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On-Line Real-Time Self-Service Circulation at Northwestern University

Before discussing circulation, some background on the situation at Northwestern University might be in order. In the first half of 1967, a detailed study of all the library's operations was made because it was obvious that some changes were necessary. Over the years, many procedures had degenerated and were now being done primarily because they had been done that way before. The results of the study indicated that a new approach was needed; a completely integrated system should be developed and maintained. It was further apparent that only a system that was efficient and responsive would have substantial impact on the library's operations. Only one direction appeared to provide a possible solution—an on-line, real-time system.

Design and development of a completely integrated library operating system was to be done in modules; the first to be tackled was circulation. The major intent of the circulation module is to maintain control over those items in the circulating collection which are not in the location described in the card catalog. The circulation department as a whole is certainly interested in every item put out by technical services, but the computer-based circulation system is involved only when an item is removed from its assigned place for more than casual browsing or normal in-house use. At that point, a record is created indicating the item in question, the user (student, faculty member, department, another library, cataloger, or the bindery), the date on which this transaction took place, and the date of the end of the particular loan period. If a question should arise about a particular book, the file can be interrogated, the record displayed, and certain changes made, if necessary. Upon return of the book, the record is deleted from the file and the item returned to its

proper location. Certain other housekeeping chores are accomplished over a period of time, such as overdue notices, fine notices, or requests to return a book.

The heart of the system is an IBM 360-30 computer which is shared with the university's administrative data processing department. It has a core memory of 96K, with the library teleprocessing system utilizing a 48K foreground partition. The circulation file is maintained on IBM 2311 data cells. The computer is located in an administration building about one-half mile from the library. Two dedicated phone lines are used to connect the computer with the various terminal equipment in the library. This terminal equipment will be described in more detail below.

The teleprocessing and batch programs are written primarily in assembly language. The teleprocessing package, in addition to circulation, also handles a complete technical services operation. Implemented early in 1972 this part of the system covers all types of material at all stages of processing, from preorder searching of MARC records to production of punched book cards for the circulation module.

One of the major considerations in designing the module was deciding on the means to collect the book data. Either the data are reconstructed each time the book is presented for charging, or data are carried in machine-readable form by the book. In the former case, manual transcription can lead to many errors, and, depending on the type of data involved, it can be time-consuming and/or difficult to construct accurately. In the latter case, machine-readable data can be used over and over again, will not vary from time to time, and can be ready very quickly by a machine.

At Northwestern the use of at least the call number for book identification was anticipated. Although the classification number is generally straightforward (the Dewey Decimal classification system is used), such elements as Cutter letter and number, work letter(s), and the edition, volume or copy, can become fairly complex. Also, in a collection of more than one million volumes, many items differ in call number by only one or two out of twenty or more characters. Almost everything seemed to indicate that a punched book card was necessary. Once this decision was made, it became necessary to determine the data elements to be converted and the way in which the book cards should be prepared.

A survey of the literature led to the conclusion that there were two ways of approaching the problem: (1) convert-as-you-go, that is, make book cards as books circulate, or (2) convert-at-one-time, prior to implementation. An interesting discovery concerning the as-you-go method of converting as books circulate was that its major proponent gathered data in the very libraries in which we are working. Unfortunately, no actual cost comparisons were made. While several approaches were mentioned for the one-time method, there are very little data of value.

Another conclusion that rapidly became obvious was that little, if any, consideration was being given to the need for the presence of certain data elements in the punched card and/or the circulation file. Identification of a book by call number and/or accession number, and some or all of the author and title seemed to be taken for granted. Where this was not so, no reason was given for the particular data elements used or omitted. Answers for many of our questions were not in the literature.

The data elements to be converted were given first consideration. Since the items to be controlled are normally shelved and retrieved by call number, this would be the most direct means of identification. Also, the call number is unique; only by error would two or more items have the same one.

