
Microcomputers in Libraries

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WRITING AN ARTICLE dealing with any aspect of the use of microcomputers is somewhat like taking a still photograph of a hurricane. It may be possible to suggest something of the nature of the thing, but a static medium such as an article or a photograph cannot possibly capture the complete scope and impact of such a dynamic phenomenon. Although microcomputers are in many ways a natural, evolutionary outgrowth of previously existing computer developments, their effect has surely been revolutionary in its breadth and depth. Despite great advances in the use of shared computer systems and telecommunications networks, the mainframe computer was and is the province of the wealthy institution. The minicomputer brought computing power to mid-sized institutions, but was still beyond the grasp of most small institutions and virtually all individuals. The microcomputer has made automation accessible to nearly every small business or individual with a desire and need for a computer. The availability of relatively inexpensive, independently operated personal computers has brought automation to people, situations, and tasks that might otherwise never have been automated. At the same time, microcomputers used as intelligent terminals have led to great improvements in the use of larger computers.

The greatest impact of microcomputers may be that they have done so much to demystify the computer. The computer, previously the carefully guarded tool of highly specialized scientists and technicians, has become accessible to everyone. It has become clear that the use of this wonderful tool, seemingly so complex and unfathomable, can be learned in a very short period of time by virtually anyone. The computer is not just a tool for complicated, large-scale, long-term projects; it can

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now be effectively used to solve common everyday problems as well. As computing has become available to the nonspecialist, it has become possible for computers to find their way into virtually every aspect of human activity, including a wide variety of library uses and applications.

MICROCOMPUTER HISTORY AND DEVELOPMENT

The microcomputer was made possible by the introduction of the microprocessor in 1971. Although computers aimed at the individual user had been made and marketed before that time, they were of rather limited capability, were physically cumbersome, were difficult to use, and cost too much to appeal to more than a handful of highly motivated specialists. The microprocessor, which was developed for use in hand-held calculators, placed all of the essential elements of a computer's central processing unit on a single tiny square of silicon. The microprocessor was quickly adapted to other uses, including video games, control and monitoring functions in machinery and vehicles, and microcomputers.

Although there is some disagreement as to the identity of the first true microcomputer, kits for building rather primitive microcomputers appeared as early as 1973. The July 1974 issue of *Radio-Electronics* featured an article on the building of a "personal minicomputer" based on a microprocessor (Titus 1974, p. 29). A typical home-built microcomputer had very limited abilities, used a teletype and punched paper tape for input and hard copy output, relied on a television for monitor output, allowed for program and data storage on cassette tape, and required the manipulation of toggle switches to accomplish basic tasks such as loading data from a tape, running a program, or sending output to a printer. These kits had limited appeal and did not find their way into the mass market, but these kits did have a significant impact on computer enthusiasts and led directly to commercial developments that had a more far-reaching effect.

A major landmark year for microcomputer development was 1977. In that year, the first commercially produced microcomputers were introduced. The most notable of these were the Apple II, the Commodore PET, and the Tandy/Radio Shack TRS-80 Model I, which constituted the first efforts of three of the most successful microcomputer companies. Despite differences in appearance, these three products were in most ways quite similar. Each provided the purchaser with a box housing the microprocessor, a limited (by 1988 standards) amount of computer memory, and a keyboard. The Commodore also provided a built-in monitor; monitors were optional for the TRS-80 and Apple II, each of which could use an ordinary television as a monitor. Each initially made use of a cassette tape recorder for primary long-term storage, although floppy disk drives were very soon added to the options lists. The compact packaging and relatively low price of these computers and others introduced in the late 1970s made them very attractive to

computer enthusiasts, to some small businesses, and, perhaps most importantly, to educators. Suddenly, in 1977, teaching programming skills, making effective use of computer-assisted instruction, and employing computers for other educational purposes became economically feasible even for small schools. Apple and Commodore in particular quickly rose to prominence as providers of computers and software to schools.

