The Minicomputer and its Use in Library Operations at the University of Maryland

Minicomputers are being put to work in many different environments. With every repetitive paper handling task, there is a potential minicomputer application.

According to a recent study by International Data Corporation, publishers of *EDP Industry Report*, worldwide shipments of minicomputers will jump almost 50 percent this year, to a shipped value of $835 million.¹ By 1977, minis should represent a $2.5 billion business. Some promising fields are: business and banking, where mini-based point-of-sale and accounting systems are just beginning to tap the potential of autotransaction; support of data entry systems and telecommunications networks, where minis are used for message-switching; automated manufacturing, where minis are used in closed-loop systems; and customized packages that give sophisticated users clusters of inexpensive minis for on-line jobs that once required large machines. Minis are being shipped at a rate of 2,800 per month, and the installed population will outnumber general-purpose computers before the end of 1974. IDC expects that within five years the mini shipment rate will be 10,000 per month. The marketplace for minis is diffused, fragmented, and hard to define. Most manufacturers sell their machines as tools—most minis are dedicated to a single function. Currently, 58 percent of minis—and 96 percent of mini-peripherals—produced in the United States go to OEM suppliers. Potential end-users of minis are attracted by their increasing ease of
use, even more than by their declining prices. Larger memories allow program-
ing in higher level languages, rather than in machine languages. For example, 
Microdata has just announced a new small business system programmable in 
simple English sentences. Raytheon has announced a new mini that will be 
available on a rental basis, and a new mini array processor ($57,000) that can 
add two arrays of more than 16,000 numbers each into a third array, from a 
single instruction, and twenty times faster than the CPU could do the job 
under standard program control. The mini market currently supports at least 
fifty viable suppliers. IBM has not really entered the mini market, but rumors 
persist of a "System/2." If it ever appears, a true IBM minicomputer could 
change the shape of the industry.

An important educational application involves the effective use of mini-
computers to handle the acquisition and circulation systems in university 
libraries.

The study of minicomputers and their successful application to library 
data processing should certainly include a review of the Singer Company’s 
System 10 minicomputer and point of transaction terminal system in use at 
McKeldin Library at the University of Maryland.

We feel that we have taken an innovative approach to the library’s 
biggest headache—effective circulation control—without impairing service to 
our students, faculty or staff.

Before detailing how the system operates, let me first give some back-
ground on the University of Maryland and the kind of decentralized library 
system that it operates.

The University of Maryland is the seventh largest university system in 
the United States. The College Park, Maryland campus, where McKeldin 
Library is located, is the third largest campus in the United States. In 1972-73 
it served an enrollment of 35,000 students with over 7,000 faculty and staff 
members, and the university is continuing to grow.

McKeldin Library is the central library of the university. It contains 
reference works, periodicals, circulating books, and other materials in all fields 
of research and instruction. The university library system, with its five 
branches, has nearly 2 million volumes and 19,000 active subscriptions to 
serials, periodicals and newspapers, plus a large collection of government 
documents, phonorecords, films, and filmstrips. The branch libraries include: 
the undergraduate library which houses 200,000 volumes; the engineering and 
physical sciences library which includes 200,000 volumes for engineering, 
physics, chemistry, biology, and botany studies; the architecture library with 
50,000 volumes; and the College of Library and Information Services library 
with 40,000 volumes.
The central McKeldin Library with 900,000 volumes for faculty and graduate students, plus the university's main reference section, is also open to undergraduates. About 100,000 books may be out on loan at any one time, reflecting an in/out transaction rate that can approach 10,000 a day.

The demand for library services has nearly quadrupled in the last ten years. The student enrollment, which is increasing at a rate of 5 percent per year, has nearly doubled in the last ten years. In 1963 the enrollment was less than 20,000 and the library contained 550,000 volumes. During the following ten-year period the book budget also increased from $400,000 to over $2 million per year.

The Singer System 10 is not our first attempt to automate the library's circulation; in fact, the library has utilized a computer in its circulation operation for more than eight years. However, we do think that this Singer approach is our most effective to date in providing better service to our patrons and improved control for the librarians.

Immediate benefits of our new system include faster charging, discharging, recalling, and sending out overdue notices more promptly than in the past, operating our personal reserve system more efficiently, and garnering statistics on use that enable faster purchase of additional copies that are in demand.

When we are able to go to an on-line system that will provide round-the-clock input and access to data, rather than our present batching operation, we will be able to provide even faster service.

An important requirement for this kind of program is the up-to-date information from the university administration for the user address file. If this information is kept current, the library can notify a borrower that the book he charged out the day before is needed for a class reserve. But current address data are vital to assuring that borrowers will receive immediate notification. Our file of 55,000 names and addresses is entirely updated four weeks after the start of each semester and changes are received continually.