An accession number would also be unique, but in looking for a particular book it would become necessary to utilize both the accession number and the call number which would be both cumbersome and redundant. Also, if the circulation file were ever to be analyzed in terms of usage of parts of the collection, the accession number would be meaningless. To use only the author and/or the title would introduce some sticky problems: it is not always easy to determine the exact author and title of a book; these data fields would often be longer than either the call number or the accession number and therefore more difficult to reconstruct accurately; it would be difficult to distinguish between multiple copies, volumes or editions; and foreign materials, especially items in Russian, Chinese or the like, could not be handled in the original language. Again, analysis of the file would be most difficult.

It became evident, then, that use of the full call number was the absolute minimum. But was it sufficient? Admittedly, it would be "nice" to have at least some portion of the author/title data available in the book card and in the circulation file. This is especially true since the major use of such data would be for printed notices (overdues, fines, etc.) sent to users. Obviously there would be increased (one-time) costs in converting more than the call number. Carrying these extra data fields in the file would also increase the file size—by at least one-third—but this would be an ongoing increased cost. Would these increases buy more than something "nice"?

A look at the library's records indicated that less than 5 percent of the items that circulated required any kind of follow-up other than discharge. Those increased costs, then, would be magnified in terms of a percentage of usefulness. Also, if a more complete bibliographic conversion was ever attempted, such partial data would not be usable. Since no estimate of the increased costs due to conversion could be made at the time (the increased file costs could be estimated), no final decision was made—only a temporary one to forego author/title during a comparative study to be undertaken.

While it was estimated that convert-as-you-go was cheaper, the library staff was not anxious to live for an extended period under two systems. It

was felt that while living under two systems the best features of either, especially the new one, would be terribly overburdened by the poorest features of either, especially the old one. It was decided to run a short experiment in order to determine the best and cheapest method for one-time conversion.

Two alternative methods were chosen for study: (1) keypunching directly from the shelflist, and (2) typing sheets, directly from the shelflist, to be scanned later by optical character recognition (OCR) equipment and converted via computer to punch cards.

Because of the constraints imposed by the scheduled implementation date, very little time was available for rigorous experimentation. While work continued on design of the system, from two to four hours a day over a period of seven days were devoted to the testing. We felt that the results would at least be indicative of the real costs.

Keypunching, though requiring a somewhat longer period of time, appeared to be the cheapest method. (OCR was less expensive until the computer time for producing the cards and subsequently running them through an interpreter was included.) Use of keypunch machines could also permit a complete in-house operation and would allow day-to-day control over the final product. Moreover, the testing indicated that error rates in the OCR method might be significantly higher, since it was more difficult to read the typed sheets than the punched cards (due to the OCR input being encoded in a manner that made proofreading difficult). The question of adding author/title data was reopened at this point. Indications were that an additional \$50,000-\$60,000 would be needed if these two elements were to be included for each record. The call number would have to suffice, and an in-house keypunch operation would produce the book cards.

The major portion of the operation, conversion of the items in the main stack collection, took sixty-four days. Some 700,749 cards were produced at an average cost of 1.1 cents per card, with the costs broken down as follows:

operators	\$4,200
equipment (4 IBM 029 keypunches)	960
card stock	980
supervisor	<u>1,600</u>
	\$7,740

The keypunching operation was then reduced in scope, other smaller collections were converted, and all new items were routinely routed through keypunch prior to shelving. An effort was subsequently made to put the cards into their respective books. By the time the circulation module was put into operation, over 800,000 books were ready to go. For about \$30,000, or just under \$0.04 per book, machine-readable cards were prepared and placed in the books, and a general inventory had taken place.

Part of the decision to use punched book cards was, of course, related to the availability of equipment to read the cards. IBM 1031 badge/card readers, while far from ideal, were found to be at least usable. As used at Northwestern, these units are one-way machines; they simply transfer data from the library to the computer. Associated with each badge/card reader is an IBM 1033 printer. Essentially a Selectric keyboard, this too is a one-way machine, strictly under computer control and only capable of printing out a small variety of messages. The current configuration in the main university library consists of four of these 1031/1033 units. Units are located on the third, fourth and fifth floors of the university library. They are used exclusively for the processing of standard book loans. A standard loan implies a book with a punched card, a user with a punched identification badge, and a normal loan period, currently four weeks. If any one of these three criteria is missing, the user must go to the main circulation desk. The 1031/1033 unit located there is slightly different—the badge/card reader also contains a set of twelve slides. These slides allow a variety of transactions to be processed. The only necessity is a punched card with the book information. The slides can then be set to provide for any one of several loan periods and also for user identification if no badge is available.

