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AFOSR 68-0244
FINAL SCIENTIFIC REPORT

RETRIEVAL OF TECHNICAL DOCUMENTS

by

Lea M. Bohnert

for

Director of Information Sciences
Air Force Office of Scientific Research

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TEXTBOOK OUTLINE

RETRIEVAL OF TECHNICAL DOCUMENTS

By Lea M. Bohnert

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Introduction

The aim of this textbook is to present the common and usual features of retrieval work, wherever performed and whatever called, for the guidance of students and laymen and as a basis for further research by retrieval and library experts.

There are many new labels for library work. Some examples, arranged alphabetically, are "data retrieval", "document retrieval", "documentation", "information science", and "information storage and retrieval". Some experts claim that these activities represent two or more disciplines under these diverse labels. Others, including the author, claim that one distinct activity is common to most of these activities.

The work experience of the author totals twenty-five years and includes seventeen years of operating experience, more than three years of research, five years of consulting, and ten years of teaching, the last activity on a part-time basis until the fall of 1967.* The operating experience was of a practical nature, and in industrial and governmental research laboratories or agencies. The author became conditioned to look for the common features, the minimum conditions, for an activity to be considered retrieval work.

Therefore, a retrieval model has been developed and tested on the basis of the work experience, analysis of recorded descriptions of operating retrieval services, and extensive and intensive discussions with colleagues and students, two groups that share many members.

* Since September, 1967, the author has been an Assistant Professor in the Graduate School of Library Science at the State University of New York at Albany.

There are many handicaps and difficulties in trying to identify and to describe a common core for the many apparently diverse activities. In modern society, there is an increasing proliferation of services, of choices. One learns to notice the small differences, the nuances, in a complex world. Two additional distractions are the curse of constantly changing terminologies and the bane of new equipment that obsoletes its predecessors and demands to be used. It is always dangerous to start with answers instead of questions.

The scope of the retrieval services studied and analyzed are those handling technical documents. This results in an emphasis on complex subject matter and the use of new equipment. However, the basic characteristics of library work can be perceived in technical document retrieval work.

The objective in this textbook is the description in clear and elementary language of the activities usually performed by retrieval services. Once the "usual" (the next most important word to "retrieval" in this book) has been identified and investigated, then the more complex and sophisticated kinds of retrieval services can be described and studied.

Elegance and brevity have been deliberately sacrificed to explicitness and clarity. No new terminology is introduced. Instead a few generally known and accepted terms have been sharpened up a little, and then used as consistently as possible by the author, with a few colleagues doublechecking.

A self-imposed limitation is the use of as precise and as concrete words as possible. For instance,

1. the word "document" instead of "information",
2. the word "reader" instead of "user",
3. the word "service" instead of "system",
4. the word "retrieval" instead of "information storage and retrieval",
5. the word "appropriate" instead of "relevant" with documents.

There are a number of major themes, or contentions, that run through the textbook.

1. The first theme is that library and retrieval work are identical.
2. The second theme is that document requests are the key to retrieval work.
3. The third theme is that subject document requests are a peculiar kind of document request that provides a minimum description of the document being requested.
4. The fourth theme is that microfilming technology has provided so far the most useful equipment for retrieval work, principally in the storage and reproduction of documents.
5. The fifth theme is that data processing technology is increasingly proving its usefulness in retrieval work, principally in the preparation and matching of property control and index records.
6. The sixth theme is that "data retrieval" is a special kind of document retrieval.

Method

The bare bones of the model stick out from this uncompleted manuscript even more than they probably will from the next draft, the one designed hopefully for book publication. Cartoons, diagrams and tables have been used to make even more obvious the joints of the model. However, it is believed that this presentation of the textbook will serve to test fully and severely the worth of the approach chosen.

The retrieval model consists of four parts. First, there is a definition of retrieval based on;

1. a version of the Shannon general communication model modified for retrieval purposes;
2. an appreciation of Mooers' insight, recorded in 1950, that retrieval work is activated by the destination, or would-be receiver of a recorded message;
3. an extrapolation of Fairthorne's "marking and parking" analysis to retrieval records and procedures.

The second part of the retrieval model is the specification of the two functions, the two purposes, of retrieval. One function covers all the activities resulting in the identification of appropriate documents, if any exist, upon receipt of a document request. These activities will be called "searching".

The other function covers all activities resulting in the delivery of one or more copies of identified documents, if any copies are available through the particular retrieval service. These activities will be called "locating".

Retrieval work is analyzed in terms of making possible, or carrying out, either or both of the two retrieval functions. Cataloging and indexing are considered preparations for searching. Acquisition and shelving are considered preparations for locating.

The third part of the retrieval model consists of the four physical objects of main interest in retrieval work, namely, the four kinds of records.

They are called "documents", "document substitutes", "retrieval aids", and "data", which are documents composed of items of equal interest to readers.

Document requests do not rate as a fifth kind of record because they can be considered throughout retrieval work as "pretend" or "shadow" documents until the existence of documents fulfilling such requirements is proved or disproved. It is better to consider them as retrieval aids.

Finally, the fourth and last part of the retrieval model consists of the five basic operations, the manipulations, performed upon the four kinds of retrieval records. They are called "preparation", "matching", "transportation", "storage", and "reproduction".

All of them are employed in carrying out various types of retrieval work but two must be employed in order to distinguish retrieval from other message

delivery services, such as the postal and telephone service. The two are matching, or screen, and storage or delay. The employment of those two ensure that the reader determines what and when he wants to read.

The rest of the textbook follows from the bare bones of the retrieval model explained and described in the first three chapters. Chapter IV, "Significance of Technical Document Retrieval", describes the unique characteristics of retrieval work performed with technical documents for technical readers.

After two general chapters, Chapter V, "Kinds of Technical Documents", and Chapter VI, "Document Retrieval Processes", there are seven chapters that take up the application of the five operations to each of the four kinds of retrieval records.

Chapter VII. Preparation of Technical Documents.

Chapter VIII. Processing Technical Documents.

Chapter IX. Kinds of Document Substitutes.

Chapter X. Processing Document Substitutes

Chapter XI. Kinds of Retrieval Aids.

Chapter XII. Processing Retrieval Aids.

Chapter XIII. Processing Items in Documents.

The last two chapters are general in nature.

Chapter XIV. General and Special Purpose Equipment.

Chapter XV. Design and Improvement of Retrieval Services.

Chapter XIV is a survey of equipment from the viewpoint of actual applications to retrieval work. A history of equipment of retrieval interest is presented as Appendix C in tabular form with citations for the applications of each type of equipment to retrieval work. The benefit of the historical approach for students and laymen is that it helps to explain the available equipment in terms of proven use to retrieval work. "Nothing clears the mind...." * like attempting to specify exactly how a specific type of equipment is useful in a particular job.

* Dr. Samuel Johnson, "Nothing clears the mind so much as the knowledge that you are going to be hanged in the morning."

Introduction

page 12

Chapter XV attempts to show some of the practical benefits to operating retrieval services of using the approach presented in this textbook.

Acknowledgements

First and foremost, I wish to thank the Air Force Office of Scientific Research for making it possible for me to concentrate for the last two years on the development of a retrieval model for teaching and research purposes. The foresightedness and bravery of Dr. Harold Wooster, AFOSR Director of the Information Sciences, are well-known. I hope this textbook will testify more to the former than to the latter characteristic.

I also wish to thank Mrs. Rowena Swanson of the AFOSR for her early insistence that I devote at least one full chapter to equipment. I trust that the fact that Appendix C, History of Equipment of Retrieval Interest, now occupies more than a third of the pages of this manuscript will not alarm her.

Finally, but most important, I wish to thank the two monitors of my AFOSR contract, Captain Thomas K. Burgess and Captain Eliot Sohmer, for constant patience and optimism. Especially, I would like to thank Captain Sohmer

who has had to monitor the second year of the contract during which the worst and best expectations often became realities.

Next, I would like to thank the consultants who officially and practically advised me throughout the two years of the AFOSR contract. They were:

1. Robert A. Fairthorne
2. Madeline Berry Henderson
3. Calvin N. Mooers
4. John O'Connor
5. Alan M. Rees

Of them all, Mr. Fairthorne will have to bear the most responsibility for the author being sometimes more right than wrong.

Among the many unofficial consultants, I will mention only my debt to Mr. Robert T. Jordan because of his endless care in rephrasing my vaguest thoughts into practical points for discussion.

C-E-I-R INC. shared the cost of the second AFOSR contract. I wish to thank the contract manager, Mr. H. F. Woodbury, the technical advisor, Dr. W. Simonson, and the librarian, Mrs J. Schmid, who abetted me in large and small matters.

Most of all, I owe appreciation to the nearly 300 students who have taken my courses over the last ten years. They have allowed me to present half-baked ideas and have not hesitated to help in the final cooking. In particular, I would like to thank Mr. Jackson Davis, a graduate student at the School of Library Science of the State University of New York at Albany. For the last six months, he has contributed changes, big and small, to the construction of the textbook.

DEFINITION OF RETRIEVAL

Summary

"Retrieval" is defined as the processes performed by a documentation, or recorded message delivery, service that provides documents only upon request by a potential reader or destination. The definition is based on the classic communication model of Dr. Claude E. Shannon.

The characteristics of recorded communication are described and diagrammed.

Finally, three other message delivery services are compared with the working methods of libraries or retrieval offices.

A. Definition of Retrieval

Retrieval work is defined as the processes performed by a recorded message, or document, delivery service that provides documents only upon request by a destination or a potential reader. The requestor is usually the person who wishes to read the document.

In 1950, Calvin N. Mooers described the unique characteristic of retrieval work. "In information retrieval, the addressee or receiver rather than the sender is the active party."* This is unusual because most message delivery services, such as postal and telephone services, perform work at the direction of the originators, or sources, of the messages.

* Mooers, Calvin N., "Information Retrieval Viewed as Temporal Signalling", Proceedings of the International Congress of Mathematicians, Sixth Congress, Cambridge, Massachusetts, August 30 - September 6, 1950; Vol. 1, Providence, Rhode Island, American Mathematical Society, 1952.

B. Definition of Documentation

Documentation work is defined as the services providing regular assistance in delivering recorded messages to individuals. To require delivery, a recorded communication must have at least one destination that is different from the source of the message. Recorded communications intended only for the individual who has originated them usually do not require delivery services.

IF PERMISSION IS GRANTED, a "Blondie" cartoon,
dated 6/12/67, by
Chic Young,
WILL APPEAR IN THIS SPACE

C. Communication Model

The concept of documentation as a message delivery service, and the definition of retrieval, are based on the classic communication model developed by Dr. Claude E. Shannon of the Bell Telephone Laboratories.

According to Dr. Shannon, "By a communication system we will mean a system of the type indicated schematically in Figure 1. It consists of essentially five parts:

1. An information source which produces a message or sequence of messages to be communicated to the receiving terminal.
...
2. A transmitter which operates on the message in some way to produce a signal suitable for transmission over the channel.
...
3. The channel is merely the medium used to transmit the signal from transmitter to receiver During transmission, or at one of the terminals, the signal may be perturbed by noise. This is indicated schematically in Figure 1 by the noise source acting on the transmitted signal to produce the received signal.
4. The receiver ordinarily performs the inverse operation of that done by the transmitter, reconstructing the message from the signal.
5. The destination is the person (or thing) for whom the message is intended."*

Shannon's Figure 1 is shown as Diagram 1 on page 5.

* Shannon, Claude E., "The Mathematical Theory of Communication". In Shannon, Claude E. and Weaver, Warren, The Mathematical Theory of Communication. Urbana; The University of Illinois Press, 1949, pages 4-6.

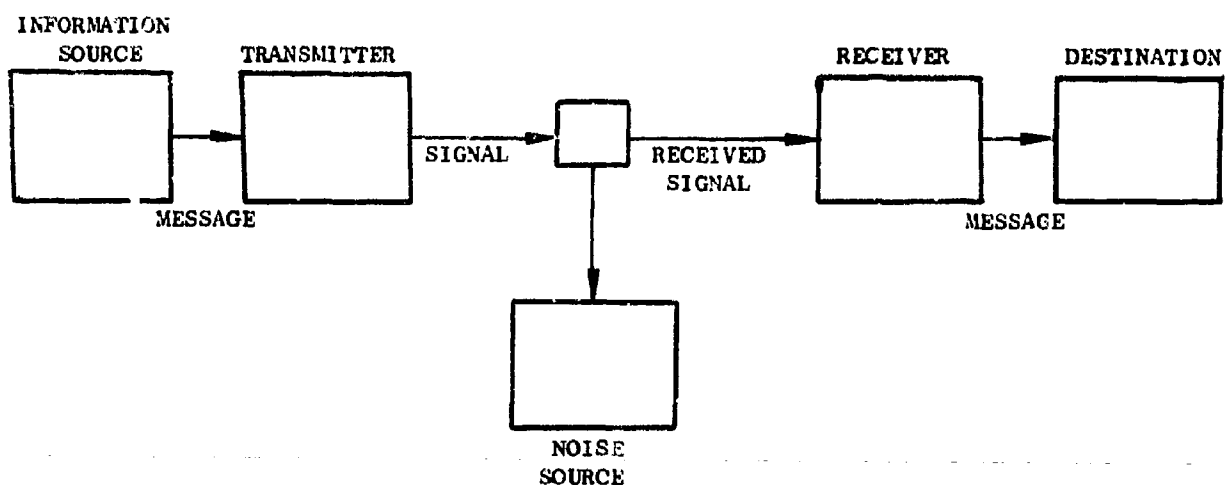


Diagram 1 - "Schematic diagram of a general communication system"

Shannon, Claude E., "The Mathematical Theory of Communication."
In Shannon, Claude E. and Weaver, Warren The Mathematical Theory
of Communication. Urbana: The University of Illinois Press,
1949, page 5, Fig. 1.

Documentation Services also have the same five parts.

1. The source is the individual who is the author or the producer of the recorded message.
2. The transmitter is the activity of writing or printing the message.
3. The channel consists of the means of physical transport used for delivery of the recorded message. Noise is the errors made in "writing" the message. These are mostly typographical errors and sometimes, mutilation or deterioration of the message that makes reading difficult or impossible.
4. The receiver is the activity of reading the message.
5. The destination is the individual who reads the message.

D. Definition of Document

A document is defined for retrieval purposes as a physical representation of a message that can be stored and transmitted. Communications usually have to be recorded, if only briefly as in telephone conversations, in order to be transported over time and distance. However, telephone messages are only temporarily recorded for transporting purposes. Therefore, they cannot be retrieved. Unrecorded communications, such as most face-to-face conversations and flag signals, are not considered documents by this definition.

Documents are intended to be read or heard. At least, reading is the reason why documentation services deliver messages to destinations. This is the case, even though it is well known that documents have more than one use, some decorative and some functional. Documentation services seldom provide documents to be used as prestige items or as blunt objects.

IF PERMISSION IS GRANTED, A "Wizard of Id" cartoon,
dated 6/30/67, by C. Parkers,
WILL APPEAR IN THIS SPACE

E. Recorded Communication Model

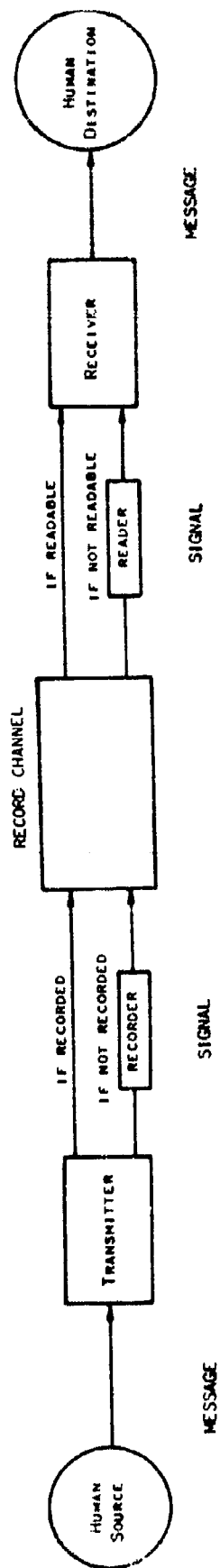
A number of changes have to be made in the Shannon model of a "general communication system" (See Diagram 1 on page 20) to narrow its application to only recorded communications. First, the source and destination are required to be human beings, and this change is indicated by drawing circles around "Human Source" and "Human Destination". (See Diagram 2 on page 25.)

Second, a record channel is established between the transmitter of the source and the receiver of the destination. The channel accepts only "recorded" signals and the receiver only accepts "readable" signals.

If the signal produced by the source is not recorded, it must go through some sort of recording process before it can be accepted by the record channel.

Furthermore, if the recorded signal that has been transported is not readable, then the signal must be made readable before it can be delivered.

DIAGRAM 2



RECORDED COMMUNICATION MODEL

F. Description of Documentation Services

In modern society, documentation services such as telephone companies and postal services are big business. To demonstrate how library or retrieval services are similar and dissimilar to some of the better known recorded message delivery services, a comparative chart of four documentation services has been prepared. (See Table 1, Minimum Operating Conditions for a Recorded Message to be Delivered by Four Services, on page 27.)

By definition, documentation services physically transport a recorded message from some source to some destination. As a minimum, documentation personnel must be able to handle the physical forms in which messages are submitted for delivery and in which they are expected to be delivered. They usually receive and deliver the same physical kind of recorded messages.

CHAPTER 1

TABLE 1.

MINIMUM OPERATING CONDITIONS FOR A RECORDED MESSAGE TO BE DELIVERED BY

	A. NUMBER OF SOURCES	B. ADDRESS OF SOURCE KNOWN TO:		C. MESSAGE DELIVERY INITIATED BY:		D. ADDRESS OF SERVICE KNOWN TO:		A.
		A. DESTINATION	B. SERVICE	A. SOURCE	C. SERVICE	A. SOURCE	B. DESTINATION	
1. TELEPHONE SERVICE	ONE	NO	YES	YES	NO	NO	NO	
2. POSTAL SERVICE	ONE	NO	NO	YES	NO	NO	YES	NO
3. BROADCASTING STATIONS (RADIO AND TV)	ONE	NO	YES	NO	NO	YES	YES	YES
4. MAIL SERVICE	ONE	NO	YES	NO	YES	NO	NO	YES

A

OPERATING CONDITIONS FOR A RECORDED MESSAGE TO BE DELIVERED BY FOUR SERVICES

G. MESSAGE DELIVERY INITIATED BY:			D. ADDRESS OF SERVICE KNOWN TO:		E. TIME OF DELIVERY DETERMINED BY:			F. PLACE OF DELIVERY DETERMINED BY:			G. ADDRESS OF DESTINATION KNOWN TO:		H. NUMBER OF DESTINATION:
SOURCE	C. SERVICE		A. SOURCE	H. DESTINATION	A. SOURCE	C. SERVICE		A. SOURCE	C. SERVICE		A. SOURCE	B. SERVICE	
B. DESTINATION			B. DESTINATION			D. DESTINATION							
YES	NO	NO	NO	NO	YES	NO	NO	NO	YES	NO	YES	YES	ONE
YES	NO	NO	YES	NO	NO	NO	YES	NO	YES	NO	YES	YES	ONE
NO	NO	YES	YES	YES	NO	NO	YES	NO	YES	NO	NO	NO	MANY
NO	YES	NO	NO	YES	NO	YES	NO	NO	YES	NO	YES	YES	ONE

B

The examples of documentation services shown in Table 1 on page 27 are telephone service, postal service, broadcasting stations, and library service. They differ from each other in several ways. For instance, the first two perform work at the request of the originators of the messages. The third, broadcasting stations, perform work at their own direction in the hope that the destinations will like the messages sent them. The fourth, retrieval, does its work at the request of the destination.

Sometimes one-to-one communication is provided, as by mail and telephone services. Sometimes one-to-many communication is provided, as by radio and television.

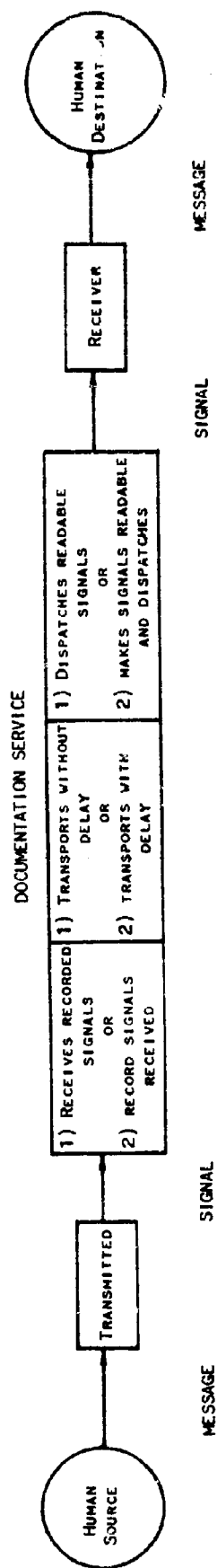
To deliver recorded messages, service personnel in documentation services must know something about the sources and a good deal about the destinations of the messages. If they know little of one, they try to compensate by knowing more about the other.

Reproduction and storage operations are frequently employed in documentation services. Time delays are inevitable in both the recording and transporting of messages. Queueing is common. Letters wait in mail boxes until picked up at scheduled times. Books wait on library shelves until removed for reading.

Message delivery services also differ as to who determines the time and place for the message delivery. Sources and destinations are often the active agents, or deciders, in message delivery. Sometimes service personnel determine the time when messages are to be delivered over radio and television channels. However, the place of delivery is determined by the destination, the owner of the radio or television receiving equipment.

Diagram 3 on page 30 represents the usual sequence of message delivery by documentation services.

DIAGRAM 3



DOCUMENTATION SERVICES MODEL

DESCRIPTION OF RETRIEVAL WORK

Summary

Retrieval personnel perform two functions upon request of a potential reader, the identification of appropriate documents and the delivery of one or more copies. There are three constant handicaps in retrieval work; not knowing who will request a document, nor when the request will be made, nor how the request will be phrased, until it is made.

To perform retrieval work, four kinds of records have to be manipulated. They will be called "documents", "document substitutes", "retrieval aids", and documents composed of equally important items, or "data". The physical work performed on the four kinds of records by retrieval personnel can be analyzed into either "parkings" or "markings".

There are five basic operations that combined in various ways result in retrieval work being performed. The operations will be called "preparation", "transportation", "matching", "storage", and "reproduction".

Summary (continued)

There are numerous retrieval processes, such as acquisition, indexing, searching, dissemination, and circulation. These can be analyzed in terms of combinations of various of the five operations being applied to the four kinds of retrieval records.