The five-year period beginning in 1977 was one of fantastic growth in the fledgling microcomputer industry. Many new products were introduced, some of which were great successes while others were less successful and were eventually dropped from the market. Even successful companies had their problems and sometimes introduced products that were dropped from the market almost immediately. The microcomputer software industry came into existence during this period, and many currently successful software producers grew from products developed and produced during the late 1970s. This five-year period of rapid growth and diverse developmental activities reached a climax in 1981 with the introduction of the IBM PC, the machine that finally brought an element of standardization to microcomputer technology. Although that standardization is not and cannot be universal, the introduction of a product from IBM, the computer industry's one traditional giant, was bound to have a profound impact on the industry as a whole. "IBM compatible" quickly became a major catchphrase, and both producers and consumers of microcomputer hardware and software immediately divided into two camps. These two groups included those who eagerly embraced the IBM standard and moved to develop additional products and services based on that standard, and those who rejected the IBM standard in favor of some other hardware manufacturer, usually Apple. The latter group has become especially prominent since the introduction of the innovative and influential Apple Macintosh in 1984. Although the preferences of different people for different computers is an unusually emotion-laden topic and is often expressed as if it were a matter of open warfare (Magid & Marty 1988, pp. 70-77), the real conflict is probably a matter of truly personal factors rather than the clear superiority of one computer over another. The big difference between IBM fans and Macintosh aficionados appears to center upon subjective distinctions in what people in the two groups do and how they do them, although those distinctions are frequently expressed as if they represented an objective reality that should lead to the absolute dominance of one group over the other.

MICROCOMPUTERS IN LIBRARIES

Pratt (1984) has described the literature on microcomputer use in libraries as being "a mile wide and an inch deep" (p. 248). Despite four years of developing use and a rapidly growing literature since the publication of that statement, it is for the most part still accurate. The

literature to date is mostly descriptive rather than analytical, mostly pragmatic rather than theoretical. It is clear that the microcomputer has very quickly become a standard and nearly ubiquitous part of the repertoire of tools for use in libraries. It is equally apparent that librarians are still in an era of discovery with regard to microcomputers, exploring their uses and limitations, and accepting them into libraries with a mixture of enthusiasm and caution. Much of the literature seems to reflect a search for uses for a new tool rather than effective exploitation of available tools to meet well-defined needs. Many of the earliest reports on the use of microcomputers in libraries are arguably more valuable as philosophical statements of acceptance of a new way of doing things than as descriptions of valid applications of computer procedures for the accomplishment of needed processes. The later literature has shown a certain degree of maturity, reflecting more carefully planned applications of tools to tasks. This growing sophistication of use is probably in part a matter of the availability of increasingly capable hardware and software, and in part a matter of an increase in the sophistication of librarians as consumers and developers of microcomputer systems. Early microcomputers were not really amenable to the solution of complex tasks, but as microcomputers with increased processing speed, greater storage space, and more sophisticated input and output devices have become available, librarians have eagerly sought new ways of making use of the increased capacity of the machine. Similarly, those librarians who pioneered microcomputer use in libraries frequently had little or no prior automation experience. They were poorly prepared to select and use microcomputer hardware and software. More recent developments have taken place in an environment of increasingly sophisticated hardware and software and increasingly knowledgeable librarians.

There have been very few research reports dealing with microcomputers in libraries, and the cumulative impact of research that has been done is negligible. This does not necessarily reflect any fault on the part of authors interested in the use of microcomputers in libraries. The professional literature of any new area of interest typically begins with descriptions of products and their application in specific environments and develops a research component gradually. One problem in assessing and using the literature of microcomputer applications in libraries is the necessarily ephemeral nature of the literature. By the time a review of a particular software package has appeared in print, that software package may have been revised so extensively that the review is no longer valid. Case studies of the experiences of individual libraries are of interest but suffer from the same problem: by the time the case study appears the library may no longer be doing what was described. Directories and catalogs of hardware and software are potentially useful as a means of making comparative judgments but also suffer from becoming quickly out of date.

