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An overview of materials scheduling, this write-up outlines system components, standardization, costs, limitations, and expansion capabilities of the New York Statewide Film Library Network. Interacting components include research staff; materials libraries; hardware; input/output (operation modes, input format conventions, transaction codes); file organization and access; software (executive, access, and processing functions); and programs independent of the executive routine. System standardization is described in the areas of digital coding for film items, customer numbers, producer numbers, material library procedures, reporting, and programing. (TI)

STATEWIDE FILM LIBRARY NETWORK:
SYSTEM WRITE-UP

Dominick Auricchio

CENTER FOR INSTRUCTIONAL COMMUNICATIONS • SYRACUSE UNIVERSITY

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PREFACE

This research project is supported by the U. S. Office of Education under Grant number OEC-1-7-070259-2656.

This document was compiled by Dominick W. Auricchio with the assistance of Muriel L. Day. The author is deeply indebted to Mr. Todd Sullivan whose reports on the System-1 Specifications - Files, and Input/Output furnished much of the information for this document.

This write-up is meant to be an overview of the Materials Scheduling System, and has been written for both the general reader and the data processing expert. For more detailed information about the system, please refer to the references given in Appendix A.

In some cases IBM 360 terms have been used. These can be ignored by the general reader.

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1. INTRODUCTION

The Statewide Film Library Network is a generalized materials-scheduling-telecommunications system designed to process all media. This Network is being developed in New York State to provide better service to school teachers using 16 mm educational films. The Network is designed to include film libraries at three levels: local libraries located in Boards of Cooperative Educational Services (BOCES) throughout New York State, regional libraries at large public libraries and State University of New York campuses, and a statewide library at Syracuse (the Syracuse University Film Rental Library - SUFRL).[1]

Services provided through the Network's computerized system include film use scheduling, materials handling reporting, extensive statistical reporting on film usage, and the inter-library loan of films to backstop requests for film usage which would otherwise go unfulfilled. (The system will be expanded eventually to include bibliographic and catalog production services, as well as handling other forms of educational media.)

The computerized system is currently being operated at the Syracuse University Computing Center, using an IBM System/360 Model 50 computer which has the following configuration:

(a) one 2050 Processing Unit which provides 262K bytes (actual) of main storage, divided into four variable-sized partitions under the MFT-I (release 14.0) version of the OS/360 operating system; (the Network's system resides in an upper partition of 43,008 bytes);
(b) one 2314 Direct Access Storage Facility;
(c) six 2402 Magnetic Tape Units (four 9-channel and two 7-channel units);
(d) one 2540 Card Read Punch;
(e) one 1403-N1 Printer;
(f) various remote I/O devices linked to the computer by one 2848 Display Control Unit and one 2701 Data Adapter Unit containing an IBM Type 2 Adapter for Teletype input.

Communications between the Film Libraries and the computer are maintained by Teletype model 33 ASR Teletypewriter terminals operating on TWX (Teletypewriter Exchange) service. The programming of the system has been done predominantly in S/360 Assembler Language, with a few programs written in PL/I.

This configuration permits on-line (real-time) teleprocessing which is the central concept in the system. The real-time or telecommunications mode of operation provides the user with immediate service via the Teletype terminal, wherein the system makes the results of processing available to the user within seconds after the receipt of input. See Figure 1, page 2.

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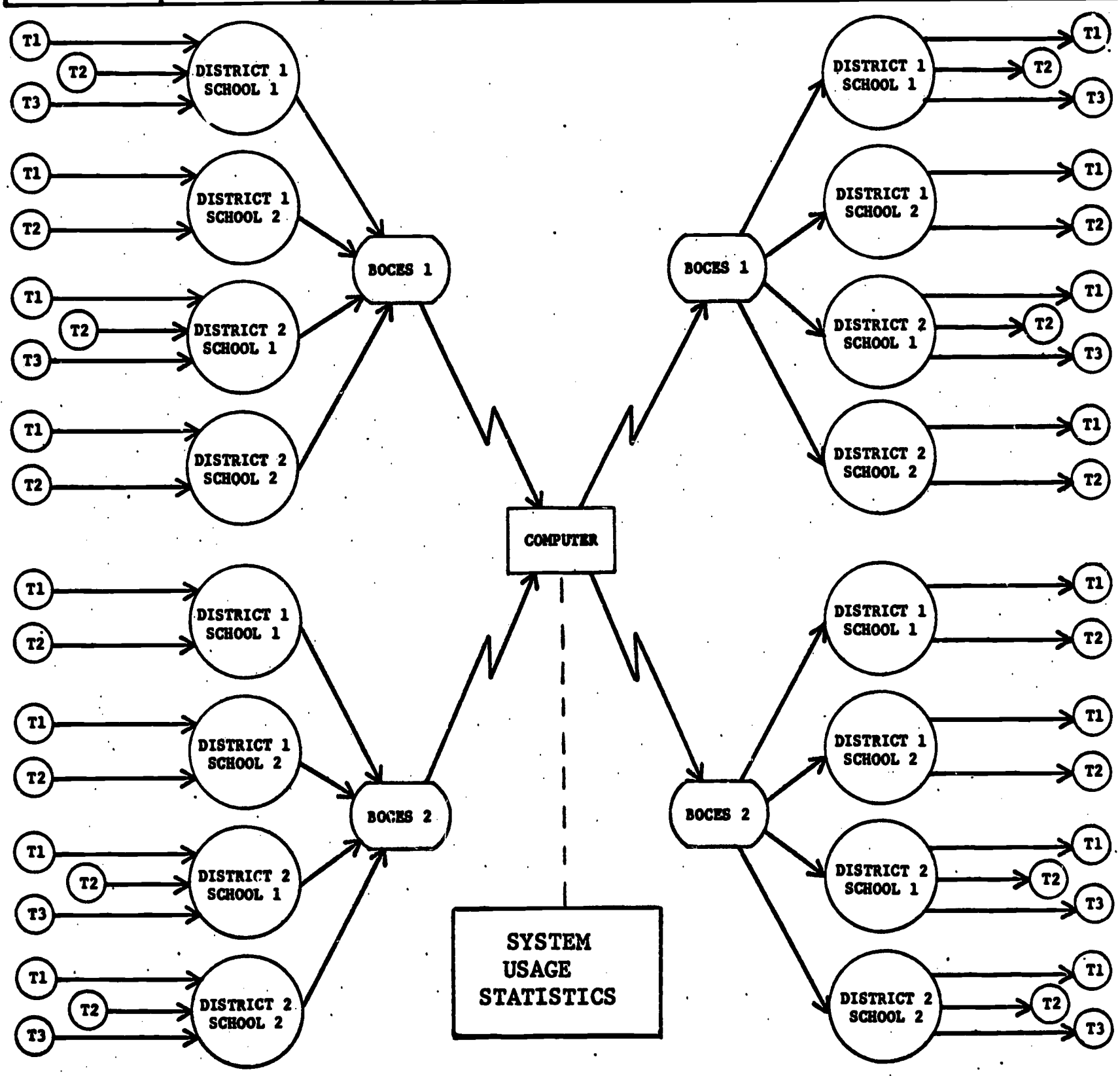
1 At the time this document was issued, four libraries were participating in the Network: Erie County BOCES No. 1 at Buffalo, Suffolk County BOCES No. 3 at Huntington, Westchester County BOCES No. 1 at Yorktown Heights, and SUFRL at Syracuse.

