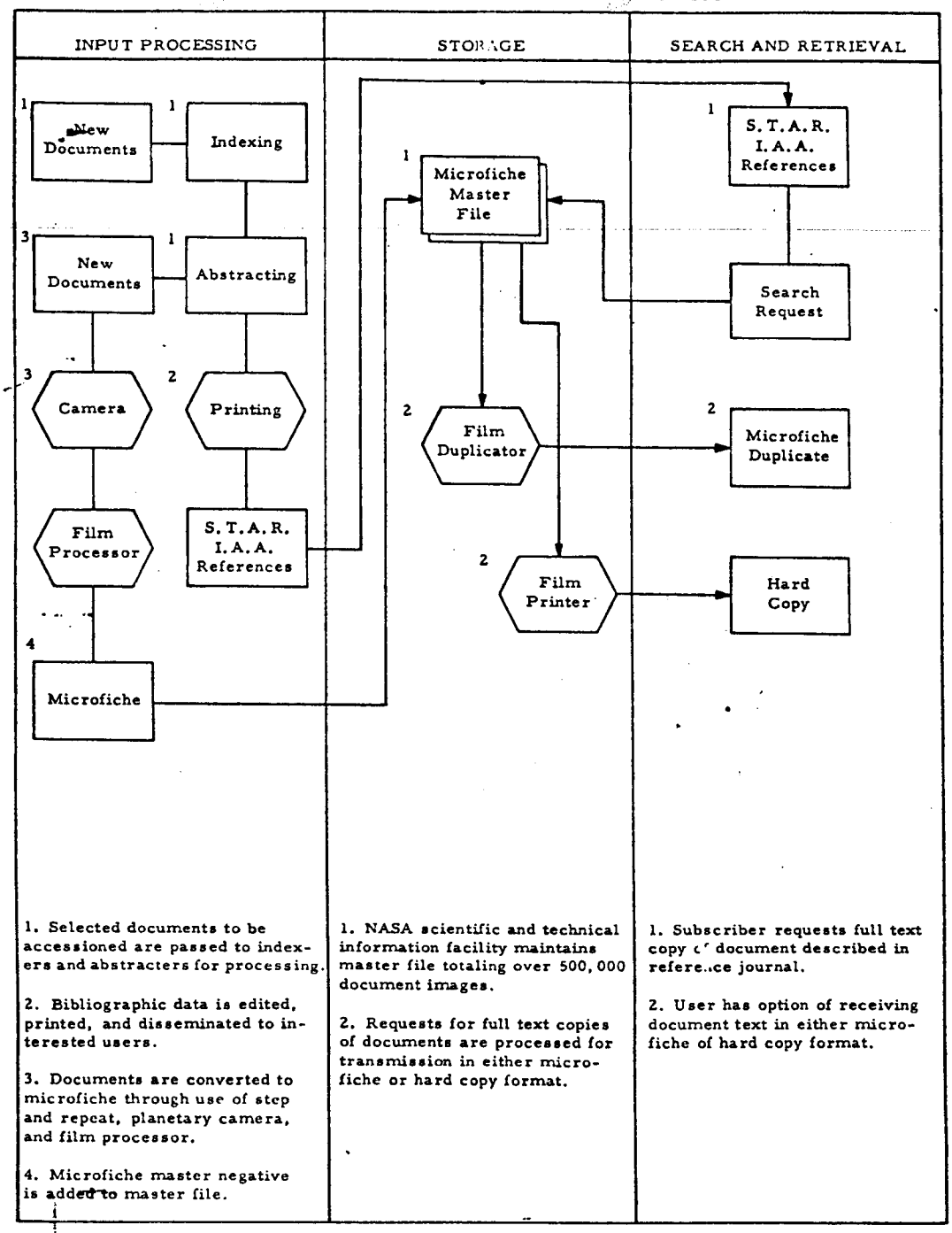
REMARKS. Without the benefits of microfilm as a storage and dissemination medium, it would almost be impossible to effectively serve the scientific and technical community. In addition to the problems of making, assembling, and warehousing paper copies, the packaging and shipping would represent a formidable effort. Fortunately, the steady improvement in microfilm technology has made it possible for information handling activities to keep abreast of the increased creation of paper documents. In 1969 NASA distributed almost 10 million microfiche under its information dissemination program. This in itself was a gain of almost one million microfiche over the previous year's total.

AEROSPACE INFORMATION DISSEMINATION



NAME OF SYSTEM:

NASA-RECON Automated Reference

ORIGINATOR:

Office of Technology Utilization

Scientific & Technological Information Division

National Aeronautics and Space Administration (NASA)

Washington, D.C. 20546

OBJECTIVE. To develop a document reference system that will increase efficiency in the dissemination and use of NASA's large collection of scientific and technical information.

BACKGROUND. Since 1958 NASA has been discovering new things about materials, machinery, and human beings, as well as about the earth, the moon and the universe. The responsibility for collecting, maintaining, and identifying the documentary results of these worldwide aerospace research activities rests with NASA's Scientific and Technical Information Division. In performing these most important duties the Division personnel summarize, index, and store this wealth of knowledge for the benefit of a broad array of people associated with scientific and technical pursuits. Each day the NASA Scientific and Technical Information Facility at College Park, Md., receives hundreds of scientific and technical documents. These papers are promptly checked to avoid duplication and examined for relevance. Professional indexers examine each document as it enters the system and record its appropriate reference data, including selection of authorized indexing terms. Trained abstractors then write a short but valid resume of the document's contents in cases where such action has not been taken previously. After a final review, the complete bibliographic record is entered into the memory of a high-speed electronic computer.

NASA's current information file numbers several hundred thousand documents, with most of the material maintained in microform. An analysis of the various users of this large body of information shows that NASA and its related industrial firms are involved in 60 percent of the total research inquiries. The academic community follows with 21 percent, and other Government agencies and foreign users are involved in the remaining 19 percent.

With the continuous growth of the Central File's accessioned scientific and technical material, researchers were spending an increasing portion of their time in locating meaningful document information. To alleviate this condition, the NASA authorities established the RECON system after an in-depth study of advancements in computerized information retrieval applications.

THE NEW METHOD. The NASA-RECON (*RE*mote *CON*trol) Automated Reference System consists of a high-speed computer and its stored bank of reference information located at College Park, Md., plus 21 remote information terminals located at selected aerospace centers throughout the United States. Each terminal complex includes a keyboard for entering queries into the system, a cathode-ray tube (CRT) for visual display, and a teleprinter for printout. The system has the capability of giving the NASA scientists and engineer users real-time, on-line machine access to specific reference data pertaining to NASA's Information Facility.

In preparing to use the RECON system's bibliographic data, the user must choose his inquiry terms from the NASA Thesaurus (list of indexing terms), available at each terminal location. This Thesaurus contains several thousand terms, many of which specifically relate to aerospace disciplines. Aside from these alphabetically-arranged terms, several related appendixes are also included in the same volume. These are a permuted KWIC (keyword-in-context) index; a list of subject terms by subcategories, and a heirarchical display of broad and narrow terms. Each of these index lists was developed to assist the user in determining which terms to use when conducting his search.

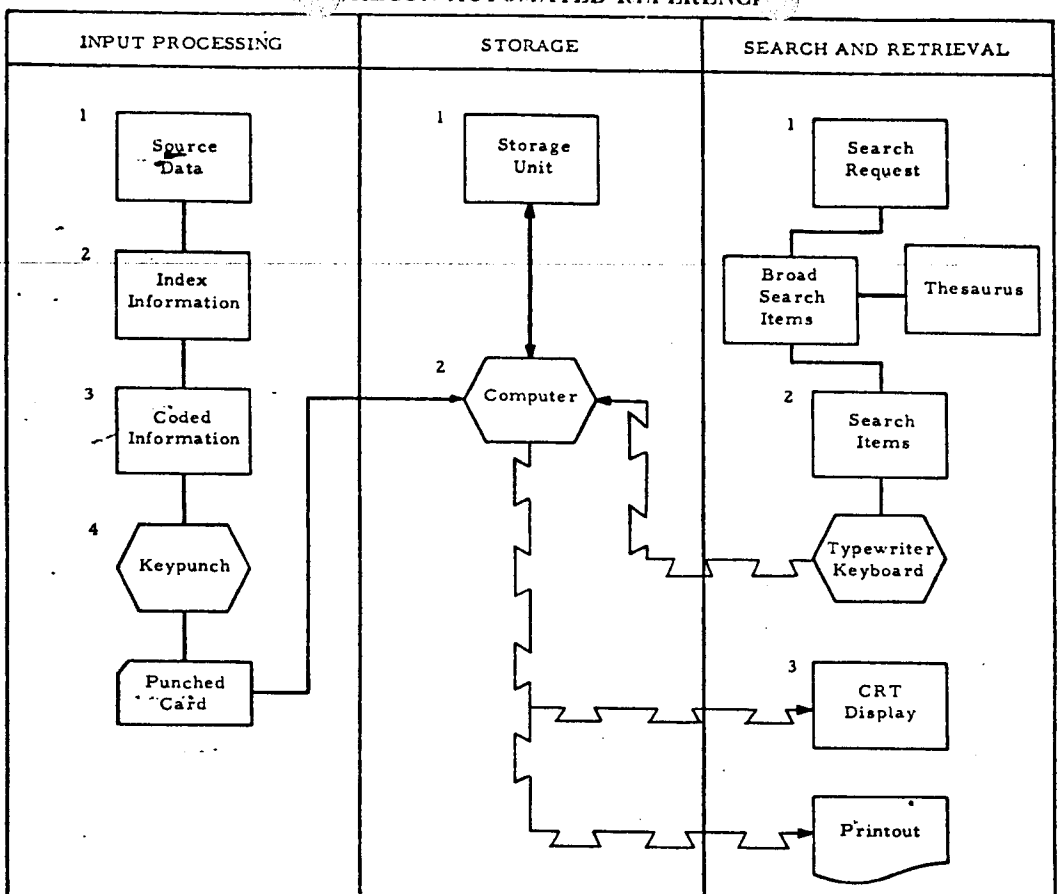
The user starts the search by entering his identification code on the console keyboard and then typing out his search question. Within seconds the bibliographic replies are displayed on the CRT. Depending upon the user's input query, the answer might cover accession numbers and titles, or display a catalog listing of information on a particular scientific discipline. If the list is long, he can instruct the computer to printout the selected citations on a printer located next to the CRT.

As an example of the system's flexibility, suppose a user needed detailed information on an ultrahigh-frequency radio transmitter used on a Lincoln Experimental Satellite. The search could be conducted under three indexing terms: Lincoln Experimental Satellites, ultrahigh frequency, and radio transmitters, terms that can be recognized by the computer. In response to how many documents were indexed under these terms, the CRT display showed ten under the first, 93 under the second, and 110 under the third. The computer could then be asked to display the titles, authors' names and other information on each of the three sets of terms. However, this action would be impractical due to the number of reports. To save time, the computer could be asked to cite the number of documents indexed under all three terms. The computer's reply would quickly reveal on the CRT display that only one document was indexed under the three terms specified. By pushing another button the CRT would show that the item was a 26-page report, dated July 19, 1968, and prepared by Dr. R. E. Jones. With this information, the user would be able to obtain an abstract of the paper or a microfiche copy of the complete report.

REMARKS. This real-time, on-line, time-sharing automated information system with remote access terminals possesses a wide range of coordinate reference capabilities. With proper search preparation on the part of the user, it can be used to correlate and manipulate reference data in a variety of ways to achieve search satisfaction. Its great speed and search flexibility reduce the search time of hundreds of scientists and technicians to a minimum and thus afford them a higher percentage of time for more creative pursuits.

Costs for development, acquisition, and operation of such a sophisticated system are high in relation to other automated retrieval systems. In time, such costs will become lower and thus more competitive as improvements in hardware and programing occur.

NA[illegible]/RECON AUTOMATED REFERENCE



1. Technical literature and specialized reports generated by Government agencies, laboratories, and other institutions.

2. Information specialists index each accessioned document in a variety of ways, i.e., author, subject, key terms, etc.

3. Code clerks transform information into coded terms.

4. Information is converted into punched cards and is entered into the computer.

The facility at College Park, Maryland contains over 1/2 million references.

1. The input information is stored on random access storage units.

2. Search information received from remote terminals is interpreted per appropriate computer program and answer sent via leased wire to requesting terminal.

1. Scientists and technicians at 21 remote locations have access to the NASA facility data bank. Initial search requests are defined through use of NASA thesaurus.

2. Search terms compatible with stored terms are entered into the system through use of a typewriter keyboard.

3. Answers to queries are displayed on cathode ray tube display screen and also printed on printout form.

NAME OF SYST :

National Marine Data Inventory (NAMDI)

ORIGINATOR:

National Oceanographic Data Center (NODC)

2nd and M Streets, S.E.

Washington, D.C. 20390

OBJECTIVE. To establish and operate a system that will assure rapid and economical storage, retrieval, and dissemination of marine (oceanographic) data in various formats to meet a wide variety of user needs.

BACKGROUND. The National Oceanographic Data Center (NODC) was established in 1960 under the sponsorship of 10 Federal agencies, including the Atomic Energy Commission, Coast Guard, Bureau of Commercial Fisheries, Geological Survey, and the National Science Foundation. It was organized to fill the needs of Government, industry, academic and research institutions, and the public for "an efficient mechanism for processing, exchanging, and storing globally collected marine data and information." The collection of oceanographic data originates with many domestic and foreign organizations. The information collected encompasses such subject matter as geological sampling, marine biology, surface ocean current information, and oceanographic station data.

Because NODC's in-house data processing capabilities were originally unable to satisfy the information storage and retrieval requirements, the Center for many years shared computer time with the Naval Research Laboratory and the Department of the Treasury. As national interest in environmental and oceanographical disciplines increased during the latter half of the 1960's, it became apparent that NODC would need to augment its in-house computer processing capability. Consequently, the Advisory Board to NODC recommended acquisition of a "medium scale" third-generation computer system. A System 360 Model was installed in late 1969 and is now handling many of the Data Center's more demanding data processing requirements.

THE NEW METHOD. The National Marine Data Inventory (NAMDI) system is but one of many data and information collection and disseminating services offered by NODC to the wide diversity of interests in the oceanographic field. The NAMDI inventory contains quantitative information on all types of "ocean station" data and samples collected during 1,500 U.S. research and survey cruises occurring since 1960. The information is compiled from summaries provided by about 40 Federal and institutional activities. A policy of expanding the source base of inputs has been pursued for some time, with a view to eventually including the entire U.S. marine data-gathering effort.

The basic inputs to the program cover three categories of information and data as follows: the "Master Card Record," concerning the cruise, station, and associated surface meteorological data; an "Observed Depth Card," containing data observed at a particular depth in the ocean; and a "Standard Depth Card," covering both computer and observed interpolation of values. The information is periodically forwarded to the Data Center for conversion to punched card format for entry into the computer data bank. The inventory file is now updated monthly as a result of the recent increase in computer capabilities.