IDENTIFYING AND SELECTING HARDWARE AND SOFTWARE

The selection of specific hardware and software is a potentially difficult task. Although the availability of software for library-specific tasks is still somewhat limited, it is increasing very rapidly. Libraries also need general purpose software such as word processors, data management packages, spreadsheets, and communications programs. There are dozens of commercial offerings in each of these areas, and being an informed consumer is a difficult task. The proliferation of hardware presents an equally formidable selection problem. The availability of a large variety of IBM-compatible "clones" at bargain prices makes basic hardware selection problematic, and the situation is greatly aggravated with regard to selection of peripheral devices such as printers, monitors, and modems.

The problems of selecting hardware and software for use in libraries have been addressed by a number of authors usually in the form of general introductions to microcomputer use with comments on the application of microcomputers to library problems, or as sections in other works on the use of microcomputers in libraries (Chen & Bressler 1985; Kesner & Jones 1984; James E. Rush Assoc. 1984; Costa & Costa 1986; Rorvig 1981; Walton & Taylor 1986). The problem with any selection guide is its inherently ephemeral nature. The availability of microcomputer hardware and software changes so rapidly that any listing in book form will inevitably be out of date before it is published. Such books can, however, act as guides to general principles of selection and do provide some idea of the varieties of hardware and software available at the time the book was prepared.

The periodical literature of library science is only marginally better than the monographic literature as a source of information to guide microcomputer and software selection. Several periodicals do include product reviews and articles on microcomputer use including *Library Journal*; *American Libraries*; *School Library Journal*; *Library Hi Tech*; *Information Technology and Libraries*; *Access: Small Computers in Libraries*; *Library Software Reviews*; and *Database*. Periodicals, however, suffer from the same timeliness problems as books, although to a somewhat lesser extent (the degree of time lag depends upon the publication; some product reviews appear as much as a year after they are written). Although articles and reviews in library science journals may be valuable primarily as retrospective sources of information, the advertisements in these periodicals can act as indicators of the varieties of specialized hardware and software available. In such a rapidly changing environment, awareness of what is currently being offered can be essential, and constant monitoring of advertisements is one way to maintain that awareness.

The best sources of up-to-date information on general purpose hardware and software are probably microcomputer periodicals, such as *Byte*; *Personal Computing*; *PC World*; *PC Magazine*; *PC Week*. These publica-

tions provide frequent comparative reviews of hardware and software and also act as primary news sources for developments and changes in the microcomputer industry. The advertisements carried in microcomputer magazines can also be useful sources of information, and most advertisers are more than willing to send further product information.

A final very important source of information on microcomputer products is personal contact. Whenever possible, some sort of hands-on experience with the product should precede the decision to acquire it. Many software vendors will provide demonstration programs either free or for a small fee. Unfortunately, even small prices for demonstration programs can accumulate rapidly, and the quality of demonstration programs is quite variable. The best are scaled-down versions of the product, capable of exhibiting most of its characteristics. The worst are more promotional than demonstrative in nature and amount to disk-based advertisements for the product. The prospective customer rarely has any means for assessing in advance which approach will be taken in a demonstration program and therefore has a substantial likelihood of investing in a demonstration program that does not provide an adequate demonstration. Vendors of library-specific hardware and software are conspicuous presences at most library association conferences, and librarians should take advantage of such opportunities to encourage the vendors to demonstrate their wares.

Personal contacts can also be made at local microcomputer expositions or at meetings of microcomputer user groups. Microcomputer expositions or fairs are regular occurrences in many localities and provide an opportunity to see new hardware and software offerings and explore with vendor representatives the specifics of pricing, service availability, and vendor support. User groups often sponsor presentations by vendors and also act as clearinghouses for sharing experiences. Although expositions and user groups are unlikely to focus on library-specific hardware or software, they can provide a very valuable opportunity to learn about general purpose hardware and software.

LIBRARY APPLICATIONS OF MICROCOMPUTERS

Microcomputers have been used in libraries in a wide variety of ways, most of which fall into three major categories: (1) provision of microcomputer hardware and/or software for public use, (2) use of microcomputers as intelligent intermediaries to larger systems, and (3) use of microcomputers as stand-alone systems for supporting library functions.