FIGURE 1

USER-COMPUTER INTERFACE

TEACHERS PREPARE BOOKING REQUESTS & SEND THEM TO SCHOOL A.V. COORDINATOR OR SECRETARY	SCHOOLS SEND REQUESTS TO BOCES VIA: 1)MAIL OR 2)BOCES DELIVERY SERVICE OR 3)PHONE	BOCES TRANSMIT VIA TELETYPE & PHONE LINES (TWX) TO COMPUTER 1)BOOKING REQUESTS 2)SHIPPING LIST REQUESTS	COMPUTER ATTEMPTS BOOKINGS IN BOCES OWN FILM COLLECTION. IF BOOKING NOT MADE A MANUAL BOOKING IS ATTEMPTED AT CENTRAL LIBRARY	COMPUTER TRANSMITS BACK TO BOCES 1)CONFIRMATIONS & REFUSALS 2)SHIPPING LISTS	BOCES SEND CONFIRMATIONS & REFUSALS TO SCHOOLS VIA: 1)BOCES DELIVERY SERVICE 2)OR PHONE. BOCES USE SHIPPING LISTS FOR DELIVERY & PICK-UP OF FILMS	SCHOOLS CONFIRMATION & REFUSALS ARE RETURNED TO TEACHERS BY BUILDING A.V.COORDINATOR OR SECRETARY



It is planned that the system will also operate in another mode - the batched mode - where input and output occur at the computer site. This mode will provide non-immediate service for high volumes of data at a lower cost, as the expense of telecommunications is eliminated.

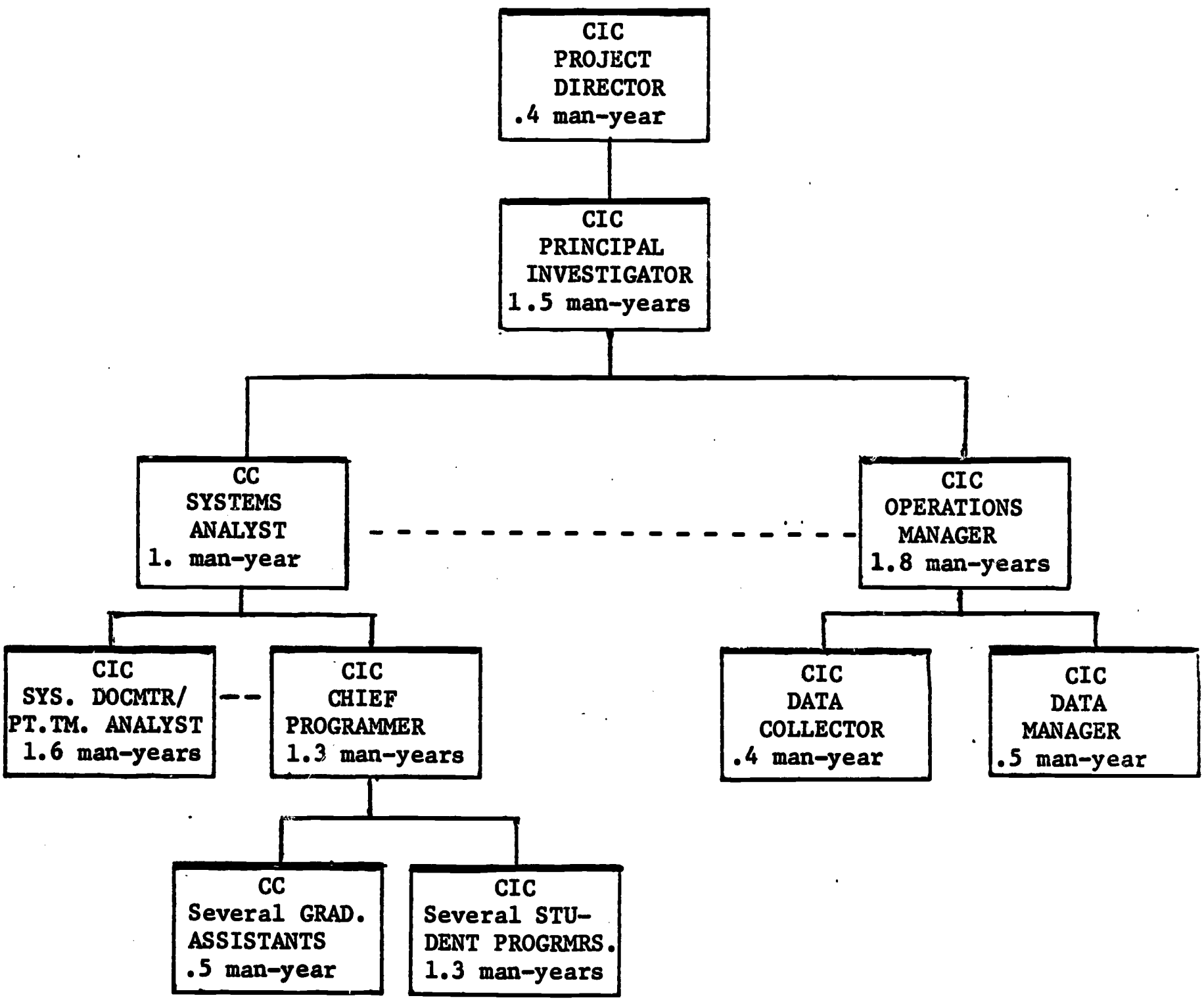
2. SYSTEM COMPONENTS

The Network is composed of many interacting modules. They include: research staff, materials libraries, hardware, input/output, files, and software. These components will each be considered in turn.

2.1 Research Staff

The most important consideration in any system is the people involved. The research staff at Syracuse University was composed of personnel from the Center for Instructional Communications (CIC), and the Computing Center (CC). The organizational chart below identifies each staff position, and the approximate corresponding man-years spent on the project.

Figure 2. Research Team Organizational Chart.



Director - (by regulation a faculty advisor) had to be assigned to provide part-time guidance and support. In an operating situation this position would become full time, and incorporate the responsibilities of the principal investigator.

Principal Investigator - had complete responsibility for supervision and administration of the research.

Systems Analyst - was responsible for designing the system and coordinating the various system components. This position in an operational situation could be incorporated into the chief programmer position, or be a consultant position.

Operations Manager - was responsible for acting as liaison between project staff and personnel at the libraries; data collecting, staff training, and handling business affairs. This position would remain unchanged in any future operation.

Data Collector - was responsible for the data collected for the early Film Distribution Study.

Data Manager - was responsible for data collection and data computer preparation. This position would be needed if additional libraries were to be added to the system.

Chief Programmer - was directly responsible for the writing and coordinating of all computer programs both for operational and record-keeping functions. During the developmental stage there was also a team of part-time assistant programmers assigned to specific programming tasks; one of these positions might be needed to accompany the chief programmer in an operational situation. In addition to these part-time assistant programmers, there were four part-time students assigned to handle small jobs in programming.

Documentor - was primarily responsible for documenting the system. A constant documentation of procedures, programs and the changes relative to them is not only valuable to the development of any system, but also to the Network staff as a means of coordinating their efforts, and of keeping them informed of constant changes. This position could be incorporated into that of the chief programmer in an operational situation, and would be important in preserving records for any future development.

2.2 Materials Libraries

One of the main purposes of this Network was to provide better service to Local Materials Libraries' customers. To implement this a three-tiered Materials Library hierarchy was planned - Local, Regional, and Central.

If the local library (usually having a small collection and serving a small geographic area) could not fill one of its customer's requests, the Regional Library covering this area (one of several in the state servicing a large geographic area) would try to fill it.

If the request still could not be filled then the state's [CENTRAL BACKUP] library would try to fill it. See Figure 3 below.