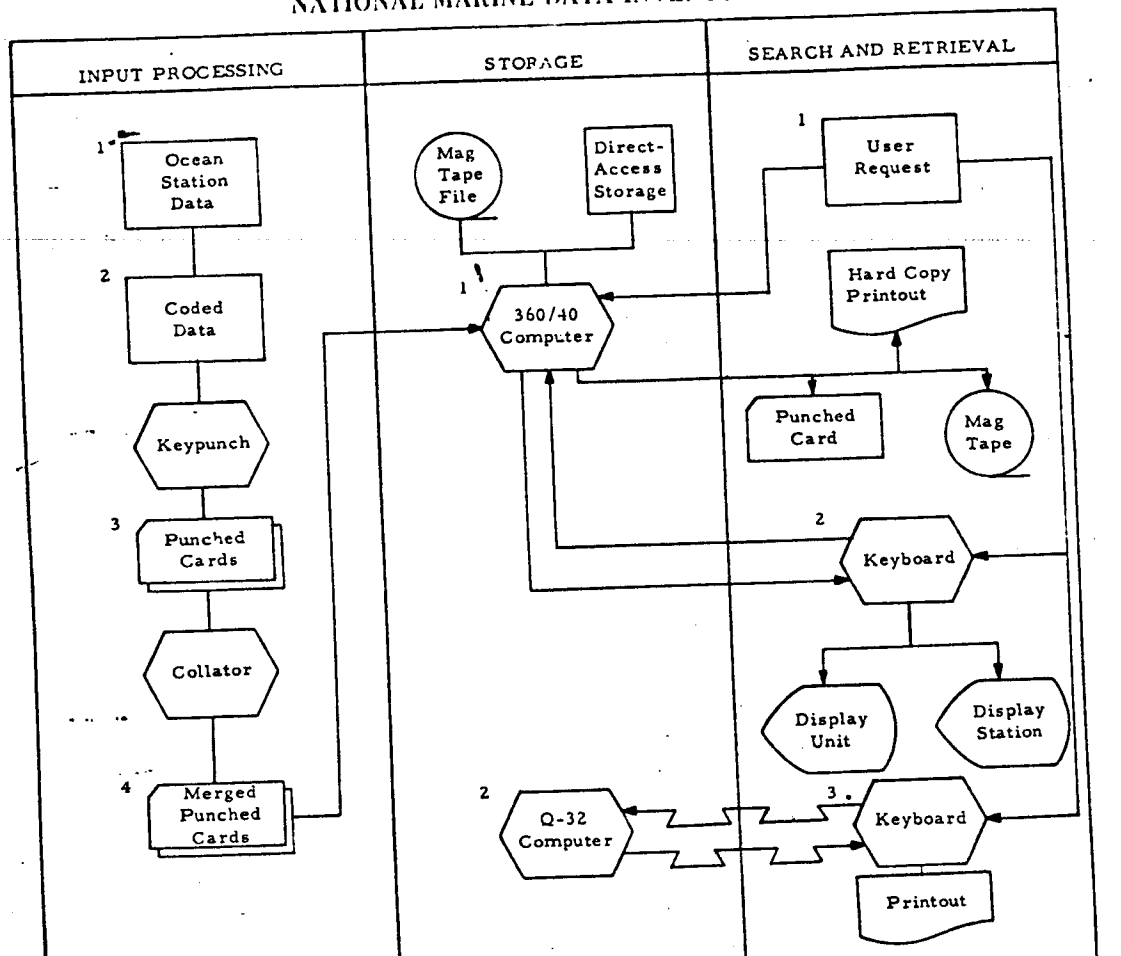
The full NAMDI inventory comprises 13 separate program libraries, tailored to meet individual user's needs. An archival file is maintained in both punched card and magnetic tape formats. The inventory data can be provided to users on machine-generated printouts, punched cards, and magnetic tapes.

As a result of daily requests from the oceanographic community for specific data, the NAMDI has been processed into a remote time-sharing computer. Communication with the computer is by NODC teletype-dataphone, in English, followed by simple rules

for sentence construction which obviates the need to use programing language.

REMARKS. The new on-line direct access storage facility provides the Data Center with the capability to retrieve in a given moment large volumes of information in the form of summaries, inventories, and large segments of the basic file. The new computer capability also provides expanded programing capacity required to serve the needs of the oceanographic community and permits closer interaction between users and the new NODC facility.

NATIONAL MARINE DATA INVENTORY



1. Data forwarded to NODC in specified format.

2. Data in coded form is key-punched, verified, and converted to punched card format.

3. Punched cards are merged with working deck and held for monthly updating action.

4. New updated punched card deck converted to magnetic tape format.

1. The National Marine Data Inventory File is contained on punched cards and magnetic tape. Selected data is stored on direct access replaceable magnetic disk packs.

2. Generalized data stored on vendor Q-32 timesharing computer in Santa Monica, Calif.

1. User may obtain complete updated file of inventory data in a variety of formats to include hard copy printout, punched cards, and magnetic tape.

2. User desiring selective graphic displays of data and information may communicate directly with computer through graphic input-output consisting of a CRT, light-pen, and functional keyboard, or alpha-numerical information on display station.

3. User desiring selective data may communicate with computer from remote teletype-dataphone.

NAME OF SYSTEM:

Automated Name Search

ORIGINATOR:

Securities and Exchange Commission (SEC)

Washington, D.C. 20549

OBJECTIVE. To operate an automated name index search system that will eliminate data duplication, reduce timelags in processing of cases, and thus increase the effectiveness of the Commission's clerical and professional personnel.

BACKGROUND. The Securities and Exchange Commission (SEC) is a regulatory agency of the Government responsible for protecting the interests of the public and investors against malpractices in the Nation's securities and financial markets. In performing these varied duties, the Commission is interested in such matters as company registrations, corporate financial statements, stock exchange activities, and brokerage house operations. As an adjunct to regulating these financially oriented institutions and activities, a large file on individuals associated with these enterprises is maintained.

Several years ago, due to an increase in workload and prospects of an expanded area of subject matter interest, the SEC requested the Office of Records Management, National Archives and Record Service, to conduct an in-depth study of its paper handling activities. The survey conclusions, among other suggestions, recommended that the various widely dispersed record collections be centralized. For example, index cards created and maintained by operating divisions as aids in processing their work totaled 20 separate files. A contributing factor to the workload problem was the limited amount of data that could be recorded on the index cards. For example, because social security numbers were not contained on the cards, it was often impossible to identify particular individuals from a listing of apparently identical names. Further, the card file system had no manipulative features that could help in revealing relationships between individuals and a particular case file.

Collectively, about 30 man-years were required to maintain and service the 1.5 million personnel cards, indexes, and case records. The index cards contained from one to six items with information such as name, file number, and cross-references.

Based on the findings of the survey, the Office of Records Management recommended establishment of an automated information storage and retrieval system. In addition to the personal index data needs, the equipment would also be used to effectively handle other file maintenance requirements within the SEC.

THE NEW METHOD. The new system is oriented around the name search file, which is an automated index collection of information extracted from the various documents and files of the Commission. The file collection is used primarily for developing association and relationship data between individuals and companies.

The initial conversion of the index card file collection was to punched cards. After data validation and necessary corrections, a computer-oriented alphabetical magnetic tape index file was produced, which serves as the principal data source for the name search process.

Name and case number inputs to the automated, master index file are extracted from selected cases and transcribed on a transcript sheet form. Keypunch operators convert the information to punched card format. After alphabetical batching, the punched cards serve as the computer input for merging the information into the index file master tape.

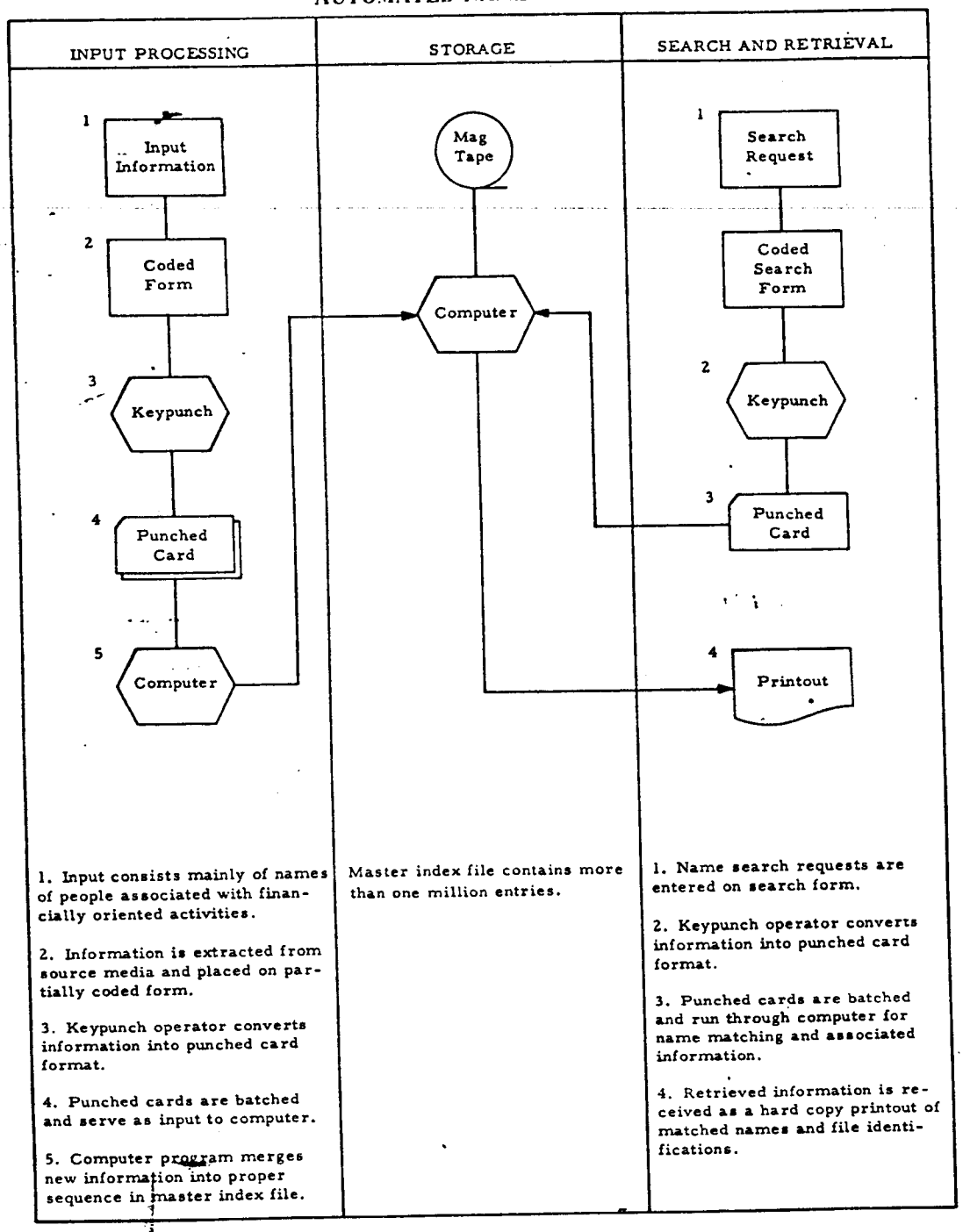
Computer name searches are initially processed in the same sequence as is the input source data. The computer searches each name entry for matches or near matches against the master index file. In instances where matches or near matches occur, an

additional computer program causes case file numbers of such names to also be identified. The retrieval of the information is in the form of a computer printout and is used by the searcher to identify and obtain the appropriate case documents for possible relationships or association purposes.

REMARKS: The magnetic tape file system was selected because of the quality, repetition, and the diversity of data characteristics needed by the SEC's examiners, attorneys, and other personnel. The data is needed in a quick, accurate, and usable form and at a reasonable cost. The former system of manually maintained records was too costly in terms of manpower, quality of results, and timeliness of action.

The computerized magnetic tape file provides quick and accurate responses to name checks, and is the most effective way of developing individual relationship and association data. By proper scheduling of inputs the computer search program can perform this type of search requirement in a matter of hours, in contrast to the manual effort which often took days to complete.

AUTOMATED NAME SEARCH



NAME OF SYSTEM:

Animal Inventory Management

ORIGINATOR:

National Zoological Park
Smithsonian Institution
Washington, D.C. 20009

OBJECTIVE. To establish a simple, economical, and effective document reference system that will give immediate access to the current inventory of and information on the National Zoological Park animal population. To also assure a system capability for limited manipulation of data about animals to meet unpredictable research or other needs.

BACKGROUND. The National Zoo currently maintains and manages a group of about 3,200 animals. In supervising this unusual activity, veterinarians, administrative personnel, and the many animal keepers need access to a large array of information on individual animals and various animal groups. Each of these user groups need both specific as well as general data on unpredictable animal happenings or events. The former conventional method of maintaining information on the zoo population made it difficult to readily correlate, compare, or analyze data in the desired manner.

THE NEW METHOD. The Animal Inventory Management System uses an 8 x 10 inch, edge-notched card form containing 166 coding positions as the basic index reference media. The cards are made in sets consisting of the basic card and two 5 x 8 inch carbon interleaf card forms containing 80 coding holes that serve as duplicate reference files. The larger edge-notched card is maintained in the Chief Veterinarian's Office, while the two smaller cards serve the index reference needs of the Administrative Office and the Animal Keeper's Office.

Under the edge-notched card system a separate card is maintained for each animal in the Zoo. For ease of identity, cards at each of the three file locations are color-coded—blue for birds, white for mammals, and beige for reptiles. The color code permits the file to be readily divided into the three categories, thus aiding both the card filing task as well as the reference search request. While this card filing arrangement is basically equivalent to a conventional card filing system, the coding characteristics of the edge-notched card system give the file its nonconventional classification.