Some of the earliest uses of microcomputers in libraries involved providing microcomputer hardware and/or software to library patrons, mostly in school and public libraries. This role of the library as a "computer resource center" (Costa & Costa 1986, p. 117) is a very natural extension of the library's traditional function of providing patrons with the information they need in the form in which it can best be used (Polly 1986; Dewey 1984).

The use of microcomputers as access mechanisms for larger, remote computers allows for effective use of distributed processing. Information can be input, edited, and formatted locally prior to being uploaded to a remote computer and can similarly be downloaded to the microcomputer for later processing. The overall effects are a reduction in demands placed on the larger computer and on telecommunications systems and the ability to make use of downloaded data for local purposes. A microcomputer accompanied by appropriate communications hardware and software has become the preferred tool for online retrieval from commercial database services. The adoption of the OCLC M300 (a modified IBM PC) for use in interacting with the OCLC system was a major advance in the use of microcomputers as access mechanisms for large computer systems. A microcomputer running specialized communications software is now the standard means for accessing bibliographic utility databases.

Although the public use of microcomputers and the use of microcomputers in providing access to remote computer systems are significant parts of the library microcomputing environment, the most active and arguably most problematic area is in the use of microcomputers to directly address library problems. Such uses can be divided into two broad categories: (1) the use of general purpose hardware and software to accomplish library tasks, and (2) the use of hardware and/or software specifically designed and developed for library purposes.

THE USE OF GENERAL PURPOSE SOFTWARE IN LIBRARIES

General purpose microcomputer software, such as word processors, data managers, and spreadsheets, has an obvious potential for application to the office operations that make libraries like other businesses. Spreadsheets can be used to manage budgets and prepare fiscal reports, data management packages can be used to maintain name and address files, and word processors are indispensable tools for the voluminous and repetitive correspondence essential to library operations. There are also many ways in which general purpose software can be imaginatively used in tasks more directly related to the primary functions of libraries. As Sherouse (1982) has pointed out, an advantage of using a general purpose software package rather than a package designed specifically for library use is the ability to flexibly tailor the product to meet local needs (p. 46). This can be of value when the librarian perceives commercially available library software as being too rigid, or when the librarian deliberately wants to deviate from standardized practices. In some cases, and this was universally true prior to the development of software designed to support library operations, adapting general-purpose software is the only available approach to automating a function other than writing a totally new program. Adapting a general purpose package may also be an economical approach, particularly if the package can be used for several library functions. Special

purpose software is frequently expensive, and buying several packages to support a library's needs may involve a substantial investment. If those same functions can all be achieved through the use of one general purpose package, the investment will usually be much less. The use of general purpose software for a variety of purposes also means that the user needs to learn only one set of commands and routines. Unlike many library-specific programs, general purpose software rarely requires any special hardware configuration. The computer that is used for general office functions can also easily be used for library operations, making the required hardware less expensive and adding a further element of simplicity of operation. A final advantage is that any community is likely to have a number of users of a general purpose program, and these users can act as a support group and source of advice. Similarly, every popular package is the subject of a variety of books and articles that can add to the librarian's understanding of the software and its use.

The literature on the use of general purpose software for library tasks is large and quite diverse. Most of the literature has concentrated on the application of data management packages, such as the dBase series, or spreadsheets, such as Lotus 1-2-3. Beiser (1987) has provided a fairly comprehensive view of the use of dBase III for library purposes, with applications for mailing list management, bibliographies, community resources files, newspaper indexes, abstracts, serials union lists, reference archives, acquisitions, serials control, catalog production, registration, overdues accounting and processing, reserve operations, circulation, statistical processing, and more. Data management packages have also been used for maintaining profiles of faculty research interests (Pasterczy 1985, pp. 265-76; Borovansky & Machovec 1985, pp. 300-05), managing serials functions such as check-in and binding (Evans & Ewing 1986, pp. 111-21), maintaining a sheet music index (Carter 1983, pp. 52-55), creation of a bibliographic retrieval system (Armstrong 1984, pp. 197-201). Clark (1985) and Auld (1986) have provided books on the use of spreadsheets in libraries to accomplish such tasks as preparing summaries of library activities, overviews of collection use, conducting studies based on *Output Measures for Public Libraries* (Zweizig & Rodger 1982), and assessing data from various statistical reports.