There are two themes running through retrieval work. One is subject analysis that mainly affects selection, indexing, searching, and evaluating procedures. The other is application of equipment. Equipment mainly affects the accounting of property, and the storage and reproduction of documents. Microfilming and data processing are the two technologies that have proved most useful.

Summary (continued)

Historically "personal retrieval" came before the establishment of retrieval services to provide regular assistance to organized groups of individuals.

Retrieval services differ considerably from personal retrieval because a number of viewpoints have to be accommodated.

Unfortunately, there are few sources for recorded descriptions of operating document retrieval services. The best source is the National Science Foundation's series of pamphlets, "Nonconventional Technical Information Systems in Current Use", that started in 1957.

A. Two Functions of Retrieval

Upon request of a potential reader, retrieval personnel perform two functions.

- (1) The identification of appropriate documents, if any are known to exist.
- (2) The delivery of one or more copies, if any are available.

Retrieval work is based on the receipt of document requests from authorized customers of the retrieval service. Before appropriate documents can be identified in response to a document request, retrieval personnel must either know of their existence or know of methods to determine if they do exist.

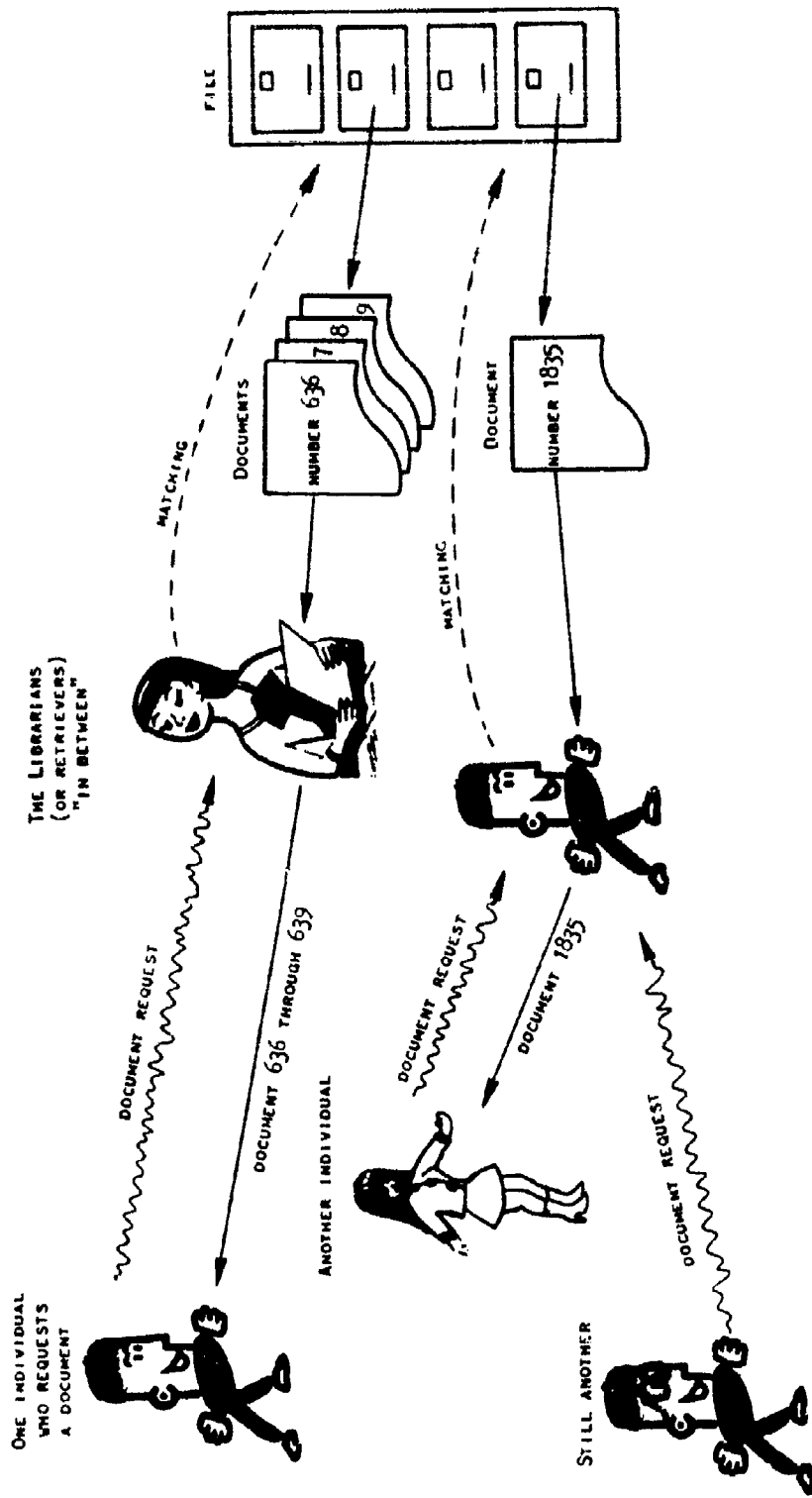
And, before copies of documents can be delivered, retrieval personnel must either have copies in their own collection, or have access to other collections that will make copies available.

The word "appropriate" is used with documents, instead of the adjectives "relevant", "right", or "correct" because it signifies a more modest, a more realistic, goal for library or retrieval personnel.

If a librarian is able to identify and to deliver copies of the documents in its collection that are most appropriate to a request, she has done a good job. In fact, she may have done the best possible job depending on the kind of request, the collections, and the retrieval services available.

Diagram 4 on page 36 shows what is involved in servicing individual document requests by a retrieval service.

DIAGRAM 4



SERVICING INDIVIDUAL DOCUMENT REQUESTS

B. Handicaps of Retrieval

There are three constant handicaps in retrieval work.

(1) It is not known who wishes to read a document, until a request is made.

(2) It is not known when a document will be requested, until a request is made.

(3) It is not known how a document will be requested, until a request is made.

It is known, however, who are the individuals that have the right to request documents from a particular retrieval service. Also known are the times of day in which most requests will be made, because this is established by the retrieval service.

There are three known methods of preparing for the various ways in which document requests are likely to be phrased. One method is to investigate previous experience of the kinds of document requests made by the group of readers to be served, or failing that to study the request patterns of any similar group of readers, if any such exist.

A second method is to train the readers to request documents in certain ways that are suitable to their work and for the kinds of appropriate documents that are available.

A third method is to develop a flexible and generalized indexing language that allows the reader considerable freedom in making document requests. This is like the cook or druggist that can concoct many different products from a standard set of components.

C. Four Kinds of Records

All varieties of records are handled in retrieval work, from books, "the heavy marked objects" of Robert Fairthorne, to the latest kinds of machine records, such as reels of magnetic tape, that are also heavy, marked objects.

It is useful in retrieval work to differentiate four basic kinds of records that have to be manipulated. First, it is useful to differentiate the original document from all other types of records because it is the reason why retrieval services exist at all. All other records are derivative. The word "document" will therefore be reserved for this purpose. Other records manipulated in retrieval work will be called either "document substitutes", "retrieval aids", or "data", that is, documents composed of items of equal interest to readers.

The last two categories, document substitutes and retrieval aids, are usually prepared by retrieval personnel. Sometimes they are prepared by the readers themselves, or colleagues of the authors.

Substitutes for documents are defined as any record that a reader will usually accept, or even prefer, to read instead of the document. Some examples are abstracts (informative), summaries, translations, and copies of documents, in part (extracts) or as a whole.

Aids are defined as records designed to be manipulated instead of the original document in order to identify and to deliver copies of the requested documents. Some examples are charge-out slips, catalog cards, and bibliographies. Because they are deliberately designed for retrieval purposes, they are usually the records that are the easiest and least expensive to handle.

Documents composed of items of equal interest to readers usually look different from documents that are expected, and usually are, to be read in their entirety. When parts of documents are requested, retrieval involves (1) the identification and delivery of the "correct" document and (2) the location of the part of the document that fulfills the request. This is often called "data retrieval".

Data retrieval can be considered a certain type of document retrieval.

The data may be small, even a tiny record with a couple of symbols, but it is still a recorded message that is retrievable.

D. Marking and Parking Analysis

All physical work performed on the four kinds of records in libraries or retrieval offices can be analyzed into a series of "parking" and "marking" steps. This is Robert A. Fairthorne's terminology to distinguish certain of the observable, the describable, aspects of library work that should be considered for delegation to clerks or machines.

Once a record has been created, parkings are usually cheaper and easier than markings. Therefore, efforts should first be directed to arranging the books of documents in some "helpful order". Dr. S. Ranganathan* meant helpful arrangements for the reader, or helpful for librarians assisting the readers. Two good examples are special areas assigned to reference books and current periodicals.

* Fairthorne, Robert A., Towards Information Retrieval, Butterworth's London, 1961, p. 95.

The most useful way of parking a document is to hand it to the person who has requested it. Anything else is less direct, and so, less satisfactory.

Whenever possible the markings already on the documents should be accepted as parking instructions. For instance, it is advisable to shelve technical reports alphabetically by the name of the author or the corporate source, if marks establishing these points are prominently displayed on the covers of the reports. Government documents displaying a series number are usually filed by that number. Issues of the same periodical with dates printed on the cover are usually arranged by the date.

Parking analysis applies to readers as well as documents. By parking documents on shelves in subject groupings, readers are led to park themselves near the documents in which they are interested. Special reading areas for current periodicals, and special displays of "new books" accomplish the same results. Readers are thus encouraged to perform much of their own retrieval work.

Markings have to be added when the markings already on the documents are not suitable or sufficient for parking instructions. Then a mark, the simpler the better, has to be added to the document. Examples of marks of different orders of complexity used as parking instructions in libraries are accession numbers and book call numbers.

Sometimes new marked objects have to be generated to facilitate retrieval, either as a reading substitute or as a manipulative aid. Because such records are designed for retrieval purposes, they are usually inexpensive to handle.

Parkings, or combinations of markings and parkings, can also be performed with the records that function as substitutes or as retrieval aids. The card catalog is a parking arrangement of retrieval aids that are less expensive and more convenient to manipulate than the original bulky documents would be.

E. Five Basic Operations

There are five basic operations that combined in various ways result in retrieval processes, such as acquisition and indexing, being performed.

The operations will be called preparation, transportation, matching, storage and reproduction. These physical operations can in turn be analyzed in terms of parking and marking methods.

The preparation operations cover all work involved in the physical production of documents. For example, technical writing and editing are preparation processes as well as are the printing and assembling copies of documents.

Document retrieval like other record handling activities has been seriously handicapped by the increasing numbers and varieties of recording media and techniques. Once produced, marked objects are as intractable as any other piece of inanimate matter. Therefore, some control over the physical production of documents is advisable in order to ensure that they are easier to handle later.

Sometimes librarians have been unable to influence the preparation of certain kinds of documents, and so have turned as a second choice to the development of copying equipment that would ensure copies easier to handle than the original documents. Library leadership led directly to the development and application of microfilming equipment to such bulky and fragile documents, as newspapers, doctoral theses, and rare books or manuscripts.

The transportation operations cover all the work involved in moving documents from one physical location to another. For example, routing and mailing of documents are transportation operations. Transportation is the basic operation that has to be performed by all delivery services of recorded messages.

The matching operations covers all the work involved in identifying appropriate documents, such as the indexing of documents and the searching for requested documents. It also includes the locating of copies of a document after an appropriate document has been identified.

The storage operations cover all the work involved in maintaining records in one physical location in order to be able to provide them upon request later.

For example, filing and shelving are storage operations. Storage of some kind is essential because delay is a necessary feature of retrieval work.

It can be storage of documents, of document substitutes, of retrieval aids, or of all of them.

The reproduction operations cover all the work involved in making copies of existing documents, in whole or in part. For example, microfilming and photostating are reproduction operations. Frequently, the best solution to some retrieval difficulties is the rapid and economic production of copies of a document, so that the copies can be parked in different ways and marked in different ways. The result of reproducing a document is a document substitute.

All operations described are also applicable to document substitutes and to retrieval aids.

F. Retrieval Processes.

There are several retrieval processes, such as acquisition, indexing, dissemination, searching, and circulating. Each of the processes can be applied to documents and to substitutes for documents. Retrieval aids are employed in retrieval processes, but they also have to be acquired or created. They can be disseminated and circulated but only are indexed or searched as retrieval aids.

Some retrieval processes, such as acquisition and indexing, are characterized as input procedures. Other processes, such as searching, disseminating, and circulation, are characterized as output procedures. This dichotomy is useful as long as it does not hide the intimate relationships among the so-called input and output procedures.

For instance, some people are surprised to learn that subject indexing necessarily involves the analysis of document requests, part of the output procedures, as well as documents, part of the input procedures. In fact, the main objective in subject indexing is to describe the subjects of documents in similar language to that used in subject document requests.

G. Role of Subject Analysis

Subject analysis affects most retrieval processes. The first decision that has to be made on a subject basis is whether to assist in the preparation of a document on a certain subject or not. Once a document exists on a subject, a decision may have to be made whether to acquire copies of the document or not.

Subject analysis of the current documentary interests of readers determines the routing of recently received documents. Shelving arrangements in public, university, and school libraries are usually on a subject basis. Special libraries increasingly cannot afford to arrange documents on a subject basis because of the conflicting subject interests of their readers and of the quantities of records to be handled.

H. Role of Equipment

Equipment for recording and moving documents are of permanent interest to librarians and retrieval personnel. Two technologies have been of special and continuing interest. Microfilm technology has primarily interested individuals concerned in reducing costs of storage and reproduction. Data processing technology has specially interested other individuals concerned in facilitating identification, including subject description, of documents of any physical form. The advantages of one technology seem to be the reverse of the other.

1. Contrast with "Personal Retrieval"

Historically "personal retrieval" came before the establishment of retrieval services to provide regular assistance to organized groups of individuals.

Because everyone has had some experience in handling their own records, individuals sometimes find it difficult to appreciate how retrieval services differ from personal retrieval.

The best way to arrange a personal collection is often different from the best way to arrange a collection of similar size and subject that is to serve a number of readers. This is because some compromise has to be reached as to the kinds of document requests to be regularly handled by the service. The agreement is usually made explicit in the document selection policy and the indexing system chosen for the particular retrieval service.

J. Sources of Recorded Descriptions

In order to understand the nature of library or retrieval work, it is necessary either to have personal work experience or to be able to analyze recorded descriptions. Unfortunately, there are few detailed reports describing operating retrieval services. Most authors, editors, and publishers have been more concerned with how things could, or should, be done better especially with the aid of the latest equipment. They have not spent much time or space recording how retrieval services are actually being operated. It is always difficult to make improvements, but nearly impossible, when one is not familiar with the work involved.

Therefore, it was gratifying in 1957 that the Office of Scientific Information Service of the National Science Foundation decided to undertake a series of pamphlets with the title "Nonconventional Technical Information Systems in

Current Use". The first edition, dated January, 1958, contained descriptions of 26 operating retrieval services. The fourth edition, dated December, 1966, became available in the spring of 1967. It contains descriptions of 176 services, more than half of which use computers.

WAYS OF REQUESTING DOCUMENTS

Summary

Retrieval personnel must deal with at least two different languages. The first is the recorded language of the documents and the second is the language of the document requests, whether recorded or not. A single language has more than one way to express the same thing; the problem is compounded for librarians who must deal with two.

Document requests are composed of two parts, a description of the document being requested and a specification of the physical access preferred to the document being requested. Both must be provided before retrieval work can begin.

The kind of physical access preferred is often indicated by the pragmatics of the situation in which the document request is presented. For instance, a document request phrased in the same way would be understood differently when presented at the circulation desk, the reference desk, or in the periodical room.

Summary (continued)

The many conceivable ways of describing documents can be analyzed into four main kinds. The first three kinds of description can be, and are, used for describing any physical object. The first can be used by itself. They are.

1. Descriptions of the physical characteristics of the object being requested.
2. Descriptions of the history of the objects.
3. Descriptions evaluating an object from a specific viewpoint.

The fourth kind of description is unique for documents, "marked objects" of any kind. It is a description of the subject of a document. This involves semantics, the interpretation of the physical marks on the documents. Librarians have recognized and systematized all four kinds of document descriptions by establishing rules, explicit conventions, for the handling of document requests. Some are called descriptive cataloging rules and others are called subject indexing rules.

Summary (continued)

The kind of document description furnished by a requestor depends on two main factors. They are his familiarity with the document being requested and the kinds of document search that he wishes to be made.

Sometimes documents are requested when only a part of a document, an item, is to be read. Then regular document retrieval is required, plus, if requested, identification of the item in the document that is specified as being of interest. This is often called "data retrieval".

Motivations for making document requests are not as suspect as the motivations for writing and publishing. At least, they have not been as much investigated or studied. However, the savings in work and time have often been underestimated in making document requests and in reading any appropriate documents that have been identified.

Summary (Continued)

Once the key role of document requests in retrieval has been established, it is possible to diagram a retrieval service. It also is then possible to diagram and to compare the potential and actual scopes of a retrieval service.

A. Languages Involved in Document Requests

One of the main handicaps in retrieval work is that service personnel do not know in advance how document requests will be phrased. However, they can study past requests for similar documents or past requests of the same readers. Then they can develop predictions of how documents will be requested in the future.

Retrieval personnel must deal with at least two languages. The first is the recorded language of the document. The second is the language of the document requests, whether recorded or not. There are substantial differences between spoken and written language. Neither of these languages is under the control of retrieval personnel.

Therefore, a paramount concern of retrieval personnel has to be the similarities and the differences between the two languages. They have to investigate and to study the ways in which documents are usually requested and the ways in which documents are usually written. Any compatibility between the two languages may be helpful.

The matching of the two languages is the most difficult job of retrieval personnel. Frequently, a third language, a library classification or a subject authority list, has to be developed to aid in the translation between the first two languages.

B. Differences between Recorded and Unrecorded Language.

Mr. James C. Bostain, a Scientific Linguist at the Foreign Service Institute of the Department of State in Washington, D. C., lists four major differences between spoken and written language.

- "1. In every language, talking and writing are different systems. They overlap and bear a general resemblance to each other, but it is the resemblance of brothers, not of twins. Nobody writes exactly what he says, or says exactly what he writes.
2. 99 percent of our linguistic activity is concerned with speech, not writing; but 99 percent of our study is concerned with writing.
3. Talking and writing are learned by different methods. We learn to talk with almost no instruction (correction, yes; instruction, no). In school we learn to talk about writing, but not to talk about talking; hardly any child of 30 can make three consecutive true statements about the way he talks.

When he does try, he talks about talking in terms of our writing system, which is worse than most others. On top of confusion, chaos.

4. Talking and writing have different units. We write with word units, we talk with phrase units. A sentence like Put it in the corner has five units in writing, but only two in talking."*

* Bostain, James C., ENGLISH--FACT AND FANCY, School Television Service Teachers Manual, WETA/Channel 26, Washington, D. C., 1964, Part 1, page 18.

The main advantage of recorded language is that the record is a physical object of a relatively permanent kind. In fact, once recorded, a message is expensive and difficult to change. It is as intractable as any other piece of inanimate matter. This is an advantage in the study of documents. Documents, unlike readers, at least stay still and await the pleasure of retrieval personnel.

Recorded language has the handicap that it is necessarily less complete communication than is possible between people conversing face-to-face. No immediate feedback, questions and answers is possible. Even telephone conversations are usually less satisfactory than in-person talks.

Without the presence of the speaker, or the environment in which the record originated, the reader must depend on the recorded marks as a guide to the competence of the writer. Queen Victoria tried to transcend these limitations in writing by capitalizing and underlining words to convey emphasis or importance.

In mechanized indexing or translation, the handicaps of recorded language show up clearly because the main sources of information about a document are the marks in the documents themselves. The difficulties and importance of indexing and translating work has again been demonstrated in much of the recent work on mechanized indexing and mechanical translation.

Investigating how individuals talk when no record has been made is impractical.

Linguists must record languages in order to study them. Most individuals do not notice how they or others talk, anymore than they notice how people breathe or stand. Talking is harder to analyze than writing because it is a more flexible and subtle mode of communication. Two people hearing the same thing can continue to disagree longer than when they read the same thing, to which repeated reference can be made.

A substantial difficulty for librarians is the necessity of describing one of the languages, the spoken language of a document request, in terms of the written language of the document. The temptation to confuse the two languages is considerable, and the warnings against doing so are few. Because both

talking and writing are in the same natural language, the similarities seem to most people more obvious than any differences.

C. Two Parts of Document Requests

Document requests are composed of two parts, a description of the document being requested and a specification of the physical access preferred to the document being requested. Both must be provided before retrieval work can begin.

D. Kinds of Physical Access Requested

Only knowing which are the appropriate documents being requested is not sufficient. It is also necessary to know whether the reader prefers to take home a permanent copy, wants to borrow it, or just to take a quick look at the document.

Two kinds of physical access can be distinguished. The first is direct access by readers or their assistants to the storage areas of the documents and document substitutes, or to the rapid reference area where retrieval aids are located.

The second type of access occurs when readers delegate access to retrieval personnel. If either of the two types is dominant, a different kind of retrieval service is required.

E. Ways of Describing Documents

At first, there may seem to be numerous ways of describing documents being requested. Individuals seem to have a variety of ways of making requests depending on what they want and the urgency or difficulty of the request. However, from a retrieval viewpoint, there are four main ways of describing documents that are being requested. Most actual document requests can be analyzed in terms of the four kinds.

A document request includes a description, more or less complete and more or less accurate, of an item requested by one individual of another. One way of requesting an item, no matter what it may be, is to describe its physical characteristics. Therefore, documents, like fruits, coats, or human beings, are requested by describing their physical characteristics. In the case of documents, the physical description includes a description of the marks on them.

A second way of describing a document is to trace its previous history.

Descriptions of who had the document previously, or where the document is located now, are examples. Also included in historical descriptions are what has previously been recorded elsewhere about a document. Examples are abstracts, indexes, and reviews.

A third kind of description involves an evaluation or judgment of a document from a specific viewpoint. What might be a "good book" on turtles for a child would probably not be appropriate for either a college student or an expert on turtles. Evaluative descriptions cannot be used alone because a viewpoint has to be specified, according either to some physical characteristic of a document, to some event in its history, or to some subject.

A fourth way to describe documents is unique to marked objects. It is in terms of the subjects or subjects treated, and involves semantics, or the interpretation of the marks on the documents. In other words, what is a document about? Or to use Dr. John O'Connor's formulation, "What does it mean to say that a document is about subject S?".*

In order to be able to predict how documents will be requested in the future, there has to be some experience, some consensus, on how such documents are described. The social practice or agreement is preferably explicit and to be found in a number of different kinds of records. In fact, librarians have established conventions on these matters.

