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The Ups, Downs and Demise of a Library Circulation System

THE AUTOMATED CIRCULATION SYSTEM discussed in this paper was in existence in the spring of 1978 when the fifteenth annual Clinic on Library Applications of Data Processing was held. The system was not a failure in the sense that it never succeeded in becoming an operational system. It did become operational and had functioned in the Undergraduate Library at the University of Illinois at Urbana-Champaign for two and one-half years (from May 1976 to December 1978). The system was stopped because it was replaced by a larger computer system that could perform known item searching by author, title and author/title, in addition to performing circulation functions. The university agreed to replace the Undergraduate Library system with the larger system as part of the negotiations for hiring a new director of the University Library.

Cessation of operation of the former system did not represent a failure of automation per se, i.e., manual techniques did not triumph over computer technology for circulation recordkeeping. Nevertheless, it still failed becuase it did not become a "convincing" automated system, one with a sufficiently strong reputation to survive in a time of rapidly developing automated systems for libraries. In addition to its one major failure—the failure to survive—the system encountered a number of lesser (but still significant) problems and failures during the course of its development. These are worth documenting in the hope that they will be instructive to librarians and library system developers who will be planning, building and installing systems in the future. The intent in documenting

this set of problems and failures is to seek out generalizations that could apply to other systems, indeed, to any system, whether a circulation system or other library system, whether commercially purchased or custom-developed. The details are important only insofar as they supply evidence of general classes of problems that could occur again. The selections that follow will describe the system in its operational form, summarize the history of its development (which is where the problems are to be uncovered), and conclude by extracting a list of generalizations that may be relevant to other systems.

THE UNDERGRADUATE CIRCULATION SYSTEM

This automated circulation system was functionally much like other on-line circulation systems. It could charge, discharge, renew, record holds for later borrowers, send overdue notices, compute fines automatically, bill for lost books, and record and report statistics. One advantage of this system over commercial turnkey systems was in the billing for fines and lost books. Fines and lost book charges were transferred in machine-readable form directly from the circulation system to the university's accounts receivable automated system, providing cost benefits both to the accounting office and to the library.

The host computer was an IBM 370/168. The library terminals were IBM 3277 cathode ray tubes (CRTs) which were used for all on-line transactions including charging, discharging and updating of library records. A leased telephone line carried the messages between the eight CRTs in the Undergraduate Library and the computer. Other offices and departments of the university also shared the same computer.

The system used three files: patron file, overdue file and book file. Patron records included their identification number (Social Security number), address and status (e.g., student, faculty, staff, or permit holder). Overdue records contained information about each overdue transaction (notices sent, patron response, fines, billing for lost books). A record for each cataloged item was in the book file. An arbitrary item number was assigned to each record, and each item was stamped with its number. Book records contained brief bibliographic and circulation information. Bibliographic data included were call number, author, short title, imprint date, status (such as "missing"), and the location of the book, such as "browsing area." Circulation information consisted of the item number, identification number of patron to whom the book was charged, due date, renewal information, reserve status, hold and restriction information, and counters to keep track of the number of times the book was charged or renewed. Records in all three files could be modified, created or

deleted on-line from the IBM 3277s by staff with appropriate security codes.

As many as ten books could be charged to one patron in a single transaction. By typing the charge transaction code on the CRT, the screen displayed a fill-in-the-blanks charge format. On this display, library staff typed the patron's identification number and the number of each book being charged. This information, along with a computer-calculated due date, was immediately written into the book record file. As a double check, the computer responded with the call number and author next to each item that had been charged. Discharging was a similar process. When the discharge transaction code was entered, a formatted screen appeared on which up to ten books could be discharged at once using item numbers. Discharging removed the patron's identification number from the book record. Although bar coded labels and wands were not used, charging and discharging were nonetheless quite simple and fast processes.

When a book was overdue, the computer automatically created a record for the overdue file. Student notices for books four days overdue (the bulk of the workload) were computer-printed on continuous-form postcards. Successive notices were sent as form letters using information from a computer-generated overdue books report. Items which were eleven, twenty-five, and thirty-five days overdue appeared on this print-out. At the time of discharging, all overdue discharge dates were entered automatically in the overdue file, shutting off further notices.

