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REVIEW OF TECHNICAL DOCUMENTS

by

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# RETRIEVAL OF TECHNICAL DOCUMENTS

*By Lea M. Bohnert*

**Introduction:** Objectives and Scope. ........................................... 1

**Chapter I.**  Definition of Retrieval. .................................................. 16

**Chapter II.**  Description of Retrieval Work. ......................................... 31

**Chapter III.**  Ways of Requesting Documents. ......................................... 57

**Chapter IV.**  Significance of Technical Document Retrieval. ...................... 81

**Chapter V.**  Kinds of Technical Documents. ........................................... 98

**Chapter VI.**  Document Retrieval Processes. ........................................... 106

**Chapter VII.**  Preparation of Technical Documents. .................................. 117

**Chapter VIII.**  Processing Technical Documents. ...................................... 119

**Chapter IX.**  Kinds of Document Substitutes. ........................................ 122

**Chapter X.**  Processing Document Substitutes. ........................................ 128

**Chapter XI.**  Kinds of Retrieval Aids. .................................................. 131

**Chapter XII.**  Processing Retrieval Aids. .............................................. 137

**Chapter XIII.**  Processing Items in Documents. ....................................... 141

**Chapter XIV.**  General and Special Purpose Equipment. ............................. 153

**Chapter XV.**  Design and Improvement of Retrieval Services. ....................... 156

**Appendix A.**  Selective Bibliography of U. S. Congress Publications of Retrieval Interest, Arranged by Date. ......................................................... 158

**Appendix B.**  Selective Bibliography of Glossaries of Retrieval Interest, Arranged by Date. .......................................................... 162

**Appendix C.**  History of Equipment of Retrieval Interest. ........................... 165
# LIST OF DIAGRAMS AND TABLES

<table>
<thead>
<tr>
<th>Diagram</th>
<th>Title</th>
<th>Page</th>
</tr>
</thead>
<tbody>
<tr>
<td>1</td>
<td>&quot;Schematic Diagram of a General Communication System&quot;</td>
<td>20</td>
</tr>
<tr>
<td>2</td>
<td>&quot;Recorded Communication Model&quot;</td>
<td>25</td>
</tr>
<tr>
<td>1</td>
<td>&quot;Minimum Operating Conditions For A Recorded Message to be Delivered by Four Services&quot;</td>
<td>27</td>
</tr>
<tr>
<td>3</td>
<td>&quot;Documentation Services Model&quot;</td>
<td>30</td>
</tr>
<tr>
<td>4</td>
<td>&quot;Servicing Individual Document Requests&quot;</td>
<td>36</td>
</tr>
<tr>
<td>5</td>
<td>&quot;Retrieval Service Model&quot;</td>
<td>79</td>
</tr>
<tr>
<td>6</td>
<td>&quot;Retrieval Work Procedures&quot;</td>
<td>80</td>
</tr>
<tr>
<td>7</td>
<td>&quot;Potential Scope of a Retrieval Service&quot;</td>
<td>102</td>
</tr>
<tr>
<td>8</td>
<td>&quot;Actual Scope of Retrieval Service&quot;</td>
<td>103</td>
</tr>
<tr>
<td>2</td>
<td>&quot;Checklist for Describing &amp; Analyzing an Individual Retrieval Service&quot;</td>
<td>114</td>
</tr>
</tbody>
</table>
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 1960, 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...
Introduc—

delivery services, such as the postal and telephone service. The two are
matching, or search, 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.
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."
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 APOS 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
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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.

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.

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

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.
Chapter I

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.
**Table 1.**

<table>
<thead>
<tr>
<th>A. DESTINATION</th>
<th>B. SERVICE</th>
<th>A. SOURCE</th>
<th>C. SERVICE</th>
<th>A. SOURCE</th>
<th>B. DESTINATION</th>
</tr>
</thead>
<tbody>
<tr>
<td>1. TELEPHONE SERVICE</td>
<td>ONE</td>
<td>NO</td>
<td>YES</td>
<td>YES</td>
<td>NO</td>
</tr>
<tr>
<td>2. FAX SERVICE</td>
<td>ONE</td>
<td>NO</td>
<td>NO</td>
<td>YES</td>
<td>NO</td>
</tr>
<tr>
<td>3. FACSIMILE MACHINES (Fax and TV)</td>
<td>ONE</td>
<td>NO</td>
<td>YES</td>
<td>NO</td>
<td>NO</td>
</tr>
<tr>
<td>4. RADIO SERVICE</td>
<td>ONE</td>
<td>NO</td>
<td>YES</td>
<td>NO</td>
<td>YES</td>
</tr>
</tbody>
</table>
### Operating Conditions for a Recorded Message to Be Delivered by Four Services

<table>
<thead>
<tr>
<th>Source</th>
<th>C. Service</th>
<th>A. Source</th>
<th>B. Destination</th>
<th>A. Source</th>
<th>C. Service</th>
<th>A. Source</th>
<th>B. Destination</th>
<th>D. Destination</th>
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</table>
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.
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".
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

Serving 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.
Chapter 11

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.
Chapter 11  

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.

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.
Chapter II

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.
Chapter 11  

page 54

I. 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
WAYS OF REQUESTING DOCUMENTS

Summary

Retrieval personnel must deal with at least two different languages. The first is the recorded language of the document 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.
Chapter III

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.
Chapter III

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 in 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."

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.

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 (AAO) 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.
Chapter III

0. 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".
Chapter III

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.*
Chapter III

1. 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 services;

3. retrieval services and distribution services.

Document requests are restricted to messages 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.
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.

RETRIEVAL WORK PROCEDURES

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

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.

Chapter IV

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.
Chapter IV

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.*

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.*

*Ibid, p. 143*
Chapter IV 

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.
Chapter IV

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. M. L. Goldin (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.