The major functions of the unit at the main circulation desk are to handle renewals and discharges. The discharges amount to about 1,000 items per average day, with peak periods during the year being several times this figure.

For each transaction processed through the unit (in all but two special cases), a message is printed out on the associated 1033 terminal. There are six basic messages currently in use. The most common is the date due. If an attempt is made at a first time charge, and if the data input through the terminal are acceptable (a valid call number which is not already in the file, and a valid user number, by badge or through the slides), a message will be quickly printed, showing the user number, the date due and the call number of the item. This message is then removed from the terminal, placed in the book, and is the user's pass to borrow the item from the library.

If, however, any of a variety of factors are not as they should be, another message will be printed. In place of the due date will appear UNPROCESSED ERRXX. If this occurs at one of the units in the stack area, the user should take his material and the printed slip to the main circulation desk. The staff at the main desk can then, hopefully, discern the reason for the error message and make the proper adjustments. The types of errors that can occur, and that can be "caught" by the program will be discussed below.

The third type of message is actually very similar to the first type, the date due. It occurs when an item is renewed. In lieu of the words DATE DUE, RENEW TO is printed, and the new date is calculated by adding the same length of loan period as in the prior transaction to the current date due. Thus, an item may be renewed any time after the initial transaction up to and

including the third day after the date due. Beyond that date, special handling is required. Also, an item may be renewed only three times; the fourth attempt will be rejected. If so desired, either situation, overdue by more than three days or over-renewed, can be circumvented by simply discharging the item, then starting the cycle anew with an initial transaction.

The fourth type of message is also similar to the first type. It indicates that the charge is to a carrel and for an indefinite period (in reality, for a quarter). Faculty and students who have assigned carrels have this privilege. The item, however, may not be taken from the library. The word CARREL printed in place of the due date indicates this to the user and to the exit attendant.

The fifth and sixth types of messages occur when a book is discharged, a simple operation which entails running the book card through the badge/card reader after setting the appropriate slides. In the usual situation, no message is printed when an item is discharged, even if a fine is to be assessed. Fine notices are generated by the evening batch runs. However, if another user has requested that a save, or hold, be placed on an item so that he may have it next, at the time of discharge a message is printed with the identification number of the requester, the call number of the item, and the words SAVE REQ. The item is then put on a special shelf, and the batch program that night prints a notice for mailing that the item is available.

The fifth type of message occurs when an item that has been determined to be lost or missing is attempted to be discharged. Lost or missing items are routinely put into the master file so that, for example, if a lost item suddenly popped up, the borrower who had reported it lost and probably incurred a fine may be at least partially reimbursed. The message in this case reads LOST/MSG.

The second type, the error message, covers a wide variety of situations including:

1. record already in file—such as books returned to the stacks before being discharged or attempted renewals on the units located in the stack areas,
2. invalid record length—including book cards without sufficient data or dropped digits on user numbers entered on the slides,
3. invalid charge code—e.g., attempt to give indefinite loan to regular borrower,
4. invalid user number—for expired badges,
5. cannot renew—overdue,
6. cannot renew—already three renewals,
7. cannot renew—save on file,
8. record not in file—for attempted renewal of item not yet charged out or discharge of item not charged out,
9. record being processed by another terminal,

10. user number in hold list—a small list of numbers can be put into a special hold list, such as users with large unpaid fines or lost badges,
11. expired badges,
12. attempted transfer of noncarrel charge—carrel charges, to a room or desk number, can be transferred to a user for outside borrowing, and
13. invalid transaction date in slides—it is possible, for example, to have books discharged as of an earlier date (because of backlogs or machine downtime) and dates outside a given range rejected.