Statistics on circulation were produced at regular intervals or on request, depending on the type of report. Charge statistics by patron type were produced daily and monthly. Special reports, such as the number of books charged each hour, charges by classification number, lists of missing items and items in special locations, were produced on demand. Statistics on books discharged by the hour were periodically requested to determine peak periods when more student assistants were needed for shelving. Tabulations of overdue books and fines by patron type were also generated routinely.

In comparing this automated system to the preceding manual system, the staff in the Undergrduate Library made several observations. They estimated that paperwork for circulation control was reduced approximately 75 percent. Overdue notices were sent much sooner, the first when the book was only four days overdue. With the manual procedure, the first notice had been sent when the book was two weeks overdue. Since patrons were reminded earlier, their fines were generally less. Billing of student fines became an automatic procedure, entirely eliminating typed vouchers. Patrons no longer had to fill out keysort cards to charge books, which reduced errors and speeded the charging process. Discharg-

ing was considerably faster on the computer because staff no longer had to search tub files for charge cards. The staff believed that patron satisfaction had definitely improved as a result of these new, faster and more accurate circulation procedures.

DEVELOPMENT OF THE SYSTEM

Preliminary Planning Stage: November 1965–December 1969

The preliminary planning stage of an automated system is generally characterized by discussion of alternatives, estimations of costs and benefits, visits to other libraries or conferences to discuss alternatives, and preparation of budgets to seek additional money to automate. Small amounts of money are spent on such things as staff travel to other libraries or conferences, but no new line item in the budget is established expressly for the automation project under consideration. The preliminary planning stage may be long or short, depending on the library and the functions being automated. For example, some libraries evaluated OCLC for years before they joined. Others took as little as six months from the time they first decided to consider OCLC until they had a budget and joined.

At the University of Illinois, the preliminary planning stage for the Undergraduate Library's circulation system took a little over four years. Preliminary planning began in November 1965, when the library's automation committee assigned the Automation Librarian to study circulation procedures in the Undergraduate Library. The Automation Librarian studied the library in spring 1966, but no recommendations were made at that time.

In June 1966, IBM entered the picture by assigning a company representative to study the Undergraduate Library's circulation procedures to determine whether it was feasible to automate circulation given the technology of the late 1960s. IBM's study was free to the library. (In the 1960s, almost all of IBM's data processing income came from the sale or lease of computer hardware. As a marketing strategy, IBM would frequently study a customer's operation free of charge, find automation "feasible," and generate income by selling or leasing hardware to the customer.) The study took nine months and culminated in March 1967 in a proposal to automate circulation with an IBM 1030 system connected on-line to an IBM 360/50 at the university's Office of Administrative Data Processing. Since the 1030 equipment read Hollerith punched data, students would need to carry Hollerith punched identification cards and the library would have to put book pockets and punched book cards in all circulating materials.

The library asked IBM for a comparison of off-line 1030 and off-line 357 systems with the on-line 1030 system. They responded with comparative cost figures for all three systems. Since computer usage costs were difficult to predict, estimates of these costs were supplied for the three alternatives. Computer charges for the on-line 1030 system were estimated to be nearly the same as for the two off-line systems, making the on-line system only a few dollars a month more expensive than the other two. Total recurring operational costs for the on-line 1030 system were estimated to be $3000 per month.

By November 1967 the library administration concluded that autmomated circulation based on any of the alternatives was more expensive than manual circulation. Furthermore, since a new Undergraduate Library building was scheduled for occupancy only nine months later in summer 1968, the administration agreed that automated circulation should be deferred until after the move to the new building. Accordingly, the library suggested a new date of summer 1969 for automating circulation. Circulation was expected to increase substantially in the new building, making automation more attractive by 1969, and the library accepted the on-line 1030 system as the best system to use.