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
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

READERS
AUTHORIZED
(1) TO MAKE DOCUMENT
REQUESTS AND
(2) TO RECEIVE
DOCUMENTS

RETRIEVAL
PERSONNEL

KNOWN
DOCUMENTS
APPROPRIATE
to
DOCUMENT REQUESTS

POTENTIAL SCOPE OF A RETRIEVAL SERVICE
CHAPTER V

DIAGRAM 8

AUTHORIZED READERS

RETRIEVAL PERSONNEL

READERS WHO ACTUALLY MAKE DOCUMENT REQUESTS

AVAILABLE DOCUMENTS IN COLLECTION OR FROM OTHER DEPOSITORIES

KNOWN DOCUMENTS

ACTUAL SCOPE OF RETRIEVAL SERVICE
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 specifi-
   cations;
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;
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 character-

istic 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

I. Numbers of Readers by:
   A. Work Locations
   B. Work Assignments

III. Numbers of Documents Usually Requested:
   A. Sources
   B. Frequency of Issuance
   C. Formats
   D. Languages
   E. Subjects
   F. Evaluative Criteria

V. Frequency of Kinds of Access Usually Requested to Documents:
   A. Direct access by Readers or their assistants
   B. Indirect access, delegated to retrieval personnel

VII. Frequency of Reader's Relations With Other Retrieval Services:
   A. As Authors of Documents
   B. As Producers of Document Substitutes
   C. As Producers of Retrieval Aids
   D. Size of Personal Document Collections
   E. Personal Retrieval Sources
   F. Regular use of Other Retrieval Sources

IX. Amount of Resources Assigned To Retrieval Service:
   A. Sources
   B. Personnel
   C. Materials for Collection
   D. Space
   E. Equipment and Supplies
   F. Special Restrictions

II. Number of Authors by:
   A. Work Locations if different
   B. Work Assignments from those of readers

IV. Numbers of Documents in Collection:
   A. Sources
   B. Frequency of Issuance if different
   C. Formats from those
   D. Languages usually
   E. Subjects requested
   F. Evaluative Criteria

VI. Frequency of Kinds of Retrieval Processes Available from Service:
   A. Processing Documents
   B. Processing Document Substitutes
   C. Processing Retrieval Aids
   D. Processing Items in Documents ("data retrieval")

VIII. Frequency of Service's Relations With Other Retrieval Services:
   A. (Retrieval Personnel as Authors)
   B. As Producers of Document Substitutes
   C. As Producers of Retrieval Aids
   D. (Retrieval Personnel Collections)
   E. (Retrieval Personnel Sources)
   F. Regular Use of Other Retrieval Services
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 pattern 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.
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.


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

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 index 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
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.
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. 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 judgment 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 rulers 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.
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 copies 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 been 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.
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.
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. Microfilming 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

   Hubert H. Humphrey, chairman of subcommittee.


   Overton Brooks, chairman of subcommittee.

Appendix A


Hubert H. Humphrey, chairman of subcommittee.


Hubert H. Humphrey, chairman of subcommittee.
Appendix A


    Roman C. Pucinski, chairman of subcommittee.


    Hubert H. Humphrey, chairman of subcommittee.


    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.
Appendix A


Appendix B

SELECTIVE BIBLIOGRAPHY OF GLOSSARIES OF RETRIEVAL INTEREST, ARRANGED BY DATE


Appendix B


   Martin H. Weik, Chairman of subcommittee.
   Also available as Glossary. In U. S. Congress.


   Includes the Proposed American Standard Dictionary prepared by the ASA S3.5 Subcommittee on Terminology.

   Martin H. Weik, chairman of committee.
Appendix B


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 belts

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
Appendix C

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


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.
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
      (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.
Appendix C

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.
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.
Appendix C

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.

References:

<table>
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<tr>
<th>Dates</th>
<th>Reference</th>
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<tr>
<td>1963</td>
<td>Luhn, H. P. (editor) AUTOMATION AND SCIENTIFIC COMMUNICATION, SHORT PAPERS CONTRIBUTED TO THE 28TH ANNUAL MEETING OF THE AMERICAN DOCUMENTATION INSTITUTE AT CHICAGO, Pick-Congress Hotel, October 6-11, 1963, Short Papers, Parts 1 and 2</td>
</tr>
</tbody>
</table>

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

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 a new delivery system for the Library of the University of Delft, Netherlands
   1965
   Verhoeff, V.
   "The Delft Circulation System"

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.

Dates

References

1951 Bussa, R.
"The Use of Punched Cards In
Linguistic Analysis", Chapter 16
in Perry, 1958, p. 357-373.


1948 Perry, 1958, p. 373.

1954 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**

   (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 microphotographic reproductions of reference books.**  
       1853  
       Stevens, G. W. W.  
       MICROPHOTOGRAPHY: PHOTOGRAPHY AT EXTREME RESOLUTION  

   (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  
       Horne, Allistair  
       "By Balloon from Paris"  
       HISTORY TODAY, Vol. 13, No. 7,  
       July, 1963, p. 441-8

   (4) R. Dragon directed pigeon post for mailing  
       microfilmed letters during siege of Paris.  
       (Franco-Prussian War).  
       1870  
       Same as above
Appendix C.

II. Mechanized Aids in Processing Document Substitutes

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<td>*(5) Recordak Model 3 reader for 16 mm. film</td>
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<td>*(6) Microfilming of newspapers and their sale</td>
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<td></td>
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<td>established &quot;Biblio-Film Service&quot;</td>
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<td>operating copying camera at U. S. Department</td>
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<td>of Agriculture Library, Library of Congress,</td>
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<td>and Surgeon General's Library in Department</td>
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<td>*(8) Recordak projector for 35 mm. film.</td>
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<td>New York Public Library Demonstration.</td>
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<td>*(9) American Library Association</td>
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<td>Microphotographic symposium and equipment</td>
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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".

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

(12) World War II
Use of V-mail by USA.

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

Dates

References

1937

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

Davis, W.