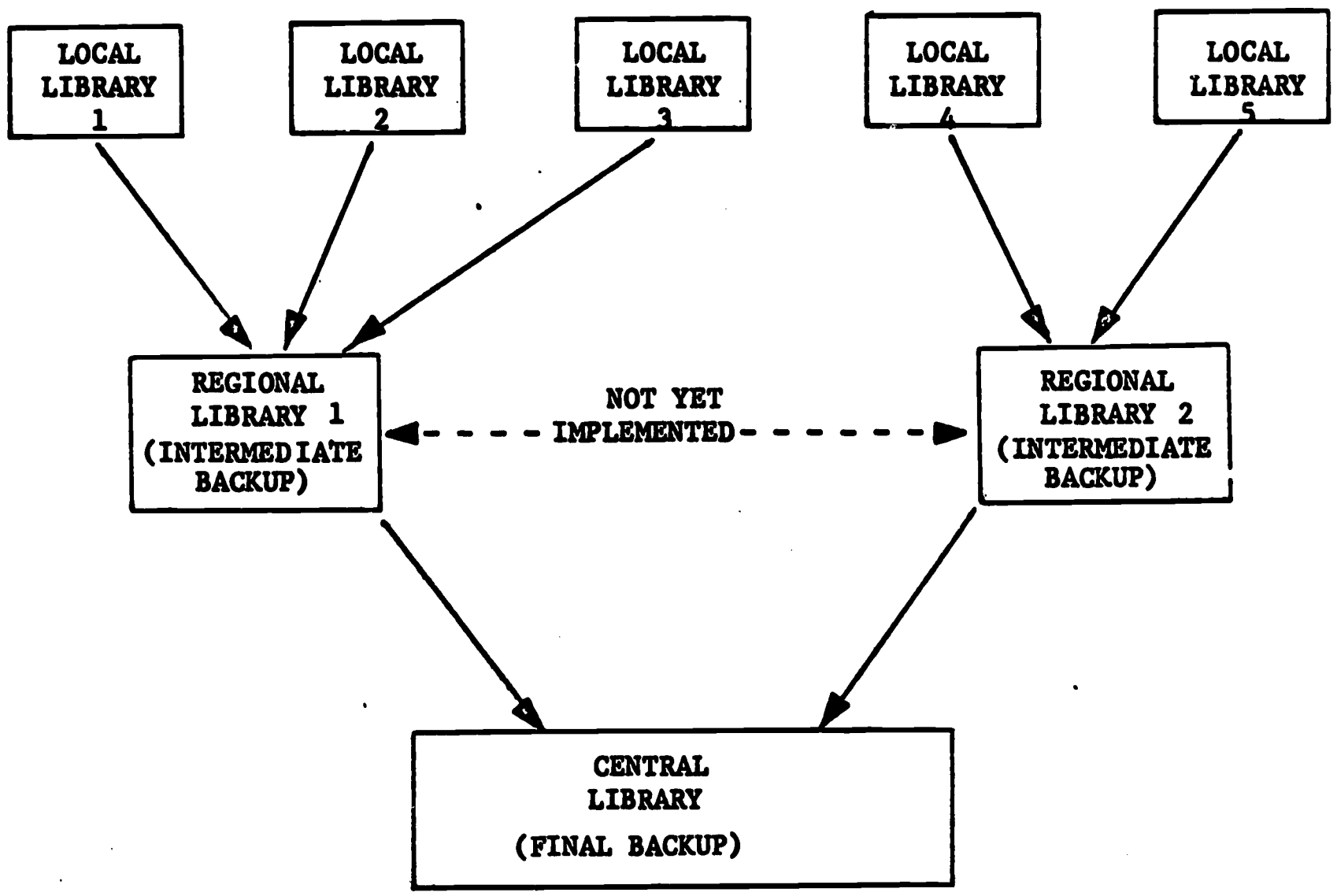


Figure 3. Three-tiered Materials Library Hierarchy.

2.2.1 Local Libraries

The three local libraries in this system were Boards of Cooperative Educational Services.

Interested school districts, in New York State, may unite and receive state aid to form a Board of Cooperative Educational Services. Such a Board, commonly called a BOCES, furnishes member districts with services they are unable to provide for themselves. One such service is frequently a film library. In general, BOCES areas correspond roughly to county boundaries.

The Network centered around the BOCES. These local libraries were generally staffed by a director, a librarian, 1-3 secretarial or clerical personnel (some working on a part-time basis), 1-2 film inspectors or packers, or both, and a delivery man.

Their film inventories ranged from 749 titles with 972 prints to 2137 titles with 2883 prints. Their yearly bookings ranged from 10,000 to 40,000. The number of districts serviced by each were 17, and the corresponding number of schools ranged from 83 to 130.

The following data was collected from each library, in order to store it on the computer's disk files, to prepare for the booking operation:

(a) Film titles with their corresponding number of duplicate prints
(b) Names and addresses of schools serviced by the library
(c) School calendars
(d) School delivery and pick-up schedules
(e) Manual bookings for the school year (needed to complete disk booking records, when computerized booking became operational after the start of the school year).

Procedures were set up (see User's Manual) whereby the libraries could use the computer to book their collections. A teletypewriter[2] was installed at each BOCES so that the booking librarian or secretary could communicate with the computer, at the Syracuse University Computing Center, which made the bookings.

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2 Teletypewriters are basically units consisting of keyboards, printers, paper tape punches, paper tape readers, and associated circuitry.

2.2.2 Regional Libraries

These libraries were to supply intermediate back-up on film requests which could not be made at the local libraries (BOCES). Each Regional Library would backstop all the BOCES covered by its assigned geographic area. In this system these were to be State University film rental libraries. Although plans were made in the System Design and appropriate fields were included in the files, Regional Libraries were not included in the current implementation due to a lack of time and money.

2.2.3 Central Library

The Central Library was the final backstop for booking film requests which could not be filled either at the BOCES library or the Regional Library. The original plan was to computerize the central library so that all its bookings, including those involving private customers (non-BOCES), could be made by the computer. In fact, this could not be done because there was no guarantee that funding would continue; consequently normal operations could not be disrupted to change procedures, and then six-months later when funds were exhausted, disrupted again to go back to the original procedures.

Instead each local library's title entry in the Short Catalog and Bookings File was coded to indicate whether it was backstopped at the Central Library or not. When back-up was required and the Central Library had the title, the computer printed out the customer number, film title and request date of the booking request at the Computing Center - for a manual backstop booking attempt at the Central Library. These requests were phoned to the Central Library once a day and confirmations and refusals were relayed back to the local library via the Computing Center's teletypewriter by system personnel. Later, when the films were to be used - they were mailed by the Central Library directly to the requesting schools. After use, the schools mailed them directly back to the Central Library.

To prevent confusion and to make the BOCES customer numbers compatible with the Central Library's customer numbers, each BOCES in the system was given a unique four-digit prefix. These were:

ERIE #1	8200
SUFFOLK #3	9200
WESTCHESTER #1	9900

These numbers identified the BOCES to the Central Library. When a request was referred, the customer number had the BOCES four-digit prefix added. In actual operation as a back-up source for three-months, the Central Library (Syracuse University Film Rental Library) received 1058 backstop requests from the largest BOCES in the system and filled 474 of them.

2.3 Hardware

Hardware consists of the physical components involved in the computer system such as the computer, tape drives, disks, etc.

2.3.1 Syracuse University Computing Center

The computerized system is currently being operated at the Syracuse University Computing Center, using an IBM System/360 Model 50 computer which has the following hardware configuration:

(a) one 2050 Processing Unit which provides 262K bytes (actual) of main storage, divided into four variable-sized partitions under the MFT-I (release 14.0) version of the OS/360 operating system; (the Network's system resides in an upper partition of 43,008 bytes);

(b) one 2314 Direct Access Storage Facility;

(c) six 2402 Magnetic Tape Units (four 9-channel and two 7-channel units);

(d) one 2540 Card Read Punch;

(e) one 1403-N1 Printer;

(f) various remote I/O devices linked to the computer by one 2848 Display Control Unit and one 2701 Data Adapter Unit containing an IBM Type 2 Adapter for teletype input.