Because the 1960s was a period of growth and prosperity for the University of Illinois (as well as higher education generally), the standard procedure for any new plan or program was to prepare a program justification report along with a request for additional funds. In March 1968, as part of the normal annual budget request cycle, the library requested start-up funds for fiscal 1969 and recurring funds beginning in fiscal 1970 to operate the on-line 1030 system. A few months later, the budget request was denied. For the first time in years, the refusal memo referred to "a period of declining budgetary funds which lies immediately ahead,"[1] and asked the library to categorize data processing requests as either "essential" or "helpful but not essential." Still uncertain about the cost benefits, the library classified the circulation system as helpful, not essential.

From mid-1968 until the end of 1969, the library went through a series of budget requests and reschedulings for the circulation system. System development was requested to begin in July 1969; then it was deferred to January 1970, then deferred again indefinitely. Budget requests were submitted to three different administrative levels, each requiring different deadlines for requests. The first requests were prepared and sent with the university's approval to the Illinois Board of Higher Education, the highest level and with the earliest deadline. On a shorter calendar cycle, budget proposals were sent to the university administration each year requesting money from the university's general reserve funds. Failing to get money at the two higher levels, the library asked the Office of Ad-

ministrative Data Processing (ADP) to assign analysts and programmers from their existing staff to design and program the circulation system.

For eighteen months nothing succeeded. In February 1969, the middle of this 18-month period, the Automation Librarian noted that nowhere on the university campus was there an operational on-line system. Neither were there available personnel with the skills needed for implementing an on-line system. This lack of expertise may have accounted in part for ADP's unwillingness to assign personnel to the on-line circulation system or to support the library's budget requests. In April 1969 ADP demanded a comprehensive long-range library automation program before it would take a first step on circulation. The library said it could not prepare such a program without technical help from ADP. ADP said it did not have sufficient staff to do long-range theoretical studies. At this low point, the library's Automation Committee acknowledged an impasse with ADP and the Automation Librarian was granted a sabbatical to survey library automation elsewhere.

While the University of Illinois at Urbana-Champaign was getting no closer to an automated circulation system during 1968 and 1969, two university libraries nearby were developing the very system that the Undergraduate Library had been requesting, i.e., an on-line 1030 system connected to an IBM 360 computer. The Eastern Illinois University library, fifty miles south, developed its IBM 1030 circulation system in 1968, which became operational in September 1968, and has been running it since.[2] The Northwestern University (Illinois) library, 150 miles north, developed a generalized teleprocessing system in 1968 that could be used for all types of library functions. In 1969, Northwestern developed a circulation system using 1030s tied into the general teleprocessing system. Northwestern's circulation system became operational in late 1969, and is still in use.[3] Apparently, budgetary and technical problems were not insurmountable at these two nearby Illinois universities.

Development Stage, First Attempt: January 1970–June 1971

In December 1969 IBM renewed their marketing efforts. Seeing their proposals to sell 1030 hardware to the library rejected partly because of ADP's reluctance to assist with development, IBM offered, for a fee, to help the library develop the system. IBM offered its Systems Engineering Services (SES), their umbrella phrase for consulting, design or programming, at $28 per hour. IBM proposed three phases: (1) functional specifications, to be done entirely by IBM; (2) design specifications, done entirely by IBM; and (3) programming consultation with ADP which would do the bulk of the programming. The library, still indefatigable, submitted yet another budget request to the university to hire IBM as proposed. For

the first time, ADP sent a supporting memo to the university administration, and in January 1970, the university approved the funds.

IBM worked on phase 1 from February to May, and produced a document of functional specifications for a charge of $3200. The functional specifications uncovered a need for terminal inquiry, so IBM 2260 CRTs were recommended as an addition to the equipment configuration.