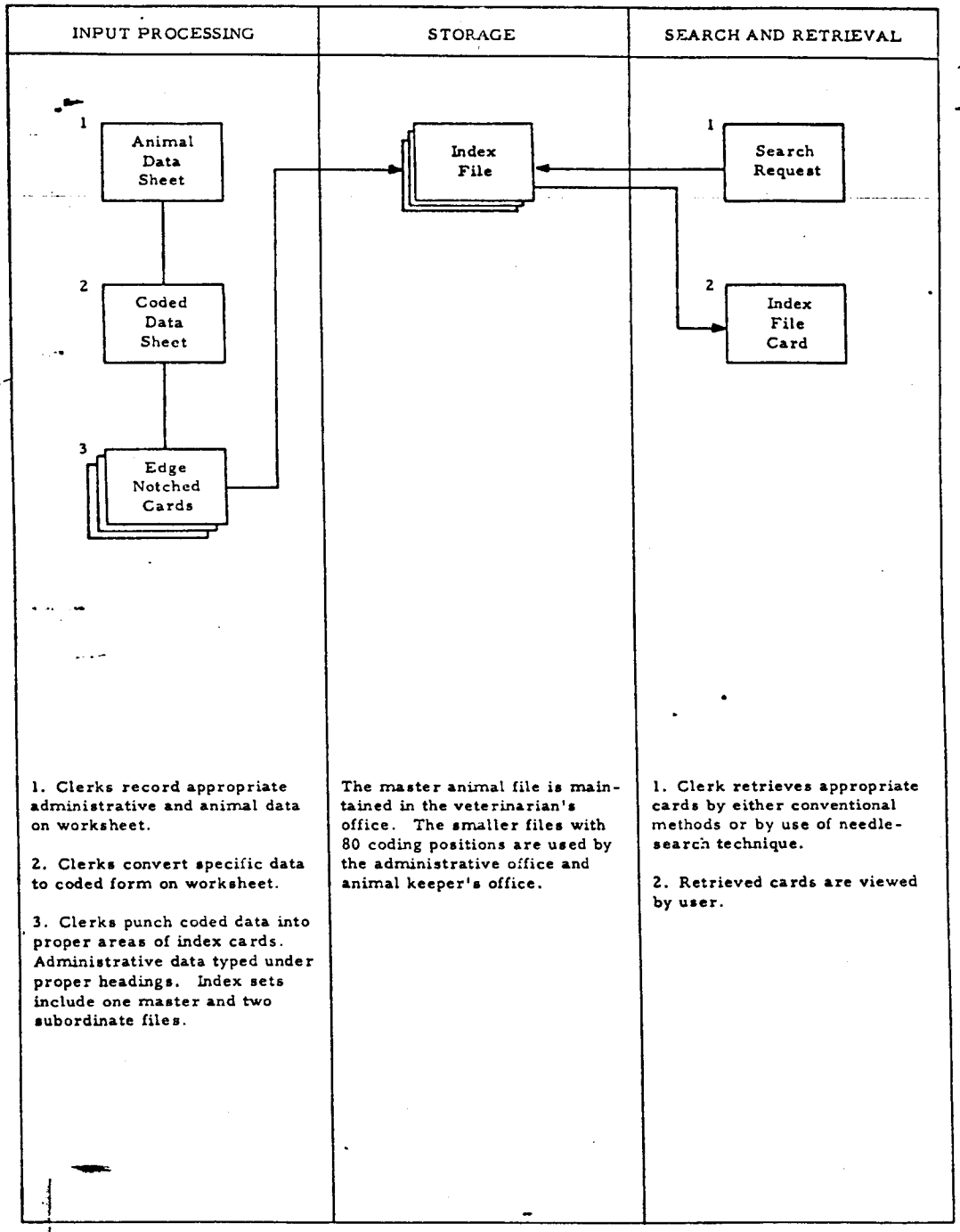
General information is typed on these cards in the conventional manner. However, the various animal attributes are entered into the master card by means of a hand punch. This punch "notches out" the specific holes that comprise the codes representing the attributes of each animal. The codes cover such animal information as identity, receiving date, method of acquisition, vaccination status, health status, and departure date.

When looking up information concerning a particular animal, the file is searched in the conventional manner. However, when conducting searches on the basis of any of the coded animal attributes, the full value of the edge-notched card system is apparent. As an example, a veterinarian may wish to know the identity of all tigers having a certain immunization profile. Initially, the searcher would isolate all the white index cards representing the mammal category. He would next use the "needle search" technique to select the edge-notched cards for all tigers from the mammal portion of the file. Finally, a second needle search would "drop out" all tiger cards meeting the immunization code criteria. With the identity of this select group of animals now known, the veterinarian would take his planned action.

REMARKS. This edge-notched card reference method is an inexpensive, simple system having minimum equipment requirements, and it can be operated by personnel without special skills or training. The system offers a limited ability to manipulate data for unpredictable purposes and may be updated to

reflect animal inventory changes. It also has features that allow for easy duplication of the master file with a minimum of additional cost or effort. A limiting condition inherent in this system is the loss of search efficiency when the file size approaches 3,000–5,000 cards. At that point the needle search process becomes increasingly slow and tedious.

ANIMAL INVENTORY MANAGEMENT



NAME OF SYSTEM:

National Driver Register

ORIGINATOR:

Federal Highway Administration
Department of Transportation,
Washington, D.C. 20590

OBJECTIVE. To establish and maintain an information storage and retrieval system that will facilitate central collection, flexibility in searching, and rapid dissemination of selective data on the Nation's motor vehicle drivers.

BACKGROUND. The National Driver Register was established by the Congress in 1961 to provide Federal assistance in driver licensing while maintaining State autonomy as to the extent of participation. The Register provides for a central driver-records identification containing the names of drivers whose licenses have been revoked or suspended for a number of causes. State participation in the system is voluntary. The Register operates purely as a service agency with the States retaining full administrative authority over driver licensing. Only authorized State and Federal officials can obtain information from the Register.

Before the Register's establishment there was no practical way for the State administrators to obtain records of driver license applicants whose licenses had been revoked or suspended by other States. A few States had reciprocal driver record exchange agreements, but this arrangement left much to be desired. Under this new system each State is given a basic procedural guide covering all aspects of the system, including state responsibilities for making the Register effective and the benefits to be derived from participation.

THE NEW METHOD. In brief, the new system can best be decribed as an authentic "information loop," as each State contributes to the Register and also receives important information from the system's growing data bank.

Submissions from the States consist of three types of inputs and one search and retrieval process. The inputs are withdrawals (and denials) of drivers licenses, recisions of withdrawals, and restorations of drivers licenses. The search processing performed for the States is called "Report of Withdrawal Searched" and is a report of a driver license revocation discovered during the search of the Register's master tape file.

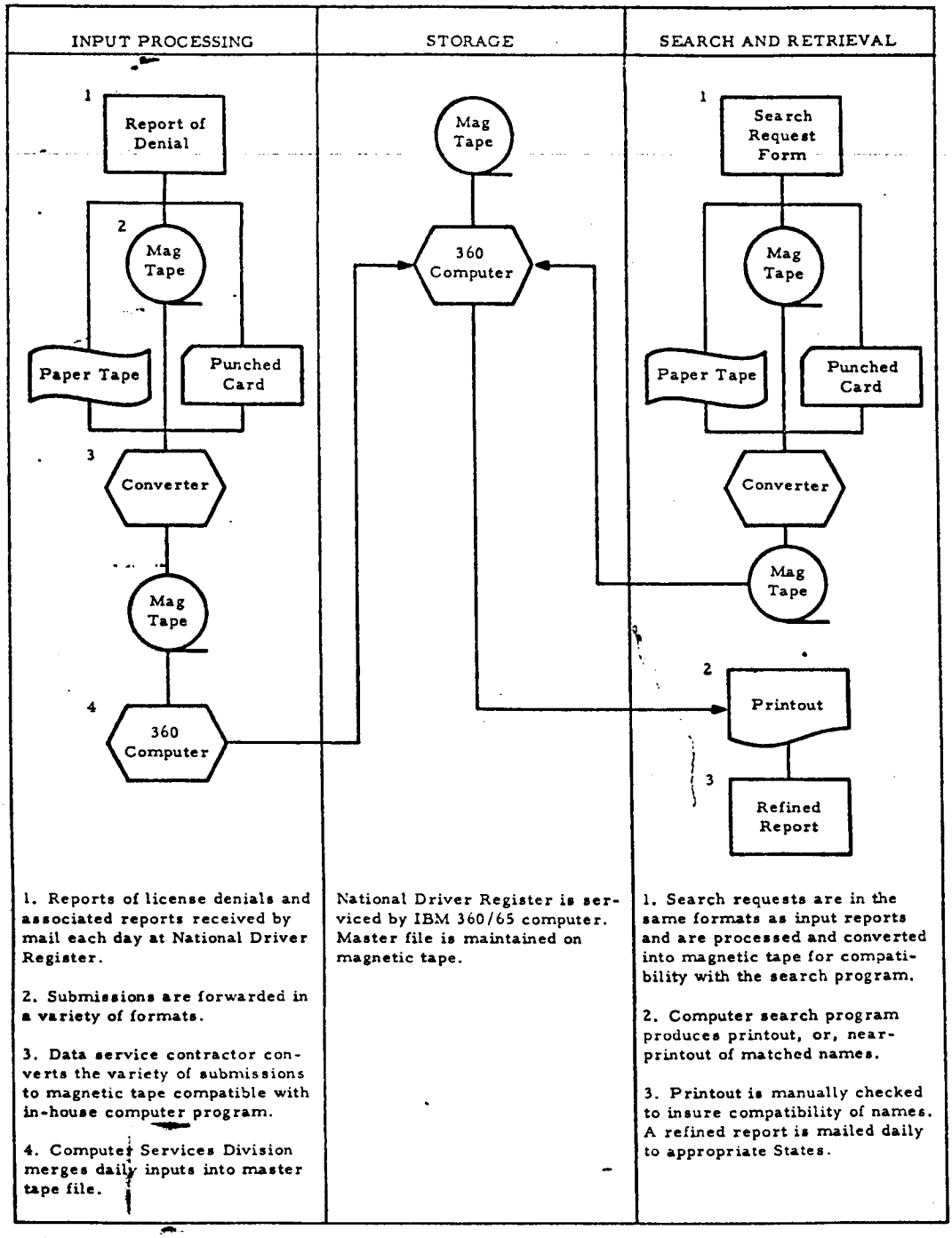
The key State inputs to the system are name and place of birth. Other identifications include such personal characteristics as color of eyes, height, and age. The standard amount of information required creates a need for at least two punched cards, and when multiple names have been used by the applicant, as many as five cards are necessary.

Although all States participate in the program and the Register has appropriate standard forms available for each type of transaction, the State submissions are typically received in a variety of formats, including paper tape, punched cards, and magnetic tape. Additionally, the content of State submissions varies to some degree. The conversion of this large volume of daily submissions to magnetic tape is performed by a local data searching organization. In the search process, the daily receipt of State requests for "license denials" are batched and run through a series of processes that convert the information to a magnetic tape machine-language medium. This tape is then programed and run against the master file for matching action. The computer search programs are highly sophisticated and flexible. For example, the system can automatically check for names that are spelled slightly differently and for numerous other alterations that applicants sometimes use to disguise their true identity. The list of verified matches of driver license revocations and denials are forwarded daily by air mail to each State.

Approximately 75,000 inquiries are received each day concerning such license revocations or denials, and of this number about 15 percent result in name matches.

REMARKS. The computer's capability to conduct programed coordinate searches of the master file for specific information is a natural for the scope and nature of this National Driver Register system. Additionally, the master file may be expanded or purged with only routine effort. The continuing problem in this operation has been the difficulty in obtaining standard input format submissions from the States.

NATIONAL DRIVER REGISTER



1. Reports of license denials and associated reports received by mail each day at National Driver Register.

2. Submissions are forwarded in a variety of formats.

3. Data service contractor converts the variety of submissions to magnetic tape compatible with in-house computer program.

4. Computer Services Division merges daily inputs into master tape file.

National Driver Register is serviced by IBM 360/65 computer. Master file is maintained on magnetic tape.

1. Search requests are in the same formats as input reports and are processed and converted into magnetic tape for compatibility with the search program.

2. Computer search program produces printout, or, near-printout of matched names.

3. Printout is manually checked to insure compatibility of names. A refined report is mailed daily to appropriate States.

NAME OF SYSTEM:

Automated Merchant Vessel Report (AMVER)

ORIGINATOR:

Eastern Area, U.S. Coast Guard,

Custom House, New York City, New York 10004

OBJECTIVE. To improve coordination and rescue operations at sea by being able to rapidly store, retrieve, and communicate essential data concerning the locations and capabilities of ships that may be called upon to render emergency assistance to those in distress.

BACKGROUND. Two of the many functions and activities of the Coast Guard are conducting search and rescue operations and assisting vessels and aircraft in distress. In performance of these responsibilities the Coast Guard for many years manually maintained a plotting chart of Eastern coastal waters for those ships for which agents submitted itineraries. Positions taken from weather reports were used to increase the accuracy of vessel plotting. Where regular Coast Guard forces were not adequate, appropriate merchant ships were asked to provide assistance during search and rescue (SAR) operations. The density of ships in the area and the size of the plotted area were small, but the potential for an enlarged mutual assistance program was readily apparent.

When a relatively low cost computer with a random-access disk memory file capability became available, the time seemed feasible to automate the plotting activity and to evaluate the SAR potential for assisting a larger number of ships. Electronic data processing equipment was installed and the AMVER System was established in July 1958. The number of ships plotted and the accuracy of their dead reckoning positions were increased by use of radio stations to relay sail plans from the ships to the Ship Plot Center. These radio sail plans included departure place and time, routing, destination, and average speed of ship advance.

During the next few years both the participation and scope of plot area increased. As a result of the success of the system, an updated electronic data processing system was placed in operation in a new AMVER Center in the New York Custom House in December 1964.

THE NEW METHOD. The AMVER System consists of a network of designated radio stations, Rescue Coordinating Centers (RCC), the AMVER Center, U.S. Ocean Station vessels, and participating merchant ships. Inputs to the system are usually messages received directly in the AMVER Center on teleprinter equipment. This information covers such things as sail plans, position reports, deviation reports, and arrival reports. The information is placed in properly coded format, punched into tabulating cards, verified for accuracy, and entered into the computer for processing, storage, and possible future use. Based on proper programs, the computer generates a special sail plan for each participating ship, or corrects one already on plot, and stores the results on magnetic memory disks ready for use in an emergency. New positions are calculated for each ship at intervals of 12 hours.

When an emergency occurs, the information retrieval capabilities of the system react with great speed. First, the controlling Rescue Coordinating Center requests a Surface Picture (SURPIC) from the AMVER Center using the same teletype network. Within two minutes, the programed computer prints out a SURPIC listing of the appropriate vessels on plot in the specified area to include their predicted positions and rescue capabilities. Simultaneously a punched card is prepared for each ship identified by the computer. The cards are placed in special data transmission equipment that sends the SURPIC by teletype to the requesting Rescue Coordinating Center for use with other available information.

