HISTORY OF LIBRARY COMPUTERIZATION

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The history of library computerization from its initiation in 1954 to 1970 is described. Approximately the first half of the period was devoted to computerization of user-oriented subject information retrieval and the second half to library-oriented procedures. At the end of the period on-line systems were being designed and activated.

This historical scrutiny seeks the origins of library computerization and traces its development through innovative applications. The principal evolutionary steps following upon a major application are also depicted. The investigation is not confined to library-oriented computerization, for it examines mechanization of the use of library tools as well; indeed, the first half-dozen years of library computerization were devoted only to user applications.

The study reveals two major trends in library computerization. First, there are those applications designed primarily to benefit the user, although few, if any, applications have but one goal. The earliest such applications were machine searches of subject indexes employing post-coordination of Uniterms. Nearly a decade later, the first of the bookform catalogs appeared that made catalog information far more widely available to users than do card catalogs. Finally, networks are under development that have as their objective availability of regional resources to individual users.

The second trend is employment of computers to perform repetitive, routine library tasks, such as catalog production, order and accounting procedures, serials control, and circulation control. This type of mechaniza-

tion is extremely important as a first step toward an increasingly productive library technology, which must be an ultimate goal if libraries are to be economically viable in the future (1,2).

Historical studies of library computerization have not yet appeared, although some reports beginning with that of L. R. Bunnow (3) in 1960 contain valuable literature reviews. Both editions of *Literature on Information Retrieval and Machine Translation* by C. F. Balz and R. H. Stanwood (4,5) are extremely useful. In addition, J. A. Speer's *Libraries and Automation* (6) is a valuable, retrospective bibliography of over three thousand entries.

ORIGINS

The origins of library computerization were in engineering libraries newly established in the 1950's and employing the Uniterm coordinate indexing techniques of Mortimer Taube on collections of report literature. The technique of post-coordination of simple index terms proved most suitable for computerization, particularly when the size of a file caused manual manipulation to become cumbersome.

Harley E. Tillitt presented the first report, albeit unpublished at the time, on library computerization at the U. S. Naval Ordnance Test Station (NOTS), now the Naval Weapons Center at China Lake, California. The report, entitled "An Experiment in Information Searching with the 701 Calculator" (7), was given at an IBM Computation Seminar at Endicott, New York, in May 1954. The system was extended and improved in 1956, and a published report appeared in 1957 (8). Tillitt subsequently published an evaluation (9).

The NOTS system mimicked manual use of a Uniterm card file. This noteworthy system could add new information, delete information related to discarded documents, match search requests against the master file, and produce a printout of document numbers selected. Search requests were run in batches, thereby producing inevitable delays that caused user dissatisfaction. When the user did receive results of his search, he had a host of document numbers that he had to take to a shelf list file to obtain titles. Subsequent system designers also found that a computerized system could cause user dissatisfaction if it did not speed up and make more thorough practically all tasks. Because use of the system dwindled, it was not reprogrammed for an IBM 704 that replaced the 701 in 1957. However, a couple of years later, when an IBM 709 became available, the system was reprogrammed and improved so that the user received a list of document titles (10).

Tillitt, Bracken, and their colleagues deserve much credit for their pioneer computerization of a subject information retrieval system. The application required considerable ingenuity, for the IBM 701 did not have built-in character representation. Therefore it was necessary to develop subroutines that simulated character representation (11). Moreover, the 701 had an

unreliable electrostatic core memory. On some machines the mean time between failures was less than twenty minutes (12).

In September 1958, General Electric's Aircraft Gas Turbine Division at Evendale, Ohio, initiated a system on an IBM 704 computer (13) that was similar to the NOTS application. Mortimer Taube and C. D. Gull had installed a Uniterm index system at Evendale in 1953 (14,15). The GE system was an improvement over the then-existing NOTS system because it printed out author and title information for a report selected, as well as an abstract of the report. Like the NOTS system, however, the GE application provided only for Boolean "and" search logic.

The celebrated Medlars system (16) encompassed the first major departure in machine citation searching. The original Medlars had two principal products: 1) composition of *Index Medicus;* and 2) machine searching of a huge file of journal article citations for production of recurrent or on-demand bibliographies. The system became operational in 1964.

The NOTS and GE systems coordinated document numbers as listed under descriptors. Medlars departed from this technique by searching a compressed citation file in which each citation had its descriptors or subject headings associated with it. The Medlars system also provides for Boolean "and," "or," and "not" search logic.