In June IBM began phase 2, and the library requested recurring funds to begin operation of the system one year later, in July 1971. Staff at IBM, ADP and the library were optimistic that the system would be ready by mid-1971. In November 1970 conversion of the shelflist to machine-readable form began. ADP wrote a program to produce book cards and library staff started putting pockets and cards into the books. The university admissions office began punching student identification badges. Scheduled completion for the conversion was June 1971. Also in November, IBM completed phase 2, delivering a very thick notebook of design specifications. Hardware components specified were 1030s for charge, discharge and renew functions, and 2260 CRTs for the file inquiry and update functions. The specifications included record layouts, file structures, screen designs for the 2260s, message formats for all transactions, and flow-charts for fifty-seven programs. ADP spent two months studying the specifications and found a few inconsistencies and omissions which IBM agreed to correct immediately at no charge. By January 1971 ADP was ready to begin programming.

Then funding problems arose again. In January 1971 the Illinois Board of Higher Education cut the circulation system from the university budget for fiscal 1972. The campus said it could not, from its own general funds, support a full year of operations, but might support one-half year. Implementation was rescheduled from July 1971 to January 1972 to cut expenses. ADP decided to proceed with batch programming in spite of the delay and wrote twenty-eight programs between January and June 1971. Since there was no money for the on-line equipment (1030s and 2260s), on-line programs could not be tested, and so were not written. In June the project was suspended. The existing programs and documentation were carefully stored. The Automation Librarian, back from sabbatical, finished the university's required period of post-sabbatical employment and resigned.

Development Stage, Second Attempt: July 1971–June 1973

The library continued to submit the same budget request to the university, and through the university to the Illinois Board of Higher Education, from July 1971 to March 1972. As time passed, technological changes occurred. IBM introduced the System 7 minicomputer with 2795

data entry units for reading Hollerith punched data. The System 7 was intended to replace the 1030s, which IBM planned to withdraw gradually from their product line. IBM also announced the 3270 line of CRTs to replace 2260s. In March 1972 IBM's local sales office dusted off its proposal for the library's circulation system based on 1030s and 2260s and changed the configuration to a System 7 with 3270s. The cost for the new equipment was about the same, except that the System 7 had to be programmed. IBM assured everyone that the System 7 programming was minimal. Furthermore, the System 7, being a small computer, could serve the library as a backup when the IBM 360 was down. The 3270s were a newer, better line of CRTs and could be programmed as 2260s (emulation mode) or as 3270s (native mode). Since no CRT programming had been done, no additional CRT development costs were anticipated beyond the original estimates. The library immediately updated its budget request to the university using System 7 and 3270s as the new equipment for circulation.

The appearance of the new terms *System 7* and *3270* in the budget request must have had some effect on the university administration. Three months after the library submitted the updated request, the university provided partial funding for the project from its existing contingency reserves. The project moved again. IBM submitted two new SES proposals to do part of the on-line programming. One proposal was for programming the System 7; the other was for the IBM 360 on-line programs which communicated with the System 7. The on-line programming to communicate with 3270 terminals was not included in the funding, but was planned for a year later in July 1973. The library and ADP concurred and signed both programming contracts with IBM. IBM promised to be finished by January 1973 in time for spring semester.

The System 7 was planned for installation on ADP premises, four blocks from the library. Hollerith data collection terminals (2795s) at the library would be connected to the System 7 over a cable run through the campus steam tunnels. Investigation showed that the temperature in the steam tunnels exceeded the maximum recommended for the cable by 30°F.University electricians consulted with IBM, who decided that the extra heat would not interfere with data transmission if a different, better cable were used. The university ordered and laid the IBM-approved substitute cable in late 1972 at a total cost for cable and labor of $3900. Since this particular combination of cable and temperature had never been tested, the library worried about the decision, but acquiesced to the authority of electricians and IBM technicians.

In January 1973 IBM failed to deliver working on-line programs for either the System 7 or the IBM 360, but gave rosy progress reports saying

completion was just a month away. In March IBM admitted the System 7 programs were not working, and promised to call in a company expert from outside the local area. Also in March, a new Automation Librarian was hired and began examining the system specifications. By May IBM had not found an outside expert, and local IBM personnel were still unable to make the System 7 work. Meanwhile the Automation Librarian had discovered a number of design flaws that affected both the on-line and batch programs.