An important new variety of general-purpose software relates to desktop publishing. Every business is involved in one way or another with the production of various kinds of publications, and libraries generally have rather extensive publishing needs. Desktop publishing systems allow for the local production of high quality camera-ready copy for publications such as newsletters, promotional or educational materials, and reports. Among the advantages of desktop publishing are:

- High quality output: documents give the impression of having been typeset by professionals.

- Versatility: most software packages offer a variety of typefaces, type sizes, and graphic effects.
- Flexibility: the system's operator can make changes to the page layout right up to the last minute before the document is printed.
- Substantial savings in time and money: the traditional publishing cycle is streamlined and typesetting costs are eliminated (Carson 1988).

High quality desktop publishing is still a rather expensive proposition. The software itself is costly, and effective use of the software requires a high capacity microcomputer with a sophisticated monitor and a laser printer. The costs can be reduced by doing only the input and layout locally, and by having the actual printing done at a printing or photocopying shop. Even if all work is done within the library, it is probable that the overall cost of most small publishing jobs will be considerably less than if all setup and layout work is done by a printshop. Given the potential for added production control and decreased costs, it seems likely that many libraries will become heavily involved in desktop publishing in the next few years.

Another recent development with considerable potential for benefiting libraries is the development of various approaches to connecting microcomputers and other computers in networks. Although it has been possible to link microcomputers in geographically confined spaces for quite some time, until recently such networks have been of very limited flexibility. In instructional settings, it is possible to link computers such that the instructor's microcomputer can monitor activity on student microcomputers and perhaps send messages to students regarding their performance. Dial-up systems in which a microcomputer acts as a centralized source of information or programs are also a possibility. The network environment that is currently generating the greatest interest, however, is the local area network (LAN). In a LAN environment, a relatively diverse set of hardware and software, perhaps including different types of microcomputers, printers and other peripheral devices, and maybe even larger computers, can be tied together so that resources can be effectively shared within a relatively limited space. A detailed description of the use of LANs in libraries has been provided by Kemper (1987). The nature of a local area network can be summarized quite succinctly:

The devices linked by a LAN are physically connected by one of several types of transmission media (wire or cable). While provision is often made for remote connection by modem to other networks or computing facilities, such connections are not necessary to the operation of the LAN. The area covered by a LAN varies; it is usually confined to a single building or one floor or section of the building, although larger LANS can extend up to several miles. The LAN is normally owned by a single organization. (Levert 1985, p. 9)

The advantages of LANs lie in effective use of resources, such as sharing a single printer among a number of microcomputers, and in the ability to readily transmit information from any microcomputer in the network to any other device in the network. It is thus possible for workers who need to exchange messages or data to do so without leaving

their desks and without generating unnecessary printed memos or documents; a document can be created by one person, proofread by another, edited and amended by a third, and set up for desktop publishing by a fourth, all by passing machine readable files among workstations in a local area network.

The adaptation of general purpose programs to library purposes is not without its problems. As Beiser (1987) has pointed out, "not everything that can be done in dBase should be done in dBase" (p. viii). It is incredibly easy to invest an inordinate amount of time and effort in developing library-oriented products based on general purpose software. The apparent cost advantage of the software may be balanced or overbalanced by the high cost of adaptation. Some library tasks are simply not amenable to the use of general purpose tools. Most data management packages, for instance, rely on fixed length data fields. Although it is certainly possible to use such software to build bibliographic databases, the inherently variable nature of the records in such databases usually makes such an application inefficient. If the database is large enough, the limitations of a data management package such as dBase may make its application ineffective as well.

Another disadvantage of adapting general purpose software is the inability to effectively exchange data with other libraries. It is possible to exchange data in the form of files formatted for a particular data management or spreadsheet package, but in practice such exchanges are generally problematic. Although standardization of data in microcomputer systems for libraries does not appear to have been a very pressing concern, it is now possible to think in terms of microcomputer-based systems that make use of MARC records for bibliographic data. If the MARC standard dominates microcomputer systems in libraries in the manner in which it has taken precedence in larger computer systems, and there is every reason to believe that it will, libraries making use of systems adapted from general purpose programs will probably find themselves excluded from opportunities to benefit from the interchange of data among libraries.