2.3.2 Local Libraries (BOCES)

Each BOCES has a teletypewriter remotely connected to the computer via TWX service. This will be changed to Data-Phone or Wide Area Telephone Service (WATS) in the future.

2.4 Input/Output

Inputs and outputs (I/O) may be defined broadly as communication between a system and its users. More specifically, inputs are the means by which the user directs the system to work for him, and outputs are the results of that work, or processing. In this system, each specific set of inputs and outputs is said to be a transaction.

The Network's system is, or will be, capable of processing a variety of transactions -- in one or both of two modes of operation. The telecommunications mode provides immediate processing of transaction inputs; output occurs immediately after the input has been entered via the Teletype terminal. This mode handles transaction inputs entered in two fashions: single inputs entered manually (individual transactions of an urgent nature), and large numbers of inputs entered via paper tape on a daily basis (the collected transactions for the day). The batched mode will be non-immediate: transaction inputs will be prepared on punched cards, shipped to the site of the computer and processed, and output will occur on the computer's printer and will be sent back to the library.

2.4.1 Telecommunications

2.4.1.1 Terminals

The model 33 ASR Teletypewriter is the means by which the Network libraries communicate directly with the system. Basically, these units consist of a keyboard, printer, paper tape punch, paper tape reader, and associated circuitry. The keyboard has two sets of characters: a set of standard typographical characters, and a set of control characters. The depression of a given key causes the generation of an electronic code representing the character, which is transmitted over the line, and may cause the paper tape to be punched with a corresponding physical code.[3] Note, that the keyboard always causes the character which is keyed to be printed, except in the case of control characters, and that in similar fashion, the paper tape read/punch unit always causes the character read or punched to be printed.

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3 The Teletypes use the ASCII code.

2.4.1.2 I/O

The term telecommunications I/O refers to the input and output formats and activities which occur when the system is operating in the telecommunications mode. In general, telecommunications I/O may be broken down into three kinds of activities: the "handshake" in which communications between a terminal and the computer are initiated, the inputting of transaction data, and the putting out of results.

THE HANDSHAKE

The handshake procedure is identical for both the manual entry of individual transaction inputs and the daily entry of transactions via paper tape. Basically, the procedure involves (1) activating the Teletype, (2) dialing the number of the computer, and upon making the connection, (3) establishing the identity of the terminal. The last is accomplished through the computer issuing a WRU character, the Teletype responding with the HERE-IS character string (which contains the terminal ID), and the computer verifying the ID as belonging to a valid user of the system. Once the handshake is completed, the user may begin entering input data.

INPUT FORMAT CONVENTIONS

There are a number of conventions governing the entry of input to the Network's system. For the most part, they have to do with the various units of telecommunications input and the order in which certain kinds of data may be entered.

Unit Delimiters

The structure of telecommunications input may be regarded as a hierarchy of elements. The largest unit of input is a transmission which consists of a number of lines of input. Each line contains one or more messages (usually a message contains the input data of a single transaction), which is divided into fields of data, and the fields in turn may be broken down into subfields. In the Network's system, a variety of delimiters are used to define these units of telecommunications input -- they are shown in Figure 4, page 10. It is important to note that these delimiters denote the end of the various units, and are therefore placed after the unit they delimit. Furthermore, the delimiter for a given unit of input implicitly defines the end of all lesser units as well. That is, for instance, if the last entry in a line of paper tape input is a subfield, the end-of-line delimiter implicitly defines the end of the subfield, field and message as well as the end of the line. Hence, only the end-of-line delimiter need be entered.

The use of the subfield delimiter is straightforward, and the field delimiter is discussed in some detail in Document Number SD-004-0, System-1 Specifications - Inputs & Outputs (see Telecommunications I/O, Mandatory Fields and Optional Fields). The use of the transmission

delimiter is also straightforward, although it differs from the other unit delimiters in that it must be entered as a discrete message in a line by itself. The difference between the other two delimiters (the paper tape entry end-of-message delimiter and the paper tape entry end-of-line delimiter) lies in how the system reacts to each. When the Teletype is functioning on-line to the computer, the system reacts to each. When the Teletype is functioning on-line to the computer, the system reacts to the first kind of delimiter, ': (XF)(RØ)', by issuing three control characters[4]: '(RT)(LF)(XN)'. These characters cause a carriage return and line feed to occur, and enable the system to read the next message. When the system detects the second type of delimiter, the (RT) and (LF) characters are not issued, as the user has already provided them, '/(XF)(RØ)(RT)(LF)'. These two delimiters allow the user to enter more than one message (transaction) on each line of input prepared on paper tape. It should be recognized that the second type of delimiter (the paper tape entry end-of-line delimiter) is intended for use in paper tape input only, and should not be used in the manual entry of transactions.

DELIMITER	UNIT DELIMITED (manual entry)	UNIT DELIMITED (Paper tape entry)
-	subfield	subfield
/	field	field
:(XF)(RØ)	message & line	message
/ (XF)(RØ)(RT)(LF)	------	line
END/ (XF)(RØ)(RT)(LF)	transmission	transmission

Figure 4. Table of telecommunications input unit delimiters.

4 Control characters in input and output are represented by two-letter mnemonics enclosed by parenthesis. They are (LF) = LINE FEED, (RØ) = RUBOUT, (RT) = RETURN (carriage return), (XF) = X-OFF, and (XN) = X-ON.

Content Delimiters

In addition to the telecommunications input unit delimiters, there are four special delimiters which are used to denote the content of input messages (Figure 5). Unlike the unit delimiters, the content delimiters must precede the element delimited.

DELIMITER	ELEMENT DELIMITED
*	Comment message
@	Transaction code message
@@	Output mode message
/	Customer number message

Figure 5. Table of telecommunications input content delimiter.

The comment delimiter (*) is useful in that it allows the user to insert verbal comments in the text of his input. Any input message which has as its first character an asterisk is considered to be a comment message, and any message so delimited will be ignored by the system, although its content will appear on the Teletype-produced input/output listing.

The transaction code message (delimited by '@') is used to indicate to the system what kind of transaction input is about to be entered. The transaction code contained in the message is a four digit number consisting of two subfields: the first two digits denote the file against which the input is to be processed, and the remaining two digits indicate the function of the transaction. A complete transaction code message, then, has a format of '@FF-TT(XF)(RØ)(RT)(LF)'. Such a message defining the transaction type must always precede the input messages of any one kind of transaction.

EXAMPLE OF BOCES (Local Library) CONTACTING THE COMPUTER.

BOCES (Local Library) contacts	-	Syracuse by pressing and dialing	-	ORIG key (originate-a-call) 710/541-1546
COMPUTER	-	replies	-	SU COMP CTR
COMPUTER	-	issues	-	WRU character
BOCES (Local Library)	-	replies	-	***EINFL-001
			-	*36/4-29-68/ (Tape ID and date)
			-	*Comment message (See sample below)

SAMPLE:

SU COMP CTR

***EINFL-001

*36/4-29-68/

*CHNG EL SCH DEL SCHEDULE EFFECTIVE 5-13-68.

@17-73

/3-3-6:

Anything printed beyond the colon (:) is a computer response.

Booked on exact day requested, i.e., 510 (May 10).

Requested for 501, booked on 0508 (May 8).