IBM reassessed the situation, and in June proposed to complete the entire system for $85,000. According to this proposal, they would solve the System 7 problem, finish all of the on-line programs, and correct all of the design flaws in the twenty-eight batch programs which were already written. The library and ADP were incredulous. What was needed was IBM's completion of the on-line programs, as they had originally proposed to do six months earlier. The library and ADP jointly agreed to cancel the programming contract with IBM, seek a refund for money paid to IBM for programming (which was granted), and cancel the System 7 lease. The library and ADP also agreed to reevaluate the entire project, correct design flaws and resume work with just the library and ADP as project participants. However, as of June 1973, development had again come to a halt.

Development Stage, Third Attempt: July 1973–May 1976

Between July and September 1973, the library and ADP reviewed the design, modified record formats to correct flaws, and reviewed currently available circulation hardware. Since all books by then had Hollerith punched book cards and 35,000 students had Hollerith punched identification cards, the library and ADP agreed to try the System 7 again. The head of ADP wrote a memorandum to the head of the library promising a completed system in one year. Shortly thereafter, a new problem developed. A few months earlier the computer center had been divided into two separate organizations, with one group assigned to run the computer and its operating system software separate from ADP. ADP was left with the sole responsibility of applications programming. In October the two groups entered into a technical debate over which IBM teleprocessing software to use for the library's on-line system. One group wanted CICS, the other wanted TCAM. The debate lasted three months, during which time no programming was done. When the debate ended, CICS was selected. ADP had no training with CICS and, as a result, had to spend the early part of 1974 learning to use it.

From March 1974 to May 1975, the project was marked by slow but steady progress. All of the on-line transactions for the System 7 and 3270s

were programmed. The batch programs were reprogrammed where required to correct design errors. The System 7 remained a nagging problem, however. It was not reading the data entry units (2795s) with consistency. Diagnostic tests were performed, and the results were not altogether surprising. The steam tunnel was, in fact, too hot for the cable, causing data to become garbled in transit. In August the System 7 was moved to the library to be near the 2795s. The System 7 was then connected to the IBM host computer over a telephone line, thus avoiding the steam tunnel. Since the cable problem had prevented a thorough test of the circulation functions, the library delayed changing over to automated circulation until the spring semester. The fall semester was planned for parallel run and test. Optimism was high that the last serious problem had been solved.

The optimism was premature, however. The System 7 was able to read the 2795s, but it began losing communication with its IBM host. The System 7 had been programmed to punch paper tape whenever the host went down—and it began punching paper tape with great frequency, even though the host computer was running fine. Within a week, the System 7 had punched several hundred feet of paper tape, enough to decorate the office area at the next staff party. Why did the System 7 think the host was down when it wasn't? ADP spent all fall trying to find out. IBM maintenance engineers checked and rechecked the hardware. In February 1976 IBM brought in a System 7 programming expert who located the problem: programming errors in the System 7 communications software supplied by IBM. IBM had recently improved the communications software, but the newer version was considerably larger. To use it, the library would have to lease a larger System 7 at a higher cost. At this point, the library made a bold decision to cancel the System 7 and rely totally on 3270s for all transactions. The 3270s had been working well for charges, discharges and renewals when the System 7 was down. Why not use 3270s all the time? The implications of the decision were considerable: 130,000 volumes had bookcards which would be useless, and the university would have wasted several thousand dollars punching student identification badges. With this key decision, the system jelled. In the two months remaining of the spring semester, the library disconnected and returned the System 7 to IBM, trained library staff on the 3270s, and performed a short parallel test. In May 1976, at the end of the spring term, the library cut over to the automated system. A few minor problems were encountered and corrected in the first two months of operation. Thereafter, the system functioned quite well.

COSTS

The two major cost components of the Undergraduate Library circulation system were development costs and recurring operational costs. Recurring costs ran approximately $40,000 per year, half for computer usage and half for lease of the IBM 3270s. By the time the system was shut down, rental credits had accrued on the 3270s to the point that they could have been purchased for about $20,000, leaving only the $20,000 annual computer use charge. Development costs relate to some of the problems encountered and are given in Table 1.