1937

Stewart, 1960, p. 29-30

1940's

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

1947

Lockrey, A. J.
"Army Microfilm Mail Technique"
### Appendix C

#### II. Mechanized Aids in Processing Document Substitutes

##### A. Mechanized Preparation of Document Substitutes

<table>
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<th>Dates</th>
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1. Copy Devices

a. Microfilm Rolls

(14) University Microfilms, Inc.  
Microfilming and Sale of doctoral theses.  
1950  
Power, E. B.  
"University Microfilms: A Microfilming Service for Scholars,"  

(15) National Microfilming Association  
established for manufacturers and users  
of the equipment  
1951  
Lewis, C. M.  
"National Microfilm Association"  
LIBRARY JOURNAL, Vol. 77, No. 13  
July, 1952, p. 1178-1181

(16) R. R. Shaw  
U. S. Department of Agriculture Library  
Microfilming of shingled catalog cards for  
publication in USDA Bibliography  
1950  
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. 196-200

(17) Recordak Lodestar developed for Sears and  
Roebuck Company. Cartridges for 16 mm.  
microfilm for inserting and storage of rolls.  
1960  
Shaw, R. R.  
"USDA Library"  
LIBRARY JOURNAL, Vol. 69, No. 8,  
April 15, 1944, p. 333-5.
Appendix C

II. Mechanized Aids in Processing Document Substitutes

A. Mechanized Preparation of Document Substitutes

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<td></td>
<td>Hawken, 1960, p. 22-23</td>
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</table>

1. Copy Devices

b. Photographic Copiers

(1) R. Graffin
Exhibited prototype of photostat

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

Hawken, 1960, p. 268

(2) Optical Society of America
Public demonstration in Detroit
of Xerox Equipment

1948

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, KADHER Press, 1944

Hawkins, R.
   
"Production of Micro-Forms" In THE STATE OF THE LIBRARY ART
   

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
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 1956

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

   Chronic, 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


   (2) Atomic Energy Commission and National Aeronautics and Space Administration standardized the reduction ratios of their cards.

   (3) Department of Defense joined standardization agreement. 1964


References


(2) T. R. Savage, "Preparation of Auto-Abstracts, etc."

International Business Machines Corporation

IBM 704 used

Bourne, 1953, p. 160

Data

1958

Appendix C

II. Mechanized Aids in Processing Document Substitutes

2. Computer Programs

a. Extracts

b. Abstracts

c. Translations


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

            1934

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

      (2) Punch Cards for Serials Acquisition

         (a) University of Texas Library

            1945

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

         (b) University of Texas Library

            1950

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

i. Invented by Alexander G. Bell of USA 1876

ii. Regular use for book requests by New York Society Library subscribers 1911

(b) Teletype

i. Invented by Morlrun-Kleinschmidt of USA 1928

ii. A. Pethybridge  Jan. 25, 1950
Racine, Wisconsin Public Library
Used for inter-library loans with Milwaukee, Wisconsin Public Library. Called Racmil-Teletype.

iii. International Business Machines Corp. issued an operating manual 1959

Dates References

King, H.


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
Appendix C

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

(3) Edge Notch Cards

(a) Kilgour, F. G.

Harvard College Library

Keysort Cards of McBee Company

<table>
<thead>
<tr>
<th>Date</th>
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<tr>
<td>1936</td>
<td>Parker, R. H., &quot;The Punched Card Method in Circulation Work&quot;</td>
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<td>LIBRARY JOURNAL, Vol. 51, No. 21, Dec. 1, 1936, p. 803-905</td>
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<td>1941</td>
<td>Quigley, M., &quot;Library F fists from International Business Machines Cards&quot;</td>
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<td>Pratt, E. C., &quot;International Business Machines Use in Circulation Department, University of Florida Library&quot;</td>
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<td>1938</td>
<td>Kilgour, F. G., &quot;A New Punched Card for Circulation Records&quot;</td>
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<td>LIBRARY JOURNAL, Vol. 64, Feb. 15, 1939, p. 131-133</td>
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## Appendix C

### III. Mechanized Aids in Processing Retrieval Aids

#### A. Mechanized Preparation of Retrieval Aids

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<td>1960</td>
<td>NSF #3, 1962, p. 101-104</td>
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<td>1961</td>
<td>NSF #3, 1962, p. 103</td>
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</table>

1. Property Control Procedures

   b. Circulation Procedures

   (4) Computer Programs for Request Processing

   (a) N. 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

   (b) ASTIA processed total of 600,000 specific document requests during

   (c) ASTIA became DDC, Defense Documentation Center

   (d) DDC converted computer program to Remington Rand 1105 Computer
### Appendix C

#### III. Mechanized Aids in Processing Retrieval Aids

A. Mechanized Preparation of Retrieval Aids

2. Index Records

<table>
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<th>Date</th>
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<tr>
<td>1951</td>
<td>Alvord, D. &quot;King County Public Library Does It with IBM&quot; PACIFIC NORTHWEST LIBRARY ASSOCIATION QUARTERLY, Vol. 16, No. 3 April, 1952, p. 123-132</td>
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<td>1955</td>
<td>NSF #3, 1962, p. 168-170</td>
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<td>1956</td>
<td>MacQuarrie, C. &quot;IBM Book Catalog&quot; LIBRARY JOURNAL Vol. 82, No. 5, March 1, 1957, p. 630-634</td>
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### Appendix C

### III. Mechanized Aids in Processing Retrieval Aids

#### A. Mechanized Preparation of Retrieval Aids

2. Index Records

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<th>b. Computer Print Outs</th>
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1. **Listing by Authors' Names with Citations**

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<tr>
<th>(b)</th>
<th>Citation Indexes commercially available</th>
<th>1963</th>
<th>SCIENCE CITATION INDEX, 1964, Institute for Scientific Information, Philadelphia, 1964.</th>
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2. **Listing by Index Terms with Citations**

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<th>(a)</th>
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1. **L. J. Bartlett**

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<th>1955</th>
<th>NSF #3, 1962, p. 171</th>
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Information for Industry, Inc. Retrieval of chemical patents using IBM 305 RAMAC