Librarians have developed descriptive cataloging rules that specify the physical features of a document that if correctly described will ensure that the right document is identified. They have developed library classification systems and subject authority lists to indicate the kinds of subject requests that can be handled most efficiently by particular retrieval services.

* O'Connor, J., "Relevance Disagreements and Unclear Request Forms", AMERICAN DOCUMENTATION, July, 1967.

F. Requestor's Knowledge of Documents Requested.

Requestors furnish descriptions of documents that depend mainly on their familiarity or knowledge of the document being requested. If a requestor knows or believes that a specific document exists, he usually is able and does provide descriptions of all four kinds. In particular, physical and historical descriptions of the document are provided. Then, if one or more of the clues provided are inaccurate, as some are sure to be, there are usually enough remaining clues to identify the requested document.

If a requestor does not know whether any document exists on a specific subject, or if he wishes to have made an exhaustive search on a subject basis, he is likely to describe the document in terms of subject. Few, if any, physical or historical descriptions can be provided for documents that are not known to exist.

Dr. Charles Bernier has called the first kind of request "questions of recall" to emphasize the fact that some previous knowledge is presumed about the existence of the document. He has called the second kind of request "questions of discovery" to emphasize that often the requestor has no previous knowledge of the existence of the documents being requested.

A definitive search can usually be made on recall questions because of the diversity and comprehensiveness of the clues usually provided. In other words, a flat "no" or "yes" answer can be provided as to whether a particular document exists. Discovery questions can never be completely answered because there is always a chance that a document like the one described may exist, even if it has not yet been found.

There are also logical differences between the search specification for questions of recall and those of discovery. Recall requests can be translated into All And Only (AAND) searches that specify that all documents be selected that have been assigned the specified indexing terms and only those documents be selected that have been assigned them and no other indexing terms. The danger in specifying All And Only searches is that incomplete descriptions, even if correct, will not result in finding the described documents.

Discovery requests are translated into All But Not Only (ABNO) searches that specify that all documents be selected that have been assigned the specified indexing terms but not only documents that have been assigned those indexing terms.

G Request for Items in Documents

Some documents are frequently requested because of one part or a single item in the document. These documents are usually arranged so that access to any individual item is equally easy or equally difficult. This type of document is designed mainly for rapid and repetitive use, or for recall searches.

Lists, tables, and diagrams are the preferred formats.

When documents are frequently requested in order to read only a specified item, retrieval is required of both the described document and the part specified in it. This is often called "data retrieval".

II. Motivations for Document Requests

There has been much discussion on the motivation of technical personnel in writing and publishing technical documents. Professional prestige and personal advancement have been shown to play significant roles. It is easy to point with pride at any physical object including documents, that one has created.

However, there has not been much discussion of the motivations of technically trained people in requesting retrieval service, even though this would seem to be of interest to librarians. Perhaps the motives for making document requests are not as suspect as those for writing documents. The usual assumption is that the document is requested to be read.

Sometimes there has been pressure against making document requests or literature searches because of the possibility that they may result in painful new knowledge. The work being planned may already have been done, and perhaps done better. Calvin Mooers has presented this perception

in his First Law.

"An information retrieval system will tend not to be used whenever
it is more painful and troublesome for a customer to have information
than for him not to have it."

* Mooers, C. N., "Mooers' Law or Why Some Retrieval Systems Are Used and Others are Not" (editorial), *AMERICAN DOCUMENTATION*, Vol. 11, No. 3, July, 1960, page ii.

I. Retrieval Model.

Once the key role of document requests in retrieval has been established, it is possible to diagram a retrieval service. (See Diagram 5 on page 79.) and Diagram 6 on page 80.

Document requests are represented as jagged lines in order to distinguish them from other types of signals sent between :

1. readers and retrieval services ;
2. retrieval services and other retrieval ices ;
3. retrieval services and distribution services.

Document requests are restricted to message: about other messages that are presumed to exist until disproven. Documents, of course, can be about anything, including about other documents, or about something imaginary, such as unicorns or Martians.

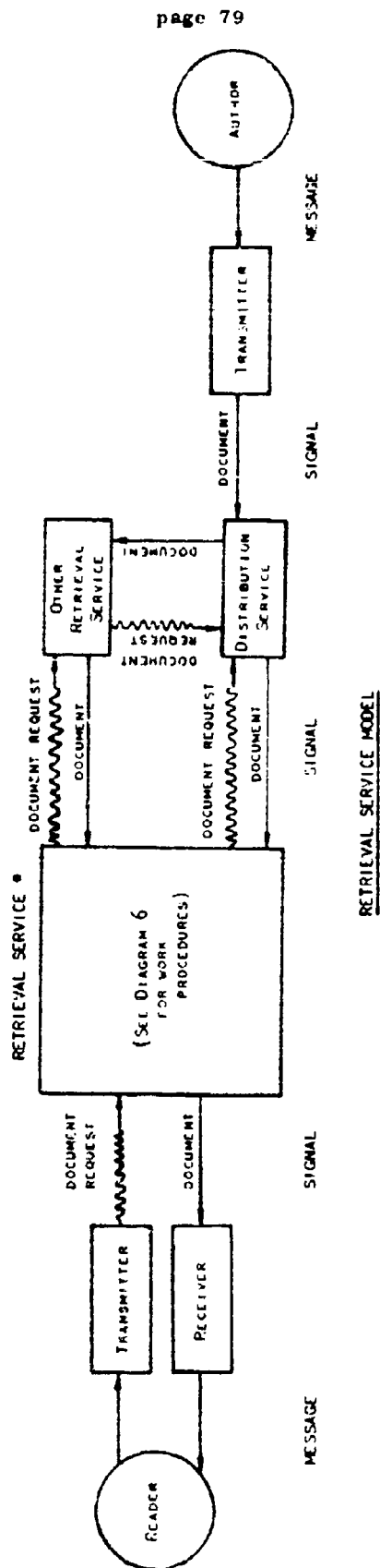
The destination of retrieval messages, the reader, is now on the left side of the diagram, instead of on the right side as were destinations in

Diagrams 1, 2 and 3. Likewise, the author, originator of retrieval messages,

is on the right side of the diagram, instead of on the left side as were sources in Diagrams 1, 2, and 3.

Finally, it should be clear why no retrieval service, not even the Library of Congress, can be "an island unto itself," and why therefore, at least one "other retrieval service" and one "distribution service" have to appear in the Retrieval Service Model.

DIAGRAM 5



CHAPTER III

DIAGRAM 6

RETRIEVAL SERVICE*

1. RECEIVES DOCUMENTS REQUESTS.
2. IF NECESSARY, RECORDS DOCUMENT REQUESTS.
3. SEARCHES AND LOCATES DESCRIBED DOCUMENTS.
4. SECURES COPIES OF IDENTIFIED DOCUMENTS FROM COLLECTION OR REQUESTS COPIES FROM
 - (A) A DISTRIBUTION SERVICE
 - (B) OTHER RETRIEVAL SERVICE
5. IF NECESSARY, REPRODUCES COPIES.
6. DISPATCHES COPIES OF DOCUMENT WITHOUT DELAY.

RETRIEVAL WORK PROCEDURES

* SEE DIAGRAM 5 FOR LOCATION OF WORK PROCEDURES
IN RETRIEVAL SERVICE MODEL

SIGNIFICANCE OF TECHNICAL DOCUMENT RETRIEVAL

Summary

Technical documents are as much an everyday tool and necessity for Scientists and technically trained people as are other recording and measuring instruments.

Technical training in the United States, as elsewhere, attempts to develop familiarity with the terminology of each specialty and systematic habits of analyzing and reporting observations and experiments. Better writing of technical documents results in easier retrieval. The practice of "team research" requires explicit objectives, detailed assignments of work, and definite deadlines. These also help to simplify retrieval work by establishing officially the documentary interests of an organization.

Two kinds of communication can be distinguished in research and development laboratories, namely communication among equally well trained individuals and communication among unequally trained individuals. The first kind of communication is represented by documents, such as technical reports,

Chapter IV

Summary (continued)

journal articles, and scientific books. The second kind is represented by textbooks, handbooks, and instruction manuals.

A. Relation to Science and Technology

Technical documents such as laboratory reports and research memoranda are as much an everyday tool and necessity for scientifically and technically trained individuals as are slide rules, or other types of observing or measuring instruments. Calibrations and photographic records to be "read" and their interpretations are matters of opinion, even when the opinion is that of a trained individual well situated to report on the matter. In a similar way, the reading of technical reports by an expert can be considered the "testing" of his opinions against those of other technically trained individuals, namely those of the author or authors.

Scientists necessarily record observations and experiments for others and themselves to read later. A viewpoint or hypothesis is necessary to determine the data to be recorded and the format in which to arrange it. Organizing the recorded observations in various ways aids analysis. Mathematical formulae are a systematic way of telling the reader how to reconstruct the numerical results.

Historically, "numeracy"* came before literacy for the good reason that numbers have to be remembered with an accuracy not usually needed for verbal statements. There is only one correct number but there is often more than one way to convey the same meaning in a language. Conversely, verbal statements can be identical but have different meanings, depending on who presents them, when, and where.

For some scientists, such as mathematicians, the main tools are documents.

It has been said that all of mathematics could be recreated by a gifted mathematician, the only tools required being paper and pencil. But even if a mathematician has the ability, he certainly would not have time in one life to reconstruct all mathematics known today.

Mathematicians have invented and developed an international language to a greater extent than has been done in any other field. In comparison to natural language, mathematics has fewer symbols, and fewer and less ambiguous rules

* Fairthorne, R.A., "Mathematics, Mechanics, and Statistics for the Information Science Curriculum, or What Mathematics Does an Information Scientist Need?", Automation and Scientific Communication, Short Papers contributed to the American Documentation Institute Meeting, Part I, Chicago, Illinois, 1963, p. 39-40.

for their manipulation. These mathematical symbols and rules are the same for mathematicians throughout the world. Chemists also have developed an international language in the standardized nomenclature for chemical compounds.

For scientists other than mathematicians, notably chemists, there is an additional reason for dependency on technical documents. Chemists constantly have to refer to records of many kinds because they cannot possibly memorize the recorded data on chemical compounds, especially the huge amount on the organic chemicals. Moreover, it is not worthwhile to memorize such technical data because it is constantly being revised. Usually the most recent data are the best because they are the result of improved instrumentation and "second thoughts".

Some physical sciences rely principally on recorded observations, because few experiments are possible. A notable example is the Science of Astronomy.

Systematic methods of recording the events then becomes of the highest importance.

Librarianship, like the other social sciences, also has to depend mainly on recorded observations, opinions on what may or may not have occurred.

B. Advantages of Technical Training

Technical training in the United States and in other technically developed countries has a number of characteristics that are advantageous from a retrieval viewpoint. For example, technical education attempts to develop familiarity with the terminology of each specialty. This results in the same kind of language being used by requestors of documents as has been used by the authors. This simplifies the translation of document requests into document descriptions. Some training is also provided in the use of the technical literature.

There are some handicaps too. Retrieval personnel handling technical documents must themselves be familiar with the various terminologies. They also must employ technical terminology in dealing with technical personnel.

Unfortunately, U. S. technical training does not include much practice in foreign languages. Fortunately, it is increasingly possible to secure adequate English translations of technical documents in the main European languages. However, there are still considerable difficulties in securing translations from the less well-known languages. Scientists from countries, such as Scandinavia, compensate for the ignorance of others in their language by being proficient in a number of other languages.

Lack of foreign language skills is still a handicap to U. S. technically trained people even though the existence of technical terminologies mitigates the problem. The amount of technical literature appearing in other languages than English continues to grow.

Technical training also tends to develop systematic habits of analyzing and reporting observations and experiments. Better writing of technical documents results in easier retrieval. It is easier to determine the subject of a document that is clearly written. It is easier to identify descriptive cataloging information in a document that is well organized and well-labeled.

Training also results in an appreciation of the "systems" approach and some familiarity with data processing equipment. Most technically trained people are favorably disposed to the use of mechanized equipment for retrieval. The balancing handicap is that they are overdisposed to equate the use of new equipment with the development of new solutions.

Another result of training in systematic analysis and reporting is a tendency for work of significance to be repeated by a number of different individuals or organizations. The aim is to be as certain as possible of observed or calculated results. Nothing is ever completed in science or technology.

C. Advantages in Redundancy of Technical Literature.

In systematic technical work, there is a tendency for work of significance to be repeated by a number of different individuals and organizations.

The aim is to be as certain as possible of observed and calculated results.

Nothing is ever completed in science or technology.

When repetition is probable or required, a clear and detailed recorded description of the original work is essential. Duplicate reporting is an essential part of the systematic development of new products or processes.

Redundancy also arises because certain technical subjects tend to be of interest at the same time to a number of individuals. Therefore, more is written about them around the same time. This is unlike fictional or poetic literature that consists of unique, or supposedly unique, creations.

Redundancy in technical literature is an advantage from the retrieval viewpoint because not every document on a subject needs to be retrieved in order to provide adequate coverage. Comprehensive collections of all relevant literature are known to be impossibilities. Now it can be shown that they are not a necessity in many situations. In fact, a collection of technical

documents on a particular subject may be adequate even though it contains only a small percent, for instance, 10%, of all the total known literature on the subject.

For obvious reasons, it is difficult to get statistics about the amount of redundancy in the literature of any specific technical field. However, during World War II, the Library of the U. S. Department of Agriculture was given an unusual assignment because of the impending shortage of Kapok.

The Agriculture Library was asked to prepare a comprehensive bibliography of papers describing methods of producing artificial rubber from milkweed floss. After three thousand articles had been listed, the librarians were asked to read through all of them, in any convenient sequence, and to prepare summaries of any new methods they encountered. Out of the three thousand articles, less than one hundred were cited as having unique information.*

* Taube, M. and Wooster, H., Information Storage and Retrieval: Air Force Office of Scientific Research Symposium, Columbia University Press, New York, 1958, p. 142-143.

In another literature study, the Agriculture Library eliminated more than 80% of the collected material because they added nothing new to what had been said previously.*

D. Advantages of Team Research

Since World War II, the practice of "team research", or work on a project basis, has grown considerably in U. S. research and development laboratories.

Research and development laboratories systematically explore and exploit ways to improve a particular product or process.

An explicit statement of its objectives by a research organization helps to guide the selection of technical documents to be collected. Work is assigned usually to groups instead of individuals. Group work of many kinds necessarily depends on clear and explicit work assignments. This helps to identify the kind of technical documents of most probable interest to a specified group of workers.

Technically trained people also tend to work in groups outside of working hours. Since the Royal Society was founded in London, in 1662, scientists have formed hundreds of professional societies and attended meetings and conferences by the thousands. The usual way of getting work done in technical societies is by appointing a committee.

The scientific method requires careful planning, detailed recording and the repetition of research and development work. Nothing is ever finished in the scientific world.

E. Communication Between Equals

There are two kinds of communication in research and development laboratories.

The first is communication among equally well trained technical individuals and is a unique characteristic of technical work. What they already know determines the kinds of recorded communication they request. This egalitarian form of communication is represented by technical reports, journal articles and scientific monographs.

The retrieval advantage is that complete documents are requested because each technical expert wants to read and judge for himself. Therefore, document retrieval is mainly required and not data retrieval. The latter is usually more difficult, because more subject familiarity is required. Furthermore, many technical readers are also authors of technical documents, and so, know how to use the technical literature.

Communication Between Nonequals.

The second kind of communication is common inside and outside of research and development laboratories. It is communication between individuals with different competences, in this case, different technical expertise

Examples of this kind of communication are textbooks, technical handbooks, and instruction manuals.

There are necessarily elements of authority involved in communication between nonequals. The greater experience or knowledge of the compiler of the instructional or advisory material must be obvious.

The retrieval advantage is that more control is exercised over the format of the technical documents because they have to be read by specified people for specific purposes. Formats can be standardized and recording media can be chosen for:

1. ease of original preparation,
2. ease of rapid look-up,
3. ease of later updating.

G. Case Study Showing Relation of Science and Communication, Including
Document Retrieval.

In the May 12, 1962, issue of the New Yorker Magazine, there was an article with the title, "A Question of Parity", by Jeremy Bernstein. It described in detail the integral part that recorded communication, as well as other kinds of communication, played in the development of a solution to a major scientific puzzle.

It relates the stories of Tsung-Dae Lee and Chen Ning Yang from their birth in China in the 1920's to their winning of the Nobel Prize in Physics in 1957. Although Lee and Yang are undoubtedly geniuses, the description of their professional relations shows in detail the interplay of personal contact and formal documentation that accompany daily scientific and technical work. Furthermore, the article is written from a viewpoint understandable to laymen.

A brief recapitulation of events in the professional lives of Lee and Yang from the Bernstein article would include the following:

1. Born in the 1920's in China, their professional paths first crossed when they both went in 1946 to the University of Chicago to study, under Enrico Fermi and Edward Teller respectively.
2. Their first collaboration was a newspaper puzzle contest with Dr. R. L. Garwin. They failed to win because they detected an ambiguity in the contest rules and so, had submitted two entries. This disqualified them.
3. Their first paper together appeared while they were pursuing their doctoral studies and was written in collaboration with M. Rosenbluth.
4. In the early 1950's, they both managed to be at the Institute for Advanced Studies in Princeton, New Jersey, or in nearby areas, so that their collaboration could continue. They were preoccupied at this time with a mystery known as "the theta-tau puzzle" that had arisen in the study of elementary particles.
5. In 1956, the Sixth Annual Conference on High Energy Nuclear Physics was held in Rochester, New York, and was chaired by Dr. J. Robert Oppenheimer. It was during conference discussions that Lee and Yang decided to make a detailed study of the experimental foundations of parity conservation, or mirror symmetry.
6. During May, 1956, their work increasingly raised doubts as to whether the Law of Conservation of Parity was valid for particles held together by only weak forces. Three weeks of intensive work, including a seminal discussion while they were driving around Columbia University, trying to find a parking place, led to their drawing up a list of experiments which should exhibit parity-conservation-violation effects, if such existed.
7. Late in June, 1956, Lee and Yang wrote a paper, including the list of experiments, with the title "Question of Parity Conservation in Weak Interactions".
8. The experimental group that took up the challenge to carry out the experiments specified by Lee and Yang was composed of Columbia University and National Bureau of Standards research workers. One member, Mrs. C. S. Wu, who had also been born in China, was personally known to Lee and Yang.

9. Before the end of 1956, the experimental data confirmed that parity was not conserved in weak interactions.
10. On Friday, January 4, 1957, the usual weekly Chinese luncheon near Columbia University was attended by Lee and Yang who reported Mrs. Wu's most recent results. This discussion triggered two other experimental physicists, Dr. Leon Lederman and Dr. R. L. Garwin (who had not been present), to a weekend of hard work.
11. By the end of the following week, physicists throughout the country had heard by word of mouth the definitive results of the experiments. Professor I. I. Rabi of Columbia telephoned the news to Dr. Julian Schwinger of Harvard, who up to then had had serious doubts.
12. On January 15, 1957, the Physics Department of Columbia University held a news conference to announce that parity non-conservation had been established.
13. The January 16, 1957, issue of The New York Times carried an editorial called "Appearance and Reality" to announce the event.
14. As late as January 17, Dr. Wolfgang Pauli in Zurich, expressed skepticism, but when the news of the experimental results reached Zurich on January 27, he too was convinced.
15. On January 30, 1957, the annual meeting of the American Physical Society was scheduled to begin. The experimental results were too recent for a paper by Lee and Yang to have been prepared and submitted in time for the meeting. Therefore a special session was organized for the last Saturday afternoon of the meeting. The auditorium at the New Yorker Hotel drew an overflow audience of 3,000 physicists who had heard the exciting news, mainly by word of mouth.
16. At the spring meeting of the American Physical Society, there was a scheduled symposium on parity. The experimental physicists gave a detailed report of their work.
17. In October, 1957, Lee and Yang received in Stockholm, Sweden, the Nobel Prize in Physics for "their penetrating research into the laws of parity, which has led to major discoveries concerning the elementary particles".
18. The cover of the December 1957 issue of PHYSICS TODAY carried a reproduction of notes on a scratch pad made by Lee during the period when the experimental results were being awaited. He was trying to concentrate on other theoretical matters. The formulae concerning the elementary particles kept intruding into the other work.

Chapter V

KINDS OF TECHNICAL DOCUMENTS

Summary

Documents of any kind are more intensively studied than document requests for the very good reason that they can be. Documents are more tractable, more amenable, to study and analysis than are the readers who make document requests.

However, it is never sufficient to study only the physical format and subject matter of a document in order to determine its use. It is always essential to identify and to investigate the audience of a collection of documents in a particular work environment. This is true even in the case of technical documents which in general can be relied on more than other kinds because of the training of technical personnel in systematic methods of planning, observing, experimenting, recording and calculating.

The definition of document should be as broad as possible in order to cover all types of records, old and new, that are provided by retrieval

Chapter V

Summary (continued)

services to technical readers. Specifically the definition of "data" as a particular kind of document helps in the analysis of "data retrieval". The subsuming of the definition of "data" within that of document will be found to agree with "Modern English Usage" by Henry Fowler in the 1965 edition published by Oxford University Press.

Other than by subject matter, there are at least five ways of classifying all kinds of documents and comparing them with the various kinds of technical documents. The five ways are:

1. Physical format, whether human or machine readable
 - a. symbols
 - b. recording method
 - c. recording media
 - d. unit or continuous formats
2. Sources, private or governmental
3. Frequency of issuance; once, periodically or irregularly.

Chapter V

Summary (continued)

4. Destinations, potential audience

- a. age distribution
- b. education distribution
- c. geographic distribution

5. Depositories or collections

- a. organization use only
- b. restricted or special collections
- c. public or free collections

Technical collections are like other depositories of documents waiting for copies to be requested. The potential scope of any retrieval service consists of all the documents known to exist that would be appropriate to the kinds of document requests most frequently requested by readers of a particular retrieval service. This, of course, is an impossibility. No librarian ever claims to have collected every appropriate document

Chapter V

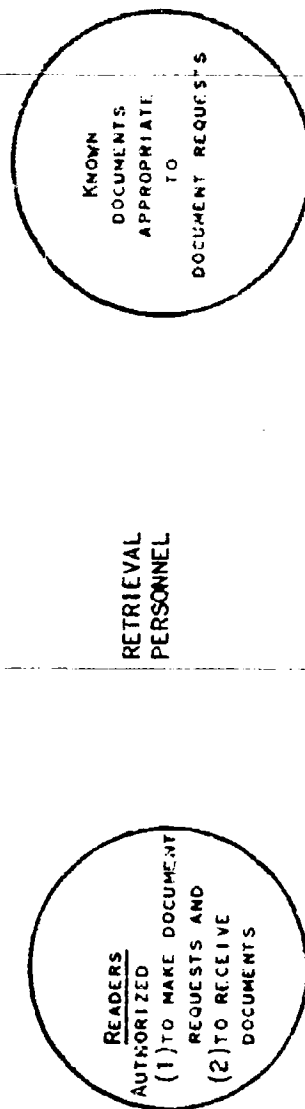
Summary (continued)

on a subject, or by any other criteria. For example, the almost-completed plays of Faulkner, like those of many other dead geniuses, are still being unearthed.