The conditions which generate the foregoing messages are usually easily taken care of by the circulation department staff. Certain other situations—system errors—entail a stop of operations and consultation with the computer operator or the programmer.

The instances where no messages are printed are when a valid discharge takes place and when items charged out do not require date due slips, such as books being put into the reserve room. Suppression of such unnecessary messages saves a great deal of machine and operator time.

While most error conditions are caught by the system program, there are, of course, some errors that cannot be caught. If a book card or a user badge has transpositional errors, that is the way the data go into the record. Once the record is created, the only way to “see” the data therein is through the IBM 2740 typewriter terminal. There are no hard copy listings of the circulation file. Access to the file can be made only by call number. It was decided that in an academic environment it was most important to know the status of a particular item, what was had by whom, rather than who had what.

For purposes of searching the file, the call number was broken down into two components, the key and the key extension. The key is made up of the Dewey number, Cutter letter and Cutter number, and work letters (these identify different works by the same author on the same subject). The key is used to compute the address on the data cell where the record is stored. The key extension carries such data as edition, volume, copy, location and oversize indicator. The file can be searched using just the key. This allows for quick access to, for instance, all records in the file for multiple copies of the same title. It also can provide for the display of fifteen records when fifteen volumes of a set are charged out which is a bit inconvenient at times. But this is far overshadowed by the problems that can occur in attempting to properly interpret some of the strange alphanumeric characters that can be assigned beyond the basic subject, author, title code: copies of volumes of parts of sections of editions, etc. It is far easier to see whether what is in the file fits the question, rather than vice versa.

It is, of course, possible to go directly to a record by using both the key and the key extension. Either approach has its benefits and drawbacks.

There are two levels of searching the file. The first uses the search command with the key, and the response, assuming one or more such records reside in the file, gives the address of the record(s) and the key extension(s). Then the desired record can be displayed by indicating the desired record address. This is done primarily because the 2740, being a typewriter terminal, is a very slow device—one line of record location is much quicker to print than three or more lines of record data. The other level is to use the display command and both the key and key extension. In either instance, the terminal operator has a choice of displaying the entire record, or any part of it. This particular approach may not be absolutely necessary to the circulation file where most records contain only three data fields. However, the same command language is used in the technical services module, and records in that file are larger.

It is possible, once the record is displayed, to alter the record by changing or adding another field. In fact, the entire record can be deleted from the file. Since operations through the 2740 do not go through all the error screening routines of the circulation program, care must be taken to avoid entering significant errors into the record. To help guard against such possibilities, there are three distinct levels of operator capability, controlled by operator codes. The lowest level allows only for display of records. The middle level additionally allows for changes of certain fields and addition of others. The top level allows for all activities, including deletion of records. The deletion of a record through the 2740 completely removes it. Discharge through the 1031, meanwhile, if overdue or carrying a save, removes the record from the master file to a daily transaction file, against which the batch programs are run each evening.

Each evening, except Friday and Saturday, the daily batch programs are run. These programs, which generate notices regarding fines, recalls, and book availables, are run against the transaction file. This file is generated during the period between batch runs. When an item is discharged, the record is removed to the transaction file, and whenever a record is altered at the 2740 terminal in such manner as to necessitate a notice that record is also copied onto the transaction file. The notices are delivered to the library the following morning, where they are stuffed into envelopes and mailed.

There is no continual machine follow-up on fine notices. The original notice is a four-part form; after the initial mailing, the three remaining parts are used for manual follow-up, if necessary. The notice that a book that had been requested is not available is a one-time thing. If the book is not picked up within a reasonable time, it is returned to the stacks. The recall or book-needed notice, is followed up, but as part of the weekly overdue run.

Once each week the overdue program is run against the master circulation file. Items usually have a four-week loan period, though there is a built-in capability of making loans for two, four, six or eight weeks, and indefinitely.

Notices are thus prepared for items based on the due date, provided they fall within a certain number of days of overdue; for example, first overdues are more than four but less than twelve days and final overdues are more than thirty-two but less than forty days overdue. On a two-week cycle, then, following the initial notice, overdues are automatically followed up.