2. **E. Wall**

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<th>1957</th>
<th>NSF #1, 1958, p. 12-13</th>
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E. I. duPont deNemours Co., Inc. produced a "Double Dictionary"

3. **W. Powell**

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<th>1962</th>
<th>NSF #4, 1966, p. 27-28</th>
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Dow Chemical Company
Appendix C

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


ii. Application of Tabledex to publications produced for International Geophysical Year.
   1962


(c) Scan-Column Index

i. J. O'Connor
   Remington Rand UNIVAC
   1962

### Appendix C

#### III. Mechanized Aids in Processing Retrieval Aids

##### A. Mechanized Preparation of Retrieval Aids

2. Index Records

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<td>1961</td>
<td>CHEMICAL TITLES, April 5, 1960, Easton, Pa., American Chemical Society, 1960-</td>
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b. Computer Print-Outs

(2) Listing of Index Terms with Citations

(d) Permutied Indexes

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

2. H. P. Luhn
   International Business Machines Corp.
   developed KWIC index, Key Word In Context to keywords in titles.

3. R. A. Kennedy
   Bell Telephone Laboratories
   IBM 7090 Computer

4. W. S. Learmouth
   Lockheed Aircraft Company
   KWIC with IBM-704 Computer
### Appendix C

#### III. Mechanized Aids in Processing Retrieval Aids

##### A. Mechanized Preparation of Retrieval Aids

**2. Index Records**

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<td>Catholic University Library</td>
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<td>Flexwriter for mass production of catalog cards for Catholic Libraries</td>
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<td>Illinois State Library</td>
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<td>Remington Rand Synchrotape</td>
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<td>Zator Company</td>
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<tr>
<td>Proposed co-operative plan for exchanging typewriter tapes for catalog card production</td>
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<td>Production of Technical Announcement Bulletin, TAB, on Remington Rand Synchrotape with computer assistance.</td>
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### Appendix C

#### III. Mechanized Aids in Processing Retrieval Aids

##### A. Mechanized Preparation of Retrieval Aids

#### 2. Index Records

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<td>(1)</td>
<td>W. Day</td>
<td>Atomic Energy Commission</td>
<td>1959</td>
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<td>Recordak Listomatic camera production of NUCLEAR SCIENCE ABSTRACTS</td>
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<td>(2)</td>
<td>S. I. Taine</td>
<td>National Library of Medicine</td>
<td>1960</td>
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<td>Listomatic camera production of INDEX MEDICUS</td>
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<td>W. Dyson</td>
<td>Chemical Abstracts Service</td>
<td>1960</td>
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<td>Listomatic camera production</td>
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<td>(4)</td>
<td>I. D. Welt</td>
<td>Cardiovascular Literature Project</td>
<td>1960</td>
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<td></td>
<td></td>
<td>(now at the American University, formerly at NAC/NRC)</td>
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<td>Listomatic production of INDEX-HANDBOOK OF CARDIOVASCULAR AGENTS</td>
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<td>(5)</td>
<td>F. Mohrhardt</td>
<td>National Agricultural Library</td>
<td>1965</td>
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<td>Friden Comos-O-Line Production of retrospective catalog</td>
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NSF #2, 1959, p. 60-61

NSF #3, 1962, p. 172-174

NSF #3, 1966, p. 55-56
Appendix C

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.
### Appendix C

#### III. Mechanized Aids in Processing Retrieval Aids

**E. Search Devices, a Mechanized Matching of Retrieval Cards**

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<td><strong>1. Edge-Notch Cards for Manual Manipulation</strong></td>
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<tr>
<td>a. W. K. Sparrow</td>
<td>Bottom edge-notched cards to prevent misfiling</td>
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<tr>
<td>filed Sept. 18, 1903</td>
<td>issued May 10, 1904</td>
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<tr>
<td></td>
<td>U. S. Patent 759,483</td>
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<tr>
<td>b. E. Eckart</td>
<td>Bottom edge-notch cards selected by lifting bars</td>
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<tr>
<td>filed Feb. 8, 1906</td>
<td>issued Dec. 10, 1907</td>
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<td>U. S. Patent 873,305</td>
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<td>c. A. Perkins</td>
<td>All edged notched on cards for manual needle sorting</td>
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<tr>
<td>filed Feb. 8, 1923</td>
<td>issued June 30, 1925</td>
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<td></td>
<td>Tallies, Cards, or the Like,&quot;</td>
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<td>U. S. Patent 1,544,172.</td>
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<td>&quot;Card and the Like for Classification Systems&quot;</td>
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<td>U. S. Patent 1,759,087</td>
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<td>d. E. M. Jelinek</td>
<td>Indexed J. cal on Keysort cards</td>
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<td>1941</td>
<td>Jelinek, E. M., &quot;Use of Punched Cards&quot;</td>
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<td></td>
<td>QUARTERLY JOURNAL STUDIES ON ALLOYS. Vol. 2, 1941, p. 216-222</td>
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<td>e. W. R. Hyslop</td>
<td>American Society of Metals</td>
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<td>1948</td>
<td>Application of metallurgical literature</td>
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<td>1949</td>
<td>Bagg, 1962, p. 228-230</td>
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<td>Perry, 1958, p. 177-178</td>
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### Appendix C

III. Mechanized Aids in Processing Retrieval Aids

#### E. Search Devices

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<td>1951-9</td>
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<td>NSF #2, 1959, p. 49-51</td>
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<td></td>
<td>NSF #3, 1962, p. 134</td>
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<tr>
<td>1957</td>
<td>Bagg, 1962, p. 31</td>
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1. Edge-Notch Cards for Manual Manipulation

- **g. H. A. Geer**
  - Parke, Davis & Company
  - Keysort Cards
  - for Data Retrieval

- **h. H. N. Staats**
  - Fast Access Coed Small Images, Inc.
  - FACSI reprint articles from the JOURNAL OF THE SOCIETY FOR NON-DESTRUCTIVE TESTING of 3/1 reduction on edge-notched cards (8x10½)
### Appendix C