With reference to the SURPIC's, the Rescue Coordinating Center in its initial notice specifies the parameters of the emergency. These factors include the date and time to the nearest hour, the geographical area, and

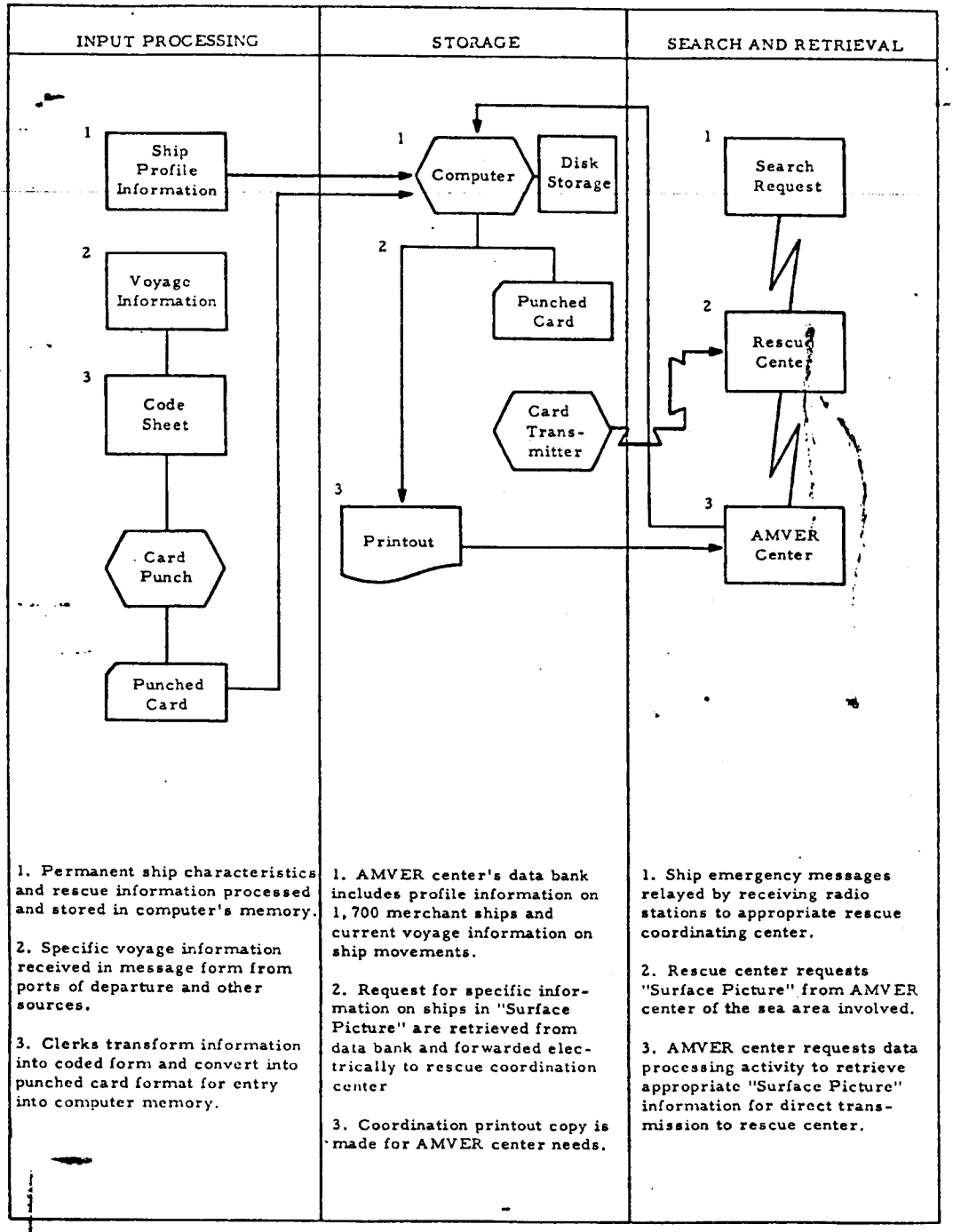
the category of ships involved. The areas of search may be a circle defined by a center point and radius of any number of nautical miles; a rectangle whose sides are specified parallels of latitude, and meridians of longitude; or a path of any width along the track of a ship or aircraft. The request will usually specify whether the message is for all ships on plot or only for those with a doctor on board.

The contents of the retrieval answer from the AMVER Center will include the ship's name and international call sign; predicted position and time of arrival thereat; course, speed, and radio watch schedule; availability of a doctor, radar, and radio telephone; and estimated time of arrival at destination.

REMARKS. The AMVER System is an excellent example of the use of modern electronic and computer technology to improve service. The computer's instant reaction to preset mathematical programs concerning ship positions is illustrative of the system's information search capability.

The computer's magnetic memory contains a list of more than 17,000 ships along with their search and rescue characteristics. Three thousand different vessels are plotted each month on 6,000 separate passages. During each month in the North Atlantic maritime region about 100 requests for Surface Pictures are acted upon by the system in resolving actual or potential emergencies.

AUTOMATED MERCHANT VESSEL REPORT (AMVER)



NAME OF SYSTEM:

Personnel Skills Inventory

ORIGINATOR:

United States Coast Guard
400 Seventh Street, S.W.
Washington, D.C. 20591

OBJECTIVE. To establish an economical and effective retrieval system to assist in the identification of personnel qualified to fill specific job requirements.

BACKGROUND. A traditional personnel policy within the Armed Forces is the reassignment of uniformed personnel to new positions upon completion of a designated period in job assignment. These job changes are necessary to equalize time spent by personnel at oversea posts or on ships away from families; to give individuals experience in a variety of assignments; and to reassign personnel to positions of greater responsibility when they are promoted.

As the base of knowledge and specialization expands, a somewhat similar pattern occurs within the services. Thus, the need to select individuals having the proper skills and other qualifications becomes a real challenge. The Coast Guard was aware of the need to increase the effectiveness of their officer assignment activity. Several rather simple index reference systems were evaluated. The optical coincidence card technique was selected as best-suited to their particular needs.

THE NEW METHOD. The Termatrex optical coincidence card system consists of a group of 9 x 9 inch opaque, plastic index term cards, a hole drilling machine, and a simple, backlighted card viewing device (light box). Each optical coincidence card represents a characteristic or attribute of significance in the determination of officer assignment qualifications. Approximately 500 cards make up the personnel skills inventory file. They are initially arranged under about 30 broad categories of interest and include such personnel characteristics or attributes as civilian education, language facility, military specialty, and past assignment data. Within each of these primary categories is a large grouping of more specific information such as year of birth, level of education, specific languages, and particular job qualifications and levels of past assignments.

The optical coincidence cards contain 100 vertical and 100 horizontal positions that total 10,000 hole positions or numerical "addresses." Each officer on active duty with the Coast Guard is assigned one of these coordinate addresses to identify his service record jacket. For example, an officer assigned the address at the intersection of vertical position 26 and horizontal position 43 would be given the coordinate number 2643 to identify his service jacket. A hole is drilled in all those cards representing an officer's service profile, at his "dedicated" address position.

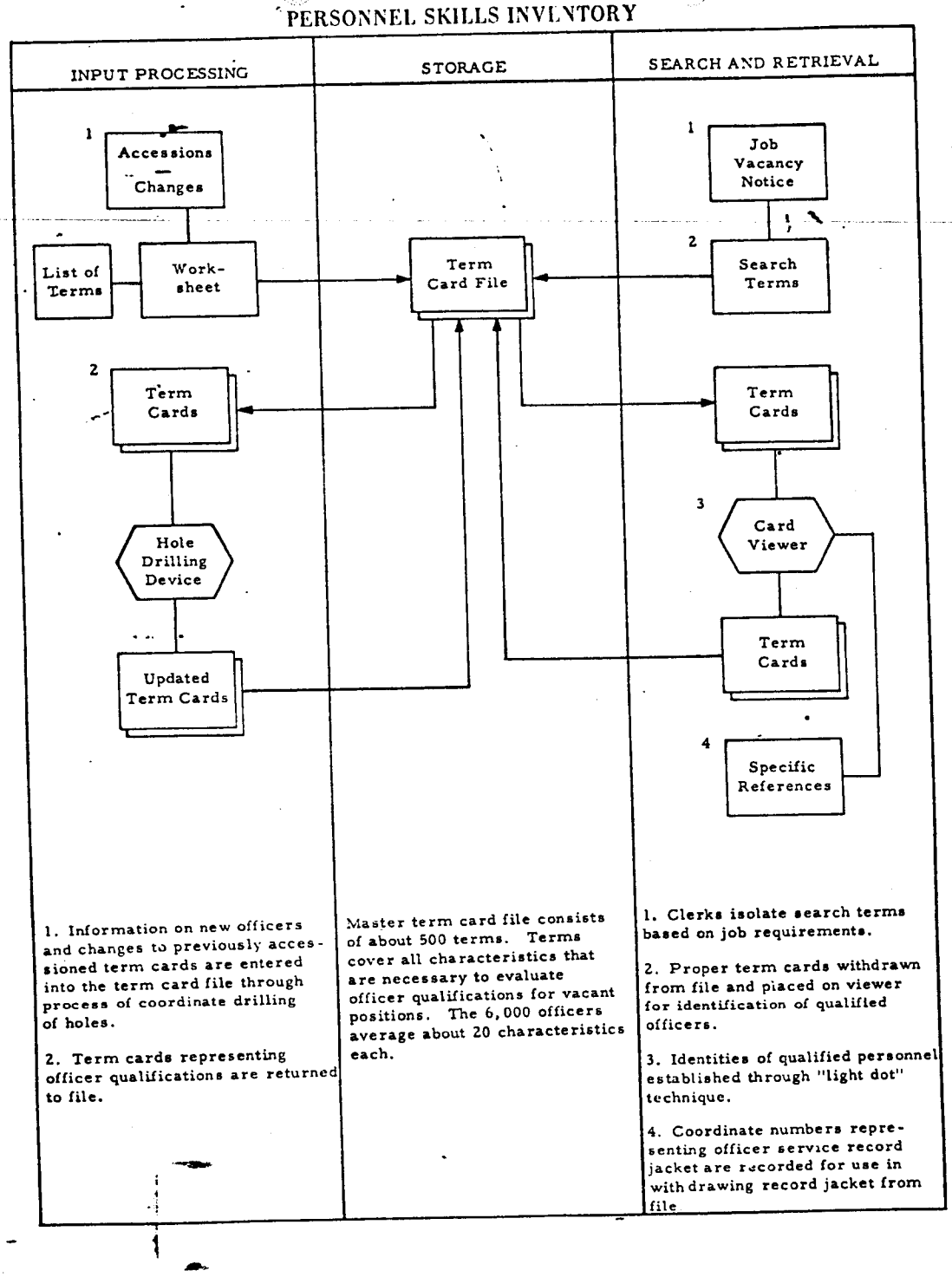
Searches are initiated upon receipt of an officer's position vacancy notice in the Coast Guard headquarters, Officers Assignments Activity. These notices list specific skills and background requirements for the forthcoming vacancy. For example, among other demands the position may call for an advanced degree in oceanography, a familiarity with Spanish, and four years experience as a navigator. A clerk handling such a requirement would first note the proper major category index tab and withdraw the cards representing those characteristics or attributes.

The selected optical coincidence cards are carefully superimposed on top of the backlighted viewer. With the light turned on, a dot of light will reveal numerical coordinates representing service record jacket numbers of officers having the desired qualifications. Should there be no coincident holes, the originator of the search may wish to change the search criteria. Within seconds, cards representing changes or compromises may be placed on the light box. At the completion of a successful search the service record documents are withdrawn from the document file for assignment action.

REMARKS. While this system's procedural applications are similar to those described in the Joint Chiefs of Staff records retrieval system, the optical coincidence card in this example represents characteristics unique to personnel job qualifications. The JCS system highlighted indexing terms associated with identification of documents by subject matter content.

This index reference and retrieval system permits rapid and flexible searches. Output is accomplished in a few minutes—only the time it takes to pull the appropriate cards, place them on the viewer, and check for co-ordinate numbers. A search question can be rephrased by adding or removing cards. While not used directly to make assignment decisions, this technique does allow the Coast Guard to maintain positive control over the initial identification and screening process relating to eventual selection.

PERSONNEL SKILLS INVENTORY



NAME OF SYSTEM:

Computer Output Data Retrieval

ORIGINATOR:

Division of Disbursement
Bureau of Accounts-Fiscal Service
Department of the Treasury
Washington, D.C. 20220

OBJECTIVE. To evaluate and operate a microform data storage and retrieval system that will result in significant tangible savings and operational improvements in the check inquiry activity.

BACKGROUND. The Division of Disbursement—one of five divisions in the Bureau of Accounts—functions as a service organization providing centralized disbursing facilities to about 1,600 civilian agency offices of the Executive Branch of the Government. Its primary mission is issuing Government checks and savings bonds. During the last fiscal year, the Division issued 425 million checks with a face value of about $100 billion. The centralized disbursement activity is carried out by 10 regional disbursement offices located throughout the United States.

A record is made of each Government check issued. This record is used as a basic source of reference in the processing of check nonreceipt claims and various types of inquiries. No other permanent record of checks is prepared or maintained. Prior to 1949, all of the disbursement check records were in the form of paper copies. These copies were costly both to produce as well as service. Storage of the records became an increasingly serious problem as did the deterioration of the paper.

To resolve this growing storage and maintenance problem, a microform system was adopted in 1950 that proved relatively effective until increasing workload again created problems in the late 1950's. After a three-year evaluation of improved methods and equipment, the Treasury Department settled on a combination magnetic tape and microfilm system. The analysis of the various system proposals was based primarily on quality, cost, and speed. One of the real breakthroughs came from the fact that magnetic tape systems were already integrated in the production of the checks. Thus, the adopted system permitted the disbursement offices to move from the high speed method of microfilming checks into an ultra-high-speed system of preparing microfilm directly from the already edited magnetic tape.

THE NEW METHOD. The computer-microfilming system, now commonly called the COM (computer output microfilm), accepts check issue data from the magnetic tape produced for the check writing function and converts the tape's binary-coded bits to human-readable characters on 16-mm. microfilm. This process is performed by a Digiprint COM recorder that displays the characters on a cathode ray tube in a frame format.

In addition to serving their own disbursement needs, the Chicago-based system duplicates microfilm records of recurring benefit payment checks for use by other administrative agencies for security backup purposes. The Chicago office also duplicates the microfilm record of benefit payment checks for 55 regional offices of the Veterans Administration (VA). This arrangement allows VA to deal personally with veterans and their dependents concerning the average of 8,000 monthly check payment problems.