In the case of faculty (who are not subject to fines), items are charged to them for the regular loan periods, but no overdue notices are prepared, except for recalls. At the end of each quarter, a listing is sent to each faculty member indicating the items still charged to him.

Also on a quarterly basis, listings are generated for items on indefinite loan. This includes charges to departments, such as cataloging or reserve room, and to carrels. Also included are those items charged to lost or missing. Thus all items in the file are completely followed up on at least a quarterly basis.

Management reports, so far, are at a minimum. This has primarily been due to the priority placed on bringing the technical services module to completion. Output is presently prepared on a weekly basis showing, by particular Dewey classification, the number of items charged out under a variety of categories: students, faculty, guest borrowers, reserve room, lost/missing, other libraries, departments, and renewals.

One use to which these data have been put is a follow-up on a policy change made early in 1971. During the first year of the systems operation, the loan period was two weeks. The circulation department felt that the number of renewals was using up an inordinate amount of staff time. They suggested that a four-week period would provide a better operating environment and might also serve the user better. It was further anticipated that while the number of save requests would probably increase, these would be offset by a decline in renewals.

The data studied covered two six-month periods—one with the two-week loan, the other with the four-week loan. It was found that the number of saves increased by 109 percent while the renewals decreased by 38 percent. Translated into time units, however, 12 percent less time was spent in processing these requests. This certainly confirmed the department's feelings, especially since there was an increase in overall circulation of just over 31 percent.

Every member of the circulation department is extremely happy with the system. As head of the department has stated, "No one on the staff would consider returning to the manual system." When everything is functioning properly, things could hardly be better. But, being a completely on-line system, it is at the mercy of the equipment. If a 1031/1033 terminal goes down, there is at least some inconvenience. If the 2740 goes down, there are problems. If the phone lines act up, there are big problems. If the computer "gets sick," there goes the ball game—almost. Fortunately, the amount of downtime of these items is generally inversely proportional to the problems

created. Thus, while some of the equipment may occasionally be out of service, the average amount of downtime for the system as a whole, can be measured in, at most, a few hours per week. Certainly a livable situation, but of sufficient concern to warrant certain back-up capabilities.

In addition to coping with machine downtime, there must be quick and fairly efficient means for charging out items which have no prepunched book cards. Putting these two conditions together, the back-up system consists of a Standard Register Source Record Punch and a two-part form. This form, with carbon interleaf, provides a date due slip (top part) and a composite card for later processing when the system comes back up. When necessary, the borrower presents the book card and ID badge at the main circulation desk. These are placed in the source record punch and the data are transferred to the two-part form. Also transferred are data from internal slides, thus preparing a printed date due slip and a punched composite card—so called because this one card carries all the data needed for the master file record. When the system resumes operation these cards are given priority handling.

This is a comparatively slow process and the machine is far more sensitive than the 1031. It all too frequently misses punches, especially in poorer quality badges. This is rarely discovered until after the user has departed. But on the whole, it does a much better job than keypunching all the data into the card which is necessary when there is no punched book card.

In this case, the call number is printed on the form, along with the user number, and the due date is stamped in the appropriate location. The top slip again goes with the book, and the bottom card goes to keypunch where it is turned into a composite card. At the same time a book card is prepared, to be filed awaiting the return of the book. Copying of call numbers and ten digit user numbers is extremely error prone and keypunch errors do occur. Again, these cards must have priority handling to insure their entry into the system as soon as possible. When delays in keypunching occur, it would be possible to have the book returned and "discharged" before the composite card is ready for charging.

The major problem with this back-up is that transactions take place without the usual error detection in operation. An item being renewed may have a save requested, it may already be in the file for some strange reason, or the user may be one of those whose number has been blocked.

What has been the impact of the computer-based circulation module on the library? Most noticeable to both the staff and the users has been the change in actual operations involved with charging out an item. For about two-thirds of such transactions, it is a self-service operation. The three 1031/1033 terminals located in the stack areas are not manned. The user, who has a badge and desires to borrow a book which has a punched card, approaches one of these terminals, places his badge in the appropriate slot of the 1031, and places the book card in its slot. In a few seconds the terminal reads and ejects the

badge and the book card. Then the 1033 printer goes to work and prints the date due slip. The user pushes a specially designed lever on the top of the printer which cuts the paper; and then he removes the slip. The slip and book card go into the pocket of the book and the badge goes into the user's pocket. He shows both the book and badge to the exit attendant and leaves the building.