2703/510:. (2) (BKD ON PRINT #2)
46682/501: 0508 (1) (BKD ON ALTERNATE DATE, ON PRINT #1)
57867/501:. (3) (BKD ON PRINT #3)

(REQUEST DAY)

(SYSTEM NBR., OR CATALOG NBR.)

(A 'SLASH' at the beginning of any line indicates to the computer that the data following is a customer number which consists of District, School, and Check Digit.)

('@' signals the computer that the user has entered a specific service transaction, i.e., @17-73 informs the computer that 'REQUEST NORMAL BOOKINGS' input follows.)

2.4.2 Transaction Codes

Transaction codes are required to specify the types of transactions which are being inputted to the computer so that the appropriate computer program can process them.

The following transaction codes represent only those which are currently implemented. More have yet to be added to the system.

(a) Update - request, capture, and cancel bookings.

(b) File Maintenance - add, delete, and change records.

(c) Display (Query) - print out the contents of fields and records specified by the user.

2.4.2.1 Update Codes

The following codes update the Short Catalog & Bookings File which is the one concerned with film booking.

TRAN. CODE	PURPOSE
@17-11	CUSTOMER BOOKING CANCELLATION
@17-12	LIBRARY BOOKING CANCELLATION
@17-71	CAPTURE NORMAL BOOKING (Captures bookings on the computer disk files which have previously BEEN MADE MANUALLY.)
@17-73	REQUEST NORMAL BOOKING (Attempts a booking on the requesting library's holdings. If it cannot be made there, then it attempts a booking at the central library, if the central library has a copy.)

2.4.2.2 File Maintenance

TRAN. CODE	PURPOSE
@17-31	ADD/REPLACE TITLE (Add a new title or replace an existing one.)
@17-32	ADD/SUBTRACT/REPLACE PRINTS (Add on to, or subtract from, or replace the total number of prints for a film.)
@17-98	LOAD KWIKBØØK (Used to capture historical records out of the Short Catalog & Bookings File for putting out statistical reports.)

2.4.2.3 File Display

TRAN. CODE	PURPOSE
@17-32	DISPLAY PRINTS (Displays number of prints on a given film.)
@17-91	DISPLAY OPEN RANGES (Displays all the available dates for a film.)
@17-92	DISPLAY BOOKED RANGES (Displays actual dates and customer numbers for periods the film is booked.)
@17-95	PREPARE SHIPPING LIST (Causes the film numbers with corresponding school numbers and delivery dates, on the day(s) requested, to be selected and sorted by delivery day, district, school, and film number (system number).
@17-99	DISPLAY SHIPPING LIST (Displays the shipping list prepared by @17-95 transaction code above.)

2.4.3 Batch Mode (non-immediate)

The Batch Mode of Input designed to handle large volumes of input when the processing results are not needed immediately has yet to be implemented. However, data punched on cards to look like teletype input (omitting non-printing control characters and inserting an '@' following the last character on a card) can be processed by the system in the Batch Mode.

2.5 Files

The Statewide Film Library Network is based on a real-time system of computer programs which operate on input submitted to the system, the output generated from the input, and various kinds of stored data about films, the Network libraries, and their customers. These four elements of the system - programs, input, output, and stored data - comprise the subject matter of the information that is stored in the files associated with the system.

2.5.1 Organization

2.5.1.1 Direct Access

A direct access file is one in which each physical record has a discrete location and a unique address. Thus, the records are stored in such a way that the location of any one record can be determined without extensive searching. Records can be accessed directly rather than serially.

The System has its own direct access routines which are simplified versions of the Input-Output routines which the computer manufacturer supplies. They allow the use of variable length records and blocks and always access a fixed physical block size of 256 characters (bytes). A variable number of actual (logical) records can be stored in a physical block. The routines also allow a file to have header records (fixed information stored in records on a file, i.e., title, film number, producer code, etc., in the Short Catalog and Bookings file; and detail records (varying numbers of transactions pertaining to a single header record, i.e., one record containing customer number, ship date, use date, etc., for each booking confirmed on a given title in the Short Catalog and Bookings file). All direct access files are stored on the 2314 disk unit and data can be retrieved from them in either the direct access or sequential mode.

2.5.1.2 Sequential Access

A sequential file is one where data must be accessed serially so that to retrieve a given record all the previous records must also be read. Thus, if a record is to be retrieved at the very end of the file, the entire file must be passed before it can be retrieved.

2.5.1.3 Partitioned Access

A partition access file is a file which is broken up into several sequential sub-files. A directory is set up containing the name and start address of each sub-file.

2.5.2 Types

2.5.2.1 System Programs

Since the system normally operates on a real-time basis in a relatively small partition of main storage in the S/360 computer, and since the total main storage required for all the system's programs far exceeds the 43,008 bytes of storage available in the partition, the system's programs are broken into a large number of modules which are stored on disk and usually are called into the partition only as they are required. Thus, the system's programs and associated information comprise one category of files associated with the system.

2.5.2.2 Input/Output

The input and output which the system user sees is substantially different, in form, from what the S/360 computer and the Network's system require for internal manipulations. There exists, then, a set of programs which perform transformations (editing) on all input submitted to the system and all output emitted by the system. In order that the system's input and output be flexible with respect to format and content, these editing programs are generalized in that they are interpretive; that is, these programs use

computer-stored tables describing the various input and output formats in performing the editing functions. Also, since certain operations performed by the system's programs involve information stored in the data files, tables exist which similarly describe the formats of the various data files. These descriptive tables for input, output, and data file formats comprise another category of files associated with the system.

2.5.2.3 Data

The data files contain all the various kinds of information about the libraries, library customers, films, and bookings that are necessary to the functioning of the Network. The records in these files are described with respect to both format and content by a collection of tables, and consequently their formats are modified with relative ease.

2.5.3 List of Files

2.5.3.1 Direct-Access

Additions File

FILE USE: This file is used to contain pointers to all records added to direct-access files over a day's operations - it is a means for maintaining the logical sequence of records in those files. For a detailed description of the file use, see Document #SD-003-0, Section 3.1, Direct-Access Files - FILE UPDATING.

Master Catalog File

FILE USE: This file serves as a primary information source for materials contained in the collections of the Network libraries; it functions as a union-list of materials that are available within the Network. While the file currently contains only records of films, provisions have been made so that other forms of educational media may be represented.

Main File Descriptor Tables File

FILE USE: This file contains data used by the programs (EIØMØD and its member programs) which perform the various editing functions in reformatting both internal input records from input messages and internal output records from data stored in the data files, for all transactions processed against the data files. In addition, information contained in these tables is used by some of the programs which process the file maintenance transactions.

Character Record Maps File

FILE USE: This file is used by some of the programs from EIØMØD which perform two of the principal transaction I/O editing functions: the reformatting of internal input records from telecommunications input messages, and the generation of internal output records from data stored in data files and program work areas and communications sections in main storage.

Film Library Tables File

FILE USE: This file is used to store daily and cumulative input statistics, parameters, and variables needed for various routines by Library. In addition, information needed for processing booking requests such as: school, calendars and delivery tables.

Film Number Cross-Index File

FILE USE: This file is used for processing input from those libraries who use their own catalog numbers instead of system numbers for identifying film. It cross-references these two numbers.

Customer Information File

FILE USE: This file's primary use is in processing booking requests and preparing output from such processing; secondary use is as a limited customer information source.

Short Catalog & Bookings File

FILE USE: This file's primary use is for processing booking requests. Header records contain constant information about each film such as: title and film number. Detail records contain booking information on films including customer number and request day.