SPECIAL PURPOSE SOFTWARE FOR LIBRARIES

Although software designed for other purposes can be adapted for library functions, the most effective solution frequently lies in the use of programs written specifically to address library problems. The development of library microcomputer software began very shortly after the introduction of the first commercial microcomputers and has continued in a rapid, if not very systematic, manner.

The general history of the development of microcomputer software for library-specific purposes has been one of overcoming hardware shortcomings. The earliest commercially available microcomputers were, in 1988 terms, distressingly slow, could store very limited amounts of data, and depended on ridiculously inconvenient input, output, and

storage mechanisms. Keyboards were not adequately similar to typewriter keyboards, monitors could display only a limited number of characters and frequently could display only uppercase characters, printers worked unbearably slow to produce products that were only marginally legible, cassette tape storage devices were slow and cumbersome, and early disk storage systems were capable of storing comparatively small amounts of data.

Despite these limitations, it was clear that microcomputers had much to offer librarians, and viable, if limited systems, were developed. Many of the earliest systems were developed by individual librarians who already had, or were willing to acquire, the skills necessary for writing their own programs. Other librarians worked with programmers in their own institutions or communities, sometimes hiring them on a contract basis, sometimes inveigling the assistance of friends or colleagues. Many of the products of these efforts were distributed to other librarians through various—mostly informal—means and thereby came into moderately widespread use. Some of these products were later transformed into commercial endeavors, and some currently successful commercial software is based on early programs developed by or for individual librarians.

As roadblocks have been removed or reduced by the advancing development and refinement of microcomputer hardware, library-specific software has become increasingly more sophisticated and more capable, but there are still limits to the abilities of microcomputer software. Even very small libraries maintain records that are large in microcomputer terms, and maintain large numbers of such records. This has generally meant that microcomputer software for libraries has necessarily been compromised in various ways. Many microcomputer-based circulation systems, for instance, make use of very abbreviated records, maintain data only for materials that are currently checked out, and even then are capable of coping with a very limited number of transactions and borrowers. The production of catalog data has typically meant reliance on records that are of an abridged nature and that do not in any way conform to the MARC standard for machine-readable cataloging. These limitations are being overcome as faster microcomputers with greater storage capacities become available and affordable, but software development always has a tendency to lag slightly behind hardware availability.

As a result of the size and number of many library records, advances in microcomputer storage devices have been especially important to the development of microcomputer-based programs for libraries. Tape storage gave way to single-sided diskettes, single-sided diskettes were quickly replaced by double-sided diskettes, recording density for diskettes has been progressively increased, and diskettes have been replaced, or at least augmented, by various fixed disks of ever-increasing capacity. A very important recent development is the widespread use of

optical disc systems which allow for very high capacity storage, making it possible to design library microcomputer systems that access fairly large databases of full MARC records (see Andre's article in this *Library Trends* issue).

Several catalogs of library-specific software have been published (Dewey 1987; Gates 1985; Miles 1986; Nolan 1982; Nolan 1983; Walton & Taylor 1986). These catalogs uniformly suffer from the same limitations noted earlier in regard to sources of information on the availability of software: none are truly comprehensive, and all are to some extent out of date by the time they are published. These listings do, however, provide some indication of the varieties of software that are available and are valuable as clues to what can be expected in terms of the processes that can be automated on a microcomputer, the hardware required for their automation, and the approximate cost of the software. The listings are purely descriptive, however, and do not provide any real input into the comparative evaluation of the products described.

Walton and Taylor (1986, pp. 510-18) have provided a listing of subject categories for library-specific software. These categories include acquisitions control; audiovisual, equipment and facilities management; bar code label production; bibliography production; catalog card and label production; cataloging; circulation/overdues; computer-aided instruction; documents control; gateway software; indexing; integrated system; interlibrary loan; inventory; online catalog; readability estimates; retrospective conversion; school library budget management; selective dissemination of information; serials control; shelf space management; statistics; and utility software. Other authors have developed other categorizations, but it is clear from examining any of these directories that systems are available to address nearly every library function.