The actual scope of any retrieval service is fortunately more curtailed and therefore, possible of accomplishment. Among all the documents known to exist on a subject, there are some that are known not only to exist but to be available. Availability is a matter of access, either in the collection of the retrieval service, by loan from other retrieval services, from a distribution service that provides documents for a price. Among the authorized readers of a particular service only a few actually request documents from the retrieval service. (See Diagrams 7 and 8 on pages 102 & 102 of this chapter.)

CHAPTER V

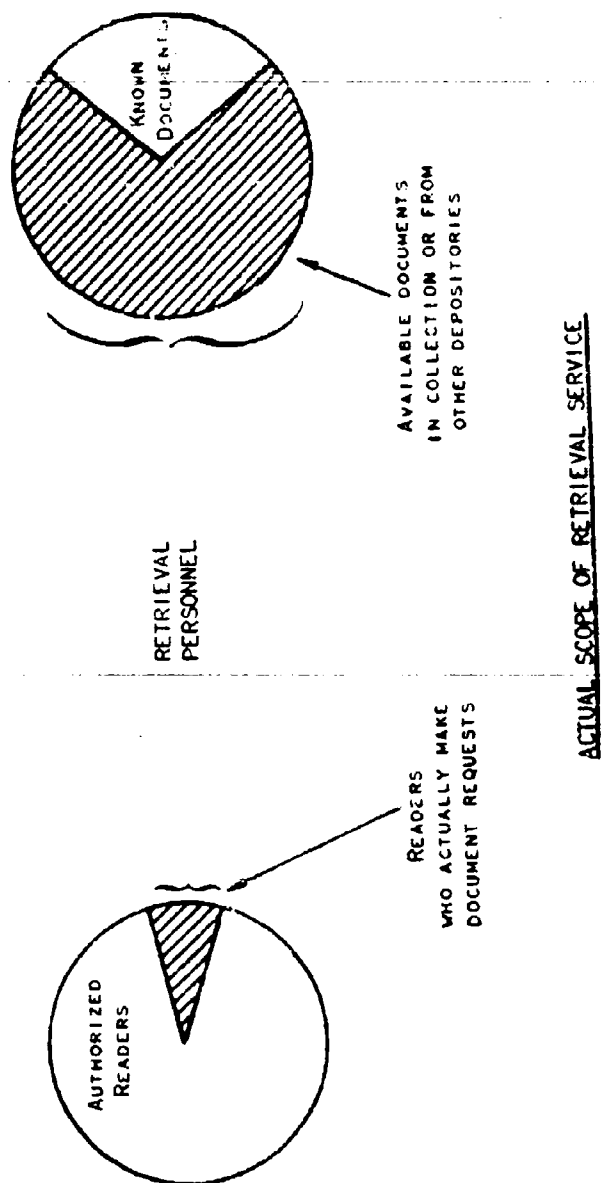
DIAGRAM 7



POTENTIAL SCOPE OF A RETRIEVAL SERVICE

CHAPTER V

DIAGRAM 8



Chapter V

There are the following types of technical documents as evidenced by

the separate style manuals or writing instructions:

1. daily diaries of work accomplished, often known as laboratory or engineering notebooks;
2. proposals and plans for work to be approved or scheduled;
3. progress reports on work being performed, usually by a group;
4. manuals and other types of instructional materials;
5. book publication;
6. journal publication;
7. technical handbooks, or reference tools;
8. specialized publication forms, such as patents, standards, and specifications;
9. diagrammatic representations, such as maps and engineering drawings;
10. abstracts, both informative and indicative;
11. indexes;
12. critical reviews, and state-of-the-art surveys;
13. dictionaries and directories;

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Chapter V

14. conference planning and oral presentations;

and combinations of any of these.

Chapter VI

DOCUMENT RETRIEVAL PROCESSES

Summary

There are a few new retrieval techniques among the many established library procedures for providing, upon request, identification and delivery of appropriate documents. All can be analyzed in terms of five operations and four kinds of records.

There are five basic and observable operations that must be performed with records of some kind in order for retrieval to be accomplished.

They are called "preparation", "matching", "transport", "storage", and "reproduction". These operations are performed on four kinds of records, "documents", "document substitutes", "retrieval aids", and "data", that is, documents composed of items of equal reader interest.

Retrieval personnel have most control over the preparation of document substitutes, retrieval aids, and data. Therefore, these are the cheapest and least expensive records to be processed in retrieval. In particular,

Chapter VI

Summary (continued)

retrieval aids, such as property control and index records, are well designed for the matching operation.

It is worthwhile to start with the application of the five operations to the original documents because it is often overlooked how much of retrieval work can be accomplished solely by the handling of documents.

Preparation of documents is the most crucial operation for retrieval as well as for any other purpose. This is so because the first recording is generally the only one, and so it has to be lived with. If the original document is well designed, subsequent operations can be performed well.

If the document is not well designed, the usual case, subsequent operations are adequately performed only at considerable care and cost.

The way a document is prepared can substantially help or hinder future retrievability. Technical editors and printing experts have to serve a

Chapter VI

number of competing responsibilities, those to authors and to other sponsors of documents as well as to the future readers of the document.

The matching operation is essential for complete retrieval service because it helps to ensure that the reader can determine what he wants to read.

It consists of the inspection of one kind of record for a stated characteristic that is believed to apply to some of the records being examined.

One example is looking through a stack of books in order to determine whether there is among them a book written by H. G. Wells. Other examples are looking at certain documents for specified dates of issuance or specified words in titles.

Matching of the document description received against the description of the document requested would be necessary even if one assumed that documents are received by the retrieval service at the moment they are requested by a reader.

Chapter VI

The matching operation applied to documents and document substitutes is awkward and costly. Retrieval aids are designed mainly to facilitate the matching operation, and so should be and are usually employed in that operation.

Transport, storage and reproduction operations are the same for documents and document substitutes except for document substitutes that are much shorter than the original document. All operations applied to retrieval aids usually are and should be easy and inexpensive because they were only created to facilitate retrieval. In particular, property control and index records are usually easy to handle.

The records that require the most retrieval work, and therefore, are the most expensive to process are called "data", that is documents composed of items of equal reader interest. Preparation is a necessity in handling data because its format determines rapidity of look-up and ease of updating. Familiarity with subject matter and skills in displaying it are both required.

Chapter VI

It is often forgotten that processing items in documents, or as it is often called "data retrieval", must start with retrieval of the correct document in which the item requested is located. It is not possible to find departure times for planes in railroad timetables, even if train connections for the same places are recorded.

If the only operations performed with documents are preparation, matching and transport, only a rudimentary kind of retrieval can be achieved. When storage is lacking, documents are routed as they are received by a retrieval service to readers on the basis of their previously stated documentary interests.

There are two ways in which these stated interests are different from usual document requests. First, they only concern documents as they are received into a collection. Second, the stated interests stand as continuing requests until they are changed.

Chapter VI

Without storage, the time of reading is determined by the receipt of records into a collection, not by individual requests of readers.

Furthermore, the kind of documents routed have been described in broad terms in order to encompass current reading interests.

Thus storage of documents is essential for complete retrieval service because the scheduled delay ensures that readers can determine when they want to read. Storage arrangements of documents, document substitutes or retrieval aids, suitable when readers perform their own searches differ considerably from those suitable when retrieval personnel make the searches as delegates of the readers.

Chapter VI

The reproduction operation often provides an effective solution to retrieval difficulties because production of more copies of a document make possible multiple transports and multiple storage arrangements for what previously was one document. The production of a copy of a document results in the creation of a document substitute, and so reproduction methods will be treated as operations concerned with the preparation of document substitutes.

Chapter VI

In order to be able systematically to describe and to analyze individual retrieval services, a checklist has been developed for recording the

kinds and frequencies of the activities performed by a particular service.

The checklist is shown in Table 2 on page 114 of this chapter.

The arrangement of the major divisions in the two columns reflects the original structure of the general communication model of Dr. Claude E.

Shannon. His model is shown in Diagram 1 on page 20 .

Numbers and frequencies mean nothing alone, so the checklist shows the

kinds of characteristics or activities covered by each of the main divisions,

which have Roman numerals.

TABLE 2

CHECKLIST for Describing and
Analyzing an Individual Retrieval Service

- | | |
|--|---|
| <p>I. Numbers of Readers by:</p> <ul style="list-style-type: none">A. Work LocationsB. Work Assignments | <p>II. Number of Authors by:</p> <ul style="list-style-type: none">A. Work Locations if differentB. Work Assignments from those of readers |
| <p>III. Numbers of Documents Usually Requested:</p> <ul style="list-style-type: none">A. SourcesB. Frequency of IssuanceC. FormatsD. LanguagesE. SubjectsF. Evaluative Criteria | <p>IV. Numbers of Documents in Collection:</p> <ul style="list-style-type: none">A. SourcesB. Frequency of Issuance ifC. Formats differentD. Languages from thoseE. Subjects usuallyF. Evaluative Criteria requested |
| <p>V. Frequency of Kinds of Access Usually Requested to Documents:</p> <ul style="list-style-type: none">A. Direct access by Readers or their assistantsB. Indirect access, delegated to retrieval personnel | <p>VI. Frequency of Kinds of Retrieval Processes Available from Service:</p> <ul style="list-style-type: none">A. Processing DocumentsB. Processing Document SubstitutesC. Processing Retrieval AidsD. Processing Items in Documents ("data retrieval") |
| <p>VII. Frequency of Reader's Relations With Other Retrieval Services:</p> <ul style="list-style-type: none">A. As Authors of DocumentsB. As Producers of Document SubstitutesC. As Producers of Retrieval AidsD. Size of Personal Document CollectionsE. Personal Retrieval SourcesF. Regular use of Other Retrieval Sources | <p>VIII. Frequency of Service's Relations With Other Retrieval Services:</p> <ul style="list-style-type: none">A. (Retrieval Personnel as Authors)B. As Producers of Document SubstitutesC. As Producers of Retrieval AidsD. (Retrieval Personnel Collections)E. (Retrieval Personnel Sources)F. Regular Use of Other Retrieval Services |
| <p>IX. Amount of Resources Assigned To Retrieval Service.</p> <ul style="list-style-type: none">A. SourcesB. PersonnelC. Materials for CollectionD. SpaceE. Equipment and SuppliesF. Special Restrictions | |

Chapter VI

First, the kinds and numbers of readers, I, are compared with the kinds and numbers of authors, II. The more differences there are between those two groups, authors and readers, the more work retrieval personnel have to do. Readers have to be provided with appropriate documents produced by the authors when requested by the readers.

Next the kinds and numbers of documents usually requested, III, are to be compared first with the kinds and numbers of documents in the collection,

IV, and later with kinds and frequencies of relations of the retrieval service with other retrieval services, including their collections, VIII.

The kinds and frequencies of access usually requested to documents, V, are to be compared first with the kinds and frequencies of retrieval processes available from the service, VI, and later with the kinds and frequencies available through a service's relations with other retrieval services, VIII.

Chapter VI

Finally, the kinds and frequencies of readers' relations as a whole with other retrieval services, VII, are to be compared with both retrieval processes available from service, VI, and the kinds and frequencies of a particular service's relations with other retrieval services, VIII.

This last comparison establishes the outside retrieval environment of a particular retrieval service. The retrieval environment of a group of electronic engineers working in a research and development laboratory in Chicago would be markedly different from the same group doing the same work in Antarctica.

The final main division covers the amount of resources assigned to the retrieval service, IX is literally the payoff. All the previous comparisons mean nothing unless viewed in the context of how much money and authority are available to the particular retrieval service.

Chapter VII

PREPARATION OF TECHNICAL DOCUMENTS

Summary

The preparation of documents is of crucial importance to retrieval personnel because physical form severely limits any handling of documents.

The first recording of a message is the most important because it is usually the only recording.

Librarians have known and have had to live with the difficulties resulting from documents of different sizes, weights, and permanences. The new media such as reels of magnetic tape or microfiches, are still the "heavy marked objects" of Fairthorne but they are more awkward to park, and more difficult to mark, and impossible to read without the aid of special devices.

Most of the new methods of marking the original recording that have proved practical are based on the use of some kind of keyboard. Mechanization of speech conversion and patten recognition have both proved to be more intricate

Chapter VII

than expected. The best way often is to bypass the human recorder entirely by replacing him with some kind of automatic recording equipment.

Technical writers and editors as well as printing experts have a number of competing responsibilities; to authors, sponsoring organizations, and readers. Most of the last group will have to depend on the document alone because they will have little if any chance to converse with the authors.

Therefore, librarians and retrieval personnel are increasingly participating in the establishment of report standards and in the development of style manuals. Certain rules about labeling and exposition can substantially simplify the performance of the subsequent operations in retrieval work.

The first objective in technical writing and editing is to be accurate.

Style or beauty may come later. Another consideration in technical documents is rapidity of the recording. The dual demand for accuracy and rapidity in recording have directly led to the design and use of measuring and recording instruments of increasing reliability and sensitivity.

Chapter VIII

PROCESSING TECHNICAL DOCUMENTS

Summary

Aside from preparation, there are four other main operations that are applied to documents. Three operations, matching, transport, and storage, are described in this chapter. Reproduction operations will be treated in the next chapter because they result in the preparation of document substitutes.

One of the essential operations in retrieval is the matching operation. It ensures that the kind of document to be read is under the control of the reader. However, the matching of the description of documents, requested against the actual documents is such a laborious job that it is seldom done.

When it is done, the matching is often accompanied by an evaluative decision, comparing a particular document in some way with other documents similar to it. Book reviews and book selection are two examples.

Chapter VIII

Summary (Continued)

Transport is the operation common to all message delivery services.

Acquisition, circulation, and retirement or disposal processes are the result of mainly transport operations in retrieval work. Transport of documents has always cost considerable money. It is one of the chief reasons for preferring to manipulate brief records in place of the original document. In addition to cost, the transport of documents is handicapped by copyright rules, industrial proprietary interests, and government security regulations.

Storage of documents is the other essential operation in retrieval work. It ensures that the time of reading is under the control of the reader, not the retrieval personnel, much less the author. Either documents must be acquired and stored in anticipation of document requests or arrangements must be made with other retrieval services, or distribution services, to have rapid access to identified documents.

Chapter VIII

Summary (continued)

Different storage arrangements are preferable depending on whether the reader performs his own searches or delegates the searches to retrieval personnel. The U. S. Patent Office is an unique example of a retrieval service where up to 50 copies of an individual patent are stored in up to 50 storage locations depending on the subject classification numbers assigned to the patent. The searcher, the patent examiner, not only does his own searching but must judge whether the equipment described in the patent application is similar or not to the descriptions of the closest kinds of equipment already patented that he can find. Therefore, the procedure saves substantially the time of the patent examiner.

Chapter IX

KINDS OF DOCUMENT SUBSTITUTES

Summary

Document substitutes are defined as any record that a reader will accept, or even prefer, to read instead of the original document. Their only purpose is the reading convenience of the readers. Four kinds of document substitutes have been identified. They are duplicates of documents, extracts, abstracts, and translations. The sequence of listing is that of increasing complexity in preparation.

The main benefit of document substitutes is the multiplication of records available for conveying the message of the document. This saves the time of the reader. Time is saved in not having to wait until someone has finished reading a copy. Time is saved in reading the shorter record. Time is saved in not having to learn another language in order to read a foreign technical document.

Chapter IX

Summary (continued)

Three decisions are usually necessary before a document substitute is produced. The first decision is which, if any, document substitutes should be produced. The second decision is how to preserve the readability of the message while the language of the document is drastically shortened or translated. The third decision is whether any kind of equipment would be useful.

Only the first and third decisions have to be made when it is decided to copy the entire document. Whenever a new record is created, even a duplicate, there is an opportunity of improving the reading and handling by changing in some way the physical format, the media or recording method.

Sometimes only parts of a document, extracts, have to be copied for the convenience of readers. Then the difficult choice of which parts are to be copied has to be made. If an easy-to-recognize part, such as the table of contents, or sometimes the conclusions, can serve as a substitute for

Chapter IX

Summary (continued)

the whole document, then the selection process is minimal.

Computer programs that have attempted to produce abstracts have found it more possible to produce extracts, as in the so-called "auto-abstracts"*.

Microfilm and photostatic equipment offered the first opportunities for converting certain kinds of documents that were especially difficult to transport or to store into more manageable physical formats. Chief among the troublemakers were newspapers, some periodicals, and rare or fragile manuscripts. A number of scientists and librarians collaborated to produce in 1937 a microfilm camera capable of microfilming newspapers. It was shown at the World Congress on Documentation in Paris in that year.** Commercial companies then became interested.

* Luhn, H. P., "The Automatic Creation of Literature Abstracts", IBM JOURNAL, Vol. 2, No. 2, April 1958, p. 159-165.

** Davis, W., DOCUMENTATION UNFINISHED, Statement at the 25th Anniversary Meeting, of the American Documentation Institute, Hollywood-By-The-Sea, Florida, December 12, 1962 (multi:th).

Chapter IX

Summary (Continued)

As with all photography, microphotography has a marvelous ease of input of material properly placed in front of the camera. Cameras have the capability of what might be called parallel and instantaneous input in contrast to the sequential input of keyboarding method.

Of course, not all readers' benefits can be achieved together. Microfilm equipment which simplifies the transport, storage, and reproduction of documents handicaps the final step of reading by requiring a special reading device.

It is now practical to wait for a document request before making a copy.

This flexibility saves the cost of charging in and out of loaned materials as well as the storage space required for extra copies that may possibly be requested.

Chapter IX

Summary (continued)

The largest federal government distributor of unclassified technical reports, the Federal Clearinghouse for Scientific and Technical Information in the Commerce Department, has had a computer system since 1965. It processes single document requests that result in the typing of a reproduction order, when the inventory of copies is depleted, and of a mailing label for the dispatch of the copy to the requestor. Copies are made with Xerox Copyflow equipment.

The computer system is based on the 1961 system started by the then Armed Services Technical Information Agency, ASTIA, now the Defense Documentation Agency, DDC. In 1965, the processing of all requests for unclassified technical reports produced by the Department of Defense, or its contractors, was transferred to the Federal Clearinghouse in the Commerce Department.

Chapter IX

Summary (continued)

The kind of abstracts that preserve the message of a document while presenting it in far fewer words are called "informative abstracts".

"Indicative abstracts" are considered a kind of retrieval aid, namely index records. They talk about the message. They do not attempt to convey the message of the original document.* Abstractors (informative usually have to be more familiar with the subject of documents than do subject indexers. This is the reason why authors often prepare abstracts.

Translators have the most difficult job of all - to convey the message of a document while presenting it in another language. There is a well known saying, "All translators are traitors", that shows the impossibility of the job, even for highly trained human translators.

* Bohnert, Lea M., "Limits of Indexing", in INFORMATION SYSTEMS COMPATIBILITY, edited by Simon N. Newman, Washington, D. C., Spartan, Books, 1965. (The American University Technology of Management Series, Volume 1) p. 127-133.

Chapter X

PROCESSING DOCUMENT SUBSTITUTES

Summary

Everything described in Chapter VIII about the processing of documents is also applicable to document substitutes, except that some of the substitutes have handling advantages over the original documents. Some are substantially shorter, such as extracts and abstracts.

Other document substitutes have other handling advantages over documents because the choice and design of document substitutes is usually under the control of retrieval personnel. Whenever new records have to be created, there is an opportunity for improving the physical format to make handling easier. Therefore, the transportation, storage, and reproduction of document substitutes should be simpler, and less expensive than that required for the original documents.

Chapter X

Summary (continued)

Matching applied to document substitutes is as difficult to perform as when applied to documents, with the one exception of informative abstracts. When it is essential that copies of only the most appropriate documents be delivered to a requestor, the reading of informative abstracts, when available, often provides this assurance.

A substantial and inevitable cost is the transportation of documents to be reproduced in whatever manner to become document substitutes. The microfilming itself is inexpensive compared to the costs of locating the documents to be copied, transportation to the device that does the copying, and then transportation back to the assigned storage location.

In fact, the National Library of Medicine, due to the large amount of reproduction that it does, has developed a mobile cart to bring the microfilm camera to the documents to be copied, instead of the usual way, the reverse. The camera cart stops at the end of each range of stacks where documents to

Chapter X

Summary (continued)

be copied are shelved. After copying the documents are returned to a special part of the end shelves. Therefore, no documents ever leave the shelves except to be microfilmed in the adjoining aisle.

Storage operations applied to copies and translations are similar to those applied to documents unless the physical size of the document has been drastically reduced. Storage of microfilmed newspapers, periodicals, theses, and vital corporate records requires special devices for reading, or for reproducing the documents to a readable size for reading without special devices.

Chapter XI

KINDS OF RETRIEVAL AIDS

Summary

Retrieval aids are records designed to do things that either cannot be done at all, or only poorly, with documents or document substitutes. They are designed, usually by retrieval personnel, to be manipulated in the matching operation. Some are used in searching for appropriate documents, and others are used in locating copies of identified documents for delivery.

Unlike documents and document substitutes, retrieval aids do not have to convey the message of the document. They are restricted to messages about messages. In fact, retrieval aids usually describe or refer to a single aspect or characteristic of a document or document substitute. Therefore, they do not have to duplicate either the entire documents, or even substantive portions of the original documents, such as paragraphs and sentences.

Chapter XI

Summary (continued)

Retrieval aids should be, and usually are, the easiest to handle and the least expensive records because they have been designed solely for retrieval purposes. Therefore, the regular production and employment of retrieval aids are the best evidence of the existence of a retrieval service. Indexes, much less charge-out records, are seldom required when a collection comprises a couple hundred documents and only two or three persons have access to the collection.

Retrieval aids have been divided into three categories, called "property control", "index" and "evaluative records". All add something for retrieval purposes to the document or document substitute. They are identification labels, indicative labels, and recorded statements about the worth of a document from a specified viewpoint.

Chapter XI

Summary (continued)

The first two kinds of retrieval aids, property control and index records, are similar to data, or documents composed of items of equal interest to readers. Therefore, the two favourite formats are lists of individual items, or unit records, so that rapid access is possible to any single item. (See Chapter XIII for description of data retrieval).

Property control records account for the location of a specific document whether it is occupying a temporary, permanent, or presently no parking place in a collection. The latter case includes documents being acquired, but not received yet, as well as documents no longer in the collection.