2.5.3.2 Sequential-Access

System Backup Files

FILE USE: The principal purpose of the file is to provide a back-up for all the direct-access files in the event of a drastic error by the system's programs, the computer's hardware, or the computer's software. It recreates all direct-access files at the beginning of each day's operations which results in increased system efficiency.

Input File

FILE USE: The file is used as a holding place for the internal input records until such time as the batched processing of the records is to be performed. Just prior to the actual processing of these transaction inputs, a sort is performed on the key information (the sort key fields) of all the records in the file, in order to properly sequence the records for the processing programs.

Output File

FILE USE: The file is used temporarily to store internal output records prior to their being emitted via the Teletype terminal or the S/360 printer. These include output records which must be sorted and emitted on the S/360 printer as a series of reports[5],

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5 The reader is reminded that the portion of the system which handles batched mode operations has not been implemented at this time.

information display transactions resulting from use of telecommunications mode which requires computer-printed output, and output records from information display transactions that require their output be sorted prior to being printed via the Teletype terminal (e.g., the Generate Shipping List transaction).

2.5.3.3 Partitioned Access

Program Source Decks File

FILE USE: A file to retain various program source decks.

Program Library (load modules)

FILE USE: During all phases of operation, the system resides in a 43,008-byte upper partition of main storage. Of this available storage, approximately 20K bytes is required by the system's Executive at all times: the Executive is loaded by OS/360 at operator command at the beginning of each day's operations, and is not released until the day's operations have been concluded. The remaining 23K bytes of main storage must be utilized by the system's other processing programs and their associated tables and communications sections. As a result of the limited storage available, the programs and tables are stored on disk and are called into the partition only when they are required. This file contains <u>all</u> the system's programs in load module form.

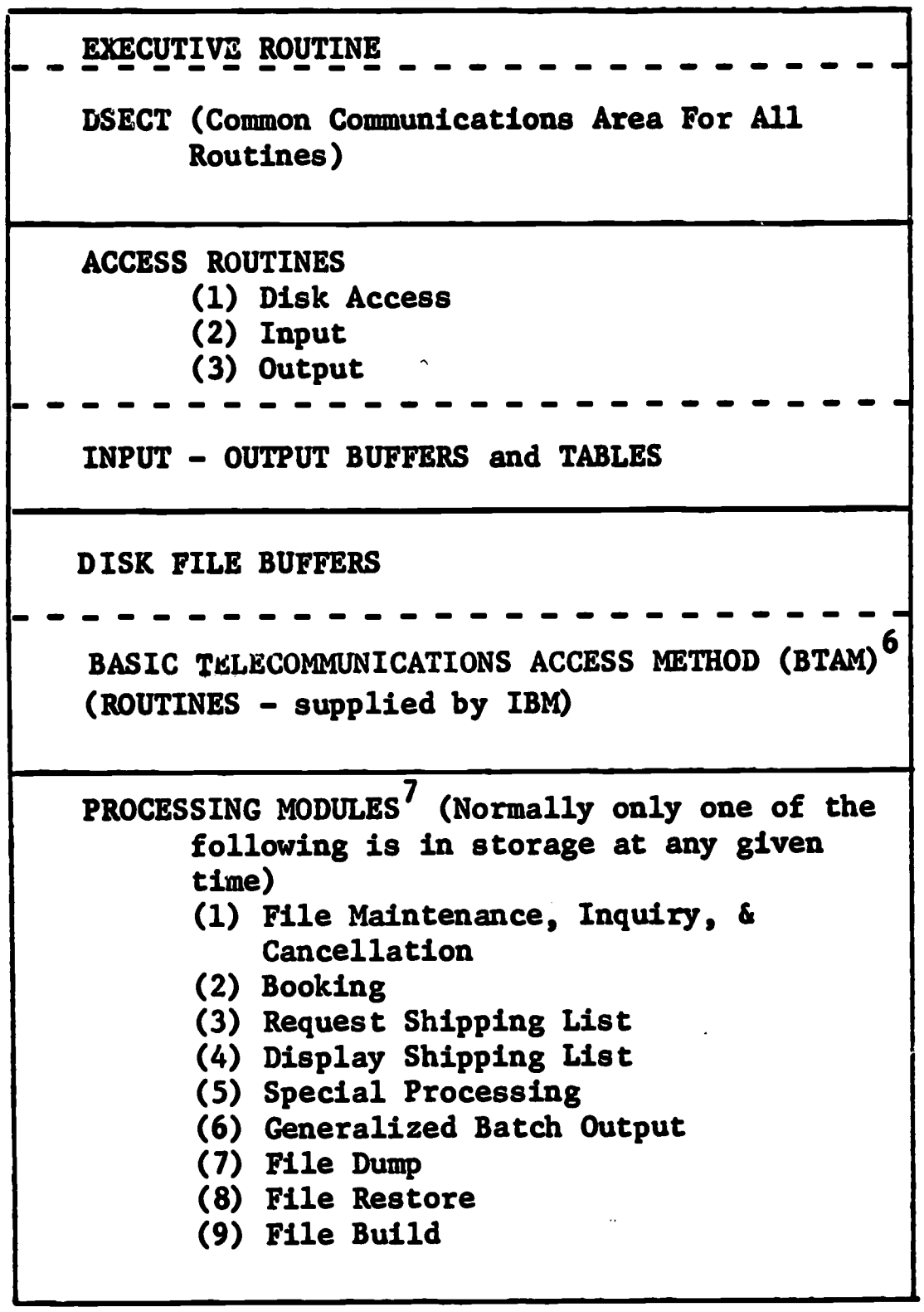
2.6 Software

Software can be broadly classified as the sequence of instructions (program) needed to direct a computer to do a particular job. Materials Library System Software consists of a number of <u>integrated</u> program routines which involve executive, access and processing functions (see Figure 6, page 19). All software has been written in 360 Assembler Language except where noted.

Figure 6

MATERIALS LIBRARY SYSTEM SOFTWARE

(Showing routines, tables & buffer areas as located in core storage of computer.)



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6 When input is via card or tape - instead of teletypewriter, BSAM (Basic Sequential Access Method) replaces BTAM.

7 A module consists of one or more program routines read into core storage as a unit by the program loader, i.e., Booking module.

2.6.1 Executive functions

Executive Routine — controls the loading of processing routines.

2.6.2 Access functions

These are made up of: input, output, and disk access routines; and are used primarily for accessing or writing data. The following programming routines are included in the Access functions.

Input Routine -- reads input, uses transaction tables to decipher the fields present on the teletype message; audits data for validity, and on user option checks for valid ranges and performs special processing on data (i.e., dates inputted to computer are of the form MMDDY, internally they appear as DDD so that 01029 could appear as 002 internally), converts data to internal form, and formats internal records.

Output Routine -- prints out computer responses on the teletype or on the computer's high-speed printer, or both; dependent on an input parameter (mode code).

Disk Access Routine -- reads and writes records to and from disk, either sequentially or randomly; and issues error messages for missing, duplicate, or unreadable records.

BTAM -- Basic Telecommunications Access Method - handles the input/output interface between the telecommunications data transmission devices and the programs of the Network's system.

2.6.3 Processing functions

These are composed of routines which actually manipulate data to perform some specific task. Only one processing module is normally in computer storage at any given time because of storage limitations.

2.6.3.1 INTEGRATED ROUTINES

File Maintenance, Inquiry, & Booking Cancellation -- adds, deletes and changes records on the disk files. It also prints out the contents of certain data fields, open booking ranges and booked ranges for a film. In addition, it cancels bookings on user request.

Booking -- attempts to book a film on the exact day, on the alternate day if given, or within a specified range. The output message consists of: a confirmation, a refusal, or a referral -- leading to a backstop booking attempt at the Central Library.