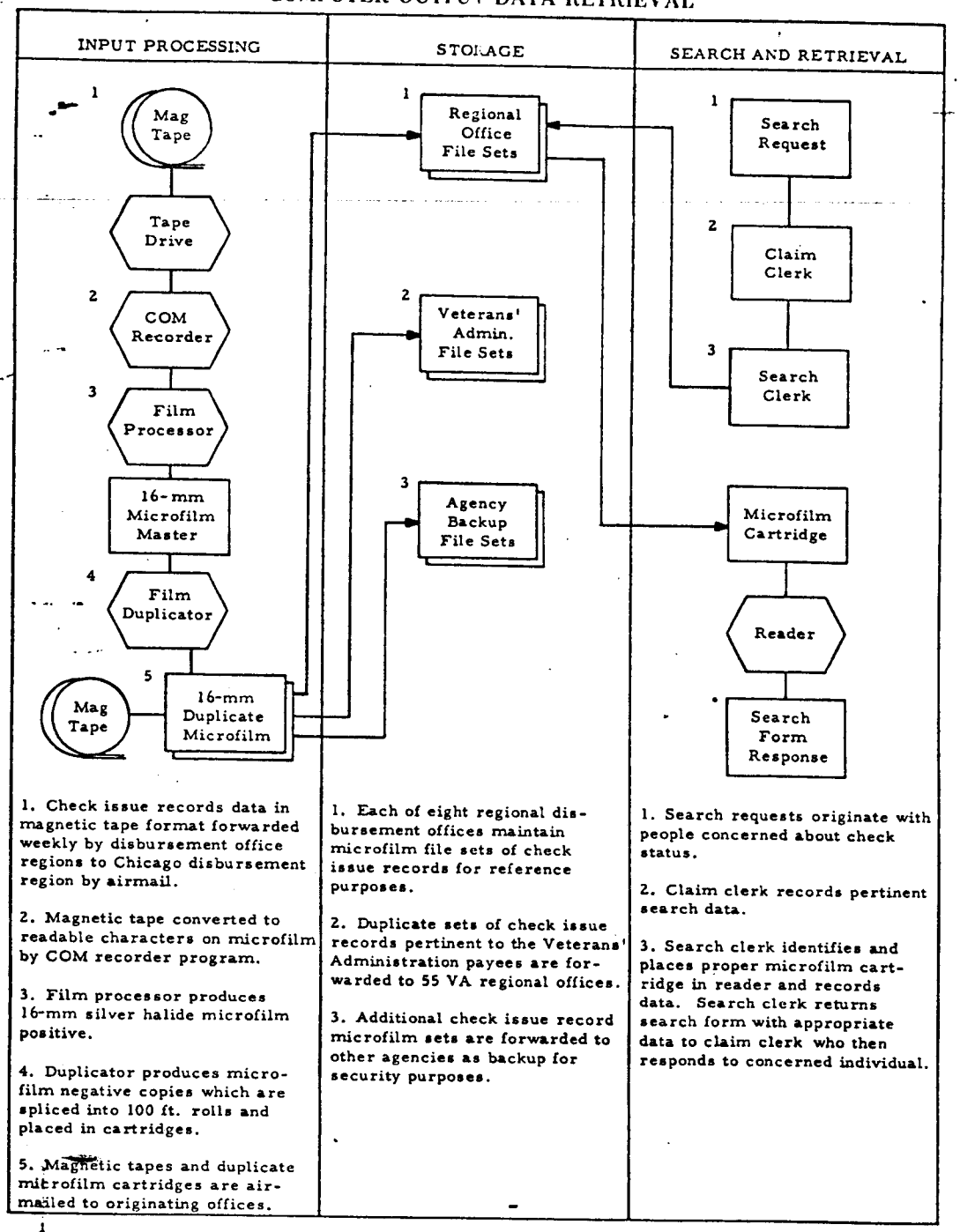
Search actions relative to check payment problems are usually generated through personal inquiry at any of the regional offices. Claims clerks receiving the query initially record all known information on a claim form that is passed to search clerks located in the microfilm file area. As check issue records are controlled by check serial number sequence, microfilm cartridges are positioned in the storage container to show their range of numbers. The searcher places the proper cartridge in the reader and, with knowledge of the cartridge's number range and the number being searched, is able to quickly bring the proper image within close proximity of the

viewing screen before making a detailed examination. Once the proper record is found, the search clerk completes the form and passes it to the claim clerk for final action.

REMARKS. The use of microfilm in the check handling function has had a profound effect on the Division of Disbursement's productivity. In 1949 one employee could, in effect, completely process about 61,000 checks per year. Currently each employee handles 299,000 checks, or five times as many. The elimination of paper check issue records in favor of microfilm and the consistent improvement in the microfilming techniques contribute substantially to this increase in productivity.

Film is now being produced at the rate of over 1½ million check record images per day. A single roll of microfilm holds 102,000 check records. From the standpoint of effectiveness, the current system enables check issue records to be produced 70 times faster than the old paper copy system permitted.

COMPUTER OUTPUT DATA RETRIEVAL



1. Check issue records data in magnetic tape format forwarded weekly by disbursement office regions to Chicago disbursement region by airmail.

2. Magnetic tape converted to readable characters on microfilm by COM recorder program.

3. Film processor produces 16-mm silver halide microfilm positive.

4. Duplicator produces microfilm negative copies which are spliced into 100 ft. rolls and placed in cartridges.

5. Magnetic tapes and duplicate microfilm cartridges are airmailed to originating offices.

1. Each of eight regional disbursement offices maintain microfilm file sets of check issue records for reference purposes.

2. Duplicate sets of check issue records pertinent to the Veterans' Administration payees are forwarded to 55 VA regional offices.

3. Additional check issue record microfilm sets are forwarded to other agencies as backup for security purposes.

1. Search requests originate with people concerned about check status.

2. Claim clerk records pertinent search data.

3. Search clerk identifies and places proper microfilm cartridge in reader and records data. Search clerk returns search form with appropriate data to claim clerk who then responds to concerned individual.

NAME OF SYSTEM:

Battelle Clue-Word Card

ORIGINATOR:

Defense Metals Information Center
Battelle Memorial Institute
Columbus, Ohio 43001

OBJECTIVE. To design and operate an index filing and retrieval system that will more effectively handle the growing mass of scholarly and scientific reference material reaching the market place.

BACKGROUND. The Battelle Memorial Institute is organized into several subdivisions known as Information Analysis Centers. Each is oriented toward research and development in such disciplines as mechanical engineering, physics, chemistry, and metallurgy. Management at Battelle found that conventional methods for classifying and indexing documents were not well-suited to the needs of the scientists, engineers, and other members of the professional staff. Consequently, after extensive research and testing, they developed their own unique system and installed it first in the Defense Metals Information (Analysis) Center.

THE NEW METHOD. The clue-word indexing technique developed by the institute's staff is a closely coordinated team effort comprising the scientists and other users, the information panel, and the center's information specialists. In the delegation of responsibilities, members of the information panel control the selection of documents to be accessioned; the method of indexing; and access to the index and file for search purposes. The information specialists have responsibility for overall operation and maintenance of the system.

The basic input action of the clue-word index technique is the underlining of significant words in the document by members of the information panel. Additionally, brackets are placed around the more significant portions of the text and illustrations. In total, this highlighted information forms an extract of the document.

While marking is a relatively simple and fast process, every effort is made to reduce the total time spent on this task by the scientists and other professional personnel who index the documents. Thus, information specialists, clerks, and typists do most of the routine work such as preparing duplicating stencils for the 5 x 8 inch clue-word extract cards. The Information Center personnel also add the document's control number and other standard identifying data. The extract card file is arranged alphabetically by the clue-word index terms. Each time a document is entered into the system, a sufficient number of extract cards are duplicated to permit filing a card under each of its underlined index terms and a few standard headings such as title and author's name.

Under actual search conditions a scientist normally answers most of his search needs by personally referring to the clue-word index with its key terms and extracts. Should he desire additional information, the referenced document may be obtained from the Central File. Typically, he starts the search by looking at the cards filed under the index term that he feels is the most pertinent to his search question. If this does not produce the desired results, he then looks for clues or leads in the form of other underlined words appearing in the extract, and thus is lead to other parts of the card file until he finds the information he is seeking.

REMARKS. Two of the more favorable benefits obtained from this system are the richness of material uncovered and the ease in indexing due to the close association that the scientists and other users have with the indexing and document selection processes.

The system's wide search versatility and latitude permit searchers to locate clue-word cards for as many pertinent documents as they wish. Thus, a search can be shallow or exhaustive, depending on the user's needs. There is also a high degree of relevance in

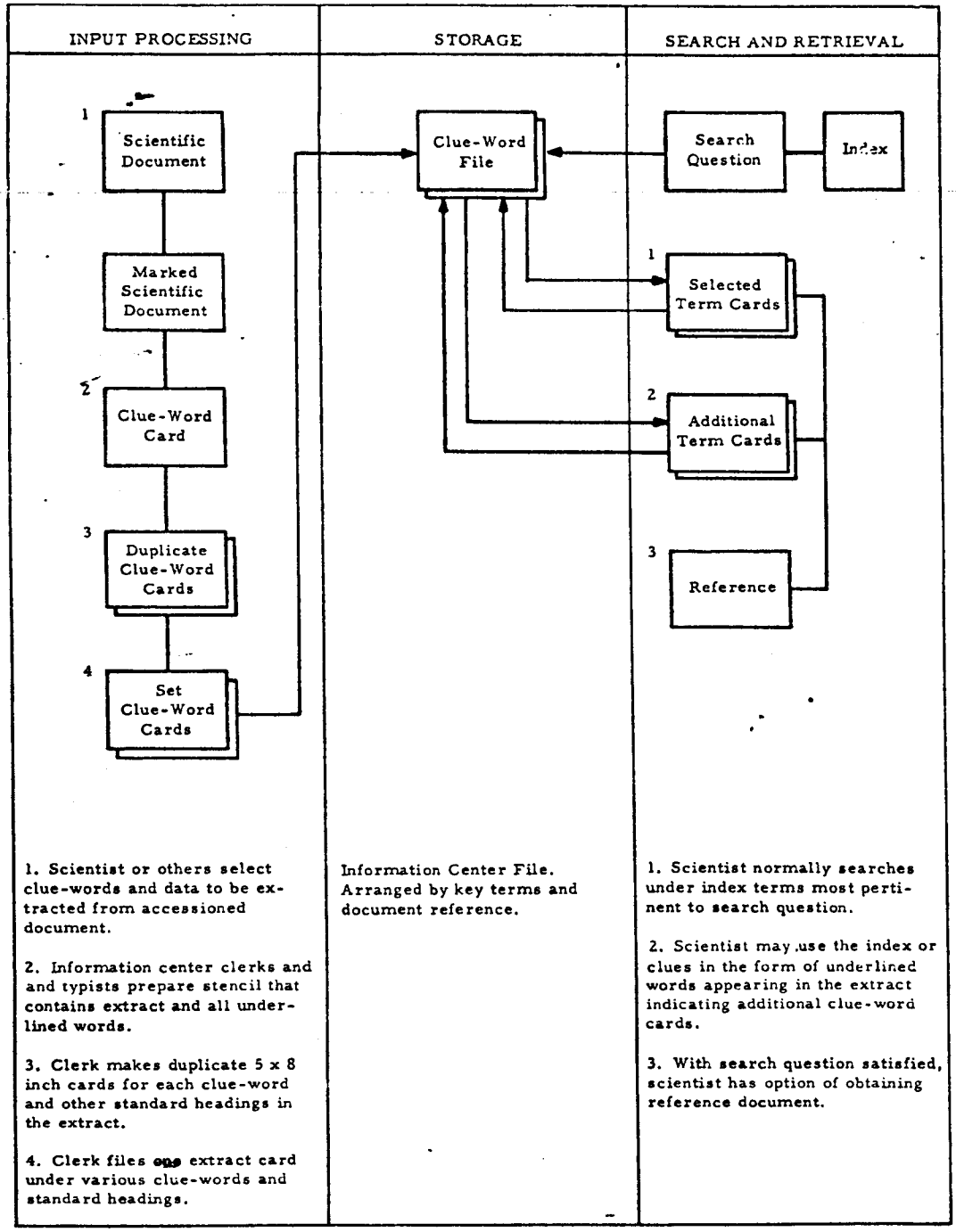
data retrieval is due to the concentration of meaningful information on each clue-word extract card.

The system is actually very simple, yet highly effective in terms of results. However, some limitations should also be noted: (1) the relatively slow filing action due to the large number of index cards required per document; and (2) the effectiveness of this type system is largely dependent upon the existence of close cooperation and understanding between the users and the operators of the system.

The searching of the clue-word extract card file is susceptible to automatic searching by computer, and thus under certain circumstances the clue-word system may be a satisfactory substitute for the more expensive full text indexing systems. Officials of Battelle have developed a proposal to utilize a computer for searching, but it will be necessary to convert the present clue-word extract cards to machine-language format before proceeding with the project.

Anyone starting a clue-word system at this time should give serious consideration to capturing the index data in machine language, possibly as a by-product of the typing operation, since some type of machine processing would probably be desirable later.

BATTELLE CLUE-WORD CARD



NAME OF SYSTEM:

Battelle Dual Dictionary Index

ORIGINATOR:

Radiation Effects Information Center (REIC)

Battelle Memorial Institute

Columbus, Ohio 43001

OBJECTIVE. To design and develop a simple yet effective coordinate indexing system that will enable the hundreds of users to conduct their own searches.

BACKGROUND. The Radiation Effects Information Center, one of Battelle Memorial Institute's many technical information analysis groups, investigates such scientific areas as radiation effects on humans, on space travel, and on various metal devices. This dynamic and expanding area of science, with its many new discoveries, prompts the writing and circularization of a considerable volume of literature.

Since its inception in 1957, REIC has been offering a "current awareness service" to its many sponsors such as the Air Force, the National Aeronautics and Space Administration, the Atomic Energy Commission, and numerous contractors and subcontractors. As part of this service, each sponsor is sent a monthly announcement of the documents accessioned during the prior month. These announcements include such information about the document as the title and author and an abstract or extract of the information.

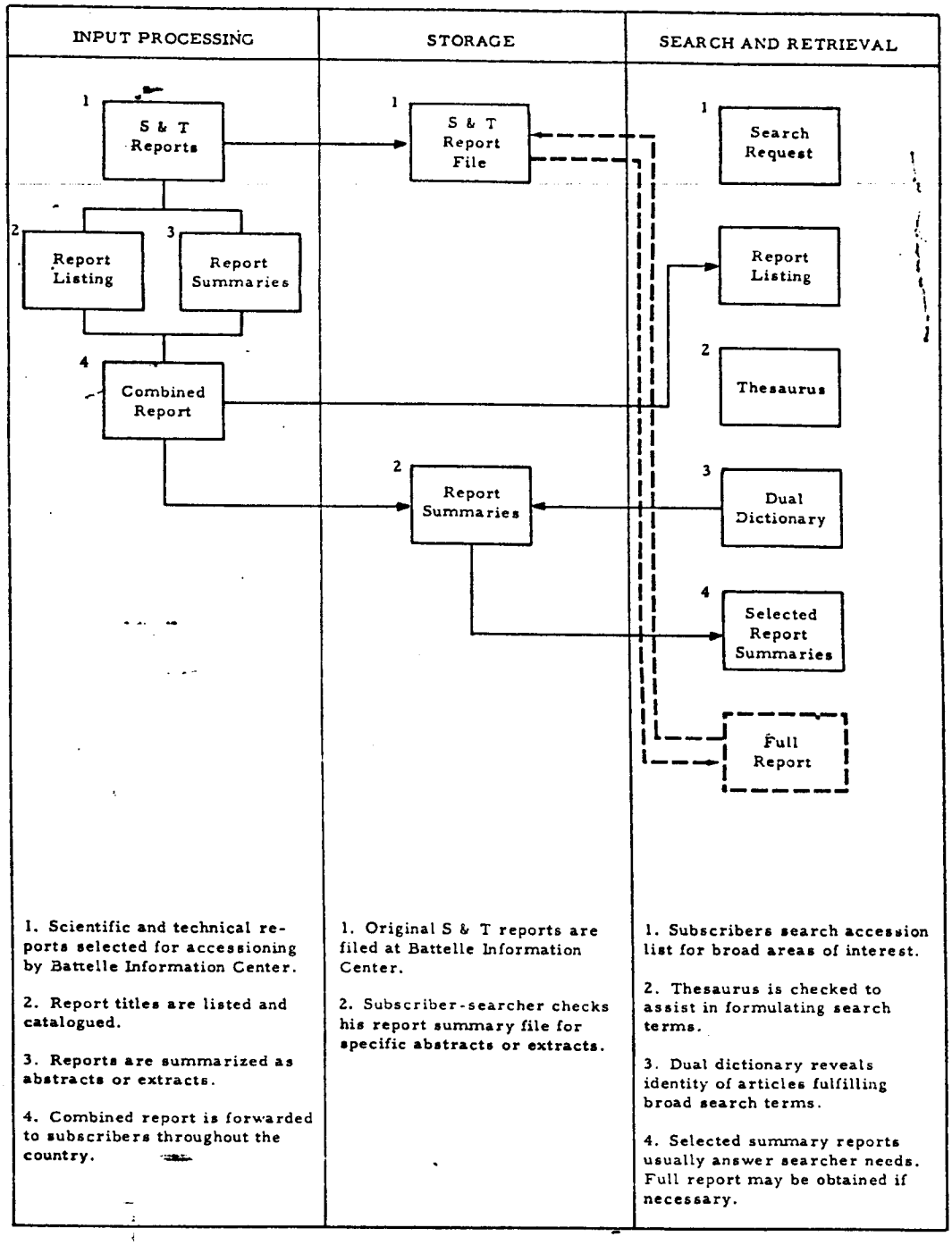
To assist the users in assimilating this vital information and in conducting their own searches, a simple, inexpensive, and comprehensive dual dictionary (or index) system was developed.

