The Edgewood Arsenal Technical Library uses a retrieval system designed and developed for the Library by a contractor. The contractor indexes and processes documents on punched cards, and tapes generated on the Contractor's IBM 1401 are converted to Honeywell 200/400 tapes for use on EA's Honeywell computer by National Institutes of Health and Army Map Service. Search outputs enable the user to obtain desired items from the Library by use of the pertinent call numbers. The addition of an alphabetic printout capability of the existing system is now in the operational testing stage. The hopes of the designers of the system to provide half-day response to user questions have thus far been frustrated by several factors, including the high cost of operating the system and its low speed.

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Mechanization Study of the Army Study Documentation and Informa- tion Retrieval System, U.S. Army Library, Washington, D. C.
Final Report of on-site survey
C. A. Kershaw, D. Crowder, J. E. Davis, E. G. Loges, E. Merendini, S. M. Thomas
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The objectives of the Army Study Documentation and Information Retrieval System(ASDIRS) are to provide a central library of Army studies readily accessible in the Pentagon. At the present time, a bibliographic quarterly catalog of Army studies and a permuted descriptor/title index are provided. The catalog of Army studies is produced using an IBM 1401 computer, and the permuted descriptor title index to the catalog is produced using an IBM 7090 computer. The central library of Army studies will provide a reference card file and the Termatrex retrieval system for easy subject access to the collection. The bibliographic catalog is distributed Army-wide and has been favorably received.

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Seven of the facilities stored their thesauri in computer memory and used them for automatic error control and/or code conversion for natural language input. Only three found links and roles to be worth the added programming complexity.

Eighteen facilities stored their search files in an inverted form (e.g., a file ordered by descriptors) and four in the direct form (e.g., a file ordered by accession numbers). Searching a direct file can be a long procedure since the file must include a record for each acquisition in the library. Each of these records must be searched in serial sequence to determine if it has the desired combination of descriptors. An inverted file, on the other hand, has one record for each descriptor and, therefore, is only as long as the descriptor thesaurus. Furthermore, a search can be confined to only those descriptors of interest. Searching this latter type of file, however, requires a more sophisticated program (see Section VI, "File Structure"), but the total search time can be much shorter. For this reason, the use of direct files in mechanized searching is unusual, although direct files are often used after an inverted file search in order to obtain bibliographic information relative to the retrieved accession numbers.

Two kinds of retrieval system philosophics which employ a direct file search were encountered. One (e.g., NPS) is a

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programs that serve a multitude of facilities. (These generalized programs represent a considerable cost economy, since a single program development can be used by several facilities. The generalized program approach can make the difference between being able to justify and afford a mechanized search process, and having none at all.)

Almost all of the libraries complained of a poor understanding of library problems on the part of the programmers, and, in general, the programmers criticized the librarians for not understanding the potentials and limitations of computer applications. Poor communications between librarian and programmer can be blamed for many of the system development problems experienced. Some of these problems manifested themselves only after the system was operating and improvements more difficult to undertake. For example, Boolean search capabilities were sometimes designed into the retrieval program with severe, although emintentional, limitations. One such limitation was the inability of the program to relate both the AND and the OR operators. Also, the capability for search complexity often seemed far more sophisticated than necessary to satisfy the actual user's needs.

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