Property control records are designed mainly to aid in the location of copies for delivery. They depend mainly on bibliographic identifications of individual documents. Therefore the main purpose of descriptive cataloging work is to identify individual documents in order to locate copies of specific documents for delivery.

Chapter XI

Summary (continued)

Index records are designed to describe some aspect concerning the contents of a document or document substitute. They describe an aspect of a document that cannot be learned solely from it or from a document substitute. Indexing adds something for searching purposes. It adds or assigns one or more labels to a document to indicate the group or groups of documents of which it is a member because of certain aspects it shares with those documents. Each group of documents assigned an indexing label have in common the same subject matter.

"Subject indexing" or "subject cataloging" are the names that librarians use for the work of assigning subject tags to groups of documents in a collection in order to facilitate later their retrieval together when requested.

Subject indexing is not performed on a single document in isolation but on individual documents of a particular collection. Indexing is best viewed

Chapter XI

Summary (continued)

as something added to a document, like editing, rather than as something contained in the document that can be pulled or squeezed out. For the latter case to be true, authors would have to know the subject characteristics of most of the collections to which their document will be added.

There are at least four different ways of subject indexing.

1. hierachian classification names
2. subject headings
3. coordinate indexing terms
4. keywords.

The use of the last method depends upon the happy coincidence of the same terminology being used consistently by authors and document requestors.

Evaluative records are designed to provide evaluations, judgements, of the worth of documents in terms of the documentary interests of the readers of a particular retrieval service. Different types of evaluative records result from book reviews, critical literature searches, or surveys of the state-of-the-art.

Chapter XI

Summary (continued)

Often property control and index records are combined into one record.

Any subject arrangement of, or index to, bibliographic descriptions of documents represent such a combination. Catalog cards filed in drawers are another example.

The same two retrieval aids are frequently found in combination with a particular document substitute, namely abstracts. This combination is well established, as is proven by the number of polished indexing and abstracting journals. A recent example of this popular threesome is called "Selective Dissemination of Information", or "SDI", but the procedure applies only to records being added to a collection. Furthermore, it is usually employed in conjunction with an announcement service to readers of documents that are appropriate to their previously recorded statements of current documentary interests.

Chapter XII

PROCESSING RETRIEVAL AIDS

Summary

Because the preparation of retrieval aids is usually under the control of retrieval personnel, three of the operations, namely transport, storage, and reproduction, should be and usually are easy and inexpensive to perform. Two kinds of retrieval aids, property control and index records, involve data retrieval. They are records consisting of items arranged in lists, or items or unit records arranged in files, for rapid access to any single item.

The operation of major interest performed with retrieval aids is the matching operation. It is the operation that must be prepared for before storage, but that is performed after storage. The conjunction of these two operations, matching and storage, distinguishes retrieval work from other kinds of message delivery services.

Chapter XII

Summary (continued)

Matching necessarily involves a description of the document being requested and descriptions of existing or available documents. The part of a document request that describes the document being requested is matched against the descriptions of the documents in a collection. Sometimes before a document request can be processed, considerable interpretation and even additions have to be made to the original description of the document requested.

Subject searching is the matching of subject indexing terms assigned to documents being requested against indexing terms previously assigned to documents in a collection. Locating is the matching of bibliographic descriptions provided in document requests against the bibliographic descriptions previously assigned to documents in a collection.

Chapter XII

Summary (Continued)

The most difficult search to perform is a "pure" subject search, because a minimum of description has been provided: namely, a subject description. Different words and phrases are invariably used in the document request and in the documents that may correspond in subject matter to that requested. It is the job of the subject indexer to bridge this considerable gap by understanding, interpreting, both languages. Frequently it is necessary to set-up an inbetween language to make explicit the subject correspondences between the two or more ways of describing the same subject matter.

Chapter XII

Summary (Continued)

Searches vary as to difficulty depending on the clues provided in the document request and on the capabilities of the particular retrieval service. Therefore, it is usually good search strategy to convert, whenever possible, the more difficult type of subject searches into the least difficult type of search, that of bibliographic description.

For instance, if a subject search concerns library automation, it may be possible to convert the search into one for documents with the two words in their titles. However, the documents resulting from such a search must be carefully screened to ensure that their titles do correctly indicate their subject matter.

Chapter XIII

PROCESSING ITEMS IN DOCUMENTS

Summary

Data retrieval can be distinguished from other types of document retrieval by the fact that it involves only records composed of items of equal interest to readers. Therefore, records to be used for data retrieval are designed to facilitate equal ease of access to any of the items of which they are composed. However, document retrieval always must precede data retrieval. It is impossible to locate an item requested until the correct document of which it is a part has been located.

Formats of records designed for data retrieval distinguish them from those designed to be read as a whole and usually requested for that purpose.

Lists and unit records are the popular formats. The formats must accommodate ease of original preparation, rapidity of look-up, and regular updating.

Chapter XIII

Summary (Continued)

Technical data records differ from non-technical types only because the recorded opinions are of individuals trained to be better than average observers recorders and measurers. Technical data still consists only of recorded opinions, but they are regularly corrected and updated as better methods are developed for observing, recording and measuring.

Chapter XIII

All retrieval processes handle records of some kind. Therefore, data must be some kind of record, no matter how small a record or how strange a record.

It is not possible to distinguish data by the fact that it always contains numerals, because it does not always do so. Dictionaries are as much retrieval devices as are mathematical tables or timetables. Nor is it possible to distinguish data by the fact that it is composed only of expressions that can be handled by computers, because data processing equipment manipulates only symbols. The symbols can be made equivalent to whatever one chooses, such as mail order items, insurance premiums or indexing terms.

Chapter XIII

It is both consistent and useful to restrict the meaning of "data" to a special kind of record namely those records that are composed of items of equal interest to readers. This type of record is designed so that the items of which it is composed are equally accessible, or equally inaccessible to readers. The records are not expected to be read in their entirety from beginning to end. Usually only a single item is requested or read at a time.

When items or data are requested, instead of complete documents, it is always first necessary to retrieve the document in which the item requested is located. It is no use to look for a French word in a Chinese dictionary or the departure times for planes from Washington, D. C., to Albany, New York, in railway timetables connecting the two places.

Chapter XIII

In other words, document retrieval must precede data retrieval. The correct document must be retrieved before the item requested can be located. Some evaluation or judgement is necessarily involved in determining which is the correct document.

Readers who are interested in items in records are, therefore, only interested in the document in so far as it facilitates or handicaps access to the items.

Records requested for the purpose of reading only a part, or an item, are usually distinguishable by format from documents requested for the purpose of reading them in entirety. The format is designed to provide equally easy access to the individual items. Popular formats are lists, tables, graphs, and drawings. Examples are directories, catalogs, maps, and engineering drawings.

Chapter XIII

Records requested for the purpose of reading only a single item at a time are called "reference tools" by librarians and segregated into special reading areas from which they are not allowed to leave.

If only one item at a time is of interest, then the record can be larger than one that is usually read from beginning to end. Examples are telephone directories and mail order catalogs. Such records do not even have to be well printed, easy to read, or on paper pleasant to handle if they are only consulted briefly and by different individuals. They do have to be strong enough for much handling by impatient people.

Motives for requesting rapid retrieval of technical data arise from the need for accurate data in research and development work. Complexity and rapid obsolescence are characteristics of technical data.

Chapter XIII

It is neither possible or sensible to memorize much technical data because of its quantity, complexity, and finally its rapid obsolescence. It is better to copy carefully chemical formulae of any complexity and measurements of any precision. Some kinds of data retrieval are easy to delegate, as is indicated by the growing popularity of verbally requesting telephone numbers from "information", in preference to looking them up in the directories.

The users of technical data are many while the compilers are few. The two groups do not overlap substantially, as do technical authors and readers of documents that are read in their entirety. Therefore, technical data retrieval does not have the advantages of technical document retrieval resulting from the fact that most technical readers are the equals of the technical authors.

Chapter XIII

The compilers differ substantially from the users. The authority and competence of the compilers of technical data must be clear and obvious, and so, able to be relied on by technically trained individuals.

Continuity of work, as well as reliability, is required for the constant updating of technical data, and so, the permanence of an organization is indicated. Also required are presentation or display skills to ensure that the items requested can be quickly located and easily read and copied.

To process efficiently items for retrieval, it is essential to control the preparation of the record. The preparation of data should include its collection, verification, formatting, provision upon request, and regular updating.

Chapter XIII

Data cannot be collected, much less verified, without the establishment of the explicit scope of the coverage of the data, and identification of the audience to be served, or the "readience", a term suggested by Dorothy E. Cole in a recent committee meeting of Library School Faculty at the State University of New York at Albany, SUNYA. Existing sources of recorded data should be located by document retrieval methods, before a determination is made as to the advisability of collecting original data. Automatic observing, recording and measuring instruments should be considered if new data must be collected.

In any case, whether data is copied from previously recorded sources or is collected with the aid of human or mechanized observers, recorders and measurers, the only thing that can possibly be recorded are the opinions of individuals, or of their machine delegates. The individuals are properly well situated to record the best opinions in the case of technical data. However, technical data consists only of the recorded opinions of

Chapter XIII

individuals technically trained and provided with good observing and recording equipment. However, their recorded opinions are invariably and surely corrected soon by more recent, and sometimes better, recorded opinions.

Evaluation and judgement are always required whether previously recorded data is being collected by oneself. One's own viewpoint is usually the last to be made explicit and so, the hardest to control.

Matching is a key retrieval operation which the design of technical data records should help to ensure being easy and inexpensive to handle. Other operations, transport, storage and reproduction, also should be substantially simplified by the standardization of formats and the mechanization of recording and measuring means.

Chapter XIII

Because of the rapid obsolescence of technical data, maintenance is a constant responsibility. This often justifies the use of automatic recording and measuring equipment if the job of original preparation has not already done so.

Examples of data retrieval services can be found in the four editions of NONCONVENTIONAL TECHNICAL INFORMATION SYSTEMS IN CURRENT USE published since 1958 by the National Science Foundation. Since the first edition, which arranged systems alphabetically by name, the distinction between data and document retrieval has been carefully indicated by arranging the descriptions into categories.

Chapter XIII

An example where the dissimilarities are obvious between the compilers and user of technical data is a service named Volunteers for International Technical Assistance, VITA, of Schenectady, New York. The volunteers are not only technical experts but of linguistic and cultural backgrounds different from most of the individuals who send in written requests for advice on technical problems. The individuals requesting technical advice are situated in developing areas, including ones in the United States of America. The problem of communication is at its maximum, but direct correspondence between the technical volunteer and the individual requesting assistance tends to overcome this difficulty.

Chapter XIV

GENERAL AND SPECIAL PURPOSE EQUIPMENT

Summary

As in other work, equipment is employed as an aid in retrieval work mainly to handle larger numbers of unit items and to handle them faster.

Cheaper, better, or additional work are less usual aims or accomplishments.

The most successful areas of application of equipment to retrieval work are in the reproduction and storage of documents and document substitutes.

Three main technologies have been the main source of equipment applications to retrieval. They are microfilming, data processing, and most recently, non-photographic copying devices, principally the electrostatic devices.

The copying devices have the opposite advantages of the manipulative devices, principally data processing equipment, namely ease of initial recording and lack of need for proofreading.

Chapter XIV

Summary (continued)

A benefit of studying historically the applications of general and special purpose equipment is an appreciation of when and why different types of equipment were tried. The competing motives are always evident between need of work to be done and availability of equipment.

General purpose equipment has often proved to be the best for retrieval work because of the all-pervasive role of records in modern society. For instance, data processing equipment was invented for census takers and developed further for accountants, bankers, and schedulers, military and civilian. Not surprisingly they have also proved useful in property control procedures for documents. Especially since 1960, data processing equipment has proved increasingly useful because of the capability of printing two alphabets, a choice of upper and lower characters, and most punctuation marks, if not diacritical marks and chemical symbols.

Chapter XIV

Summary (continued)

Some equipment, originally special purpose, namely microfilming equipment for business records, were developed by a group of scientists and librarians between 1920 and 1940 into generally useful equipment. Microfilming is a help mainly in the storage operations with records of any kind. It also results in benefits to the transport and reproduction of documents. Micro-filming equipment now aids census takers, bankers, accountants, and military and civilian planners and schedulers.

Special purpose equipment is not only expensive at the prototype stage, but the development work to a workable machine is long and expensive too. The Rapid Selector is the only example of a device designed for retrieval that enjoyed, and therefore survived, a protected and protracted adolescent period of eighteen years.

Chapter XV

DESIGN AND IMPROVEMENT OF RETRIEVAL SERVICES

Summary

To design or to improve any activity, it is necessary to understand the activity. This has been the motivation of this textbook, to establish minimum conditions for an activity to be describable, and hence analyzable, as retrieval service.

There are a number of key assumptions. The first assumption is that libraries are not "islands unto themselves" but only one way of many of handling recorded messages. The second assumption is that retrieval work is centered on the document requests it received from readers. To fulfill document requests adequately is the aim of retrieval. The third assumption is that retrieval work has been accomplished if the documents delivered are those most appropriate to the document request in the collection of from any cooperating agency.

Chapter XV

Summary (continued)

The final assumption is that a first approximation to describing regular retrieval services should be in terms of physical objects and observable manipulations. Then it will be possible to investigate, and perhaps to judge, the reasons for and results of preferring one kind of record over another and manipulating one of several ways.

The model of retrieval work developed in this textbook has been based upon the definition of retrieval as a message delivery service that operates only upon request of its readers. Four physical objects and five basic operations have been distinguished and described.

Human beings and equipment also are involved in observable forms of retrieval activity. They are only of interest, as a first approximation, as agents handling more or less adequately the various kinds of records in order either to identify appropriate documents that have been requested or to deliver copies of the identified documents.

Appendix A

SELECTIVE BIBLIOGRAPHY OF U. S. CONGRESS PUBLICATIONS
OF RETRIEVAL INTEREST, ARRANGED BY DATE

1. U.S. Congress. Senate. Committee on Government Operations.
Science and technology act of 1958. Hearings before the
Subcommittee on Reorganization, 85th Cong., 2d sess., on
S. 3126 and S. 4039. Washington, U.S. Govt. Print. Off.,
1958. 541 p.
Hubert H. Humphrey, chairman of subcommittee.
2. U.S. Congress. Senate. Committee on Government Operations.
Science and technology act of 1958. Washington, U.S. Govt.
Print. Off., 1958. 198 p. (85th Cong., 2d sess. Senate.
Document no. 90)
3. U.S. Congress. Senate. Committee on Government Operations.
The National Science Foundation and the life sciences
Washington, U.S. Govt. Print. Off., 1959. 96 p.
(86th Cong., 1st sess. Senate. Committee Print)
4. U.S. Congress. House. Committee on Science and Astronautics.
Dissemination of scientific information. Washington, U.S.
Govt. Print. Off., 1959. 12p. (86th Cong., 1st sess.
House. Report no. 1179)
5. U.S. Congress. House. Committee on Science and Astronautics.
Dissemination of scientific information. Washington, U.S.
Govt. Print. Off., 1959. 182 p. (86th Cong., 1st sess.)
6. U.S. Congress. House. Committee on Science and Astronautics.
Research on mechanical translation. Hearings before the
Special Investigating Subcommittee. 86th Cong., 2d sess.
Washington, U.S. Govt. Print. Off., 1960. 183 p.
Overton Brooks, chairman of subcommittee.
7. U.S. Congress. House. Committee on Science and Astronautics.
Research on mechanical translation. Washington, U.S.
Govt. Print. Off., 1960. 51 p. (86th Cong., 2d sess. House.
Report no. 2021)

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8. U.S. Congress. Senate. Committee on Government Operations.
Documentation, indexing, and retrieval of scientific information. Washington, U.S. Govt. Print. Off., 1960. 283 p. (86th Cong., 2d sess. Senate. Committee Print. Report no. 113)
9. U.S. Congress. Senate. Committee on Government Operations.
The U.S. Government and the future of international medical research. Hearings before the Subcommittee on Reorganization and International Organizations, 86th Cong., 2d sess., pursuant to S. Res. 347, S. Res. 42, and S. Res. 255. Washington, U.S. Govt. Print. Off., 1961 3 pts. (1247 p.)
Hubert H. Humphrey, chairman of subcommittee.
10. U.S. Congress. Senate. Committee on Government Operations.
Documentation, indexing, and retrieval of scientific information: a study of federal and non-federal science information processing and retrieval programs. Washington, U.S. Govt. Print. Off., 1961. (87th Cong., 1st sess. Senate. Document no. 15)
11. U. S. Congress. Senate. Committee on Government Operations.
Coordination of information on current federal research and development projects in the field of electronics. Washington, U.S. Govt. Print. Off., 1961. 292 p. (87th Cong., 1st sess. Senate. Committee Print)
12. U.S. Congress. Senate. Committee on Government Operations.
Coordination of information on current scientific research and development supported by the United States Government: administrative and scientific projects and opportunities of central registration of research in science and engineering. Washington, U.S. Govt. Print. Off., 1961. 286 p. (87th Cong., 1st sess. Senate. Report no. 263)
13. U.S. Congress. Senate. Committee on Government Operations.
Interagency coordination of information. Hearings before the Subcommittee on Reorganization and International Organizations 87th Cong., 2d sess. pursuant to S. Res. 276. Washington, U.S. Govt. Print. Off., 1961. 1 pt. (242 p.)
Hubert H. Humphrey, chairman of subcommittee.

14. U.S. Congress. House. Committee on Education and Labor.
National information center. Hearings before the Ad Hoc Subcommittee on a National Research Data Processing and Information Retrieval Center, 88th Cong., 1st sess., on H. R. 1946. Washington, U.S. Govt. Print. Off., 1963. v. 1 (507 p.) app (679 p.)
Roman C. Pucinski, chairman of subcommittee.
15. U.S. Congress. House. Committee on Post Office and Civil Service.
Inventory of automatic data processing (ADP) equipment in the federal government. Prepared by the Bureau of the Budget for the Subcommittee on Census and Government Statistics. Washington, U.S. Govt. Print. Off., 1963. 145 p. (88th Cong., 1st sess. House. Committee Print)
16. U.S. Congress. House. Committee on Government Operations.
Availability of information from federal departments and agencies. (Progress of study Sept. 1961-Dec. 1962) Washington, U.S. Govt. Print. Off., 1963. 223 p. (88th Cong., 1st sess. House. Report no. 918)
17. U.S. Congress. Senate. Committee on Government Operations.
Interagency coordination in drug research and regulation. Hearings before the Subcommittee on Reorganization and International Organizations, 88th Cong., 1st sess. pursuant to S. Res 27. Washington, U.S. Govt. Print. Off., 1963. pts. 3 (1267)
Hubert H. Humphrey, chairman of subcommittee.
18. U. S. Congress. House. Select Committee on Government Research.
Study number IV documentation and dissemination of research and development results. (Under the authority of H. Res. 504) Washington, U.S. Govt. Print. Off., 1964. 10 studies (1533 p.) (88th Cong., 2d sess. House. Reports)

See Study 1, Administration of research and development grants, Study 2, Manpower for research and development, Study 3, Federal facilities for research and development, Study 5, Federal student assistance in higher education, Study 6, Impact of federal research and development programs, Study 7, Contract policies and procedures for research and development, Study 8, Interagency coordination in research and development, Study 9, Statistical review of research and development, Study 10E, National goals and policies, and Study 10, Staff resume of the activities of the Select Committee on Government Research of the House of Representatives.

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19. U.S. Congress. Senate. Committee on Government Operations.
Report to the President on the management of automatic data processing in the federal government. Prepared by the Bureau of the Budget. Washington, U.S. Govt. Print. Off., 1965 (89th Cong., 1st sess. Senate Document no. 15)
20. U. S. Congress. House. Committee on the Judiciary.
Hearings before Subcommittee no. 3, 89th Cong., 1st sess., on H.R. 4347, H.R. 5680, H.R. 6831, H.R. 6835, bills for the general revision of the Copyright Law, Title 17 of the United States Code. Washington, U.S. Govt. Print. Off., 1965. 3 pts (2056 p.)
21. U. S. Congress. House. Committee on Armed Services.
Report to Congress on the Department of Defense Cataloging and Standardization Programs for the Period January 1 through June 30, 1966. Subcommittee for Special Investigations, 89th Cong., 2d sess. Washington, U.S. Govt. Print. Off., 1966. (14 p.)
22. U. S. Congress. House. Committee on Science and Astronautics.
Report to Congress on the Inquiries, Legislation, Policy Studies Re: Science and Technology. 2nd Progress Report of the Subcommittee on Science, Research and Development. (89th Cong., 2d sess. Washington, U.S. Govt. Print. Off., 1966 (28 p.)
23. U.S. Congress. House. Committee on Post Office and Civil Service.
Report to the Committee of the Whole House on the State of the Union. 89th Cong., 2d sess., H.R. 2197. Washington, U.S. Govt. Print. Off., 1966 (70 p.)
24. U.S. Congress. House. Committee on Post Office and Civil Service.
Report to Congress on Government Electronic Data Processing Systems. 89th Cong., 2d sess., Washington, U.S. Govt. Print. Off., 1966 (516 p.)

Appendix B

SELECTIVE BIBLIOGRAPHY OF GLOSSARIES OF
RETRIEVAL INTEREST, ARRANGED BY DATE

1. Thompson, Elizabeth H. A.L.A. glossary of library terms with a selection of terms in related fields. 8th printing, 1965. Chicago, American Library Association, 1943. 159 p.
2. Western Reserve University. A system of documentation terminology for use at the conference on the practical utilization of recorded knowledge-present and future. (Pre-conference paper no. 1) Cleveland, School of Library Science, 1955, 7 p.
3. Mack, J. D. and R. S. Taylor. System of documentation terminology. In Documentation in Action. New York, Reinhold, 1956. p. 15-26.
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5. Wagner, Frank S. Jr. Dictionary of documentation terms. Clarkwood, Texas, Celanese Corp. of America, 1959. 37 p.
In American Documentation, v. 11, April 1960, p. 102-119.
6. Warheit, I. A. Glossary. In Reference Manual Index Organization for Information Retrieval. C20-8062. New York, International Business Machines, 1961. p. 45-49.
7. Armed Services Technical Information Agency (now Defense Documentation Center). Explanation of ASTIA terminology. Washington, 1961. 4 p.
8. Association for Computing Machinery. Tentative 1961 ACM glossary of computer terminology. New York, 1961. 186 p.
9. Glossary of ASTIA operational terms. Glossary committee. 2nd draft. Washington, Armed Services Technical Information Agency (now Defense Documentation Center), 1962. 7 p.
Albrecht J. Neumann, chairman of committee.
10. U. S. Executive Office of the President. Bureau of the Budget. Automatic data processing glossary; Elvin Sill, Jr., editor. Washington, U. S. Govt. Printing Office, 1962, 62 pages.
Also available as Datamation ADP Glossary. New York, F. D. Thompson Publications, n.d. 62 pages.