#### III. Mechanized Aids in Processing Retrieval Aids

##### E. Search Devices

<table>
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<tr>
<th>Dates</th>
<th>References</th>
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<tr>
<td>1915</td>
<td>&quot;Selective Device&quot; U. S. Patent 1,165,465</td>
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<td>1920</td>
<td>&quot;Means for Compiling Tabular and Statistical Data&quot; U. S. Patent 1,351,692</td>
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<td>1939</td>
<td>Batten, W. E., &quot;Specialized Files for Patent Searching&quot;, Chapter 21</td>
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2. Optical Coincidence Cards for Manual Manipulation

| a. H. Taylor  
Data retrieval for bird identification | filed Sept. 1915  
iissued Dec. 28, 1915 |
|--------------------------------------|-------------------|
| b. H. E. Soper  
Statistical applications | issued Aug. 31, 1920 |
| c. W. E. Batten  
Imperial Chemical Industries, Ltd.  
Retrieval of chemical patents on special punch card | 1939 |

Converted to standard tabulating cards 1947
Appendix C

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 (5×8) with
18,000 positions for searching
of instrumentation literature

1953

Wildhack, W. A. and Stern, J.,
"Documentation in Instrumentation",
AMERICAN DOCUMENTATION. Vol. 3.

Wildhack, W. A. and Stern, J.,
"The Peek-a-boo System in the Field
of Instrumentation", Chapter 15.
INFORMATION SYSTEMS IN DOCUMENTATION,
Shera, J. H., et al., editors.

"FILE IT TO FIND IT...OMNIDEX".
Omnidex, Pomona, California, 1956.

e. H. F. Benson
Omnidex Installation at General Dynamics
using standard tabulating card with pre-
perforated positions

1956

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
Appendix C

III. Mechanized Aids in Processing Retrieval Aids

E. Search Devices

2. Optical Coincidence Cards for Manual Manipulation

  g. F. Jonker
  Jonker Business Machines, Inc.
  Termatrix Cards (9x9) with 10,000 positions
  1957
  Jonker, F.
  "The Termatrix Inverted Punch Card System"
  AMERICAN DOCUMENTATION
  Thompson, M. S.
  "Peek-a-boo Index for a Broad Subject Collection",
  AMERICAN DOCUMENTATION, Vol. 13
  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
  Bourne, 1963, p. 111-115

  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
### Appendix C

#### III. Mechanized Aids in Processing Retrieval Aids

##### E. Search Devices

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<td>1963</td>
<td>NSF #4, 1966, p. 118-120</td>
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<td>1964</td>
<td>NSF #4, 1966, p. 140-142</td>
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- **2. Optical coincidence Cards for Manual Manipulation**
  - j. Termatrix installation for data retrieval
  - k. Doudnikoff, B. Westinghouse Corporation Termatrix installation for document retrieval
  - l. Royal McBee Corporation sells Keydex System, similar to Termatrix equipment
  - m. Chemagro Corporation Termatrix installation for document retrieval
  - n. Roy T. Weston Consultants Termatrix installation
Appendix C.

III. Mechanized Aids in Processing Retrieval Aids

g. Search Devices

3. Punch Cards with Sorters

<table>
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<th>References</th>
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<tr>
<td>Hollerith, H.</td>
<td>1887</td>
<td>347</td>
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<td>&quot;Art of Compiling Statistics&quot;.</td>
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<td>U. S. Patent No. 395, 781</td>
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<td>Hollerith, H.</td>
<td>1890</td>
<td>350</td>
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<td>&quot;An Electrical Tabulating System&quot;</td>
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<td>A JOURNAL OF APPLIED SCIENCE</td>
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<td>Love, A. G., Hamilton, E. L. and Helman, I. L.</td>
<td>1911</td>
<td>351</td>
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<td>TABULATING EQUIPMENT AND ARMY MEDICAL STATISTICS</td>
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<td>Office of the Surgeon General, Department of the Army, Washington, D. C., 1958, p. 36-51</td>
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<td>Scheele 1961, p. 48-54</td>
<td>1913</td>
<td>351</td>
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<td>Scheele, 1961, p. 48-54</td>
<td>1922</td>
<td>351</td>
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<td>Scheele, 1961, p. 4-5</td>
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| a. H. Hollerith | filed June 8, 1887 | 1880 |
| Invented punch card equipment with electric sorting |      |      |
| b. H. Hollerith | Application to 11th Census of the United States | 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 |
### Appendix C.

III. Mechanized Aids in Processing Retrieval Aids

E. Search Devices

<table>
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<td>1946</td>
<td>NSF #3, 1962, p. 131-133</td>
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<td>1947</td>
<td>NSF #2, 1959, p. 39-40</td>
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<td>1951</td>
<td>NSF #1, 1958, p. 20-21</td>
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<td>1951</td>
<td>NSF #2, Supp. 1960, p. 11-12</td>
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<td>1962</td>
<td>NSF #3, 1962, p. 54-56</td>
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<td>1962</td>
<td>NSF #2, 1962, p. 92-95</td>
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<td>1958</td>
<td>NSF #1, 1958, p. 37-38</td>
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3. Punch Cards with Sorters

- **f. H. Nutting**
  Dow Chemical Company
  IBM Punch Card equipment for searching of chemical compounds

- **g. K. Heuman**
  National Academy of Science
  National Research Council
  Chemical Biological Coordination Center
  IBM punch card equipment for data searching of chemical compounds

- **h. Union Carbide Plastics Company, formerly Bakelite Company,**
  developed "unit card" system with IBM sorter

- **i. C. E. Lyght**
  Merck Sharp & Dohme
  IBM sorter for searching medical literature

- **j. W. S. Jones**
  Union Carbide Chemicals Company
  IBM sorting equipment
Appendix C.