McKeldin Library's first attempt to automate its circulation system was in 1965 when an IBM 357 data collection system was installed. The system desired by the staff was one that would be simple enough for effective operation by clerical staff members and student assistants, yet sophisticated enough to provide a fully mechanized circulation control record that would include charging, discharging, personal reserve requests and recalls, overdue book notices, fines, statistics, and certain essential internal reports. It was apparent from the beginning that equipment installation would not constitute a major problem because the university's College Park campus had a centralized library.
The equipment configuration that was felt best suited to afford the library an effective circulation control system consisted of three IBM 357 input stations, each with a card and badge reading unit; three Model 372 manual entry units on-line with the card and badge reader input stations; one Model 358 input control; one 373 punch switch; and two modified 026 print card punches on-line with the 357 system.

The source documents used in the circulation system were prepunched identification badges and book cards. A student obtained his identification badge the first time he registered. It was validated automatically thereafter at the beginning of each semester until he left the university. A faculty or staff member, or any other person entitled to a badge, received one on request. When a book was processed, a book card was prepunched and placed in a pocket at the back of each book.

Considering the limitations of unit record equipment, this system was relatively effective. Certainly it was an improvement over the previous manual system. But it soon became apparent that it could not keep pace with the growth of the university and the related demands on the library. The 357 was replaced in 1967 by a more powerful IBM 1030 system.

In September 1968 we switched to a computer tape system with the installation of a UNIVAC 9300 computer. The flexibility and speed of the new computer enabled us to add another service to our patrons. Each day, the entire circulation master file is printed out on a high-speed printer. This printout indicates the call number of all books along with the social security number of the borrower. By reference to this printout a borrower can determine whether any given book should be on the shelf or is out on loan. This eliminates much time-consuming searching of the stacks to determine the availability of a given book.

Another feature of the system improved our personal reserve procedure. If the circulation printout indicates that a volume is out on loan, a potential borrower can fill out a personal reserve card on which he requests that he be notified when a specific book is returned. Data identifying the patron and the book to be held are recorded in the system on a daily basis and reserved books are automatically identified and segregated prior to their return to the shelves. The requestor is automatically notified of the availability of the reserved book and of the fact that the book will be held seven days for him.

The computer not only modernized the library's circulation operation, but it also produced timely and meaningful statistics including analysis of year-to-date circulation by type of patron (undergraduate, graduate, staff, faculty, etc.), type of book borrowed, as well as costs of books purchased by type.
The UNIVAC 9300 configuration included a processor with 32,000 bytes of core memory, a 600 line/minute printer, a card reader and six magnetic tape drives with communication devices which enabled the library to interface its systems with the University of Maryland’s UNIVAC 1108 located in the Computer Sciences Center.

Improvement in our backroom operations led us to take a closer look at improving the front end. One of the limitations of our 1030 terminals was the inability to edit input data at the source. This resulted in a great many inaccuracies getting into the system.

A key factor in our switch to the Singer System 10 data collection system was the ability of the Model 100 job information station terminals to purify input data. By using optical readers rather than sensor readers, the Singer terminals can edit data before it reaches the processor.

Up to ten transaction programs may be permanently resident within each Model 100 terminal and the programs may differ from one terminal to another. In addition each Model 100 can call up any of ninety programs from a disk-resident library. Another important factor is speed. The cycle time of the Singer terminals is four times greater than our previous system.

In the fall of 1972 we installed ten Model 100 terminals: four in the main McKeldin Library (two for charging and two for discharging), four in the undergraduate library, one in physical sciences, and one in library sciences. We expect to soon add another terminal in the architecture library.

The terminals feed data directly to a Singer System 10 processor with 30K of core memory, a Model 40 disk drive with 10 million characters of storage, and a Model 45 tape drive. Incoming transaction data are stored on the disk which, in addition to the current day’s transaction file, also houses the preceding day’s transactions, a master file of 55,000 user social security numbers, a books-on-reserve file, and system software. To protect incoming data, the System 10 records information simultaneously on disk and tape, so if one goes down, the other one is available to reconstruct data.

Input to the current system continues to come from badges and book cards. The Hollerith coded badges are embossed with the patron’s name and nine-digit social security number, followed by a tenth digit which indicates whether the borrower is an undergraduate, graduate, faculty or staff. Each category of patron can take out books for different periods of time. The 80-column card residing in each book bears the LC classification number and circulation number.

In addition to accepting badges and cards through separate slots for optical reading, the Singer terminals will accept input data, instructions and queries through a numerical keyboard and function keys. Operators are guided
in entering information by messages flashed on the terminal's display screen indicating the next step to be taken.

The terminal mask lists the various types of transactions the system will handle. The variables in each type of transaction are clearly spelled out, so that the terminal operator is led through each transaction in the proper sequence.