Shipping List Request -- prepares a shipping list on user request by selecting bookings to be shipped in the period requested, and then calls the standard IBM supplied sort to sequence the output by Ship Day, District, School, and Film Number.

Shipping List Display -- transmits shipping list to USER (film library) on request. Needed because the sort used in the previous transaction overlays BTAM causing the USER to be disconnected. Hence, he must call back to obtain his output.

Generalized Batch Output -- based on report code -- formats and prints detail records with accompanying intermediate and summary totals, by report. The data for the reports is stored sequentially on disk in report code major sequence.

Special Processing -- provides a shell for the writing of program routines to take care of unanticipated situations, i.e., KWIKBØØK Routine which was written to capture historical booking information, in order to have a complete statistical report for a film library.

The following processing routines use card and magnetic tape input; hence, cannot be read in via teletype console. They must be read in through the normal IBM job stream with the use of Job Control Cards.

File Dump -- dumps disk files onto tape in a sequential fashion, so that both the physical and logical sequence of the records written onto tape become identical. Used to reorganize files and for back-up.

File Restore -- loads files onto disk from tape.

File Build -- converts external file records from card or tape into the system's internal format and then inserts them onto disk storage, thus creating a new file.

2.6.3.2 STAND-ALONE-PROGRAMS

In addition to the above processing routines, there are three stand-alone-programs which operate independently of the executive routine, and are entered via the normal IBM job stream instead of through the teletypewriter. All three of these programs are run on request. The first two were written in PL-I. (None of these programs are shown in Figure 6, because they are not integrated with the other system software.)

MASTER CATALOG FILE MAINTENANCE PROGRAM -- inserts, deletes, changes and lists records on the Master Catalog File. This file is kept on magnetic tape and is not compatible with the disk access routines. Several variations of this program were used to:

(a) Select input to generate the Short Catalog File by library.

(b) Select input to generate inventory cards and computer grids by library; collect historical booking information for the Statistics II program below.

LIBRARY STATISTICS II PROGRAM -- run by library -- gives a summary line of output per film, listing film name, system number, producer number, number of prints, and various usage statistics. Summary totals by library are also provided.

USER STATISTICS I PROGRAM -- gives summary usage statistics by Library, by District, by School.

3. SYSTEM STANDARDIZATION

In any system, standardization is a primary consideration. In the materials-scheduling-system, standardization was attempted in the areas of coding, procedures, reporting and programming.

3.1 Coding

Information is generally coded in order to:

(a) uniquely identify it,
(b) facilitate its handling, and
(c) facilitate its retrieval.

The coding method used can be a very simple one. For example, the Film Titles in the materials system are each identified by a unique six-digit sequential number, 'AUTUMN ON THE FARM" is identified as '004480'. New film titles receive the next available sequential number.

On the other hand, the coding method used can be quite complex. In coding system customers, the numeric code of the form 'LLLDDSSTT' must identify the materials library (LLL), the district (DD), the school (SS), and optionally the teacher (TT). For example, customer number 002 01 07 08 would have the following encoded "intelligence" --

002 - Westchester #1 BOCES,
01 - District (Cortland 3 - Montrose),
07 - Furnace Woods School, and
08 - Teacher Carolyn Bronik.

Generally, the more complex the coding structure -- the more digits[8] are needed to represent the data. In the last example, if the system contained 5,000 customers (teachers), each of which were assigned a sequential number starting with '1', the customer code would only require 4 digits (0001 - 5000) instead of the '9' digits actually used. However, there would no longer be the added "intelligence" of having the Library, District, and School codes included in the customer number.

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8 Coding can be done with alpha-numeric characters instead of digits alone. In the Network, this has generally been avoided because of the added difficulties involved in processing alpha-numeric data within the computer.

In designing a code to represent a given data element (field) such as the film title or customer name above, a compromise is usually involved between built-in-intelligence (when needed) and minimization of digits.

Standardization of coding has been implemented in the areas of System Numbers, customer numbers, producer numbers, Short Film titles, and media codes.

3.1.1 System Numbers

In order to uniquely identify each media item (film) in the system a '5' digit sequential number followed by a '1' digit check digit[9] was used. The sequence started at '00001' and extended up to the current number of items contained in the system. Whenever a new item was entered into the system, it received the next sequential number not previously assigned and the check digit was calculated by the computer. A sequential system number was used because it was the simplest way to uniquely identify an item. Furthermore, there would never have to be any changes to these numbers due to a new item being added at a point where no available number exists, i. e., if this number represented an alphabetic title sequence and a new title 'A PARIS', whose alphabetic sequence number fell between '00002' and '00003', was entered in the system, then numbers '00003' and '00004' would have to be changed to '00004' and '00005' respectively in order to create an opening ('00003') to maintain the correct alphabetic sequence number. See page 23a.

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9 The check digit is generated by the computer from the '5' digit sequential number based on the following formula (only the last digit of each expression is used in the calculations):

F (check digit) = 10 - [2 (A+C+E) - (B+D)] where ABCDE represents the system number with 'A' being digit '1', 'B' digit '2', etc. The entire system number then becomes 'ABCDEF'. The check digit is used by the computer to catch transpositional errors made by users who are inputting fields which contain check digits. I.e., if a teacher is ordering 'AUTUMN ON THE FARM' which has a system number of '004480', where the last digit (0) is the check digit (computed as follows:

F = 10 - [2 (0+4+8) - (0+4)]
F = 10 - [4 - 4]
F = 10 - 0 = 0) and she transposes digits 'four' and 'five' and orders 004840 instead, the check digit which the computer calculates

A C E B D
F = 10 - [2 (0+4+4) - (0+8)]
F = 10 - [16 - 8]
F = 10 - [-2] = 12 is not the same as the actual check digit (0) in the input system number. An error message will then be typed out by the computer.

OLD ALPHA SEQUENCE NUMBER	TITLE	NEW ALPHA SEQUENCE NUMBER	TITLE
00001	A IS FOR ARCHITECT	00001	A IS FOR ARCHITECT
00002	A IS FOR ATOM	00002	A IS FOR ATOM
00003	A TRAVELERS PARIS	00003	A PARIS
00004	ABC OF HANDTOOLS	00004	A TRAVELERS PARIS
00005	ABACUS	00005	ABC OF HANDTOOLS
		00006	ABACUS

NEW TITLE ADDED HERE

If the Network is used for additional media, then the system numbers can be repeated within media code.

3.1.2 Customer numbers

These numbers are used to identify the customers in the system. Built into the number is the Local Library (LLL), District (DD), School (SS) and optionally the Teacher (TT) codes (LLLDDSSTT). If the teacher number is omitted, then the remaining '7' digit number represents the school. See example on page 22, Section 3.1. Within BOCES (LLL), the District repeats itself, i.e., 00101, 00102, 00103. Within the BOCES & District, the School repeats itself, i.e., 0010101, 0010102, 0010103, etc. If the first digit of the BOCES number is a '0', it is a local library, if a '1' it is a regional library, and if a '2' it is the central library.

When the user enters the Customer Number via the teletypewriter, then a check digit is associated with the District and School numbers to protect against transposition errors. I.e.,

/1-7-8/6*:

where the first SLASH (/) indicates that this is a customer number, the '1' represents the District (DD), the '7' represents the School (SS), the '8' represents the Check digit (C), the SLASH (/) represents the end of the school number, the '6' represents an optional Teacher's number (TT), and the COLON (:) represents the end of the customer number. The HYPHENS (-) separate subfields. The BOCES number (LLL) is not shown in the above example because it is only entered once at the beginning of the transmission from that BOCES.

3.1.3 Producer numbers

These '3' digit numbers are used to identify the film producers.