III. Mechanized Aids in Processing Retrieval Aids

E. Search Devices

3. Punch Cards with Sorters

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<td>k.</td>
<td>C. J. Maloney</td>
<td>1953</td>
<td>NSF #1, 1958, p. 39-40</td>
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<td>L. S. Army Biological Warfare Laboratory Remington Rand Sorting Equipment</td>
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<td>NSF #2, 1959, p. 133-136</td>
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<td>NSF #3, 1962, p. 142-145</td>
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<td>l.</td>
<td>B. Hildenbrand</td>
<td>1955</td>
<td>NSF #1, 1958, p. 14-15</td>
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<td>Ethyl Corporation</td>
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<td>NSF #2, 1959, p. 13-17</td>
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<td>Remington Rand Sorter with group selection device or bridge</td>
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<td>NSF #3, 1962, p. 19-21</td>
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<td>m.</td>
<td>J. B. Alden</td>
<td>1957</td>
<td>NSF #4, 1966, p. 64-68</td>
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<tr>
<td></td>
<td>Food Machinery and Chemical Corporation IBM sorting equipment</td>
<td></td>
<td>NSF #1, 1958, p. 16-18</td>
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<tr>
<td>o.</td>
<td>H. A. Geer</td>
<td>1959</td>
<td>NSF #2, 1959, p. 48-51</td>
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<tr>
<td></td>
<td>Parke Davis and Company Converted from McBeek cards to IBM sorting equipment</td>
<td></td>
<td>NSF #3, 1963, p. 138-139</td>
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<td></td>
<td></td>
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<td>NSF #4, 1966, p. 49-51</td>
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### III. Mechanized Aids in Processing Retrieval Aids

#### E. Search Devices

<table>
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<tr>
<th>No.</th>
<th>Description</th>
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<th>References</th>
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<td>4</td>
<td><strong>4. Edge-Notch Cards for Mechanical Manipulation</strong></td>
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<tr>
<td>a.</td>
<td>C. N. Mooers</td>
<td></td>
<td></td>
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<tr>
<td></td>
<td>filed Jan. 3,</td>
<td>1947</td>
<td>Mooers, C. N.</td>
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<td></td>
<td>issued Jan. 12,</td>
<td>1947</td>
<td>&quot;Card Selecting Device&quot;</td>
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<td>b.</td>
<td>C. N. Mooers</td>
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<td></td>
<td>Zator Company</td>
<td>1947</td>
<td>Mooers, C. N.</td>
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<td></td>
<td>Edge-Notched cards (5x8) with superimposed</td>
<td></td>
<td>THE ZATOR - A PROPOSAL, A MACHINE</td>
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<td></td>
<td>random coding sorted by Zator 800 selector</td>
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<td>METHOD FOR COMPLETE DOCUMENTATION</td>
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<td></td>
<td></td>
<td>(Zator Technical Bulletin No. 65)</td>
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<td></td>
<td></td>
<td></td>
<td>Boston, Zator Company, 1951</td>
</tr>
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<td>c.</td>
<td>C. W. Brenner</td>
<td>1957</td>
<td></td>
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<td></td>
<td>Zator installation for document retrieval</td>
<td></td>
<td>NSF #2, p. 3 - 4.</td>
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<td>d.</td>
<td>J. R. Hoffer</td>
<td>1962</td>
<td></td>
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<td>Zatopek installation for document retrieval</td>
<td></td>
<td>Hoffur, J. R.,</td>
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<td>&quot;Information Retrieval in Social</td>
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<td>Warfare: Experience with an Edge-</td>
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<td></td>
<td></td>
<td></td>
<td>Notched Information Retrieval System&quot;,</td>
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<td></td>
<td>AMERICAN DOCUMENTATION, Vol. 13, No. 2.</td>
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<td></td>
<td></td>
<td>April 1962, p. 169-175</td>
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## Appendix C

### III. Mechanized Aids in Processing Retrieval Aids

#### E. Search Devices

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<tr>
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<tr>
<td>1949-50</td>
<td>Perry, 1951, p. 374-376</td>
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<td>1949-50</td>
<td>Perry, 1958, p. 268-273</td>
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<td>1949-50</td>
<td>NSF #1, 1958, p. 42-43</td>
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<td>1949-50</td>
<td>NSF #2, 1959, p. 41-42</td>
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<td>NSF #1, 1958, p. 22-23</td>
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<td>1949-50</td>
<td>NSF #2, 1959, p. 24-26</td>
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</table>

**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

---

_Schultz, C. K._
Appendix C

III. Mechanized Aids in Processing Retrieval Aids

E. Search Devices

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

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<td>1955</td>
<td>NSF #1, 1958, p. 32-33</td>
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<td></td>
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<td>NSF #2, 1959, p. 35-37</td>
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<td></td>
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<td>NSF #2, 1959, p. 85-89 and p. 140-142</td>
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<td>f.</td>
<td>1955</td>
<td>NSF #2, 1959, p. 12-14</td>
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<td></td>
<td></td>
<td>NSF #3, 1962, p. 74-76</td>
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<td>g.</td>
<td>1957</td>
<td>NSF #1, 1958, p. 30-31</td>
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<td></td>
<td></td>
<td>NSF #2, 1959, p. 32-34</td>
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<td></td>
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<td>NSF #3, 1962, p. 84-86</td>
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Appendix C

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
   1954
   NSF #1, 1958, p. 18-19
   NSF #2, 1959, p. 22-24
   NSF #3, 1962, p. 79-82
   NSF #4, 1966, p. 73-76

b. C. L. Peakes
   Eakelite Company
   IBM Collator for document retrieval
   1956
   NSF #1, 1958, p. 4-5

7. Paper Tape Searches

a. J. W. Perry
   Center for Communication and Documentation
   Research, Western Reserve University,
   Effect of a selector used primarily for research
   and as a teaching tool.
   1957-62
   Perry, 1958, p. 252-253.
Appendix C

III. Mechanized Aids in Processing Retrieval Aids

E. Search Devices

8. Computer Searches

a. J. P. Eckert and J. W. Mauchly filed June 26, 1947
   Electronic Numeric Integrator and issued Feb. 4, 1964
   Computer ENIAC

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

   NSF #1, 1958, p. 24
   NSF #3, 1962, p. 135-136

   NSF #1, 1958, p. 28
   NSF #3, 1962, p. 117-119

   Moyer, R. H.
   "Automatic Search of Library
   Documents"
   COMPUTERS AND AUTOMATION, Vol 6,
   No. 5, p. 24-29, May 1957.