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11. British Standards Institution. Glossary of terms used in automatic data processing. London, Waterlow & Sons, Ltd., 1962. 131 p.
12. Taylor, Robert S. Glossary of terms frequently used in scientific documentation. New York, American Institute of Physics, Public Relations Department, 1962. 16 p.
13. U. S. Air Force. Office of Aerospace Research. Glossary of STINFO Terminology; Dana L. Thompson compiler from 18 other sources. Washington, 1963. 154 p.
14. U. S. Department of Defense. DOD Glossary Subcommittee. Glossary of information handling. Washington, Office of Defense Research and Engineering, 1964. 7 p.
Martin H. Weik, Chairman of subcommittee.
Also available as Glossary. In U. S. Congress. House, 88th 2nd press. Study number IV Documentation and dissemination of research and development results; report of the select committee on government research. Washington, U. S. Govt. Printing Office, 1964, p. 95-100.
15. Bemser, R. W. and M. Grems, comp. Glossary of information processing. (C20-8089-2) New York, International Business Machines, 1964 rev. 20 p.
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17. U. S. Department of Defense. Technical Data & Standardization Policy Committee. First draft combined vocabulary Army, Navy, Air Force DSA NASA (cooperating). Washington, 1965. 35 p. (Based on 14 above)
Martin H. Weik, chairman of committee.

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18. U. S. Department of Defense. Technical Data & Standardization Policy Committee. Technical data and standardization glossary. (TD-2) Washington, Office of the Assistant Secretary of Defense, 1965. 21 p. (Based on 17 above).
19. Glossary: terms used in statistical surveys. In American Library Association. Library Statistics: a handbook of concepts, definitions and terminology. Chicago, American Library Association, 1966. p. 127-145.
20. Joint Technical Committee on Terminology International Federation for Information Processing, IFIP-ICC Vocabulary of Information Processing, North-Holland Publishing Company, Amsterdam, 1966, 208. p.

Appendix C

HISTORY OF EQUIPMENT OF RETRIEVAL INTEREST

OUTLINE

- I. Mechanized Aids in Processing Documents.
- II. Mechanized Aids in Processing Document Substitutes.
- III. Mechanized Aids in Processing Retrieval Aids.
- IV. Mechanized Aids in Processing Items in Documents.
- V. Mechanized Combinations of Retrieval Processes.

Appendix C

Detail of EQUIPMENT HISTORY Outline

- I. Mechanized Aids in Processing Documents
 - A. Mechanized Preparation of Documents.
 - 1. Punch Card Print-Outs
 - 2. Automatic Typewriter Print-Outs
 - 3. Computer Print-Outs
 - 4. Computer Directed Printing
 - B. Mechanized Transport of Documents.
 - 1. Electric Chutes and Conveyor elts
 - C. Mechanized Storage of Documents
 - 1. Automatic Shelves
 - 2. Elevator File Cabinets
 - D. (Mechanized Reproduction of Documents results in the Mechanized Preparation of Document Substitutes, so will be treated under II. A)
 - E. Mechanized Matching of Documents.
 - 1. (Mechanized transport of documents as a matching aid is treated under I. B. Mechanized Transport of Documents)
 - 2. Punch Cards With Sorters
 - 3. Computer Print-Outs
 - 4. Special Collators

- II. Mechanized Aids in Processing Document Substitutes
 - A. Mechanized Preparation of Document Substitutes
 - 1. Copy Devices
 - a. Microfilm Rolls
 - b. Photographic Copiers
 - c. Electrostatic Copiers
 - d. Microfilm Opaque Cards
 - e. Microfilm Transparent Cards
 - 2. Computer Programs
 - a. Extracts
 - b. Abstracts
 - c. Translations
 - B. Mechanized Transport of Document Substitutes if different
from I. B. Mechanized Transport of Documents.
 - C. Mechanized Storage of Document Substitutes if different
from I. C. Mechanized Storage of Documents.
 - D. (Mechanized Reproduction of Document Substitutes is included
in II. A, Mechanized Preparation of Document Substitutes,
as II. A. 1. Copy Devices.)
 - E. Mechanized Matching of Document Substitutes, if different
from I. E. Mechanized Matching of Documents.

- III. Mechanized Aids in Processing Retrieval Aids.
 - A. Mechanized Preparation of Retrieval Aids.
 - 1. Property Control Records.
 - a. Acquisition Procedures.
 - (1) Punch Cards for Book Purchases
 - (2) Punch Cards for Serials Acquisition
 - b. Circulation Procedures
 - (1) Telecommunication Aids
 - (2) Punch Cards
 - (3) Edge-Notch
 - (4) Computer Programs for Request Processing
 - c. Disposal Procedures
 - 2. Index Records.
 - a. Punch Card Print-Outs.
 - b. Computer Print-Outs.
 - (1) Listing by Author's Names with Citations
 - (2) Listing by Index Terms with Citations
 - c. Paper Tape Print-Outs
 - d. Punch Card Actuated Camera Lists
 - 3. Evaluative Records.

- III. Mechanized Aids in Processing Retrieval Aids (continued)
 - B. Mechanized Transport of Retrieval Aids, if different from other mechanized transport procedures.
 - C. Mechanized Storage of Retrieval Aids, if different from other mechanized storage procedures.
 - D. Mechanized Reproduction of Retrieval Aids, if different from other mechanized reproduction procedures.
 - E. Search Devices, or Mechanized Matching of Index Records.
 - 1. Edge-Notch Cards for Manual Manipulation.
 - 2. Optical Coincidence Cards for Manual Manipulation.
 - 3. Punch Cards with Sorters.
 - 4. Edge-Notch Cards for Mechanical Manipulation.
 - 5. Punch Cards with IBM-01 Sorters.
 - 6. Punch Cards with Collators.
 - 7. Paper Tape Searches.
 - 8. Computer Searches
 - 9. Special Devices Utilizing IBM Cards.
 - 10. Magnetic Media Devices.

Appendix C

IV. Mechanized Aids in Processing Items in Documents, or Data.

- A. Mechanized Preparation of Items in Documents.
- B. Mechanized Transport of Documents Composed of Items, if different
from other mechanized transport procedures.
- C. Mechanized Storage of Documents Composed of Items, if different
from other mechanized storage procedures.
- D. Mechanized Reproduction of Documents Composed of Items, if different
from other mechanized reproduction procedures.
- E. Mechanized Matching of Documents Composed of Items, if different
from other mechanized matching procedures.

V. Mechanized Combinations of Retrieval Processes.

A. Devices to Locate and Copy Documents.

1. Microfilm Roll Devices
2. Microfilm Strip/Sheet Devices
3. Unit Devices

B. Devices to Search and Copy Documents.

1. Microfilm Roll Selectors
2. Microfilm Unit Selectors
3. Microfilm Sheet/Strip Selectors
4. Magnetic Media Selectors

C. Devices to Copy and Deliver Documents.

1. Telefacsimile
2. Television

D. Devices to Match, Copy and Deliver Abstracts.

1. Punch Cards, Print-Outs

Appendix C

1. Mechanized Aids in Processing Documents

A. Mechanized Preparation of Documents

1. Punch Card Print-Outs
2. Automatic Typewriter Print-Outs
3. Computer Print-Outs
 - a. H. P. Luhn
International Business Machines Corporation
Arranged computer printing for the preprints of
the International Conference on Scientific
Information.
4. Computer Directed Printing.
 - a. H. P. Luhn
International Business Machines Corporation
Arranged computer printing for the conference
papers of the 1963 Annual Meeting of the
American Documentation Institute.

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Dates

1958	National Academy of Sciences/National Research Council, PREPRINTS OF THE INTERNATIONAL CON- FERENCE ON SCIENTIFIC INFORMATION, 1958
1963	Luhn, H. P. (editor) AUTOMATION AND SCIENTIFIC COMMUNICATION, SHORT PAPERS CONTRIBUTED TO THE 26TH ANNUAL MEETING OF THE AMERICAN DOCU- MENTATION INSTITUTE AT CHICAGO, Pick-Congress Hotel, October 6-11, 1963, Short Papers, Parts 1 and 2

* Complete Citations for abbreviated references will
be found at the end of Appendix C.

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11/9/67

I. Mechanized Aids in Processing Documents

B. Mechanized Transport of Documents

1. Electric Chutes and Conveyor Belts

- a. V. Verhoeff
Assisted in the development of new delivery system for the Library of the University of Delft, Netherlands

1965

Verhoeff, V.
"The Delft Circulation System"
LIBRI, Vol. 16, No. 1, 1966, p. 1-9.

C. Mechanized Storage of Documents

1. Automatic Shelves

- a. F. Schorck, Librarian
The American University
Experiment with automatic shelves made by Elecompack Company, Ltd. of Japan.

1967

(Personal communication on 11/30/67 from H. Chatfield, Archivist, The American University).

2. Elevator File Cabinets

- D. (Mechanized Reproduction of Documents Results in the Mechanized Preparation of Document Substitutes, so will be treated under II. A.)

Appendix C

I. Mechanized Aids in Processing Document

E. Mechanized Matching of Documents

1. (Mechanized Transport of documents as a matching aid is treated under I. B. Mechanized Transport of Documents.)

2. Punch Cards with Sorters

- a. R. Busa of Italy
Centro per l'Automazione dell'Analisi Letteraria dell'Aloisianum
Supervised concordance of SUMMA THEOLOGIAE by St. Thomas Aquinas, using IBM punch card equipment, including Cardatype.

- b. J. Ellison
Supervised concordance of the BIBLE using Remington Rand UNIVAC Computer

3. Computer Print-Outs

- a. R. Busa
Centro per l'Automazione dell'Analisi Letteraria dell'Aloisianum
Supervised concordance of some DEAD SEA SCROLLS using IBM-705 Computer and IBM-101 Sorter.

4. Special Collators

- A. C. Hinman
Folger Shakespeare Library
Invented Hinman Collator for matching of First Folios of Shakespeare's plays in order to determine the original text.

References

Dates

Busa, R.
"The Use of Punched Cards In Linguistic Analysis", Chapter 16 in Perry, 1958, p. 357-373.

Perry, 1958, p. 372-373.

Perry, 1958, p. 373.

Friendly, A.
"Folger's First Folios' Bear Fruit", WASHINGTON TIMES HERALD, May 9, 1954, p.1B-3B.

Appendix C

II. Mechanized Aids in Processing Document Substitutes

A. Mechanized Preparation of Document Substitutes

1. Copy Devices

a. Microfilm Rolls

	<u>Dates</u>	<u>References</u>
(1) J. B. Dancer of England First microphotographs, 106:1 reduction	1839	Bagg, 1962, p. 11 Bourne, 1963, p. 188
(2) Sir J. Herschel (British Astronomer) proposed making and publishing microphoto- graphic reproductions of reference books.	1853	Stevens, G. W. W. MICROPHOTOGRAPHY: PHOTOGRAPHY AT EXTREME RESOLUTION London, Chapman & Hall, 1957, p. 233
(3) R. Dagron French Patent	issued 1859	Luther, Frederick "Rene Dragon and the Siege of Paris", AMERICAN DOCUMENTATION, Vol. 1, No. 4, October 1950, p. 196-206
(4) R. Dragon directed pigeon post for mailing microfilmed letters during siege of Paris. (Franco-Prussian War).	1870	Horne, Allistaire "By Balloon from Paris" HISTORY TODAY, Vol. 13, No. 7, July, 1963, p. 441-8 Same as above

Appendix C.

II. Mechanized Aids in Processing Document Substitutes

A. Mechanized Preparation of Document Substitutes

1. Copy Devices

a. Microfilm Rolls

	<u>Dates</u>	<u>References</u>
(5) Recordak Model 3 reader for 16 mm. film	1929	Stewart, 1960, p. 12
(6) Microfilming of newspapers and their sale in microfilm form	1933	Brown, K. "Newspapers on Film" LIBRARY JOURNAL, Vol. 59 June 1, 1934, p. 471
(7) Watson Davis, Director of Science Service established "Biblio-Film Service" operating copying camera at U. S. Department of Agriculture Library, Library of Congress, and Surgeon General's Library in Department of Army.	1934	Bagg, 1962, p. 12 Stewart, 1960, p. 15-16
(8) Recordak projector for 35 mm. film. New York Public Library Demonstration.	1934	Stewart, 1960, p. 15-16
(9) American Library Association Microphotographic symposium and equipment exhibit.	1936	Stewart, 1960, p. 22-23

Appendix C

II. Mechanized Aids in Processing Document Substitutes

A. Mechanized Preparation of Document Substitutes

1. Copy Devices

a. Microfilm Rolls

(10) H. G. Wells

World Congress of Documentation in Paris suggested creation of a "world brain" by microfilming "the great literature and the factual materials of the world".

1937

Wells, H. G.
WORLD BRAIN
New York, Doubleday, Doran, 1938

Davis, W.
DOCUMENTATION UNFINISHED Statement
at the 25th Anniversary Meeting of
The American Documentation Institute.
Hollywood-By-The-Sea, Fla.,
December 12, 1962 (multilith) p. 4

(11) Watson Davis of Science Service transferred
Biblio-Film Service to new organization named
American Documentation Institute.

1937

Stewart, 1960, p. 29-30

(12) World War II

Use of V-mail by USA.

1940's

Kaempffert, W. B.
"Film Mail For Jeeps"
SCIENCE DIGEST, Vol. 12,
September 1942, p. 67

(13) Office of Technical Services established in
Department of Commerce to microfilm and to
publish WWII captured enemy documents.

1947

Lockrey, A. J.
"Army Microfilm Mail Technique"
AMERICAN PHOTOGRAPHER, Vol. 36,
December 1942, p. 24-5

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II. Mechanized Aids in Processing Document Substitutes

A. Mechanized Preparation of Document Substitutes

1. Copy Devices

a. Microfilm Rolls

- (14) University Microfilms, Inc.
Microfilming and Sale of doctoral theses.

- (15) National Microfilming Association
established for manufacturers and users
of the equipment

- (16) R. R. Shaw
U. S. Department of Agriculture Library
Microfilming of shingled catalog cards for
publication in USDA Bibliography

- (17) Recordak Lodestar developed for Sears and
Roebuck Company. Cartridges for 16 mm.
microfilm for inserting and storage of rolls.

Dates

1950

1951

1950

1960.

References

- Power, E. B.
"University Microfilms: A Microfilming
Service for Scholars."
JOURNAL OF DOCUMENTATION, Vol. 2,
No. 1, June 1946, p. 23-31
- Lewis, C. M.
"National Microfilm Association"
LIBRARY JOURNAL, Vol. 77, No. 13
July, 1952, p. 1178-1181
- Shaw, R. R.
"Biblio Film Service of the U. S.
Department of Agriculture Library"
JOURNAL OF DOCUMENTARY REPRODUCTION
Vol. 5, No. 4, Dec. 1942, p. 198-208
- Shaw, R. R.
"USDA Library"
LIBRARY JOURNAL, Vol. 69, No. 8,
April 15, 1944, p. 333-5.

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II. Mechanized Aids in Processing Document Substitutes

A. Mechanized Preparation of Document Substitutes

1. Copy Devices

b. Photographic Copiers

- | | | |
|--|------|------------------------|
| (1) R. Graffin
Exhibited prototype of photostat
International Exposition in Paris. | 1900 | Hawken, 1960, p. 22-23 |
| (2) Photostat copying services in Library of
Congress and New York Public Library | 1912 | Hawken, 1960, p. 22-23 |

c. Electrostatic Copiers

- | | | |
|---|--|--|
| (1) C. F. Carlson
Xerox Inventor | filed Nov. 16, 1940
issued Sept. 12, 1944 | "Electro-Photographic Apparatus"
U. S. Patent No. 2,357,809 |
| (2) Optical Society of America
Public demonstration in Detroit
of Xerox Equipment | 1948 | Hawken, 1960, p. 268
Hawken, 1960, p. 268 |
| (3) U. S. Commercial Practice | 1960 | Hawken, 1960, p. 268 |

Appendix C

II. Mechanized Aids in Processing Document Substitutes

A. Mechanized Preparation of Document Substitutes

1. Copy Devices

d. Microfilm Opaque Cards

- (1) F. Rider
proposed microcards (3x5)

1944
Rider, F.
THE SCHOLAR AND THE FUTURE OF RESEARCH
LIBRARY: A Problem and its Solution
New York, Knickerbocker Press, 1944

Hawkins, R.
"Production of Micro-Forms" In
THE STATE OF THE LIBRARY ART
R. R. Shaw, editor. New Brunswick,
N. J. Rutgers, The State University,
Graduate School of Library Service,
1960, Vol. 5, Part 1, p. 66

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- (2) Microcard Corporation established in West
Salem, Michigan to make and to sell microcards
and microtapes

1950

- (3) Atomic Energy Commission
Largest installation of microcards
(20 million distributed by 1962)

1952

Bourne, 1963, p. 217

References

Dates

Appendix C

II. Mechanized Aids in Processing Document Substitutes

A. Mechanized Preparation of Document Substitutes

1. Copy Devices

e. Microfilm Transparent Cards

- (1) Petroleum Research Corporation
Micro-Research Cards, microfilm transparent
cards (5x8) with holes for needle sorting,
were developed for Rocky Mountain Geology Library.

Chronis, J.
"How Microfilm Library Aids Research"
WORLD OIL, Vol. 142, May, 1956,
p. 95-97

NSF #2, 1960, p. 17-18

NSF #3, 1962, p. 188-189

Bagg, 1962, p. 30-31, 60-63

Bourne, 1963, p. 108-109

page 181

- (2) Atomic Energy Commission and National
Aeronautics and Space Administration
standardized the reduction ratios of their
cards. 1963
- (3) Department of Defense joined standardization
agreement. 1964

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II. Mechanized Aids in Processing Document Substitutes

A. Mechanized Preparation of Document Substitutes

2. Computer Programs

a. Extracts

- (1) H. P. Luhn
International Business Machines Corporation
"Auto-Abstracts"

1958

Luhn, H. P.
"The Automatic Creation of
Literature Abstracts",
IBM JOURNAL, Vol. 2, No. 2,
April 1958, p. 159-165.

Bourne, 1963, p. 160

- (2) T. R. Savage
International Business Machines Corporation
IBM 704 used

1958

Savage, T. R.
Preparation of Auto-Abstracts on the
IBM 704 Data Processing System
Yorktown Heights, N.Y.,
International Business Machines Corp.
1958, 11 p.

Bourne, 1963, p. 160

b. Abstracts

c. Translations

- B. Mechanized Transport of Document Substitutes if different
from I. B., Mechanized Transport of Documents.

- C. Mechanized Storage of Document Substitutes, if different
from I. C. Mechanized Storage of Documents.

- D. (Mechanized Reproduction of Document Substitutes is included
in II. A. Mechanized Preparation of Document Substitutes
as II. A. 1. Copy Devices.)

- E. Mechanized Matching of Document Substitutes if different
from I. E. Mechanized Matching of Documents.

References

Appendix C

III. Mechanized Aids in Processing Retrieval Aids

A. Mechanized Preparation of Retrieval Aids

1. Property Control Records

a. Acquisition Procedures

(1) Punch Cards for Book Purchases

(a) Boston Public Library

International Business Machines Corp.
PURCHASE ANALYSIS PROCEDURE - BOSTON
PUBLIC LIBRARY
New York, IEM Corp., 1934

1934

References

Dates

(2) Punch Cards for Serials Acquisition

(a) University of Texas Library

Moffitt, A.
"Punched Card Records in Serials
Acquisition"
COLLEGE AND RESEARCH LIBRARIAN
Vol. 7, no. 1, Jan. 1946, p. 10-13
page 183

1945

(b) University of Texas Library

Young, E. H.
"Use of Punched Cards in the Serials
Acquisition Department of the University
of Texas"
SLA TEXAS CHAPTER BULLETIN,
Vol. 11, 1959, p. 1-3

1950

Appendix C

III. Mechanized Aids in Processing Retrieval Aids

A. Mechanized Preparation of Retrieval Aids

1. Property Control Procedures

b. Circulation Procedures

(1) Telecommunication Aids

(a) Telephone

- | | <u>Dates</u> | <u>References</u> |
|---|--------------|--|
| i. Invented by Alexander G. Bell of USA | 1876 | THE WORLD ALMANAC, 1967 edition, p. 298 |
| ii. Regular use for book requests by New York Society Library subscribers | 1911 | King, H.
BOOKS AND PEOPLE: FIVE DECADES OF NEW YORK'S OLDEST LIBRARY.
The MacMillan Company, New York, 1954, p. 63 |

page 184

(b) Teletype

- | | | |
|---|---------------|--|
| i. Invented by Morkrun-Kleinschmidt of USA | 1928 | THE WORLD ALMANAC, 1967 edition, p. 296 |
| ii. A. Pethybridge
Racine, Wisconsin Public Library
Used for inter-library loans with Milwaukee, Wisconsin Public Library.
Called Racmil-Teletype. | Jan. 25, 1950 | Pethybridge, A.,
"Racmil-Five Years Later"
LIBRARY JOURNAL, Vol. 79, No. 19
November 1, 1954, p. 2089-2092 |
| iii. International Business Machines Corp. issued an operating manual | 1959 | International Business Machines Corp.
GENERAL INFORMATION MANUAL. IBM
TELE-PROCESSING IN CIRCULATION CONTROL
AT PUBLIC LIBRARIES, ESD-8040 and
ESD-0077
White Plains, N. Y., IBM Corp., 1959,
and 1960 |

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III. Mechanized Aids in Processing Retrieval Aids

A. Mechanized Preparation of Retrieval Aids

1. Property Control Procedures

b. Circulation Procedures

(2) Punch Cards with Sorters

(a) University of Texas Library

(b) Monclair Public Library

(c) University of Florida Library

<u>Date</u>	<u>References</u>
1936	Parker, R. H., "The Punched Card Method in Circulation Work" LIBRARY JOURNAL, Vol. 51, No. 21, Dec. 1, 1936, p. 903-905
1941	Quigley, M. "Library Facts from International Business Machines Cards" LIBRARY JOURNAL, Vol. 66, No. 22, Dec. 15, 1941, p. 1065-1067
1942	Pratt, E. C. "International Business Machines Use in Circulation Department, University of Florida Library" LIBRARY JOURNAL, Vol. 67, No. 7, April 1, 1942, p. 302-303
1938	Kilgour, F. G. "A New Punched Card for Circulation Records" LIBRARY JOURNAL, Vol. 64, Feb. 15, 1939, p. 131-133

(3) Edge Notch Cards

(a) Kilgour, F. G.
Harvard College Library
Keysort Cards of McBee Company

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III. Mechanized Aids in Processing Retrieval Aids

A. Mechanized Preparation of Retrieval Aids

1. Property Control Procedures

b. Circulation Procedures

(4) Computer Programs for Request Processing

(a) H. J. Heald Armed Services Technical Information Agency (ASTIA). Single document requests are submitted on standard tabulating cards with customer codes already punched, and processed on the Remington Rand UNIVAC Solid State 90 Computer	1960	NSF #3, 1962, p. 101-104
(b) ASTIA processed total of 600,000 specific document requests during	1961	NSF #3, 1962, p. 103
(c) ASTIA became DDC, Defense Documentation Center	1963	
(d) DDC converted computer program to Remington Rand 1105 Computer	1963	NSF #4, 1966, p. 280-285

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III. Mechanized Aids in Processing Retrieval Aids

A. Mechanized Preparation of Retrieval Aids

2. Index Records

a. Punch Card Print-Outs

(1) D. Alvord King County Public Library Book Catalog from IBM punch cards	1951	Alvord, D. "King County Public Library Does It with IBM" PACIFIC NORTHWEST LIBRARY ASSOCIATION QUARTERLY, Vol. 16, No. 3 April, 1952, p. 123-132
(2) E. Garfield Welch Medical Library, Johns Hopkins University Indexes printed from IBM punch cards	1953	Garfield, E. "The Preparation of Printed Indexes" by Automatic Punched-Card Technique" AMERICAN DOCUMENTATION, Vol. 5, No. 1 January, 1954, p. 7-12
(3) H. R. Ball Bureau of Shops, Navy Department Cardatype print-outs of ship specifications	1955	NSF #3, 1962, p. 168-170
(4) C. MacQuarrie Los Angeles County Library	1956	MacQuarrie, C. "IBM Book Catalog" LIBRARY JOURNAL Vol. 82, No. 5, March 1, 1957, p. 630-634

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III. Mechanized Aids in Processing Retrieval Aids

A. Mechanized Preparation of Retrieval Aids

2. Index Records

b. Computer Print Outs

(1) Listing by Authors' Names with Citations

(a) Eugene Garfield Institute of Scientific Information Suggested Citation Indexes	1955	Garfield, E., "Citation Indexes for Science" SCIENCE, Vol. 122, No. 3159, July 15, 1955, p. 108-111
(b) Citation Indexes commercially available	1963	SCIENCE CITATION INDEX, 1961, Institute for Scientific Information, Philadelphia, 1963.