THE NEW METHOD. The dual dictionary system is similar to the columnar card system except that the index postings are listed on pages instead of individual cards. The dual dictionary consists of two identical sets of page listings, each a half-page wide and mounted side-by-side on a stiff backing sheet with a plastic ring binding at the top. Each side consists of a listing of all the indexing terms used in the system. Below each term are ten columns (final digits 0 through 9) of numbers identifying those documents that were assigned that particular term during the indexing process. Normally, each document is assigned more than one term. A copy of the Information Center's thesaurus of about 1,000 entries is attached at the back of the dictionary.

To conduct a search of the dual dictionary, the user must first determine which terms best describe his search question. He then locates his first term on one side of the dual dictionary and keeps that side opened to that page. Next, he looks up the second term in the opposite side of the dictionary and compares the document numbers, column-by-column, for matching numbers. Taking note of any matching (coinciding) numbers for these two terms, he again turns the pages on the opposite side to the next indexing term involved in the search to see if there is a further match. This process is repeated until all numbers under all the terms used in the search have been checked. The numbers that appear under all the indexing terms searched identify those documents that contain the answer to the search question. The searcher may refer to the abstract or extract contained in the monthly document announcement bulletin for a description of the document.

REMARKS. The dual dictionary system reduces the workload at the Battelle Information Center by providing each sponsor-user with a broader search capability. This capability permits them to handle many of their more routine information needs, thus reducing their reliance on the facilities of the Information Center. It also gives the searcher the opportunity to frame his search request in a wide variety of ways, thus permitting him to tailor the search to satisfy his particular needs and experience. The mechanization of the updating, together with the computer printout capabilities, assures faster announcement of newly accessioned material.

BATTELLE DUAL DICTIONARY INDEX



NAME OF SYSTEM:

Aircraft Maintenance Manual Distribution and Updating

ORIGINATOR:

Eastern Airlines

Miami Maintenance Base,
Miami International Airport

Miami, Florida 33848

OBJECTIVE. To develop and operate a company-wide aircraft maintenance information storage, retrieval, and display system that is better suited to the needs of the maintenance facilities; also, to reduce costs and elapsed time for reproducing, distributing, and updating manuals.

BACKGROUND. What began long ago as a fairly simple operation—the provision of maintenance manuals for aircraft operated by commercial airlines—today has grown as much in complexity as the aircraft themselves. From a book about the size of a modern automobile maintenance guide, these aircraft manuals have grown to enormous sizes. To illustrate, until recently it took as many as 7,000 manual pages to properly document all the engineering and maintenance details for just one type of jet aircraft. In total, the full Eastern Airline's fleet of over 250 aircraft required about 150,000 pages of technical instructions. To keep the documents current throughout the Airline's network of about 70 locations, over four million inserted changes were made in 1965. Because of this constantly expanding bulky file of information and the impending addition of three new types of aircraft to the fleet during the following three years, Eastern Airlines began studying the unique qualities of microform for solving the problem.

The company desired a microfilm system that would present the manual information in an easily accessible manner, both for mechanics and inspectors working on the line, as well as for people responsible for entering procedural and technical changes. They felt that any new system should have the capability of providing the line mechanic with specific pages covering a particular assignment.

An in-depth study of the problem resulted in the adoption of a system that utilized the best features of systems developed by three major microform manufacturers. The company believes that this system should satisfy their maintenance information handling needs for many years to come.

THE NEW METHOD. The adopted system requires the maintenance of only one master aircraft maintenance manual, kept in paper form at Miami, for each aircraft type. One person is assigned the responsibility for keeping the master copy up to date. This conventional master manual is periodically recorded in 16-mm. silver halide microfilm through use of two types of film cameras. A B–H rotary (automatic) camera is used for filming of normal text, while a Recordak planetary or overhead camera is used for the detailed wiring diagrams and other high resolution tasks.

The film is developed in a Sepratron processor. Approximately 100 diazo negative roll microfilm copies are then produced on a CBS (Columbia Broadcasting System) continuous film duplicator for distribution to about 70 primary aircraft maintenance facilities throughout the EAL network and elsewhere. An index is prepared for use with a Filmac Model 400 cartridge roll microfilm reader-printer that uses the odometer technique for image finding. The microfilm copies are loaded into cartridges and index labels are placed on the outside. The complete manual sets, usually consisting of three cartridges for each type of aircraft, are placed in special shipping containers used for distribution of the new microform copies and for return of the old copies to Miami; thus, the cartridges are used over and over again.

The user's microfilm cartridges are stored in a special receptacle located close to the reader-printer. The user—a mechanic, an inspector or supervisor—has the option of viewing the page image on the reader or of obtaining a disposable enlarged paper copy for

use in his work location. As a safety factor, the paper copies are self-erasing within 60 days.

Microform copies are also distributed for use on portable readers kept at secondary locations, such as on board aircraft involved in EAL off-system operations. These readers operate on aircraft, motor vehicle, or self-contained battery power. The microform manual file and reader for this secondary use are contained in a single package weighing about 14 pounds and about the size of a portable typewriter, in contrast to the 80-pound weight of a set of paper manuals.

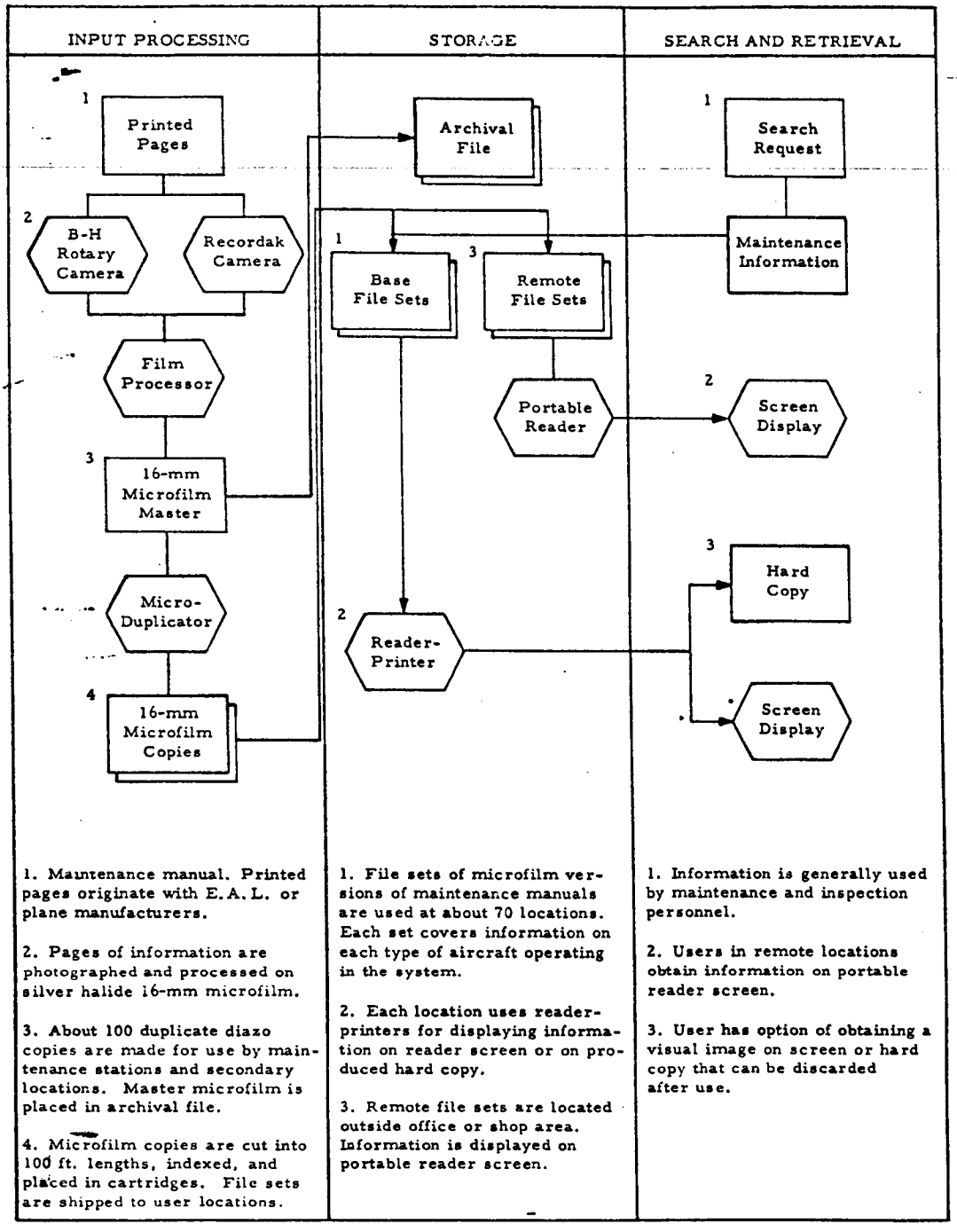
New information of importance received between each month's file updating is handled by teletype messages or through use of temporary paper revisions, which are filed in a binder adjacent to the viewer equipment. Careful control keeps this supplemental paper to a minimum, and it is destroyed upon receipt of the completely updated microform copy.

REMARKS. One of the problems generally associated with the distribution of technical information is that of file integrity. However, under this system excellent file integrity is assured due to the specially maintained single master paper copy. Formerly, about 75 people throughout the Eastern Airline network had some responsibility for maintenance of the aircraft manuals.

Due to elimination of the time consuming mass paper printing, packaging, and shipping processes and the close cooperation between the airline and the many aircraft manufacturers, the time required to provide current information to the many maintenance facilities has been greatly reduced. The new system has reduced the former space requirement of a 12-foot shelf of books to a reference file about the size of a shoe box.

In summary, in addition to the tangible benefits in the form of savings in personnel, handling, storage, and other costs, this system has resulted in greatly improved quality control; greater flexibility in file location and display methods; and earlier receipt of the latest technical changes at the using locations.

AIRCRAFT MAINTENANCE MANUAL DISTRIBUTING AND UPDATING



1. Maintenance manual. Printed pages originate with E. A. L. or plane manufacturers.

2. Pages of information are photographed and processed on silver halide 16-mm microfilm.

3. About 100 duplicate diazo copies are made for use by maintenance stations and secondary locations. Master microfilm is placed in archival file.

4. Microfilm copies are cut into 100 ft. lengths, indexed, and placed in cartridges. File sets are shipped to user locations.

1. File sets of microfilm versions of maintenance manuals are used at about 70 locations. Each set covers information on each type of aircraft operating in the system.

2. Each location uses reader-printers for displaying information on reader screen or on produced hard copy.

3. Remote file sets are located outside office or shop area. Information is displayed on portable reader screen.

1. Information is generally used by maintenance and inspection personnel.

2. Users in remote locations obtain information on portable reader screen.

3. User has option of obtaining a visual image on screen or hard copy that can be discarded after use.

NAME OF SYSTEM:

ZIP Code Data Retrieval

ORIGINATOR:

National Education Association (NEA)

1201 16th Street, N.W.,

Washington, D.C. 20036

OBJECTIVE. To evaluate and select a data retrieval system that will provide a fast and efficient method for looking up postal ZIP Codes so that they may be added to the mailing addresses of Association members. Also, to provide a simple, inexpensive method for updating data in the ZIP Code directory.

BACKGROUND. The National Education Association (NEA) represents the professional interests of about one million teachers in the United States. The advent of the ZIP Code and the requirement for bulk mailers to add geographical code elements to each mailing address created data retrieval problems for the NEA.

Their initial need was to determine the best method for retrieving ZIP Code information for inclusion on the NEA master mailing list. The basic method for accomplishing this task was the Post Office Department's bulky, 1,800 page National ZIP Code Directory. Its page format comprises five columns of alphabetically arranged listings of States, cities, towns, and streets, with ZIP Codes shown for each entry.

The manual Directory search routine consisted of finding the member's State, followed by an alphabetical rundown of the State's city or town, and finally the street address. The ZIP Code would then be noted on the member's master address card. To alleviate this tedious and time consuming method of finding and posting ZIP Codes for over a million members, the NEA study group recommended adoption of the ZIP Code Data Retrieval System employing microfilm strips.

THE NEW METHOD. Initially, the NEA converted the ZIP Code Directory to a magnetic tape format and arranged for a commercial firm to convert the magnetic tape information into 16-mm. microfilm through use of COM (computer output microfilm) equipment. This action was taken in conjunction with a program to mechanize the overall mailing list operation. The 16-mm. rolls of microfilm were photographed and developed, and the film was spliced into 12-inch strips, each containing 12 pages of ZIP Code information. Film strips were then mounted on plastic strip holders measuring about 14 inches long and indexed to reflect the proper geographical area. A visual index label located on the front of each plastic strip holder indicates the State to which the contained microfilm information applies. Color coding is added for ease of identification when a States's listings overlap into additional strip holders. Located on the back of each strip holder is a second and more precise index listing showing city, town, and street information, which is only visible when the holder is removed from the data file. The full ZIP Code inventory comprises 200 visible strip holders housed in a 200 slot "honeycomb" file container easily accessible to the searcher and viewing equipment.