   "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

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

   NSF #1, 1958, p. 28
   NSF #3, 1962, p. 117-119

   Moyer, R. H.
   "Automatic Search of Library
   Documents"
   COMPUTERS AND AUTOMATION, Vol 6,
   No. 5, p. 24-29, May 1957.

   "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

d. H. E. Tillitt
   Naval Ordnance Test Station
   IBM-701 used for document retrieval
   Converted to IBM 7090
   1961

   NSF #1, 1958, p. 28
   NSF #3, 1962, p. 117-119

   Moyer, R. H.
   "Automatic Search of Library
   Documents"
   COMPUTERS AND AUTOMATION, Vol 6,
   No. 5, p. 24-29, May 1957.

   "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

e. R. H. Moyer
   University of Pennsylvania
   IBM 705 used in document retrieval
   1957

   NSF #1, 1958, p. 28
   NSF #3, 1962, p. 117-119

   Moyer, R. H.
   "Automatic Search of Library
   Documents"
   COMPUTERS AND AUTOMATION, Vol 6,
   No. 5, p. 24-29, May 1957.

   "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

f. E. C. Warden, 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
Appendix C

III. Mechanized Aids in Processing Retrieval Aids

E. Search Devices

8. Computer Searches

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<td>1958</td>
<td>NSF #2, 1959, p. 47-48</td>
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<td>1958</td>
<td>NSF #2, 1959, p. 135-136</td>
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<td>1960</td>
<td>NSF #3, 1962, p. 110-112</td>
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<td>1960</td>
<td>NSF #3, 1962, p. 101-104</td>
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<tr>
<td>1964</td>
<td>NSF #4, 1966, p. 381-384</td>
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</table>

- **g. W. H. Waldo**
  Monsanto Chemical Company
  Converted to IBM 704

- **h. B. K. Dennis**
  General Electric Company
  Flight Propulsion Division
  IBM 7090-1401 system

- **i. H. Heald**
  Armed Services Technical Information Agency, ASTIA
  Now Defense Documentation Center, DDC.

- **j. J. W. Perry**
  Western Reserve University
  GE-225 computer

- **k. F. B. Rogers**
  National Library of Medicine
  Medical Literature Analysis and Retrieval System, MEDLARS, using Honeywell H200 computer.
### Appendix C

#### III. Mechanized Aids in Processing Retrieval Aids

**E. Search Devices**

**9. Special Devices Utilizing IBM Cards**

<table>
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<tr>
<th>Date</th>
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<table>
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<tr>
<th>Date</th>
<th>References</th>
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</table>
| 1954 | Jahoda, Gerald  
"Electronic Searching"  

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<th>Date</th>
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| 1955 | Luhn, H. P.  

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<tr>
<th>Date</th>
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<tr>
<td>1958</td>
<td>Jahoda, op. cit.</td>
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<th>Date</th>
<th>References</th>
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</table>
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.

(2) U. S. Patent Office
Changed to IBM-101 steriod compound searches.

Date: 1957

References
Andrews, D.D., et. al

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

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.,
   PROCEEDINGS

2. COMAC became Special Index Analyzer, SIA, and IBM-9900 1958
   NSF #2, Supp. 1960, p. 33-35
   Bourne, 1963, p. 122-133

3. Benson-Lehner Corporation
   Developed COMAC Mark-2 1962
   Bourne, 1963, p. 122-123, 134
### Appendix C

#### III. Mechanized Aids in Processing Retrieval Aids

**E. Search Devices**

<table>
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<tr>
<td><strong>10. Magnetic Media Devices</strong></td>
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<tr>
<td><strong>a. Magnetic cards</strong></td>
<td></td>
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<tr>
<td>(1) R. M. Hayes and G. W. Mayle</td>
<td>filed Nov. 26, 1956</td>
<td>&quot;Card Processing Apparatus&quot;</td>
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<tr>
<td>Invention of Magnacards</td>
<td></td>
<td></td>
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<tr>
<td>(2) Prototype of Magnacard developed for Rome Air Development Center</td>
<td>1956-58</td>
<td>Bagg, 1962, p. 34, 76-78.</td>
</tr>
<tr>
<td>Requires computer direction</td>
<td></td>
<td>Bourne, 1963, p. 185-186.</td>
</tr>
<tr>
<td>(2) General Electric Company Scheduled Information Searching Selector, GB-250, for 1960 delivery to Western Reserve University, but it was never completed. GB-225 computer substituted.</td>
<td>1961</td>
<td>Bourne, 1963, p. 184-185.</td>
</tr>
<tr>
<td>(3) S. Herber of Herber and Company developed prototype of Heatwole-40.</td>
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Appendix C.

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

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

   b. Eastman Kodak Company
      Recordak Lodestar with Kodamatic Counter

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,

      Bagg, 1962, p. 96, 96, 106

      Bagg, 1962, p. 96-97


   b. Information Retrieval Corporation
      1962
      developed an improved AMPHIS and called it
      Command Retrieval Information System, CRIS

   b. Information Retrieval Corporation
      1962
Appendix C

V. Mechanized Combinations of Retrieval Processes

A. Devices to Locate and Copy Documents

<table>
<thead>
<tr>
<th>Microfilm Strip/Sheet Devices</th>
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<tr>
<td>b. MBS Micro-Image Locator</td>
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<tr>
<td>c. VERAC 903</td>
<td></td>
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<tr>
<td>(1) Avcc Corporation developed prototype with financial support from Council on Library Resources</td>
<td>1960</td>
<td>Bagg, 1962, p. 36, 96.</td>
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3. Unit Devices

Appendix C

V. Mechanized Combinations of Retrieval Processes

E. Devices to Locate and Copy Documents

<table>
<thead>
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<th>Dates</th>
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<td></td>
<td>Goldberg, E.</td>
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<td></td>
<td>&quot;Statistical Machine&quot;</td>
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<td>1928</td>
<td>U. S. Patent No. 1,838,389</td>
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1. Microfilm Roll Selectors

<table>
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<th>Dates</th>
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</table>

a. E. Goldberg of Germany

- Filed April 5, 1928.
- Issued December 19, 1931.

b. V. Bush

- Mass. Inst. of Technology
- Constructed prototype of Microfilm Rapid Selector, with money from Eastman Kodak Company and National Cash Register.