(2) Listing by Index Terms with Citations

(a) Dual Dictionaries		
i. L. J. Bartlett Information for Industry, Inc. Retrieval of chemical patents using IBM 305 RAMAC	1955	NSF #3, 1962, p. 171
ii. E. Wall E. I. duPont de Nemours Co., Inc. produced a "Double Dictionary"	1957	NSF #1, 1958, p. 12-13
iii. W. Powell Dow Chemical Company	1962	NSF #4, 1966, p. 27-28

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III. Mechanized Aids in Processing Retrieval Aids

A. Mechanized Preparation of Retrieval Aids

2. Index Records

b. Computer Print-Outs

(2) Listing by Index Terms with Citations

(b) Tabledex

- i. R. S. Ledley
National Bureau of Standards

1957

Ledley, R. S. "Tabledex: A New Coordinate Indexing Method for Bound Book Form Bibliographies", In International Conference on Scientific Information, Washington, D. C., Nov. 16-21, 1958. PROCEEDINGS, Washington, D. C. National Academy Of Science - National Research Council, 1959, Vol. 2, p. 1221-1243.

- ii. Application of Tabledex to publications produced for International Geophysical Year.

1962

Ledley, R.S., et al. SELECTED BIBLIOGRAPHY OF THE INTERNATIONAL GEOPHYSICAL YEAR. AN EXAMPLE OF TABLEDEX FORMATS. National Biomedical Research Foundation Report No. 62071/18100.

(c) Scan-Column Index

- i. J. O'Connor
Remington Rand UNIVAC

1962

J. O'Connor
"The Scan-Column Index"
AMERICAN DOCUMENTATION, Vol. 13, No. 2, April 1962, p. 204-209.

References

Dates

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III. Mechanized Aids in Processing Retrieval Aids

A. Mechanized Preparation of Retrieval Aids

2. Index Records

b. Computer Print-Outs

(2) Listing of Index Terms with Citations

(d) Permuted Indexes

- i. J. Citron, L. Hart, and H. Ohlman
Systems Development Corporation
Computer printed index to keywords
in titles, in section headings, and in
the text.

1958

Citron, J., Hart, L., and Ohlman, H.,
"A Permutation Index to the Preprints
of the International Conference on
Scientific Information".
Santa Monica, California, System
Development Corporation, (SP 44) (n.d.)

Bourne, 1963, p. 16-19

- ii. H. P. Luhn
International Business Machines Corp.
developed KWIC Index, Key Word In Context
to keywords in titles.

1961

CHEMICAL TITLES, April 5, 1960,
Easton, Pa., American Chemical
Society, 1960-

page 100

- iii. R. A. Kennedy
Bell Telephone Laboratories
IBM 7090 Computer

1961

Kennedy, R.A.,
"Mechanized Title Word Indexing of
Internal Reports"
IN MACHINE INDEXING, PROGRESS AND
PROBLEMS. Paper presented at the
Third Institute on Information Storage
and Retrieval, Feb. 13-17, 1961.
Washington, D. C., American University
School of Government and Public Admin-
istration, Center for Technology and
Administration, 1961, p. 112-132.
NSF #3, 1962, p. 166-167.

1961

- iv. W. S. Learmouth
Lockheed Aircraft Company
KWIC with IBM-704 Computer

NSF #3, 1962, p. 174-175.

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III. Mechanized Aids in Processing Retrieval Aids

A. Mechanized Preparation of Retrieval Aids

2. Index Records

c. Paper Tape Print-Outs

(1) F. J. Witty Catholic University Library Flexowriter for mass production of catalog cards for Catholic Libraries	1957	Witty, F. J., "The Flexowriter and Catalog Card Production: Perfect Solution for Short Runs?" D. C. LIBRARIES, Vol. 28, No. 3, July, 1957. p. 2-4.
(2) L. A. Kenny Illinois State Library Remington Rand Synchronotape	1959	Kenny, L. A., "New Card Making Equipment at State Library", ILLINOIS LIBRARIES Vol. 41, No. 6, June 1959, p. 417-420
(3) C. N. Mooers Zator Company Proposed cooperative plan for exchanging typewriter tapes for catalog card production	1960	Mooers, C. N., "The Tape Typewriter Plan: A Method for Cooperation in Documentation" ASLIB PROCEEDINGS, Vol. 12, No. 8, August 1960, p. 277-291
(4) Armed Services Technical Information Agency Production of Technical Announcement Bulletin, TAB, on Remington Rand Synchronotape with computer assistance.	1960	NSF #4, 1966, p. 381-384

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III. Mechanized Aids in Processing Retrieval Aids

A. Mechanized Preparation of Retrieval Aids

2. Index Records

d. Punch Card Actuated Camera List

- (1) M. Day
Atomic Energy Commission
Kerordak Listomatic camera production of
NUCLEAR SCIENCE ABSTRACTS
- (2) S. I. Taine
National Library of Medicine
Listomatic camera production of
INDEX MEDICUS
- (3) M. Dyson
Chemical Abstracts Service
Listomatic camera production
- (4) I. D. Welt
Cardiovascular Literature Project
(now at the American University, formerly
at NAC/NRC)
Listomatic production of INDEX-HANDBOOK OF
CARDIOVASCULAR AGENTS.
- (5) F. Mohrhardt
National Agricultural Library
Friden Compos-O-Line Production of
retrospective catalog

<u>Dates</u>	<u>References</u>
1959	Day, M. S., and Lebow, I., "New Indexing Pattern for Nuclear Science Abstracts, AMERICAN DOCUMENTATION, Vol. 11, No. 2, April 1960, p. 120-127.
1960	Taine, S. I. "The National Library of Medicine Index Mechanization Project" BULLETIN OF THE MEDICAL LIBRARY ASSOCIATION, Vol. 1, no. 1, January 1961, pt. 2, p. 1-96.
1960	Dyson, G. M. "Current Research of Chemical Abstracts JOURNAL OF CHEMICAL DOCUMENTATION, Vol. 1, No. 1, January 1961, p. 24-28.
1960	NSF #2, 1959, p. 60-61 NSF #3, 1962, p. 172-174 NSF #3, 1966, p. 55-56
1965	

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III. Mechanized Aids in Processing Retrieval Aids

A. Mechanized Preparation of Retrieval Aids

3. Evaluative Records

a. Book Selection Procedures

b. Retirement and Weeding Procedures

c. Book Reviews

d. State-of-the-Art Reviews

B. Mechanized Transport of Retrieval Aids, if different
from other mechanized transport procedures.

C. Mechanized Storage of Retrieval Aids, if different
from other mechanized storage procedures.

D. Mechanized Reproduction of Retrieval Aids, if different
from other mechanized reproduction procedures.

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III. Mechanized Aids in Processing Retrieval Aids

E. Search Devices, a Mechanized Matching of Retrieval Cards

1. Edge-Notch Cards for Manual Manipulation

		<u>Dates</u>	<u>References</u>
a.	W. K. Sparrow Bottom edge-notched cards to prevent misfiling	filed Sept. 18, 1903 issued May 10, 1904	"Card Index" U. S. Patent 759,483 Perry, 1958, p. 4
b.	E. Eckart Bottom edge-notch cards selected by lifting bars	filed Feb. 8, 1906 issued Dec. 10, 1907	"Card Index" U. S. Patent 873,305 Perry, 1958, p. 4
c.	A. Perkins All edged notched on cards for manual needle sorting	filed Feb. 8, 1923 issued June 30, 1925	"Sorting and Classifying of Flat Sheets, Tallies, Cards, or the Like," U. S. Patent 1,544,172.
d.	E. M. Jellinek Indexed Jellinek on Keysort cards	filed Sept. 27, 1928 issued Dec. 10, 1929 1941	"Card and the Like for Classificatory Systems" U. S. Patent 1,739,087 Jellinek, E. M., "Use of Punched Cards" QUARTERLY JOURNAL STUDIES ON ALPHABETIC Vol. 2, 1941, p. 216-220
e.	M. R. Hyslop American Society of Metals Application of metallurgical literature	1948	Perry, 1958, p. 248-249
f.	National Bureau of Standards and National Research Council used Keysort cards for selecting compound descriptions on basis of infrared spectral data.	1949	Bagg, 1962, p. 228-230 Perry, 1958, p. 177-178

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III. Mechanized Aids in Processing Retrieval Aids

E. Search Devices

1. Edge-Notch Cards for Manual Manipulation

	<u>Dates</u>	<u>References</u>
g. H. A. Geer Parke, Davis & Company Keysort Cards for Data Retrieval	1951-9	NSF #1, 1958, p. 29 NSF #2, 1959, p. 49-51 NSF #3, 1962, p. 133
h. H. N. Staats Fast Access (Co) ed Small Images, Inc. FACSI, reprint: articles from the JOURNAL OF THE SOCIETY FOR NON-DESTRUCTIVE TESTING at 3/1 reduction on edge-notched cards (8x10 $\frac{1}{2}$)	1957	Bagg, 1962, p. 31

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III. Mechanized Aids in Processing Retrieval Aids

E. Search Devices

2. Optical Coincidence Cards for Manual Manipulation

	<u>Dates</u>	<u>References</u>
a. H. Taylor Data retrieval for bird identification	1915 filed Sept. 1915 issued Dec. 28,	"Selective Device" U. S. Patent 1,165,465
b. H. E. Soper Statistical applications	1920 issued Aug. 31,	"Means for Compiling Tabular and Statistical Data" U. S. Patent 1,351,692
c. W. E. Batten Imperial Chemical Industries, Ltd. Retrieval of chemical patents on special punch card	1939	Batten, W. E., "Specialized Files for Patent Searching", Chapter 1 In Perry, 1951, p. 169-181.
Converted to standard tabulating cards	1947	Batten, W. E., "A Punched-Card System of Indexing to Meet Special Requirements", In PROCEEDINGS OF THE TWENTY-SECOND ASLIB CONFERENCE, 1947, p. 37-39

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III. Mechanized Aids in Processing Retrieval Aids

E. Search Devices

2. Optical Coincidence Cards for Manual Manipulation

- d. W. A. Wildhack and J. Stern
National Bureau of Standards
Peek-a-boo cards (5x8) with
18,000 positions for searching
of instrumentation literature

1953

Wildhack, W. A. and Stern, J.,
"Documentation in Instrumentation",
AMERICAN DOCUMENTATION, Vol. 5,
No. 4, Oct. 1954, p. 223-237.

Wildhack, W. A. and Stern, J.,
"The Peek-a-boo System in the Field
of Instrumentation", Chapter 13,
INFORMATION SYSTEMS IN DOCUMENTATION,
Shera, J. H., et al, editors,
Interscience Publishers, New York, 1955

- e. H. F. Benson

Omnidex Installation at General Dynamics
using standard tabulating card with pre-
perforated positions

1956

"FILE IT TO FIND IT....OMNIDEX",
Omnidex, Pomona, California, 1959

- f. D. F. Gamble

National Institutes of Health
NBS peek-a-boo cards for data retrieval
of cancer tested compounds

1956

NSF #1, 1958, p. 25-26

NSF #2, 1959, p. 48-49

NSF #3, 1963, p. 137-138

NSF #4, 1965, p. 115-118

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Date

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III. Mechanized Aids in Processing Retrieval Aids

E. Search Devices

2. Optical Coincidence Cards for Manual Manipulation

g. F. Jonker

Jonker Business Machines, Inc.

Termatrex Cards (9x9) with 10,000 positions

1957

Jonker, F.
"The Termatrex Inverted Punch Card System"
AMERICAN DOCUMENTATION
Vol. 11, No. 4, Oct. 1960, p. 305-311.

Thompson, M. S.

"Peek-a-boo Index for A Broad Subject Collection",
AMERICAN DOCUMENTATION, Vol. 13
No. 2, April 1962, p. 187-196.

Bourne, 1963, p. 111-115

h. A. S. Tauber

Find-It System,

Commercial service using IBM Port-A-Punch with
480 preperforated positions

1957-8

Page 198

i. Perforated Brisch-Vistem

Visirecord, Inc.

Sells cards (8x11) with 1,000 positions and cards
(10x12) with 10,000.

1959

Jolley, J. L.
"Punched Feature Cards"
DATA PROCESSING
April-June 1959, p. 4-11

Johnson, A.

"Experience in the Use of Unit Concept
Coordinate Indexing Applied to Technical
Reports"
JOURNAL OF DOCUMENTATION, Vol. 15,
No. 3, Sept. 1959, p. 145-155

Bourne, 1963, p. 115

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III. Mechanized Aids in Processing Retrieval Aids

E. Search Devices

2. Optical coincidence Cards for Manual Manipulation

j. Termatex installation for data retrieval

Carpenter, H. M.,
"A System for Storage and Retrieval
of Data from Autopsies",
AMERICAN JOURNAL OF CLINICAL PATHOLOGY,
Vol. 38, Nov. 1962, p. 449-467

1962

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1961

k. Doudnikoff, B. Westinghouse Corporation Termatex installation for document retrieval

1963

Bourne, 1963, p. 112, 114-115

l. Royal McBee Corporation sells Keydex System, similar to Termatex equipment

1964

NSF #4, 1966, p. 118-120

m. Chemagro Corporation Termatex installation for document retrieval

1966

NSF #4, 1966, p. 140-142

n. Roy T. Weston Consultants Termatex installation

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III. Mechanized Aids in Processing Retrieval Aids

E. Search Devices

3. Punch Cards with Sorters

a. H. Hollerith

Invented punch card equipment
with electric sorting

filed June 8, 1887
issued Jun. 8, 1890

References

- | | | |
|--|------|--|
| Hollerith, H.
"Art of Compiling Statistics",
U. S. Patent No. 395, 781 | | |
| Hollerith, H.
"An Electrical Tabulating System"
A JOURNAL OF APPLIED SCIENCE,
New York School of Mines, Columbia
College, Vol. 10, Oct. 1888 - July
1889, p. 239-255. | | |
| Love, A. G., Hamilton, E. L. and
Hellman, I. L.
TABULATING EQUIPMENT AND ARMY
MEDICAL STATISTICS,
Office of the Surgeon General,
Department of the Army, Washington,
D. C., 1958, p. 38-51 | 1890 | |
| c. J. Powers,
established Powers Accounting Machine Corp.,
later merged with Remington Rand Company
that used mechanized sorting equipment | 1911 | |
| d. Powers Printing Tabulator | 1913 | |
| e. H. Hollerith
Established Computing-Tabulating-Recording
company and added printing equipment | 1922 | |
| Scheele 1961, p. 48-54 | | |
| Scheele, 1961, p. 48-54 | | |
| Scheele, 1961, p. 4-5 | | |

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III. Mechanized Aids in Processing Retrieval Aids

E. Search Devices

3. Punch Cards with Sorters

f. H. Nutting Dow Chemical Company IBM Punch Card equipment for searching of chemical compounds	1945	NSF #1, 1958, p. 10-11 NSF #2, 1959, p. 45-45 NSF #3, 1962, p. 131-133
g. K. Heuman National Academy of Science National Research Council Chemical Biological Coordination Center IBM-punch card equipment for data searching of chemical compounds	1946	
h. Union Carbide Plastics Company, formerly Bakelite Company, developed "unit card" system with IBM sorter	1947	NSF #2, 1959, p. 39-40 NSF #3, 1962, p. 60-61
i. C. E. Lyght Merck Sharp & Dohme IBM sorter for searching medical literature	1951	NSF #1, 1958, p. 20-21 NSF #2, Supp. 1960, p. 11-12 NSF #3, 1962, p. 54-56
j. W. S. Jones Union Carbide Chemicals Company IBM sorting equipment	1951	NSF #3, 1962, p. 92-95 NSF #1, 1958, p. 37-38

Appendix C.

III. Mechanized Aids in Processing Retrieval Aids

E. Search Devices

3. Punch Cards with Sorters

k. C. J. Maloney
U. S. Army Biological Warfare Laboratory
Remington Rand Sorting Equipment

l. B. Hildenbrand
Ethyl Corporation
Remington Rand Sorter with group selection
device or bridge

m. J. B. Alden
Food Machinery and Chemical Corporation
IBM sorting equipment

n. Massachusetts Institute of Technology
Serials searching

o. H. A. Geor
Parke Davis and Company
Converted from McBee cards to IBM
sorting equipment

p. H. W. Serig
Advisory Group on Electron Devices
IBM Multi-column sorter

Date

References

NSF #1, 1958, p. 39-40
NSF #2, 1959, p. 53-56
NSF #3, 1962, p. 142-145
NSF #1, 1958, p. 14-15
NSF #2, 1959, p. 15-17
NSF #3, 1962, p. 19-31
NSF #4, 1966, p. 60-61
NSF #1, 1958, p. 16-17
NSF #2, 1959, p. 17-18
Nicholson, N. and Taurston, W.,
"Serials and Journals in the MIT
Library",
AMERICAN DOCUMENTATION,
Vol. 9, No. 4, Oct. 1958, p. 304-317
NSF #2, 1959, p. 48-51
NSF #3, 1963, p. 138-139
NSF #4, 1966, p. 70-73
NSF #3, 1962, p. 43-46
NSF #4, 1966, p. 49-51

III. Mechanized Aids in Processing Retrieval Aids

4. Edge-Notch Cards for Mechanical Manipulation

- Hoffer, J. R.,
"Information Retrieval in Social
Warfare: Experience with an Edge-
Notched Information Retrieval System",
AMERICAN DOCUMENTATION, Vol. 13, No. 2,
April 1962, p. 169-175.

Date

Moore, C. N.
"Card Selecting Device"
U. S. Patent 2,865,694.

Moore, C. N.,
THE ZATOR - A PROPOSAL, A MATHE-
MATIC FOR COMPLETE DOCUMENTATION
(Zator Technical Bulletin No. 65)
Boston, Zator Company, 1951

NSF #1, p. 1 - 2.

NSF #2, p. 3 - 4.

Hofler, J. R.,

"Information Retrieval in Social Warfare: Experience with an Edge-Notched Information Retrieval System." *AMERICAN DOCUMENTATION*, Vol. 13, April 1962, p. 169-175.