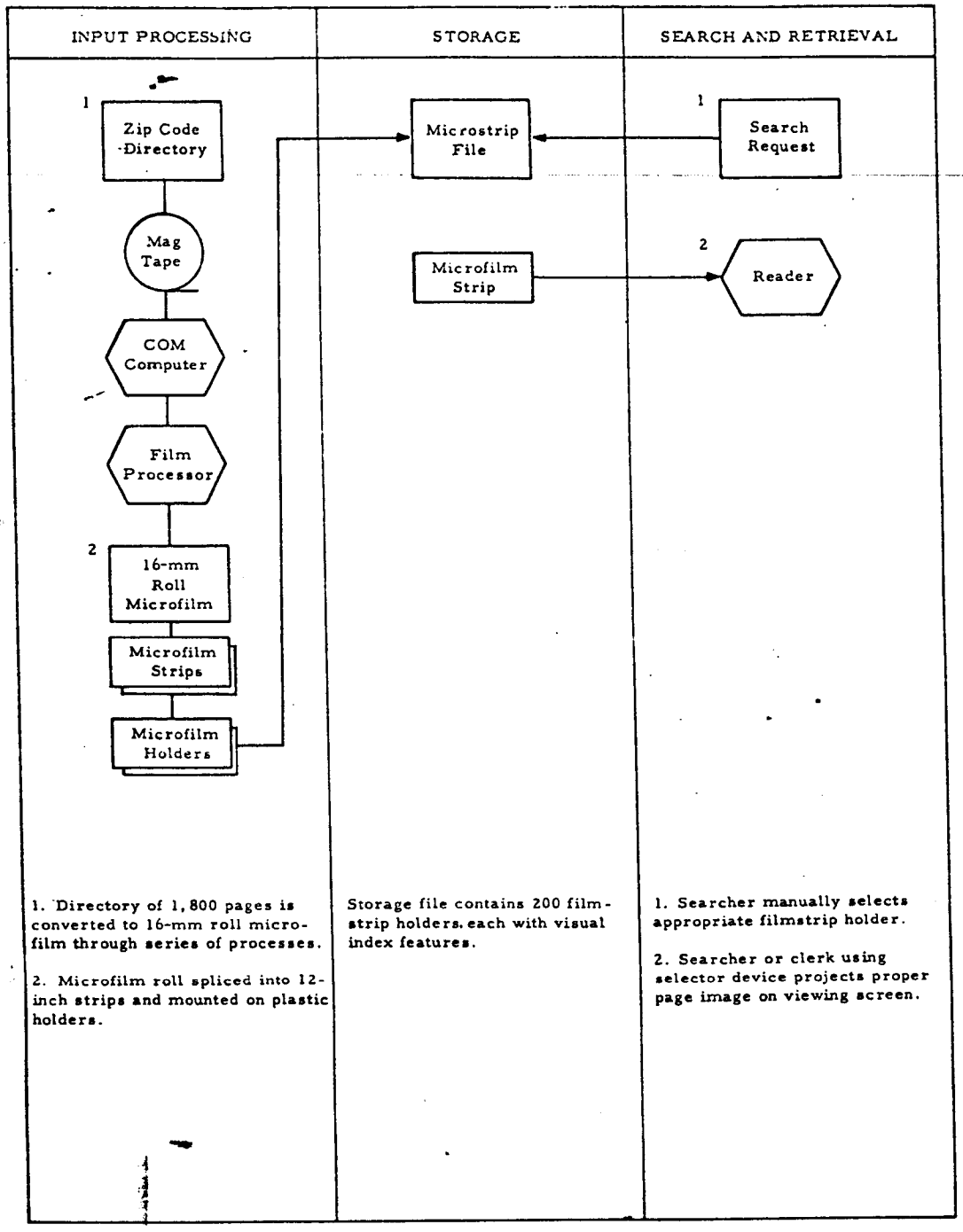
A search of the ZIP Code data file aimed at finding the ZIP Code applicable to a known address would first involve selection of the State and particular city by noting the visual index information. The selected strip holder is then manually placed in a slotted keyway on the microstrip reader. The placement of the strip holder on the reader exposes the secondary index that lists more precise information concerning street identities and microfilm strip page numbers. With the page number determined, a mechanical pointer within the system is manually positioned next to the proper page number. This action causes the page image to show on the reader screen and the searcher then matches the known street address with its proper ZIP Code identity. The search task is completed when the searcher records the ZIP Code next to the rest of the address.

REMARKS. This type system has been primarily used for storing and retrieving information and data contained in listings such as catalogs, directories, and inventory lists. The basic equipment is commercially marketed but is not compatible with other microform systems.

The one-time conversion of original listings to microstrip form can be a costly operation, but it results in a greatly improved information updating and retrieval operation. In addition, there are frequently other reasons why it may be advantageous to convert such listings to machine-language format, and once this is accomplished, the microstrips can be produced at a relatively low cost through COM (computer output microfilm) equipment. In the case of ZIP Code information, the user can obtain and update the microstrips for a small monthly service charge.

[1] The National Education Association found that the microfilm strip system provided its greatest benefits during the initial conversion of the mailing lists to include ZIP Code entries.

ZIP CODE DATA RETRIEVAL



* U. S. GOVERNMENT PRINTING OFFICE : 1971 O - 401-389

FPMR 101–11.5

RECORDS MANAGEMENT HANDBOOK

MICROFILMING RECORDS

MANAGING INFORMATION RETRIEVAL

1974

GENERAL SERVICES ADMINISTRATION
NATIONAL ARCHIVES AND RECORDS SERVICE
OFFICE OF RECORDS MANAGEMENT

National Stock Number
7610-00-387-9972

RECORDS MANAGEMENT HANDBOOKS are developed by the National Archives and Records Service as technical guides to reducing and simplifying paperwork.

RECORDS MANAGEMENT HANDBOOKS

Managing correspondence: *Plain Letters*	1972	61 p.
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Mechanizing paperwork: *Source Data Automation Equipment Guide*	1970	122 p.
Mechanizing paperwork: *Source Data Automation Systems*	1964	183 p.
General: *Bibliography for Records Managers*	1965	58 p.
General: *Copying Equipment*	1966	82 p.

FOREWORD

The use of microforms as tools to facilitate Government operations has been growing rapidly in the last few years. The concept of miniaturizing the masses of recorded information created or accumulated in today's offices appeals to both managers and workers as a possible answer to the ever-expanding paperwork problems besetting them.

Unfortunately, making the store of recorded information physically smaller will not by itself guarantee economic and efficient office operations. An effective microfilm system, like any other office system, must be properly planned, designed, installed, and operated.

It is the purpose of this handbook to provide an overview to the field of micrographics. It furnishes to records managers, management analysts, systems designers, and others concerned with more efficient office operations guidelines on when to microfilm, and on how to design a microfilm system, select the microfilm format that best meets user requirements, obtain quality microforms, and operate a microfilm system after its installation.

It is hoped that this basic handbook can assist Government officials in properly applying microfilm systems in those situations justified by cost-benefits, and in avoiding the pitfalls which can result from misapplying microfilm techniques.

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I. MICROFILM SYSTEMS OVERVIEW

Development

Throughout the ages man has attempted to record his history. Early man used drawings on cave walls. Other media were probably used but have not survived until today. The ancient Egyptians used clay tablets and papyrus, and other ancients recorded on tablets of stone. In contrast, modern man pours forth his history and every facet of his life on paper by the ton.

The Gutenberg press permitted man not only to record his history but also to reproduce it in great volumes. The electronic computer has permitted man to record and reproduce the great volumes of data so essential to modern life. But, unlike the written word, the magnetically recorded, machine-readable media of the computer have not yet reached a state of technology that permit them to be considered permanent.

By using microfilm man has been enabled, by means of the photographic process, to shrink the physical size of his written words and produce a permanent record that can later be recreated as an eye-readable image.

Microfilm technology today spans the worlds of recorded history, data processing, and photographic science. In microfilm we find elements of history, of daily business communications, and of modern science and technology. Each of these fields looks upon microfilm from its own provincial viewpoint, but each has contributed immeasurably to the progress and growth of micrographics and has provided deep insight into the proper and full uses of microfilm.

Microfilm is a photographic recording, but it differs from a photograph in that textual or graphical information is recorded. John Dancer's microphotograph of a stone memorial tablet made in 1839 in Manchester, England, was the first recorded experiment. René Dagron was issued the first microfilm patent in 1859 in France. Later, in 1870-71, during the siege of Paris in the Franco-Prussian War, messages were microfilmed and sent by carrier pigeons into the besieged city.

Modern use of microfilm did not begin until the late 1920's when the introduction of rotary, or flow, cameras made rapid microfilming feasible. Other microfilm-handling devices were soon developed, and the field expanded rapidly to cover not only security, library, and archival applications but also business recordkeeping applications. During World War II the aperture card was developed in which a 35mm microfilm image of an engineering drawing was mounted in a data-processing (EAM) card that could be machine sorted. During that period V-mail gave many Americans their first experience with microfilm copy when the letters sent and received from overseas were first microfilmed and later reproduced on photographic paper.

The use of microfilm in both business and archival storage applications has grown steadily since then. In recent years microfilm has been recognized as a suitable medium for active information systems, often replacing paper-filing and retrieval requirements completely.

Today the computer output microfilm recorder is solving one of the information-handling problems of the computer industry. Masses of information can be generated but cannot be rapidly recorded in a usable format by conventional methods. The ability of microfilm to physically reduce the great mass of the data and information currently

being generated at electronic speeds has provided the answer to a pressing problem.

Current Usage

By reducing its size, microfilm makes information more manageable. It becomes easier to store, easier to transport, and usually easier to find. Its smaller size aids in its total reproduction; 98 frames on one sheet of microfilm are much easier to reproduce than 98 pages of paper. The users of microfilm today have capitalized on these attributes. Some of the major uses of microfilm today are the following:

Historical Information. Microfilm has become increasingly popular for the storage of historical or archival information. Modern printing papers, both newsprint and book, often deteriorate after 30 or 40 years, and microfilm has been used extensively to capture and preserve fading images of papers having archival value. Even more important, fragile records are easily reproduced as microfilm. For example, the 1790 census of the United States microfilmed years ago is made available on duplicate microfilm. Obscure local newspapers, such as *The Enterprise* of Willimantic, Conn., have been preserved on microfilm and are available to the researcher of local history. All major newspapers are microfilmed routinely today as they are produced, greatly reducing the vault requirements of libraries to store back issues. For the researcher, viewing rolls of microfilm is easier than searching through dimly lit newspaper storage areas.

Business Information. Modern business lives on its paperwork but could be throttled by it if microfilm technology or other modern information retrieval techniques did not provide accessible storage media for active and inactive business transaction records. Bank checks, credit card slips, and every conceivable form of modern business records are routinely recorded on microfilm. This miniaturization provides for preservation of the information and for easy access to that needed for current operations. Inactive files cease to create a storage problem when the records are reduced to microfilm and are stored in filing equipment convenient to main operating areas. If routinely made in the regular course of business, microfilm copies may also provide an acceptable legal record. Figure 1 shows the use of microfilm for storing and retrieving inventory information.

The security offered by the use of microfilm is not insignificant. Both in government and in business, vital records are routinely microfilmed and stored offsite to prevent destruction in case of fire or other disasters,

MICROFILM STORAGE AND RETRIEVAL OF INVENTORY INFORMATION

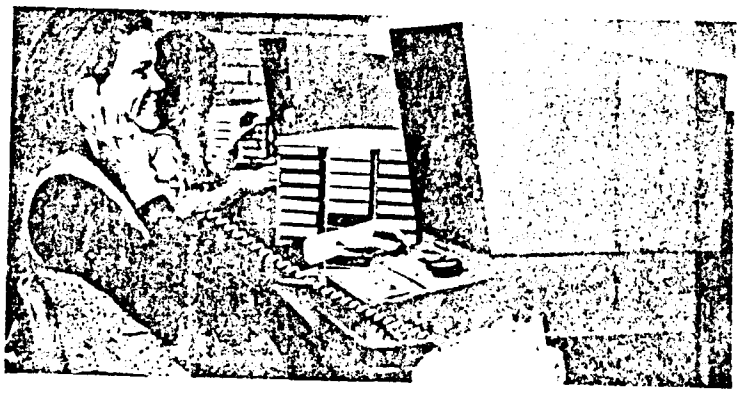
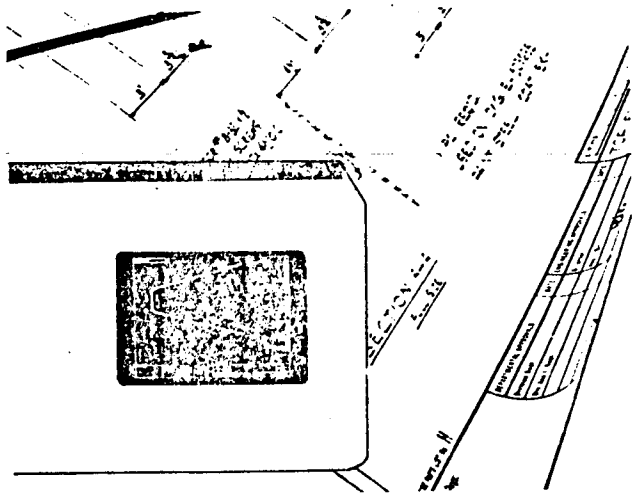


Figure 1



AN ENGINEERING DRAWING ON AN APERTURE CARD

Figure 2

and to permit the organizations to continue operations after the disaster.

Engineering Drawings. Engineering drawings are made in many shapes and sizes and are normally stored by size rather than by subject content. Microfilming engineering drawings can reduce these various sizes to one common size for all drawings. The film is mounted into an aperture card, which becomes a carrier and the indexing means for the information on the film. The tab-size aperture card with 35mm film mounted in it has been widely accepted by American businesses and governments for engineering drawings and related technical information. In particular, it has allowed rapid reproduction of complete sets of drawings for bidding purposes as required by Government procurement regulations. If information has been punched into the card, every card can be automatically titled or "interpreted" using data-processing machine methods. For the engineer or draftsman, referring to several small aperture cards is more convenient than referring to several large engineering drawings spread across a desk. (See fig. 2.)

Even more impressive is the capability of modern computers and related equipment to create graphics and engineering drawings directly on microfilm. While the technology is well established today, the cost of the required hardware and software is still very high; however, it may be justified when similar drawings must be constantly created.

Micropublishing. Microfilm formats are being used increasingly to republish and actively market information and are often offered in lieu of a paper copy. Government specifications and standards, industrial catalogs, college catalogs, and back files of newspapers are typical examples of republished information. Micropublishing also includes original material produced only in microfilm formats. Certain 1970 census information is available only on magnetic tape or microfilm. Supply catalogs on microfiche, produced under the Department of Defense project known as MINI-CATS, are another example.

Computer Output Microfilm (COM). Computer output microfilm (COM) recording has coupled the capability of the computer to produce information with the capability of the microfilm camera to record information rapidly and economically. As computers have grown in their capacity to generate information, the ability of man physically to

handle and assimilate the information has been reduced. The computer output microfilm recorder can not only reduce the physical bulk of the information to a microform (a form of microfilm), but it can also display numeric values, such as graphs, charts, or other visual symbols, in a format more readily understood than mere columns of numbers and figures. This combination has permitted microfilm to be used in highly active information systems where masses of information are recorded daily, used for a day or more, and then replaced by new microfilm. Previously, computer data printing was limited by the capabilities of the line printer, but now large business listings can be produced by COM units in less than one-tenth the time required by the line printer.