The next major development was DIALOG (17), an on-line system for machine subject searching of the NASA report file. Queries were entered from remote terminals. The SUNY Biomedical Communication Network constitutes an important development in operation of machine subject searching and production of subject bibliographies of traditional library materials. The SUNY network went into operation in the autumn of 1968 with nine participating libraries (18). Its principal innovation is on-line searches from remote terminals of the Medlars journal article file to which book references have been added. The SUNY network eliminates the two major dissatisfactions with the NOTS system and all subsequent batch systems, in that it provides the user with an immediate reply to his search query.

CATALOG PRODUCTION

In 1960, L. R. Bunnow prepared a report for the Douglas Aircraft Company (3) in which he recommended a computerized retrieval system like the NOTS and GE systems that would also include catalog card production. Bunnow's proposal was perhaps the first to contain the concept of production of a single machine readable record from which multiple products could be obtained, such as printed catalog cards and subject bibliographies produced by machine searching. Catalog card production began in May 1961 (19), the cards having a somewhat unconventional format and being printed all in upper-case characters as shown in Figure 1. Cards were mechanically arranged in packs for individual catalogs, and alphabetized within packs—an early sophistication. Accompanying the

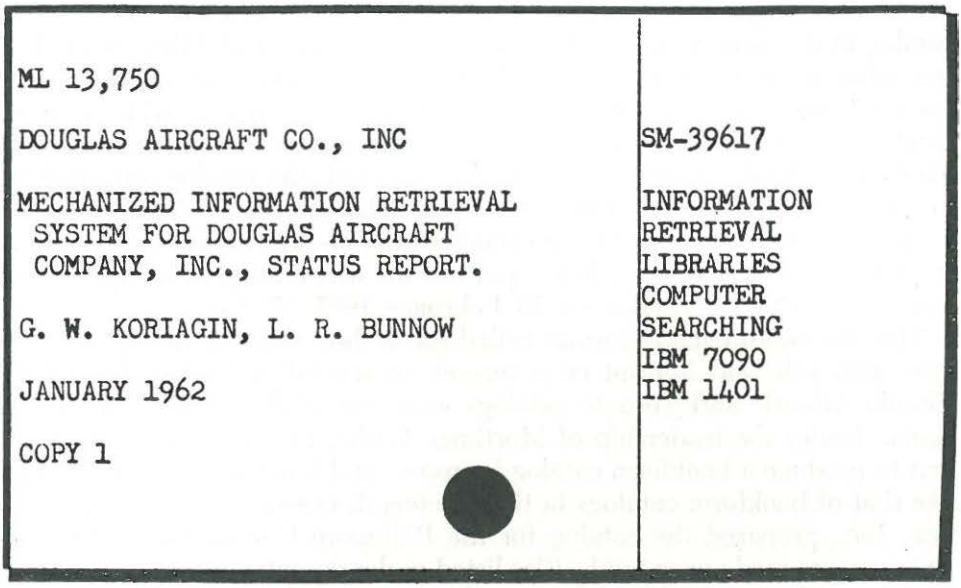

Fig. 1. Sample Catalog Card.

production of catalog cards was production of accession lists from the same machine readable data.

The next development in catalog card production occurred at the Air Force Cambridge Research Laboratory Library, which began to produce cards mechanically in upper- and lower-case in 1963 (20). A special computer-like device called a Crossfiler manipulated a single machine readable cataloging record on paper tape to produce a complete set of card images punched on paper tape. This paper-tape product drove a Friden Flexowriter that mechanically typed the cards in upper- and lower-case. Two years later, Yale began to produce catalog cards in upper- and lower-case directly on a high-speed computer printer (21). The Yale cards were also arranged in packs, as had been those at Douglas, but were not alphabetized within packs.

The New England Library Information Network, NELINET, demonstrated in a pilot operation in 1968 a batch processing technique servicing requests from New England state university libraries, via teletype terminals, for production of catalog card sets, book labels, and book pockets from a MARC I catalog data file (22). The NELINET system became operational in the spring of 1970 employing the MARC II data base. Also in 1968 the University of Chicago Library brought into operation catalog card production with data being input remotely on terminals in the Library, and cards being printed in batches on a high-speed computer printer centrally (23).

Bookform catalogs began to appear in the early 1960's, and it appears that the Information Center of the Monsanto Company in St. Louis, Missouri, published the earliest report on a bookform catalog that it had

produced by computer in 1962 (24,25). The Center discontinued its card catalog in the same year. Book catalogs can increase availability of cataloging information to users while reducing library work, and the Monsanto book catalog is an example of such an achievement, for it provides a union catalog of the holdings of seven Monsanto libraries, and is produced in over one hundred copies. As would be expected, the catalog appeared all in upper-case. However, in September 1964 the Library at Florida Atlantic University produced a bookform catalog in upper- and lower-case (26) and the University of Toronto Library put out the first edition of its upper- and lower-case ONULP catalog on 15 February 1965 (27,28).