TABLE 1. DEVELOPMENT COSTS, 1970–76

IBM SES	$ 23,000
Hardware	
System 7	37,000*
Machine time on host 360	20,000
3270s	41,000
Student identification badges	19,000*
Shelflist conversion	10,000
University personnel	
Library	60,000
ADP	100,000
TOTAL	$310,000

*Not used in operational system

The 3270 costs are the lease charges for the terminals during the developmental period before the system was operational. The figure for machine time is purely an estimate because costs for development time were not billed to the library and ADP did not keep the data; the figure of $20,000 is based on the guess that all of the machine time over a 6½-year developmental period equalled the cost of one year of operational machine time. Items marked with an asterisk were never used in the operational version of the system. Costs shown for student identification badges were the incremental costs for Hollerith punching. Since Hollerith punching was done solely for the library, these costs can be attributed directly to the circulation system. Half of the shelflist conversion costs went for punching book cards and placing them along with book pockets in 130,000 volumes. Since the book cards were never used, adding their half of the $10,000 conversion costs to the costs marked by an asterisk gives a total of $61,000 spent with no useful result. Costs for library and ADP personnel would have been lower if development had not been

interrupted and delayed as it was, but it is difficult to estimate how much lower they would have been.

Under threat of a lawsuit, IBM reimbursed the university for the full $3900 in direct costs to install the System 7 cable. Thus, this cost is not listed in Table 1. However, the cable fiasco cost an untold amount in unproductive programmer time and months of project delay.

FAILURES AND GENERALITIES—BACK TO FUNDAMENTALS

The left column of Table 2 is a list of problems or failures encountered during the development of the Undergraduate Library circulation system. In the right column are corresponding generalizations that should be followed to avoid repeating these mistakes. Most of the generalizations seem so obvious that it should hardly be necessary to state them, but they are like fundamentals in athletics. Athletes are supposed to learn the basics of their sports at an early age and then progress to the more subtle fine points. Coaches find, however, that they must stress fundamentals again and again, even at the collegiate and professional levels of sports. The same is true with the generalizations in Table 2. They are fundamentals which, if not followed, will almost invariably lead to problems.

These generalizations are relevant for libraries purchasing turnkey systems as well as for libraries developing local systems. Librarians contemplating turnkey systems should not be lulled by turnkey

TABLE 2. UNDERGRADUATE LIBRARY FAILURES

Failure	*Fundamental Generalization*
No commitment	Obtain firm commitments from the administration before starting
Piecemeal budgets	Obtain the money needed to reach some level of operation
3-ring circus (library, IBM, ADP)	Reduce complexity; have clearly defined areas of responsibility
Took too long (hardware changes, data conversion inconsistencies)	Keep the project moving
Functions not fully understood	Obtain expert technical assistance
Too much hardware	Keep the system simple
Cable installation	Follow physical installation specifications
Did not survive	Build or buy "good" systems, i.e., ones that satisfy the need, impress the administration

sales representatives into thinking that problems can thus be automatically avoided.

The specific failures, listed in the left column do not "prove" in any logical sense the corresponding generalization on the right. One case does not establish a generalization, but there have been enough cases of the type listed on the left to establish credibility for the generalizations on the right. Even though very few problems and failures have been reported in the literature, many librarians have experienced similar situations or have heard about them from others. The problems encountered by the Undergraduate Library serve as documented evidence (probably very strong evidence) for the fundamental generalizations.

For the first year, the Undergraduate Library was committed to the circulation project, but the library administration was not. Then the library administration supported the project, but ADP did not. Without ADP's support, the vice chancellor remained unconvinced. It was not until IBM proposed in 1970 to do most of the work that ADP supported the project. With ADP's support of the library's budget request, the chancellor's office became convinced. However, the strongest commitment did not come until 1973 when ADP agreed to do the entire project without IBM assistance.