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<tr>
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<td>&quot;Government's $106,000 Electronic Brain&quot;, ST LOUIS POST-DISPATCH, June 23, 1949, p. 1D</td>
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</table>

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.

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. Bagg
      National Bureau of Standards
      Developed for Navy Bureau of Ships two improved
      models of the Rapid Selector

   f. FMA, 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

<table>
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<tr>
<th>Dates</th>
<th>References</th>
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Appendix C

V. Mechanized Combinations of Retrieval Processes

B. Devices to Search and Copy Documents

2. Microfilm Unit Selectors

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<tr>
<td>1950</td>
<td>Bagg, 1962, p. 27.</td>
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<td>1953</td>
<td>Perry, 1951, p. 71-74</td>
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<td>Perry, 1958, p. 74-81</td>
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<td></td>
<td>Bagg, 1962, p. 27.</td>
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<td></td>
<td>Bagg, 1962, p. 23, 93-94</td>
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</tbody>
</table>

a. Aperture Cards

(1) A. Seidell
    proposed microfilm inserts in tabulating cards

(2) J. Langan
    U. S. Office of Strategic Services

(3) J. Langan
    assigned patent to Film 'N File, Inc.
    (later became Filmsort Co., and then Filmsort Division of Minnesota Mining and Manufacturing Company.)

(4) Central Intelligence Agency
    Intellofax System largest installation of aperture cards (more than 3 million cards in 1960)
Appendix C

V. Mechanized Combinations of Retrieval Processes

B. Devices to Search and Copy Documents

2. Microfilm Unit Selectors

a. Aperture Cards


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


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)  
      - **Dates**: 1954  
      - **Bagg**, 1962, p. 73, 68  

   2. Eastman Kodak Company made first installation for U. S. Air Force Intelligence  
      - **Dates**: 1957-58  
      - **References**: Bagg, 1962, p. 68-76  
      - **Bourne**, 1963, p. 204-207

   3. Eastman Kodak Company made three more installations for U. S. Air Force and one for EX itself  
      - **Dates**: 1961  
      - **References**: Bagg, 1962, p. 68.
Appendix C

V. Mechanized Combinations of Retrieval Processes

B. Devices to Search and Copy Documents

3. Microfilm Sheet/Strip Selectors

<table>
<thead>
<tr>
<th>a. Filmorex Selector</th>
<th>Dates</th>
<th>References</th>
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<tr>
<td>Demonstration</td>
<td></td>
<td>NSF #2, 1959</td>
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<tr>
<td>(2) Working installation at Centre Nationale de Recherche Scientif</td>
<td></td>
<td>NSF #3, 1962</td>
</tr>
<tr>
<td>(3) Rome Air Force Development Center installation</td>
<td>1960</td>
<td>Bagg, 1962, p. 66</td>
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<th>b. Microcite</th>
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<tr>
<td>(1) J. Stern</td>
<td>1953</td>
<td>&quot;A New Microcite Machine&quot;</td>
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<td>National Bureau of Standards proposed</td>
<td></td>
<td>National Bureau of Standards</td>
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<td>Microcite I</td>
<td></td>
<td>TECHNICAL NEWS BULLETIN</td>
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<td>National Bureau of Standards built prototype of Microcite II</td>
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<th>c. Walnut</th>
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<td>developed for Central Intelligence Agency</td>
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Appendix C

V. Mechanized Combinations of Retrieval Processes

B. Devices to Search and Copy Documents

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<tr>
<td>4. Magnetic Media Selectors</td>
<td>Dates</td>
<td>References</td>
</tr>
</tbody>
</table>
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

   Dates
   1843
   1934
   1953
   1966

   References
   ENCYCLOPEDIA BRITANNICA,
   Adams, S.
   "Facsimile for Federal Libraries",
   SPECIAL LIBRARIES, Vol. 44, No. 5,
   Morehouse, H. G.
   TELEFACSIMILE SERVICES BETWEEN LIBRARIES
   WITH THE XEROX MAGNAVOX TELECOPIER,
   A Study Prepared for the Council on
   Library Resources, CLR-314, Dec. 20, 1966,
   Council on Library Resources, Inc.
   FIFTH ANNUAL REPORT, 1961,
   Washington, D. C., p. 46-47.

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
### Appendix C

**COMPLETE CITATIONS FOR ABBREVIATED REFERENCES**

<table>
<thead>
<tr>
<th>Reference Form</th>
<th>Abbreviated Reference Form</th>
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<tr>
<td>NSF #2, 1959</td>
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<td>NSF #2, Supp. 1960</td>
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<td>NSF #3, 1962</td>
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<tr>
<td>NSF #4, 1966</td>
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<tr>
<td>Perry, 1951</td>
<td>6. Perry, James W. and Casey, Robert S., <strong>Punched Cards: Their Application to Science and Industry.</strong> New York, Reinhold Publishing Corporation, 1951, 506 pages</td>
</tr>
</tbody>
</table>
Appendix C

COMPLETE CITATIONS FOR ABBREVIATED REFERENCES (continued)

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

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.
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.
<table>
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<tr>
<th>KEY WORDS</th>
<th>LINK A</th>
<th>LINK B</th>
<th>LINK C</th>
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<tr>
<td>model, theory, analysis, system analysis. retrieval, documentation, information storage and retrieval. libraries, retrieval services, information systems education, training, textbook, course outline.</td>
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