Security is a very important factor in today's library. At Northwestern there are attendants at each exit to check on material leaving the library. The computer-produced date due slips offer a means for positive identification of all legitimately borrowed items. The call number on the slip can be compared with the call number on the book pocket and the identification number of the borrower can be compared to the ID card. This has, of course, not stopped all losses, but it has been significantly helpful.

In almost all instances, the user has spent a shorter period of time doing the charging himself than if he had had to use the services of a circulation assistant. The circulation department staff member, meanwhile, has gone about other business.

Much of the work of the circulation department personnel has changed. No longer are most of them tied to the task of continually filing and then unfiled charge cards. No longer do they have to spend innumerable hours deciphering names and addresses and then typing overdue notices. No longer do returned books pile up into small mountains because of lack of help or because there is limited space around the filing bins to get at the book cards. No longer can faculty borrow books "forever" because there is not enough time to send out regular (or even irregular) reminders to them.

No longer do staff members feel that the collection controls them. Now, they control the collection. Filing and unfiled the circulation file is handled by the computer. While renewals must still be handled by a staff member, more and more charging by special borrowers is being done on a self-service basis as punched badges are provided for guest borrowers and carrel holders. The processing of overdue notices has almost been reduced to an envelope-stuffing operation. The slips are inspected prior to stuffing, primarily to catch long overdue items for special handling. Names and addresses for university borrowers are printed on the notices; the batch programs have access to the student and payroll files to gather such information. On most days, only about four to five man-hours are needed to discharge returned books. Requests to check if a book has been charged out are easily processed through the 2740. Usually, there is an assigned operator on duty, both because there is a constant stream of such requests and because there are a number of file maintenance chores to perform—mail renewals, saves, and problems of various sorts. Fine notices, though only partially automated, are much easier to handle. All long-term borrowers are reminded of items charged to them on at least a quarterly basis. The staff knows that the situation is well in hand and that those areas of continued concern will be improved.

Because the system has freed so much time from simple but necessary clerical operations, the department has been able to do things which, while probably in its domain in the past, could not be effectively handled due to this heavy clerical load. Some new responsibilities have even been added: a complete inventory matching the card catalog and the holdings is under way, the collection and the card catalog are being brought into agreement, and incomplete holdings are being brought to attention.

Now that the collection is under better control, both internally and externally, the user is better served. Items are easier to find because they are more often where they should be, or are kept track of in the master file. This file also contains records of transactions in the Technological Institute Library, the largest branch on campus. (A 1031/1033 unit and a 2740 are used there, although because of smaller volume, there is no self-service operation.) Other libraries on campus may eventually be brought into the system, making the main library's union catalog an even more effective tool. There is much built-in flexibility, so that not only can a variety of due dates be offered, but items can be coded in a variety of ways—Dewey, arbitrary number, LC classification, etc. It should be mentioned that the decision to omit author and title data on the book cards has met with almost no user complaints. In the more than two years of operation, only a few individuals have made any negative comments.

But the system is not quite perfect. Some of the equipment, especially the 1033 printers, cause problems. Paper jams regularly occur, although far less frequently since the installation of specially designed cutting blades and paper channels. Badge quality is very important, and has at times caused innumerable problems. Improvements can be made, such as an on-line file of valid users and a blocking pattern that could do away with the traditional monetary fines. Automatically suspending borrowing privileges until overdue items are returned might be much more reasonable and effective.

But these are minor considerations in light of the successes so far achieved. In operation since January of 1970, the system has proven its effectiveness. While there has not been any reduction in staff, added tasks have been easily absorbed, as have significant increases in circulation volume.

Northwestern University went to an on-line system in order to produce a substantial impact on library operations. There is no question but that there is such an impact.