The Monsanto catalog format called for author and call number on one line, with title and imprint on a second, or second and third, line. Both Florida Atlantic and Toronto catalogs were essentially catalogs of catalog cards. Under the leadership of Mortimer Taube, Documentation, Inc. was first to produce a bookform catalog in upper- and lower-case, with a format like that of bookform catalogs in the nineteenth century (29); Documentation, Inc., prepared the catalog for the Baltimore County Public Library. Entries were made once, with titles listed under an entry if there were more than one. The Stanford bookform catalog appeared late in 1966, introducing a new type of unit record, whose first element is the title paragraph.

H. P. Luhn proposed selective dissemination of information (SDI) in 1958 (30), and perhaps the first library application of SDI was in the spring of 1962 at the IBM library at Owego (31), where special processing was given to new acquisitions for input into the SDI system. At about the same time, the library of the Douglas Missile & Space Systems Division instituted an SDI system that employed as input a single machine readable record from which catalog cards and accessions lists were also produced (32).

The introduction of SDI into library operation is a major, historic innovation, for SDI is a routine but personalized service in contradistinction to the depersonalized library service characteristic of all but the smallest libraries. Selective dissemination of information is one of the few examples of library computerization that takes full advantage of the computer's ability to treat an individual as a person and not as one of a horde of users.

CIRCULATION

The Picatinny Arsenal reported the first computerized circulation system (33). The Picatinny application produced a computer printed loan record, lists of reserves, overdues, lists of books on loan to borrowers, and statistical analysis, in a system that began operation in April 1962. The charge card at Picatinny was an IBM punch card into which was punched the bibliographic data and data concerning the borrower each time the book was charged. In the fall of 1962, the Thomas J. Watson Research Center (34) activated a circulation system much like the Picatinny system, except that bibliographic data was punched into a book card by machine, but information about the borrower was manually punched.

The next step forward occurred at Southern Illinois University (35), where a circulation system like the two just described began limited operation in the spring of 1964 employing an IBM 357 data collection system. By using the 357, it was possible to have a machine punched book card and a machine readable borrower's identification card that could be read by the 357, thereby eliminating manual punching. The Southern Illinois system became fully operational at the beginning of the fall term of 1964, as did a similar 357 system at Florida Atlantic University (26).

Batch processed circulation systems periodically producing a listing of books on loan have a built-in source of dissatisfaction, particularly in academic libraries, for current records are unavailable on the average for half the period of the frequency of the printout. Such delay can be eliminated in an on-line system, wherein information about the loan is available immediately after recording the loan. However, not all circulation systems with remote terminals operate interactively.

In an on-line system introduced at the Illinois State Library in December 1966 (36) the transactions were recorded on an IBM 1031 terminal located at the circulation desk, data transmitted from the terminal being accumulated daily and processed into the file nightly. As first activated, the system did not permit querying the file to determine books charged out, but this capability was added in 1969. Also in December 1966, the Redstone Scientific Information Center brought into operation a pilot on-line book circulation system based on a converted machine readable catalog consisting of brief catalog entries. This pilot system remained in operation until October 1967, and was capable of recording loans, discharging loans, putting out overdues, maintaining reserves, and locating the record in the file (37).

The BELLREL real time loan system went into operation at Bell Laboratories Library in March 1968 (38). BELLREL has a data base consisting of converted catalog records, so that in effect it also is a remote catalog access system. BELLREL serves three libraries remotely from two IBM 1050 terminals in each library. BELLREL is a sophisticated on-line, real time circulation system that not only records and discharges books, but also replies to inquiries as to the status of a title, and the status of a copy, and will display the full record for a title, as would be required for remote catalog access.

SERIALS

The Library of the University of California, San Diego, activated the first computerized serials control system (39). This system has as its objective production of a complete holdings list, lists of current receipts, binding lists, claims, nonreceipt lists, and expiration of subscription lists. Checking in was accomplished by manual removal from a file of a prepunched card for a specific title and issue. The check-in clerk sent this card to the computer center for processing and the journal issue to the shelves. This

technique of prepunching receipt cards has generated new problems in some libraries, for professional advice is often needed as to action to be taken when the issue received does not match the prepunched card. Nevertheless, the San Diego system still operates, albeit with modifications.