They were originally assigned by SUFRL (Syracuse University Film Rental Library) according to alphabetical sequence. Major producers were assigned to producer numbers 300 (CORONET), 400 (ENCYCLOPAEDIA BRITANNICA), and 500 (MCGRAW-HILL) to facilitate sorting on unit record equipment.

Additional producers were assigned vacant alphabetical sequence numbers and when these were filled, sequential numbers as acquired.

3.1.4 Film Short Titles

These '18' character fields represent abbreviated Film Titles. They have been set up to insure a uniform abbreviated title within the system and are used both for ease of storing on cards and handling within the computer.

Most of these abbreviations have been adapted from SUFRL's short titles.

3.1.5 Media Codes

These codes are used to identify media. Due to the fact that the system only handled film, these codes were not used; but, as an off-shoot of this project -- media codes were developed by Charles Bidwell, titled 'Standards for Cataloging, Coding and Scheduling Educational Media'.

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* An ASTERISK indicates an optional field.

3.2 Material Library Procedures

3.2.1 Entering a library into a system --

All libraries have to provide the same information, namely:

(a) Inventory records of all film titles circulated to schools,
(b) Inventory listing of all duplicate copies of films,
(c) Listings of all film booking records,
(d) Listings of all school calendars and holiday schedules,
(e) Listings of delivery and pick-up schedules,
(f) Listings of all districts and schools serviced and school mailing addresses.

3.2.2 Servicing a library in the system --

All libraries in the system have the same general formats for:

(a) Booking Requests,
(b) Inquiries,
(c) Cancellations,
(d) Shipping lists.

These result in uniform system usage statistics, see Figure 1, page 2.

3.3 Reporting

All reports in the system including the Bookings and Refusal, Statistics II, and the User Statistics programs, mentioned earlier, are identical in format for all local libraries.

3.4 Programming

All random-access files have the same physical block sizes and are accessed by the same access routine.

The Main File Descriptor Tables file has an entry for each field in the system, by file. Included in the entry are field system name, start position in record, and length. Any field can be retrieved by a single program routine which interprets these entries.

4. SYSTEM COSTS

4.1 Research & Operational Costs (involving three libraries for a 1-year period).

Personnel:		
Full-time (See pages 3 & 4)	$ 33,500.00	
Part-time (See pages 3 & 4)	$ 22,600.00	
		$ 56,100.00
Hardware:[11]		
Computer Cost[12]		
Research	$ 35,000.00	
Production Upper Partition (Telecommunications)	$ 400.00	
Production Lower Partition	$ 5,000.00	
IBM Type 2 Adapter (Teletype to computer interface)	$ 1,800.00	
IBM 2701 Data Adapter	$ 6,400.00	
		$ 48,600.00
TWX & Data-Phone Charges:		
Rentals (Control Ctr. & 3 Libraries), @ $1200 -	$ 4,800.00	
Line Charges, approx. 3800 minutes, for three libraries	$ 3,600.00	
		$ 8,400.00
Equipment:		
Keypunch (from 4/4/67 to 1/27/68)	$ 641.00	
		$ 641.00
Travel:		
Average per month - $117.00 -	$ 1,400.00	
		$ 1,400.00
Office Expenses:[13]		
Postage (Aver. per mth. $14.00)	$ 168.00	
Telephone (" " " $ 9.00)	$ 108.00	
Misc. Supplies (" " $24.00)	$ 288.00	
Misc. Services (" " $85.00)	$ 1,020.00	
		$ 1,584.00
Total Cost		$116,725.00

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11 Some of these costs were absorbed by the Computing Center because the research project operated on a six-months, no-cost, extension.

12 Used $5000 of $40,000 computer cost @ rate of $360.00 per hour.
Used $35,000 of $40,000 computer cost @ rate of $240.00 per hour.

13. Does not include overhead on full-time personnel; nor expenses incurred in the processing, duplicating, & mailing of reports and technical documents.

4.2 Costs for An Individual Library

4.2.1 Preparation Cost

Cost to capture all titles on booking records, preceding entry into Network, is $1.00 per item.

4.2.2 Operating Costs (for one year)

TWX INFORMATION:

The computer handles, in remote batch mode, an average of:

10 bookings per min.	=	6 seconds/per booking
1000 bookings require	=	100 minutes of transmission time
100 mins. of trans. x $.30 *	=	$30.00 approximate cost of line charges to transmit 1000 bookings.

If a library had 40,000 bookings to transmit in the school year, the cost using TWX lines would be:

40 x $30.00 = $1200.00 for line charges.

Therefore, adding both the approximate costs of line charges and Teletype-writer rental fees, the cost for a local library for one year would be:

$1200.00 + $1200.00 = $2400.00 total cost of TWX operation.

Each library can figure its approximate cost of TWX operation by using area scale below.*

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* TWX SERVICE - 1 minute minimum charge, from Syracuse, N. Y.

BUFFALO (ERIE #1)	$.30
CORTLAND	$.20
HUNTINGTON (SUFFOLK #3)	$.35
ITHACA	$.20
NORTH COLLINS	$.30
SYRACUSE	$.10
YORKTOWN HGTS. (WEST #1)	$.30

NOTE: The cost will be different if either Wide Area Telephone Service (WATS) or Data-Phone is used.

5. SYSTEM LIMITATIONS

Due to false starts, a lack of personnel, time, and money -- the materials system has the following limitations:

(a) The three-tiered booking routine has only been implemented fully at its lowest level (local libraries). The regional libraries back-up booking section has not been implemented; and the central library back-up booking section has only been partially implemented (being primarily a manual operation). All the necessary codes to complete the implementation have been provided for in the files.

About five man-months would be necessary to complete this routine.

(b) The Batch Mode Input/Output routine involving cards or tape, instead of teletype, has not been implemented.

About two man-months would be necessary to complete this routine. (A user can still use this mode if he prepares his input cards in teletype input format, excluding all control characters and inserting an '@' following the last character on a transaction.)

(c) The Generalized Report routine has not been fully debugged.

About two man-months would be necessary to complete this routine.

(d) Currently, only one telephone line is connected to the computer. If a second user tries to call when it is being used, he will get a busy signal. If the system goes beyond 'ten' libraries, more lines into the computer will be needed; so that the users can receive better service. Any additional lines will require a major one-time-modification to some of the existing routines in the system.

About four man-months will be needed for this modification.

(e) The Generalized File Maintenance routine is incomplete. Work on this routine is currently in process for another project and should take about two man-months to complete.

(f) The system's main programs and routines are written in 360 Assembler Language. Hence, implementing the computer program portion of this system on another computer would involve rewriting the programs in another language. However, because the programs are mainly interpretive (operate on control parameters each time they access data, rather than access it directly) the reprogramming effort would be reduced considerably.

6. SYSTEM EXPANSION CAPABILITIES

This system was designed for expansion. Each file in the system has parameters which indicate its name, size, record length, etc., and each field within a file has a packet giving parameters including name, start position in record, size, mode code (alpha or numeric data), etc. Accessing information in the disk files consists mainly in interpreting these packets. Only one generalized disk access routine is needed to access any current or future disk file in the system.

With the system organization in mind, the following expansion capabilities are suggested:

(a) The system can be set up to process multi-media materials with a minimum of changes.

(b) The system can then be set up to search for multi-media materials in a given subject area and print out a listing of the materials satisfying this request together with the days that these materials would be available for booking.

(c) The system can be made into a data management system which would allow extensive variations on the types of inquiries (information retrieval), processing, file maintenance, and statistical reports possible in the system.

(d) The system can be modified to allow sharing of materials between local libraries.

APPENDIX A

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