Business graphics produced by COM units open a new world for management information systems since data often is of value only if it can be easily interpreted. The capability of some COM units to rapidly record and plot complex two- and three-dimensional data relationships adds a new aspect to man's understanding of both scientific and business information. Stock exchange price, volume, and change relationships are given new interpretations when these techniques are used. (See fig. 3.)

COM PRODUCED STOCK PRICE CHARTS

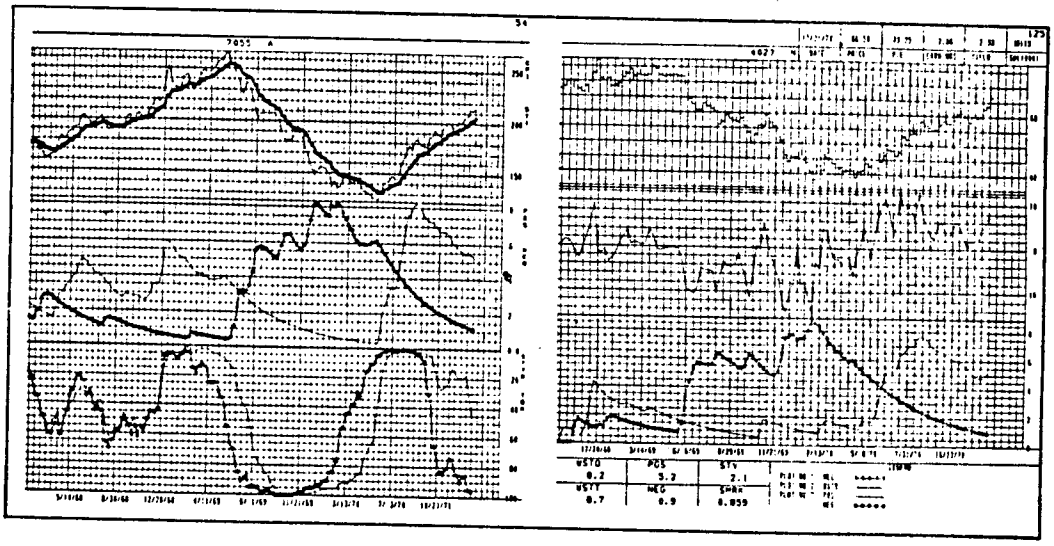


Figure 3

The same computer program that produces the information to be recorded on COM can also produce information retrieval aids in the form of visual bars, optical codes, or numbers. The COM recorder is especially adaptable to this purpose by providing indexing capabilities together with microfilming capabilities.

Future Evolution

Microfilm technology and its application in information storage and retrieval systems will increase in the coming years. Improved equipment and techniques, better systems designs, and a sensitivity to the needs of

the user will rapidly advance the art and technology in areas such as the following:

Active Information Systems. Microfilm offers systems designers a powerful tool for recording, storing, and handling information. The delays inherent in microfilming and developing the microfilm have often prevented consideration of microfilm as an active data storage and retrieval medium. But when large masses of information require organization and reproduction for later retrieval, microfilm becomes a superior medium for the storage and distribution of information.

The computer output microfilm recorder, with speeds many times faster than the computer line printer, has often permitted a line printer report issued only monthly to be replaced by a daily microform report containing updated information. In the graphic computer output microfilm field, the plotting of graphs and charts that previously took hours or even days is now accomplished in seconds on a daily basis.

The use of microfilm for active information is greatly improved by a system design that provides good indexing, good retrieval, and good reproduction means. Recent developments in hardware and systems design give new justification for microfilm use in active information systems. Good indexing methods permit the user to identify the information required, better retrieval means allow him to find it rapidly, and simplified reproduction methods give him convenience similar to that of an office copier. Future developments will bring more improvements in these areas.

Higher Reduction Ratios. Improved technology in films, lenses, and viewers has permitted increasingly greater reduction ratios and an increased data packing factor. Conventional one-step photographic recording is limited to about 40:1 reductions for most documents, but two-step photographic reduction doubles or even more than triples the reduction ratio with little loss of quality. While the cost of producing the two-step master copy is usually greater, the increased concentration of data reduces the per page reproduction costs of duplicate copies. Today large dynamic collections of data, such as the Ford Motor Co. parts catalog and the Sears Roebuck and Co. repair catalogs, are published as ultrahigh reduction microforms. Acceptance of microfilm at high reduction ratios by the Government in a Patent Office application and in other applications has made others aware of the capabilities of microfilm as a dynamic medium.

Higher reduction ratios will reduce the storage and retrieval problem by physical reduction of the quantity of film to be searched. This reduction will permit more automated retrieval units at lower cost per unit. Several such units have been introduced, and more will be produced as the use of higher reduction microfilm grows.

Machine-Readable Data Storage. The same principles used in paper-based optical character recognition (OCR) systems can be applied to alphanumeric or graphic information recorded on microfilm. The production of machine-readable data using microfilm rather than paper as the medium being read into the system can be categorized as computer input microfilm (CIM). Microfilm provides the advantage of a uniform medium for optical scanning, and it eliminates the paper-feed problems usually associated with OCR equipment. The OCR techniques permit information that has been recorded on microfilm to be reentered in the computer to allow manipulation of the data.

The older OCR techniques required a set of known typefaces to be recognized. Newer technology permits the recognition of multiple fonts and allows the recognition unit to learn the unique typeface of a particular document. In the latter case the "footprint" of the complete alphabet is the first item read on the page, permitting the recognition unit to learn all characters presented.

The use of a laser as a recording source will increase the speed and the effective

reduction ratio possible for both the recording and reading of microfilm. Units that record directly on microfilm in digital format have been produced. Material recorded in this way is not eye-readable but is in a digital-bit pattern. Packing factors for data are extremely high, permitting masses of information to be stored in a digital format that is permanent and that can be used as input to a computer. Recently laser recording has also been used for directly recording eye-readable miniaturized data onto microfilm in a special type of computer output microfilm recorder.

The use of microfilm for computer output and input offers great flexibility to system designers who wish to produce a computer microfilm record that can be read either by persons or machines. While the equipment and application of this technology are fairly expensive, future growth of the field should progressively reduce the cost of computer input microfilm equipment.

Improved Films. Film technology will change the uses of microfilm by providing higher quality and resolution, simpler processing, and, eventually, erasable films that do not require conventional processing.

- Color microfilm is becoming increasingly common in applications that require it where it is economically feasible.
- High resolution microfilm will continue to permit increased reduction ratios.
- New processing techniques for camera films offer almost instant microfilm, although caution should be taken when such films are used as permanent archival records. They must meet the standards currently in force for permanent microfilms if the records have permanent value.
- Microfilm and processes used to make copies will be simplified.
- New types of microfilm (other than silver halides) for camera use will be introduced.
- Erasable films are being developed for use as non-permanent records.

Automated Retrieval. Most devices that provide automated or semiautomated retrieval of microfilm are fairly expensive if they require electronic circuits for their control. Future developments, including market growth, will bring lower costs for these units. New units based on the use of new techniques, formats, and higher reduction ratios will also bring new dimensions to microfilm systems. The continued development and introduction of microfilm standards for quality and the various formats, sizes, and carriers of microfilm will spur new equipment production because uniformity of microfilming practices will allow wider use and interchange of mass-produced equipment. Figure 4 illustrates an example of an automated retrieval microfilm device.

Automated Searching. Automated searching implies finding a microimage in accordance with its content (indexing) rather than its physical location (retrieval). This index-search capability is easily acquired by the use of computer techniques. Microfilm storage and retrieval equipment, which combines computer searching with microfilm retrieval is currently available. It is this combination that has the greatest potential for growth, with the present use limited mainly by equipment cost and the cost of indexing. In the latter case, computer-indexing techniques will permit automatic indexing as a byproduct of information processing for publishing. As for current costs of equipment, it should be noted that these combination systems may do the job normally done solely by a computer in certain applications and at much lower cost.

The Metric System and Microfilm

Photographic films are one of the few consumer-oriented items that presently use the

tric system of measurement to some degree. Film widths (but not lengths) and the focal lengths of lenses are commonly stated in millimeters; 16mm and 35mm microfilm and 50mm lens are examples. The United States is expected to adopt the metric system within the next 10 years. The National Microfilm Association has taken active leadership in promoting this conversion process as it relates to the microfilm industry. This handbook, however, uses the units of measurement currently in common usage.

AUTOMATED MICROFILM STORAGE AND RETRIEVAL DEVICE

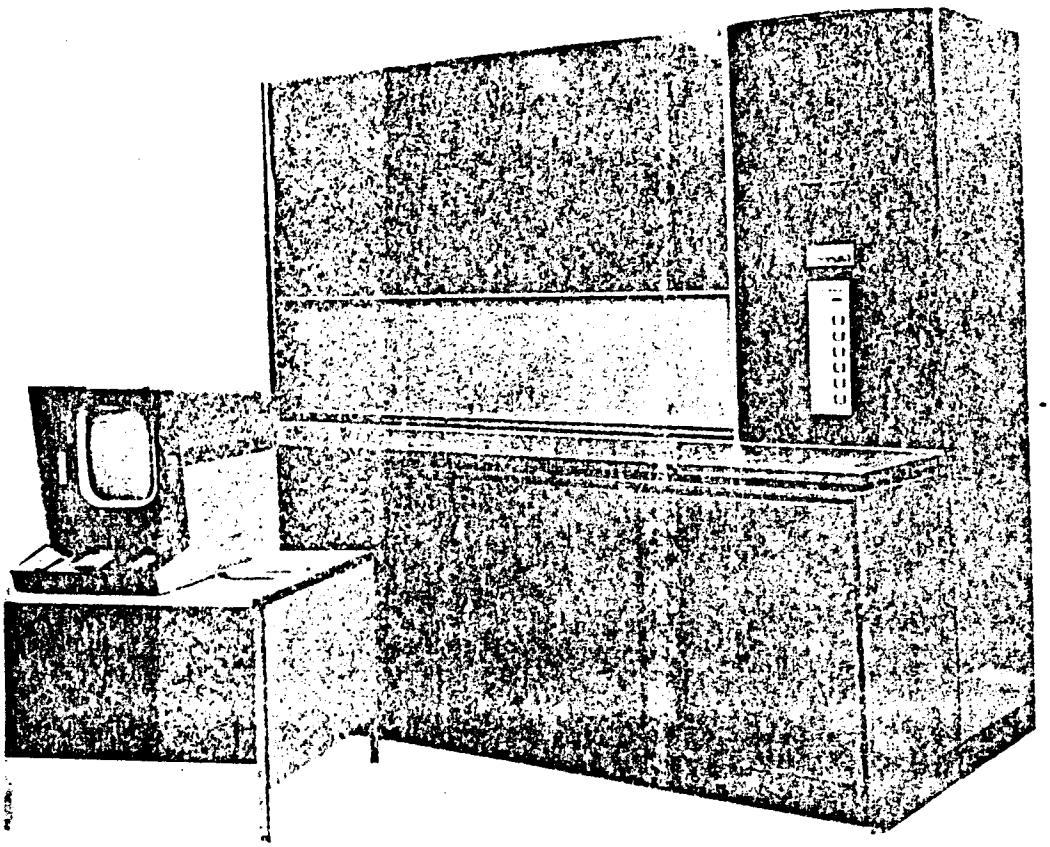


Figure 4

II. MICROFORM APPLICATIONS

Microfilm (the film medium) is used in many different formats called microforms. Figure 5 illustrates some of the various types of roll and unit microforms. The typical and popular applications of microforms that follow have been chosen to illustrate the va-

VARIOUS TYPES OF MICROFORMS

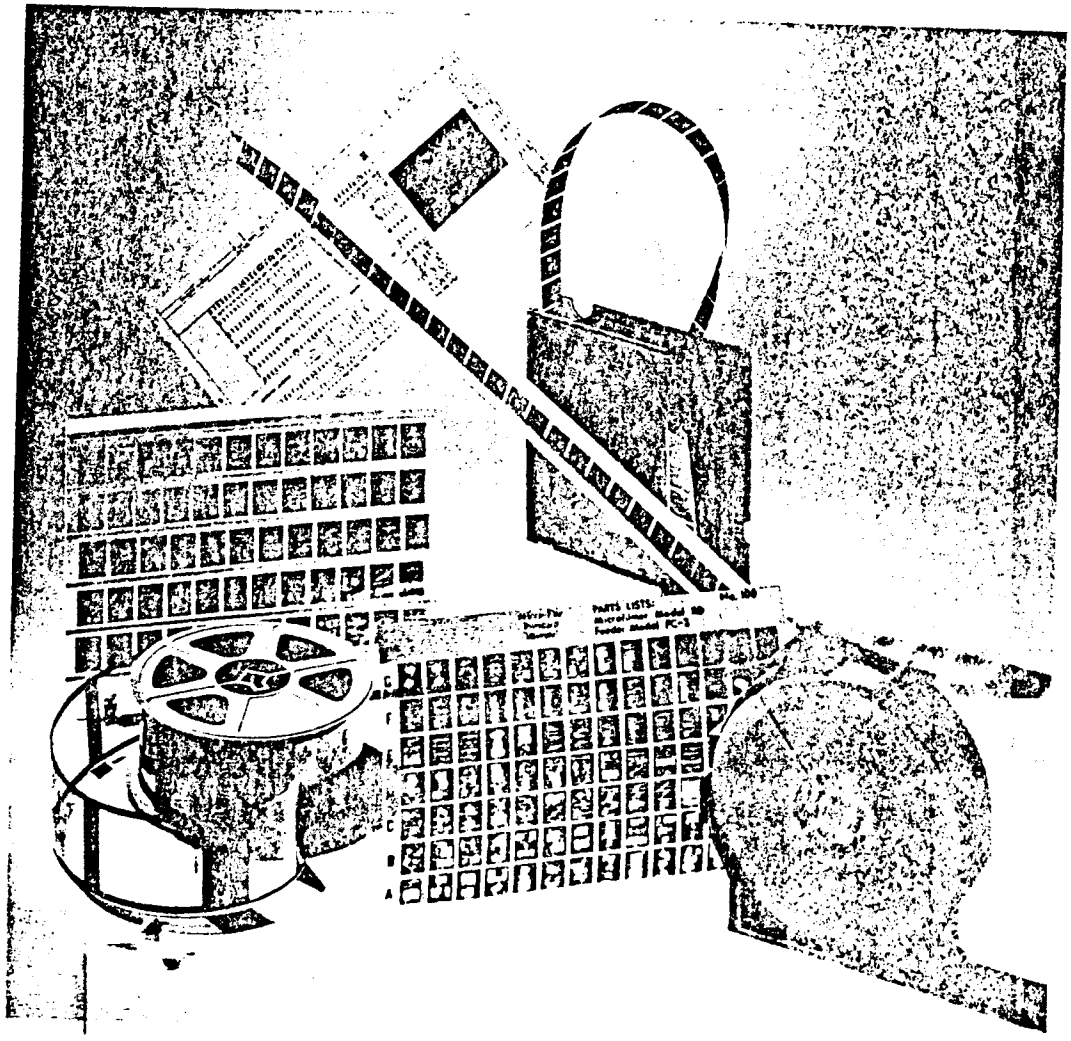


Figure 5