The Washington University School of Medicine Library activated a serials control system in 1963 (40) that was essentially like that at San Diego. A series of symposia held at Washington University, with the first in the autumn of 1963, widely publicized the system and led to its adoption elsewhere. The University of Minnesota Biomedical Library introduced a technique of writing in receipts of individual journal issues on preprinted check-in lists (41). Check-in data was then keypunched from the lists. This system obviated the problem generated by prepunched cards that did not match received issues, but, of course, reintroduced manual procedures.

Difficulties with check-in procedures, and delays in receipt of printed lists of holdings made it clear that an on-line real time circulation control system would be superior to the batch systems described in the previous paragraph. Laval University in Quebec introduced the first on-line, real time system in 1969 (42). In September 1969 the Laval on-line file held 16,335 titles. Access to the file from cathode ray tube terminals is by accession number, and the file, or sections thereof, can be listed. The system also produces operating statistics and contains the potential for automatic claiming.

The *Kansas Union List of Serials* (43), which appeared in 1965, was the first computerized union list to contain holdings of several institutions. The *Kansas Union List* recorded holdings for nearly 22,000 titles in eight colleges and universities. Reproduced photographically from computer printout and printed three columns on a page, this legible and easy-to-use *List* set the style for many subsequent union lists.

ACQUISITIONS

The National Reactor Testing Station Library was first to use a computer in ordering processes (44). A multiple-part form was produced for library records and for dealers. The Library of the Thomas J. Watson Research Center activated a more sophisticated system in 1964 that produced a processing information list containing titles of all items in process, a shelf list card, a book card, and a book pocket label (45).

The Pennsylvania State University Library put a computerized acquisition system into operation in 1964 (46). This system produced a compact, line-a-title listing of each item in process, together with an indication of the status of the item in processing. A small decklet of punch cards was produced for each item on a keypunch, and one of these cards was sent to the computer center for processing each time its associated item changed status. The Pennsylvania system also produced purchase orders.

In June 1964, the University of Michigan Library (47) introduced a computerized acquisitions procedure more sophisticated than its prede-

cessors. The Michigan system produced a ten-part purchase order fanfold, an in-process listing, and computer produced transaction cards to update status of items in process; and carried out accounting for encumbrance and expenditure of book funds. In addition, the system produced periodic listings of "do-not-claim" orders, listings of requests for quotation, and of "third claims" for decision as to future action on such orders.

In 1966, the Yale Machine Aided Technical Processing System began operation (48). It produced daily and weekly in-process lists arranged by author, a weekly order number listing, weekly fund commitment registers, and notices to requesters of status of request. Subsequently, claims to dealers were added, as well as management information reports on activities within the system. Like the Pennsylvania and Michigan systems, its in-process list recorded the status of the item in processing.

The Washington State University Library brought the first on-line acquisition system into operation in April 1968 (49). Access to the system was by purchase order number, with records arranged in a random access file under addresses computed by a random number generator (50). The Stanford University Libraries on-line acquisition system began operation in 1969 (51), and employed a sequential file of entries having an index of words in author and title elements of the entry. The Stanford system calculated addresses of index works by employing a division hashing technique on the first three letters of the word.

STANDARDIZATION

By 1965, a dozen or more libraries had a dozen or more formats for machine readable bibliographic records, and an impenetrable thicket of such records was evolving. Fortunately, the Library of Congress, with the help of the Council on Library Resources, took the initiative in standardization of format of bibliographic records and produced the now familiar MARC format (52). Just as standardization of catalog card sizes enabled interchange of catalog records, so has MARC made possible interchange of machine readable catalog records.

This standardization has encouraged developments of networks, such as the SUNY Biomedical Network, NELINET, the Washington State Libraries network, and that of the Ohio College Library Center. With each of these regional networks employing the MARC bibliographic record, it will be possible to integrate these regional nodes into a future national network.

SUBSTANCE AND SUM

The first half of the first decade and a half of library computerization was confined almost entirely to two major mechanizations of Mortimer Taube's Uniterm coordinate indexing. The computerization of single descriptors with attendant document numbers was a relatively easy task.

The first breakaway from computerized subject searching came at the

Douglas Aircraft Corporation, where the technique of producing one machine readable record from which multiple products could be obtained was introduced in 1961. The last half of library automation's decade and a half has been largely consumed with efforts to automate existing library procedures.

Although notable departures have occurred that take advantage of the computer's powerful qualities, on-line, real time techniques introduced at the very end of the historical period under review began again to use individual words as words, not unlike the logic in which the first applications employed Uniterms; and it seems likely that the immediate future will witness increasing degrees of computerization based on individual words in bibliographic descriptions rather than on the record as a whole.

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