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III. Mechanized Aids in Processing Retrieval Aids

E. Search Devices

5. Punch Cards with IBM-101 Sorters (Electronic Statistical Machines)

a. B. E. Lanham
United States Patent Office
Document Retrieval experiment

b. C. K. Schultz
Merck Sharp & Dohme
Document Retrieval

c. R. Bulkley
Socony Mobil Oil Company
Document Retrieval

d. H. C. Longnecker
Smith, Kline & French Laboratories
Document Retrieval

Date References

1949-50	Perry, 1951, p. 374-376
	Perry, 1958, p. 268-273
	NSF #1, 1958, p. 42-43
	NSF #2, 1959, p. 41-42
1950	NSF #1, 1958, p. 22-23
	NSF #2, 1959, p. 24-26
	Schultz, C. K. "An Application of Random Codes to Literature Searching", Chapter 10, in Perry, 1958, p. 232-247.
1952	NSF #1, 1958, p. 35-36
	NSF #2, 1959, p. 37-39
	NSF #3, 1962, p. 89-92
1953	NSF #1, 1958, p. 34
	NSF #2, 1959, p. 18-20
	NSF #3, 1962, p. 112-115
	NSF #4, 1966, p. 407-410

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III. Mechanized Aids in Processing Retrieval Aids

E. Search Devices

5. Punch Cards with IBM-101 Sorters Electronic Statistical Machines

e. B. Whitman
Schering Corporation
Document Retrieval

f. E. B. Edge
duPont Central Research Department
Document retrieval

g. E. L. Schulze
Proctor & Gamble Company
Document retrieval

Dates

1955

1955

1957

References

NSF #1, 1958, p. 32-33

NSF #2, 1959, p. 35-37

NSF #2, 1959, p. 85-89 and p. 140-142

NSF #2, 1959, p. 12-14

NSF #3, 1962, p. 74-76

NSF #1, 1958, p. 30-31

NSF #2, 1959, p. 32-34

NSF #3, 1962, p. 84-86

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III. Mechanized Aids in Processing Retrieval Aids

6. Search Devices

6. Punch Cards with Collators

a. F. R. Whaley Linde Company IBM Collator for document retrieval	<u>Dates</u> 1954	<u>References</u> NSF #1, 1958, p. 18-19 NSF #2, 1959, p. 24-24 NSF #3, 1962, p. 79-82 NSF #4, 1966, p. 73-76 NSF #1, 1958, p. 4-5
b. G. L. Peakes Bakelite Company IBM Collator for document retrieval	1956	

7. Paper Tape Searches

a. J. W. Perry Center for Communication and Documentation Research, Western Reserve University, WRU Searching Selector used primarily for research and as a teaching tool.	1957-62	Perry, 1958, p. 253-253.
--	---------	--------------------------

Appendix C

III. Mechanized Aids in Processing Retrieval Aids

E. Search Devices

8. Computer Searches

	<u>Date</u>	<u>References</u>
a. J. P. Eckert and J. W. Mauchly filed June 26, 1947 Electronic Numeric Integrator And issued Feb. 4, 1964 Computer <u>ENIAC</u>		Eckert, J. P. and Mauchly, J. W., U. S. Patent 3,120,606
b. P. R. Bagley Massachusetts Institute of Technology Experiment with Whirlwind #1 computer for document retrieval	1951	Bagley, P. R. M.I.T. MS Thesis Report R-200 "ELECTRONIC DIGITAL MACHINES FOR HIGH-SPEED INFORMATION SEARCHING". October 11, 1951
c. W. H. Waldo Monsanto Chemical Company IBM-702 used for data retrieval Converted to IBM 704	1956-58	NSF #1, 1958, p. 24 NSF #3, 1962, p. 135-136
d. H. E. Tillitt Naval Ordnance Test Station IBM-701 used for document retrieval Converted to IBM 7090	1957 1961	NSF #1, 1958, p. 28 NSF #3, 1962, p. 117-119
e. R. H. Moyer University of Pennsylvania IBM 705 used in document retrieval	1957	Moyer, R. H. "Automatic Search of Library Documents" COMPUTERS AND AUTOMATION, Vol 6, No. 5, p. 24-29, May 1957.
f. E. C. Marden, H. Pfeffer, and M. R. Koller National Bureau of Standards and U. S. Patent Office Used Standards Electronic Automatic Calculator, SEAC, for patent retrieval	1958	"A First Approach to Patent Searching on Standard's Electronic Automatic Computer (SEAC)" U. S. Patent Office Research Develop- ment Report No. 10, 1958, p. 22

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III. Mechanized Aids in Processing Retrieval Aids

E. Search Devices

8. Computer Searches

	<u>Date</u>	<u>References</u>
g. W. H. Waldo Monsanto Chemical Company Converted to IBM 704	1958	NSF #2, 1959, p. 47-48 NSF #2, 1959, p. 135-136
h. B. K. Dennis General Electric Company Flight Propulsion Division IBM 7090-1401 system	1958	NSF #1, 1958, p. 18-20 NSF #3, 1962, p. 110-112
i. H. Heald Armed Services Technical Information Agency, ASTIA Now Defense Documentation Center, DDC. Using Remington Rand UNIVAC Solid State 90 Computer for subject searches.	1960	NSF #3, 1962, p. 101-104
j. J. W. Perry Western Reserve University GE-225 computer	1962	Kent, A., Melton, J., and Flagg, C. "Abstracting, Coding, and Searching the Metallurgical Literature for A.S.M. - The WRU Searching Selector", In INFORMATION SYSTEMS DOCUMENTATION J. H. Shera, et al., editors, New York, Interscience Publishers, 1957.
k. P. B. Rogers National Library of Medicine Medical Literature Analysis and Retrieval System, MEDLARS, using Honeywell H200 computer.	1964	NSF #4, 1966, p. 381-384

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III. Mechanized Aids in Processing Retrieval Aids

E. Search Devices

9. Special Devices Utilizing IBM Cards

a. Universal Card Scanner, IBM-3810

1. H. P. Luhn of International Business Machines, A Prototype and shown at American Chemical Society Convention

2. Offered to U. S. Patent Office as X-794 by IBM Corporation

3. H. P. Luhn
Issued patent on photoelectric device for scanning punch cards

4. Became IBM-9310 and exhibited at Int. Conf. on Sci. Information

5. J. O. Vann
U. S. Air Force Air Research and Development Command
Used IBM-9310 for data retrieval in Current ARDC Technical Effort Program (CATE)

References

Date

"Mechanized System Launches New Era for Literature Searching",
CHEMICAL AND ENGINEERING NEWS,
Vol. 30, July 7, 1952,
p. 2781, 2806-2810.

1951

Jahoda, Gerald
"Electronic Searching"
In R. R. Shaw (editor),
THE STATE OF THE LIBRARY ART,
Graduate School of Library Service,
Rutgers - The State University,
New Brunswick, N.J., 1961, Vol. 4,
Part 4, p. 166.

1954

Luhn, H. P.
U. S. Patent No. 2,720,360.

1955

Jahoda, op. cit.

1958

Bourne, 1963, p. 123.

NSF #2, Supp. 1959, p. 29-30.

1959

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III. Mechanized Aids in Processing Retrieval Aids

E. Search Devices

9. Special Devices Utilizing IBM Cards

b. Interrelated Logic Accumulating Scanner, ILAS similar to IBM 101.

(1) B. E. Lanham

U. S. Patent Office with Census Bureau help
developed this equipment for retrieval of
steriod compounds.

1957

Andrews, D.D., et. al
"Recent Advances in Patent Office
Searching: Steriod Compounds and
ILAS". Chapter 25, p. in
Shera, J. H., et al, editors
INFORMATION SYSTEMS IN DOCUMENTATION,
Interscience Publishers, N. Y., 1957

(2) U. S. Patent Office

Changed to IBM-101 steriod compound searches.

1957

NSF #3, 1962, p. 64-65.

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III. Mechanized Aids in Processing Retrieval Aids

E. Search Devices

9. Special Devices Utilizing IBM cards

c. Continuous Multiple Access Collator (COMAC)

1. M. Taube

Documentation, Inc.

Demonstration of prototype

1957

Taube, M.,
"The Comac: An Efficient Punched Card
Collating System for the Storage and
Retrieval of Information", in
International Conference on Scientific
Information, Washington, D. C.,
Nov. 16-21, 1958
PROCEEDINGS
Washington, D. C. National Academy
of Sciences - National Research Council,
1959, Vol. 2, p. 1245-1254

2. COMAC became Special Index Analyzer, SIA, and IBM-9900

1958

NSF #2, Supp. 1960, p. 33-35
Bourne, 1963, p. 122-133
Bourne, 1963, p. 122-123, 134

3. Benson-Lehner Corporation Developed COMAC Mark-2

1962

References

page 211

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III. Mechanized Aids in Processing Retrieval Aids

E. Search Devices

10. Magnetic Media Devices

a. Magnetic cards

- | | <u>Dates</u> | <u>References</u> |
|--|---|--|
| (1) R. M. Hayes and G. W. Mayle
Magnavox Company
Invention of Magnacards | filed Nov. 26, 1956
issued Dec. 20, 1960 | "Card Processing Apparatus"
U.S. Patent No. 2,965,010 |
| (2) Prototype of Magnacard
developed for Rome Air Development Center
Requires computer direction | 1956-58 | Bagg, 1962, p. 34, 76-78.
Bourne, 1963, p. 185-186. |

b. Magnetic tape devices

- | | | |
|--|------|---------------------------|
| (1) Computer Control Company
developed CCC Index Searcher for U.S. Air Force | 1958 | Bourne, 1963, p. 183. |
| (2) General Electric Company
Scheduled Information Searching Selector,
GE-250, for 1960 delivery to Western Reserve
University, but it was never completed.
GE-225 computer substituted. | 1960 | Bourne, 1963, p. 183-184. |
| (3) S. Herner of Herner and Company
developed prototype of Heatwole-40. | 1961 | Bourne, 1963, p. 184-185. |
| (4) General Electric Company
developed Search Comparator, smaller version
of GE-250. | 1961 | Bourne, 1963, p. 184. |

Appendix C.

IV. Mechanized Aids in Processing Items in Documents, or Lots.

A. Mechanized Preparation of Documents Composed of Items.

1. Punch Card Print-Outs

2. Computer Print-Outs

B. Mechanized Transport of Documents Composed of Items, if different
from other mechanized transport procedures.

C. Mechanized Storage of Documents Composed of Items, if different
from other mechanized storage procedures.

D. Mechanized Reproduction of Documents Composed of Items, if different
from other mechanized reproduction procedures.

E. Mechanized Matching of Documents Composed of Items, if different
from other mechanized matching procedures.

Appendix C

V. Mechanized Combinations of Retrieval Processes

A. Devices to Locate and Copy Documents

1. Microfilm Roll Devices

- a. Benson-Lehner Corporation
Film Library Instantaneous
Presentation, FLIF

1957

Worsley, P. K.
"Data Retrieval with Especial
Application to Use of Film Library
Instantaneous Presentation (FLIF)
in Literature Searching"
In M. Boaz, ed. MODERN TRENDS IN
DOCUMENTATION, N.Y., Pergamon,
1959, p. 70-73

Bagg, 1962, p. 35, 98

- b. Eastman Kodak Company
Recordak Lodestar with Kodamatic Counter

1960

Bagg, 1962, p. 35, 98

2. Microfilm Strip/Sheet Devices

a. AMPHIS

- (1) E. A. Avakian
Automatic Microfilm Information System,
AMPHIS
filed Apr. 4, 1950
issued Sept. 16, 1952

Avakian, E. A.
"Stored Function Calculator"
U. S. Patent No. 2,610,791

Avakian, E. A., and Garfield, E.
"AMPHIS - The Automatic Microfilm
Information System",
SPECIAL LIBRARIES, 48 No. 4,
April 1957, p. 145-148.

Bagg, 1962, p. 36, 96, 106

- (2) Information Retrieval Corporation
developed an improved AMPHIS and called it
Command Retrieval Information System, CRIS

Bagg, 1962, p. 96-97

Bourne, 1963, p. 210-211.

References

Dates

Appendix C

V. Mechanized Combinations of Retrieval Processes

A. Devices to Locate and Copy Documents

2. Microfilm Strip/Sheet Devices

b. NBS Micro-Image Locator

(1) National Bureau of Standards, NBS

"An Automatic Micro-Image File",
NATIONAL BUREAU OF STANDARDS
TECHNICAL NEWS BULLETIN, Vol. 40, No. 7,
July 1956, p. 88-90.

Bagg, 1962, p. 36, 95.

c. VERAC 903

(1) Avcc Corporation

developed prototype with financial support
from Council on Library Resources

Bagg, 1962, p. 36, 96.

3. Unit Devices

a. Magnavox Company proposed

Magnavox Electronic Data-Image Apparatus, MEDIA

Bagg, 1962, p. 36, 97.

Bourne, 1963, p. 211-212.

Appendix C

V. Mechanized Combinations of Retrieval Processes

E. Devices to Locate and Copy Documents

1. Microfilm Roll Selectors

	<u>Dates</u>	<u>References</u>
a. E. Goldberg of Germany	1928 1931	Goldberg, E. "Statistical Machine" U. S. Patent No. 1,838,389
b. V. Bush Mass. Inst. of Technology Constructed prototype of Microfilm Rapid Selector, with money from Eastman Kodak Company and National Cash Register	1938-1940	Bagg, 1962, p. 12-13; 21. Bagg, 1962, p. 19-20.
c. R. R. Shaw U. S. Department of Agriculture Library Supervised development of Rapid Selector constructed by Engineering Research Associates (ERA) with Office of Technical Services (OTS) funds.	1947	Bagg, 1962, p. 19-22.
d. R. R. Shaw U. S. Department of Agriculture Library exhibited the ERA prototype at annual meeting of Special Libraries Association	June 23, 1945	"Government's \$106,000 Electronic Brain", ST LOUIS POST-DISPATCH, June 23, 1949, p. 1D

Appendix C

V. Mechanized Combinations of Retrieval Processes

B. Devices to Search and Copy Documents

1. Microfilm Roll Selectors

- e. T. Bagge
National Bureau of Standards
Developed for Navy Bureau of Ships two improved
models of the Rapid Selector
- f. TMA, Inc.
Developed Film Search Machine, FMA, and sold
first to Navy Bureau of Ships
- g. Recordak Corporation
Recordak Auto-Image Retrieval, RAIR, developed for
Defense Logistics Service Center

<u>Dates</u>	<u>References</u>
1949-61	Bagge, 1962, p. 40-48.
1961	Bagge, 1962, p. 35, 49-55.
1962	Bagge, 1962, p. 56-57, 35.

Appendix C

V. Mechanized Combinations of Retrieval Processes

B. Devices to Search and Copy Documents

2. Microfilm Unit Selectors

a. Aperture Cards

- | | <u>Dates</u> | <u>References</u> |
|---|--------------|--|
| (1) A. Seidell
proposed microfilm inserts in tabulating cards | 1934 | Seidell, A.
"Reforms in Chemical Publication
(Documentation)", SCIENCE, Vol. 80
July 20, 1934, p. 2064, 2070-2072.
Langan, J.
"Record Card"
U. S. Patent No. 2,512,106 |
| (2) J. Langan
U. S. Office of Strategic Services | 1946 | Bagg, 1962, p. 27. |
| (3) J. Langan
assigned patent to Film 'N File, Inc.
(later became Filmsort Co., and then
Filmsort Division of Minnesota Mining and
Manufacturing Company. | 1950 | Perry, 1951, p. 71-74
Perry, 1958, p. 74-81
Bagg, 1962, p. 27. |
| (4) Central Intelligence Agency
Intellofax System largest installation of
aperture cards (more than 3 million cards in 1960) | 1953 | Bagg, 1962, p. 23, 93-94 |

Appendix C

V. Mechanized Combinations of Retrieval Processes

B. Devices to Search and Copy Documents

2. Microfilm Unit Selectors

a. Aperture Cards

(5)	U. S. Department of Defense issued U. S. Federal Supply Specification MIL-M-18872 (Aer) requiring submission of copies of engineering drawings on aperture cards.	June 13, 1955	Bagg, 1962, p. 92 Bourne, 1963, p. 219 Perry, 1958, p. 338
(6)	Radio Corporation of America demonstrated Filmsort cards and Electrofax enlarger-printer	1956	Perry, 1958, p. 559 Bagg, 1962, p. 90,92
(7)	Eastman Kodak Corporation used Filmsort with E-Z Sort Cards	1957?	Perry, 1958, p. 312 Bagg, 1962, p. 47-52
(8)	P. M. Maginnity Gallery Chemical Company, IBM cards and McBee Cards with microfilm in boron compound mentioned	1957	Maginnity, P. M., and N. J. Allison "Use of Machine-Sorted Punched Cards in Literature Searching of Boron Chemistry", presented before Division of Chemical Literature of American Chemical Society, Sept. 1957. Bagg, 1962, p. 109 NSF #1, 1958, p. 6-7

Appendix C

V. Mechanized Combinations of Retrieval Processes

B. Devices to Search and Copy Documents

2. Microfilm Unit Selectors

b. Minicards

(1) Eastman Kodak Company developed for Rome Air Force Development Center, RADC Reduction ratio of 60 to 1 on transparent card (16x32mm)	1954	Tyler, A. W., Myers, W. L. and Kuipers, J. W. "The Application of the Kodak Minicard System to Problems of Documentation", AMERICAN DOCUMENTATION Vol. 6, No. 1, Jan. 1955, p. 18-30 Bagg, 1962, p. 73, 68 Bagg, 1962, p. 68-76 Bourne, 1963, p. 204-207 Bagg, 1962, p. 68.
(2) Eastman Kodak Company made first installation for U. S. Air Force Intelligence	1957-58	
(3) Eastman Kodak Company made three more installations for U. S. Air Force and one for EK itself	1961	

Appendix C

V. Mechanized Combinations of Retrieval Processes

B. Devices to Search and Copy Documents

3. Microfilm Sheet/Strip Selectors

a. Filmorex Selector

- | | | |
|--|------|--|
| (1) J. Samain of France
Centre Nationale de Recherche Scientifique
Demonstration | 1952 | Bagg, 1962, p. 63-67.
Bourne, 1963, p. 206-210. |
| (2) Working installation at Centre Nationale de
Recherche Scientifique | | NSF #2, 1959
NSF #3, 1962 |
| (3) Rome Air Force Development Center installation | 1960 | Bagg, 1962, p. 66 |

b. Microcite

- | | | |
|---|------|--|
| (1) J. Stern
National Bureau of Standards proposed
Microcite I | 1953 | "A New Microcite Machine"
National Bureau of Standards
TECHNICAL NEWS BULLETIN |
| (2) J. Stern
National Bureau of Standards built prototype
of Microcite II | 1960 | Bagg, 1962, p. 83-86. |

c. Walnut

- | | | |
|--|------|-----------------------|
| (1) International Business Machines
developed for Central Intelligence Agency | 1961 | Bagg, 1962, p. 86-89. |
|--|------|-----------------------|

Appendix C

V. Mechanized Combinations of Retrieval Processes

B. Devices to Search and Copy Documents

4. Magnetic Media Selectors

- | | | |
|---|------|---|
| a. Magnavox Company
suggested Magnavue | 1961 | Bagg, 1962, p. 35, 76 |
| b. Radio Corporation of America
experimenting with Video file. | 1961 | Bagg, 1962, p. 35, 58-60.
Bourne, 1963, p. 186-187 |
| c. General Electric Company
experimenting with thermoplastic media. | 1961 | Bagg, 1962, p. 37. |
| d. National Cash Register Company
experimenting with photochromic media. | 1961 | Bagg, 1962, p. 37. |

Appendix C

V. Mechanized Combinations of Retrieval Processes.

C. Devices to Copy and Deliver Documents

1. Telefacsimile

- a. A. Bain
British patent
- b. Newspaper wirephoto transmission
- c. S. Adams
National Institutes of Health Library
supervised demonstration of RC Scanner of the
Atomic Energy Commission between the Library of
Congress and the NIH Library.
- d. Morehouse, H. G.
University of Nevada Library

2. Television

- a. R. Bristol
University of Virginia Library
Supervised experimental demonstration of the use of
closed-circuit TV in a decentralized library situation,
under a grant of the Council on Library Resources

References

Dates

1843
ENCYCLOPEDIA BRITANNICA,
1966 ed. Vol. 9, p. 28.

1934

Adams, S.
"Facsimile for Federal Libraries",
SPECIAL LIBRARIES, Vol. 44, No. 5,
May-June 1953, p. 169-172.

1953

Morehouse, H. G.
TELEFACSIMILE SERVICES BETWEEN LIBRARIES
WITH THE XEROX MAGNAVOX TELESCOPIER,
A Study Prepared for the Council on
Library Resources, CLR-314, Dec. 20,
1966,

1966

Council on Library Resources, Inc.
FIFTH ANNUAL REPORT, 1961,
Washington, D. C., p. 46-47.

1957

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COMPLETE CITATIONS FOR ABBREVIATED REFERENCES

- | | Abbreviated
Reference Form |
|---|--|
| 1. Bagg, Thomas C., and Stevens, Mary Elizabeth
INFORMATION SELECTION SYSTEMS RETRIEVING REPLICA COPIES: A STATE-OF-THE-ART REPORT.
(National Bureau of Standards Technical Note 157)
Washington, D. C., Government Printing Office, December 31, 1962, 172 pages. | Bagg, 1962 |
| 2. Bourne, Charles P.
METHODS OF INFORMATION HANDLING, New York, John Wiley and Sons, 1963, 241 pages. | Bourne, 1963 |
| 3. Hawken, William R.
"Full-Size Photocopying", In STATE OF THE LIBRARY ART, edited by Ralph R. Shaw,
New Brunswick, New Jersey, Rutgers University Press, 1960, Vol. 5, Part 3, 397 pages. | Hawken, 1960 |
| 4. Kent, Allen
TEXTBOOK ON MECHANIZED INFORMATION RETRIEVAL, New York, Interscience Publishers,
1962, 268 pages. | Kent, 1962 |
| 5. National Science Foundation
NON-CONVENTIONAL TECHNICAL INFORMATION SYSTEMS IN CURRENT USE
Edition No. 1, January 1958, 43 pages
Edition No. 2, September 1959, 66 pages
Supplement to Edition No. 2, March 1960, 44 pages
Edition No. 3, October 1962, 109 pages
Edition No. 4, December 1966, 558 pages | NSF #1, 1958
NSF #2, 1959
NSF #2, Supp. 1960
NSF #3, 1962
NSF #4, 1966 |
| 6. Perry, James W. and Casey, Robert S., PUNCHED CARDS: THEIR APPLICATION TO
SCIENCE AND INDUSTRY. New York, Reinhold Publishing Corporation, 1951, 506 pages | Perry, 1951 |
| 7. Perry, James W. and Casey, Robert S., Berry, Madeline M., and Kent, Allen.
PUNCHED CARDS: THEIR APPLICATIONS TO SCIENCE AND INDUSTRY. 2nd Edition,
New York, Reinhold Publishing Corporation, 1958, 697 pages. | Perry, 1958 |

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COMPLETE CITATIONS FOR ABBREVIATED REFERENCES (continued)

Abbreviated
Reference Form

8. Scheele, Martin,
PUNCH-CARD METHODS IN RESEARCH AND DOCUMENTATION: WITH SPECIAL REFERENCES
TO BIOLOGY. (E. Holmstrom, translator) First English edition based on
Second Revised German Edition. (Library and Documentation. A Series of
Texts and Monographs, J. E. Shera, General Editor, Volume II)
New York, Interscience Publishers, 1961, 174 pages.

Scheele, 1961

9. Stewart, Jean, Hickey, Doralyn et al
"Reading Devices for Micro-Images", In STATE OF THE LIBRARY ART, edited
by Ralph R. Shaw, New Brunswick, New Jersey, Rutgers University Press, 1960,
Volume 5, part 2, 205 pages.

Stewart, 1960

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13. ABSTRACT		
A retrieval model was developed for teaching and research purposes on the basis of varied work experience and analysis of technical document retrieval and library services. The model is based on Shannon's communication model but identifies the would be reader, or destination of recorded messages, as the activator of retrieval services. Two main retrieval functions are specified; identifying appropriate documents upon request, and delivering copies of identified documents. Document requests are analyzed into two parts, a description of document and a specification of type of physical access preferred to the requested document. Four kinds of document descriptions are identified. To carry out retrieval work, four kinds of records and five basic operations are defined. Retrieval processes, such as acquisition, indexing, and circulation, are shown to consist of various combinations of two or more of the operations being performed on one or more kinds of retrieval records. Data retrieval is shown to be a special kind of document retrieval. A history of equipment of retrieval interest is presented in a tabular format with citations of the application of each type of equipment to retrieval work.		