The Singer input stations are programmed to perform the following transactions: charge, renewal, emergency charge, discharge, place personal reserve, claims returned, patron inquiry and special transactions which include paid discharge, emergency discharge, lost book, patron inquiry on keyboard, personal reserve cancel, place search, search reply, payment reply, delayed discharge, message flag, message clear and enter dates. The special transactions can only be accomplished by a designated supervisor with an authority badge.

In a charge transaction, the social security number on the badge is checked against the master file on the disc, while book card data are checked for validity against the circulation file. In addition, the input station number is checked against the location number on the book card. Cleared data go to the transaction file. Otherwise, the Model 100 indicates failed data checks.

To understand how this works, let us follow the sequence of a typical charge-out. The terminal operator indicates a charge transaction by depressing button "0" and the charge light comes on. He then enters the patron's badge. The computer edits the badge to assure validity. If the borrower is not on file, this message is returned as a one-digit code in the terminal display, and the borrower is automatically added to the file. If the borrower's address file is incorrect or incomplete, the terminal operator is instructed to obtain this information before proceeding.

When the computer accepts the badge as a valid entry, the "insert book card" light comes on and again the terminal performs a four-step edit to check the call number field and the circulation number field. It also checks to assure that the book is not on reserve. When accepted, the "insert book card" lights again to see if more than one book is being checked out. If not, a cancel key ends the transaction and completes the charge-out procedure.

The renewal transaction is similar with the terminal again checking that the book has not been reserved by another patron and is not overdue, which would require payment of a fine.

To discharge books, the terminal operator inserts the book card and the computer checks for valid circulation number, correct location (that the book is being returned to the correct library) and if it is on reserve or overdue, which triggers the fine notice procedure.
To enter a personal reserve, the operator enters the seven-digit circulation number, whether or not it is a special edition or from the reserve collection, and the borrower’s number.

The other transactions are handled only with an authority badge. They include the “claims returned” procedure which is used when a patron disagrees with the library’s claim that a book he has borrowed is still out. The pressing of the correct function key and entry of the book circulation number through the keyboard sets off a search for and flagging of the transaction record. The patron inquiry is similar to the claims returned procedure, except that it is initiated by the patron who receives a printout the next day indicating the books he had checked out.

“Message flag and clear” is a new capability that is especially useful to large libraries where patrons may have inaccurate or outdated name and address records or excessive fines outstanding. The social security numbers for these patrons are flagged so that the next time they seek to make a transaction through an input station, the unit will signal the operator of the action to be taken, including verifying the bearer’s identity in the case of a badge reported lost.

The emergency charge procedure permits a patron without a badge to take out a book.

At the end of the day all the transaction information is formatted by the Singer System 10 computer and transferred onto a magnetic tape. It is then processed by the UNIVAC 9300 computer which prepares a master tape to update the master circulation file. In addition, the 9300 prints a wide variety of reports, statistics and documents. These include the first, second, and third overdue notices mailed to delinquent borrowers. If a fourth notice is required, the borrower is automatically billed for the cost of the book plus processing charges. The 9300, incidentally, is also used for the library’s acquisition program—a separate system that we will not review here.

In addition to the terminal capabilities, another important consideration in our selection of the Singer data collection system was the unique operational capabilities of the System 10 processor. 4

The Singer System 10 is distinctively different from other competitive small-scale computer systems in three significant ways: (1) as many as twenty independent jobs can be processed concurrently with multiprogramming controlled by hardware rather than software; (2) a System 10 can be equipped with unusually large amounts of both main and auxiliary storage—up to 110,000 characters of core memory and up to 100 million characters (ten disk drives) of on-line disk pack storage; (3) CRT display units or typewriter-like workstations as well as card readers, punches and printers may be connected
to the central processor via simple two-wire lines and can be located at distances of up to 8,000 feet away, or they can be linked to remote locations with a device called a remote terminal scanning system. This is the method used to link outlying terminals, located in other library buildings, to the computer at McKeldin.

The System 10 computer is a very flexible system that can combine batch processing with timesharing operations and also offers multiprogramming.

Generally, a multiprogramming computer system that is capable of concurrently operating a number of independent programs is controlled by a software operating system that is both expensive and wasteful of memory space. However, in the case of Singer System 10 computer, a new approach to the design of multiprogramming systems has been used. Multiprogramming is controlled solely by a hardware operating system which allocates the processor to each memory partition.

The Singer System 10 computer is a fixed partition, multiprogramming computer. Each program is assigned a fixed-size area of main memory referred to as a user partition. Unlike other multiprogramming computers, the System 10 has an area of main memory, referred to as the common partition, or Common, that is shared by all programs in the system. This makes it possible for otherwise independent programs to exchange information at main memory speeds and to share common subroutines.