In the six and one-half years of development, from 1970 when the first money was granted until 1976 when the system became operational, the project received several partial budget allocations from the chancellor's office. Each allocation of funds had to be requested separately and the approval of any single request did not guarantee approval of the funds required to finish the project. Even when the system was nearing completion, the library did not know for several weeks whether permanent recurring funds for operational costs would be forthcoming. Projects do not move well under such tenuous budgetary circumstances. If a library cannot establish a solid budget with enough funds to reach an operational level, it is better to postpone the project until the necessary funds are obtainable. For example, at least one academic library purchased a turnkey circulation system, but lacked the money for a tape drive. The library thought the funds for a tape drive would come soon. The funds did not materialize. The library has been spending months keyboarding each patron one at a time into the patron file even though a complete student and faculty machine-readable file is available on the campus. Potential funding problems are not limited to locally developed systems.

At times during the first two development attempts in the life cycle of the Undergraduate Library system, the areas of responsibility

of the library, IBM and ADP were not clearly defined. There were times when IBM and the library agreed to do something, only to have ADP learn about it later and point out a problem. IBM and ADP might settle a seemingly technical question, and the library would discover that the results were not what the library wanted. There were numerous phone calls from one party to another complaining about the third. The Undergraduate Library project did not make any steady progress until IBM had been removed and the number of parties was narrowed to two, with clearly defined responsibilities for each.

The Undergraduate Library circulation system took ten and one-half years to develop—four years of preliminary planning and six and one-half years of on-again, off-again development. The terminal hardware changed four times, from 1030s to 1030s and 2260s, to a System 7 with 2795s and 3270s, to 3270s alone. Considerable staff time that had been spent on planning, design or programming was lost each time the hardware changed. Conversion of the shelflist took three years for 130,000 volumes, because it too was started and stopped along with the rest of the project. Conversion staff, who were student employees, experienced very frequent turnover. With so many people working on conversion during the three years, interpretation of shelflist records was not consistent despite diligent training efforts.

The project was marred by two design problems. First, the functions were not totally understood by IBM when they wrote the design specifications. The IBM specifications were more than 95 percent satisfactory—close enough to pass the review of nontechnical librarians and nonlibrary computer personnel. If a trained automation librarian had examined the specifications in late 1970, changes could have been made before twenty-eight batch programs were written, and several thousand dollars could have been saved. (The fact that trained experts can also be important in evaluating specifications of turnkey systems has been acknowledged by one library administrator with considerable library automation experience.[4])

The second design problem in the Undergraduate Library system was in the hardware configuration. Too much hardware was specified. Originally the library was adamantly against keyboarding circulation transactions because they thought keyboarding would be too slow and error-prone. A 1030 system, a System 7 or a bar code system was regarded as a necessity. In the operational system, however, keyboarding did work and was not too slow. With the computer programmed to respond with patron name, and call number and author of each item, checkout was also not error-prone. The library staff found that the 3270s were simple to use and reliable. Hardware configurations can, of course, include wands for reading bar coded labels or guns for reading

OCR font and still work well; that point is not in dispute. But if the hardware is kept simple, the system will be easier to use and will malfunction less frequently.

One of the most obvious failures of the system was the cable. That $3900 cable is still in the steam tunnel, both shining ends dangling unconnected. IBM's payment of $3900 to the university did not recover any of the lost time and staff salaries. IBM's original recommendations for temperature range should have been followed and, although the company did approve the changes, use of the steam tunnel should have been avoided. However, physical installation specifications are complex and require a great deal of caution on the part of purchasers. The more one deviates from the physical requirements, the greater is the risk of problems or even of complete failure of a piece of equipment.

The most serious failure of the Undergraduate Library circulation system was the failure to survive. Although this system failed for political rather than technical reasons, if it had been completed sooner and extended to other branches, it might well have secured the support of campus officials.

The pace of change is now quite fast in library automation. In the future, increasing numbers of automated systems will be replaced by more sophisticated ones. If any automated system is to survive for a normal life span of five to seven years, it must be sufficiently functional and economical to win the respect of decision-makers in the library and in the university administration. Any system that fails to convince such administrators will risk the fate that befell the Undergraduate Library circulation system at the University of Illinois in 1978.

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