Common is divided into three areas. The first 300 locations are used by the hardware executive for storing program status information and is protected. Programs may read from it, but may not write into it. The second area of Common is referred to as nonprivileged and is available to all user programs. The third area is accessible only to those user partitions which have been designated with a jumper on the associated I/O channel as privileged partitions. Nonprivileged partitions may not access this area.

Control of the processor by each of the user partitions is hardware monitored through a round-robin, time-slicing priority system. Each partition receives 37.5 milliseconds for execution.

Whatever the total memory capacity, it can be divided into discrete sections or partitions, which may vary in size from 1,000 to 10,000 characters. To each partition is connected an I/O channel capable of handling up to ten terminals.

When the system is installed, plug-in links are inserted in the memory modules to provide the user with the sizes and quantity of partitions required in his specific application. But the positioning of the links can be changed at any time to meet changing data processing demands, until the limit of 110,000 characters or 20 memory partitions is reached.
Every location in main memory is addressable. Each is numbered consecutively within the common partition and within each user partition.

The transfer of data between main memory and peripheral devices is controlled by two types of I/O channels. The File Access Channel is designed to control the high-speed devices, such as disk drives and magnetic tape drives, and the Multi-Terminal Input/Output Channel is designed to control low-speed devices such as card readers, line printers, CRT terminals, and I/O typewriters or workstations.

Unlike the IOCs, the File Access Channel is a shared facility. The devices attached to the FAC are directly accessible to all programs in all partitions. Thus, several user partitions may share the same disk or magnetic tape files.

Unlike other computer systems, peripherals for System 10 need not be located near the central processing unit, but may be distributed as dictated by application requirements.

The arithmetic and control unit controls all the system's activity, including task scheduling, instruction fetch and execution, and manages I/O peripherals. All processor partitions share the processing capabilities of the arithmetic and control unit.

System 10 software consists of two levels of assemblers and RPG compilers, as well as software for communications, business data processing and disk file management.

Automation has really paid off for the McKeldin Library in terms of greater productivity and economy. Since 1966 only one employee has been added to the loan department staff, even though circulation has been increasing at the rate of 20 percent per year. Without our present automated circulation system we would be out of business. There is no way that we could handle our present volume of transactions manually.

Additional benefits have come in the form of new information and services. For example, an employee used to work full time preparing and mailing out overdue notices on a weekly basis. The fourth delinquent notice acts as a bill for the book plus administrative costs. It goes to the university cashier for collection.

Statistics also used to be a problem area. Now we are improving our research data with each successive generation of equipment. The library has been able to better analyze its patronage to determine whether undergraduates, graduate students, or the faculty make heaviest use of its facilities. It was always assumed that graduate students and faculty members were the heaviest users. Thus it came as a distinct surprise when the survey revealed that the undergraduate usage of the library exceeds the combined usage of both graduate students and faculty.
The greater capabilities of the new system will also permit better analysis of which books are being borrowed, when, how often, and by whom. These data help the acquisitions department fill gaps in the library collection. It has already proved invaluable in filling the shelves of the new undergraduate library.

Although our operating expense had increased with each successive generation of equipment, we believe it is in line with the services performed and additional benefits received. Our present five-year lease rate for the Singer System 10 computer and ten terminals is $3,000 per month.

The next step is to convert present batch operation to an on-line, real-time system. This would substantially speed up inquiries for book locations, because borrowers would have immediate answers rather than waiting for the next day's reports.

For an on-line system, we would need to add additional core memory and probably more disk capacity. This would be no problem with the Singer System 10 because core can be added in increments of 10K up to a maximum of 110K, and the computer can operate efficiently with up to 10 disk drives added to the system.

With an on-line system we could also replace the daily printouts with CRT display terminals. To find a particular book, a patron would simply walk up to a display terminal, type in the book's call number and receive an immediate answer on availability and location.

Another application we are investigating is a subsystem for serials checking that would detect missing issues, institute claim procedures, anticipate renewal dates and handle the entire billing procedure. This job of keeping track of 19,000 serials and periodicals is now done manually with a cardex system. We could improve serials service and save labor costs with the addition of a CRT display terminal and/or workstation in the serials department.

We are also considering a library materials budget application that would provide detailed listings on allocation of funds, expenditures, funds remaining by department and category, and funds unencumbered. We have over 100 departments on campus that have yearly book budgets. Better statistics would help each department's library coordinator to make the best use of his yearly library materials allocation by providing up-to-date statistics on purchases of books, serials, and audiovisual aids.

Once one is familiar with the flexibility and multiprogramming capabilities of the Singer System 10 computer, more and more applications come to mind. We have found this terminal-oriented computer system to be particularly adaptable to our needs for data collections at the University of Maryland. We recommend it highly to any library considering an automated circulation system or other data collections projects.
REFERENCES

1. “Minicomputer Shipments, By Number, To Jump by 50% This Year,” *EDP Industry Report*, Nov. 9, 1973, pp. 1-3.