One of the problems of choosing a library microcomputer system is the fantastic variation in capability and configuration of the programs available. Prices range from under one hundred dollars to several thousand dollars. Hardware requirements range from an Apple II or Commodore 64 with minimal internal memory and a single floppy disk drive to a fully configured IBM PC or Apple Macintosh with a high capacity hard disk and a laser disk drive. Many of the programs are available for a variety of different computers and configurations; others are available only for one fixed configuration of a specific brand of computer. Most of the programs require a specific operating system environment, and some require other additional software, such as a programming language or general purpose applications package. Some of the systems described also require specialized hardware, such as a bar code reader, a printer with a special tractor drive for forms, a tape backup system, or a specially modified keyboard. In some cases the specialized software and hardware are provided in a "bundle" at one price, in others the purchaser has the option of acquiring hardware from the software vendor or independently, and in others the responsibility of acquiring appropriate hardware is left entirely up to the software purchaser. Some systems

are vended by well-known suppliers of other services to libraries, some exist for the sole purpose of providing library automation systems, and some operate primarily in nonlibrary markets but sell one or two library-directed products. Service after the sale includes such options as no service, provision of regular updates at no cost, provision of updates for an additional charge, personalized service through telephone help lines, and on-site installation and service. Some vendors provide only software service while others service both hardware and software.

The extreme variability in software capability, hardware requirements, and vendor services makes selecting and effectively using a microcomputer system for library purposes very complex. A further complexity lies in the inevitable need to update the system. Software vendors are constantly trying to improve and expand their products, removing errors, making existing processes more efficient and more effective, and adding new processes. As hardware options and capabilities increase, it is natural for software producers to respond by making it possible for their products to make use of new hardware. Although the software producer will necessarily try to make the incorporation of revisions as easy as possible, changing from one version of a program to an updated version is always somewhat disruptive, and the greater the change in the program, the greater will be the disruption. Some librarians may be tempted to avoid this disruption by not implementing new revisions. This will generally have two major negative impacts: (1) the library will be denied increased effectiveness and/or efficiency, and (2) the library may be cut off from vendor support services, since most vendors aim their support operations at the most recent versions of their products.

Another potentially painful but usually inevitable decision most librarians will have to make involves the future need to replace one microcomputer software package with another. This can happen for a number of reasons: (1) the needs of the library may grow or change such that currently used software is no longer adequate, (2) new software may be introduced that can achieve the same ends as the current software in a more efficient or more effective manner, (3) the hardware required to operate the software may no longer be available, and (4) vendor support may no longer be available either because the vendor has gone out of business or because the vendor has chosen to drop the specific software product from its offerings. No matter how carefully the selection of software is handled, it is very likely that one of these factors will eventually lead to a need for new software.

Far too frequently the realization that the software currently in use must be replaced comes as an overwhelming shock. This is an outcome of an inappropriate way of thinking that can be termed the "permanent system syndrome." The permanent system syndrome leads people to believe that the means they select for achieving a particular task will never be in need of modification or replacement. Although this belief is

rarely appropriate, it is true that many manual library systems have had much longer product lives than most automated systems will have. Even the longevity of manual systems, however, may be a result of reluctance to change rather than lack of a need to change.

Another prominent malady is the "perfect system syndrome," in which it is believed that there must be some one system that will address all of the library's needs in a particular area. If that system does not appear to currently exist, the perfect system syndrome sufferer frequently decides to wait for its appearance rather than adopting an imperfect system now. Anticipation that the perfect system is just around the corner, or fear that a package selected now will have to be replaced at some point in the future, frequently leads to a decision to delay automation altogether. The perfect system syndrome and the permanent system syndrome often work together to prevent librarians from adopting reasonable attitudes toward automation. The librarian suffering from either syndrome risks allowing the library to lag increasingly behind the times and therefore remain increasingly inefficient and ineffective. There is no perfect system for any task, and there are no permanent systems.

THE FUTURE OF MICROCOMPUTERS IN LIBRARIES

Microcomputers have had a significant effect on libraries and will continue to do so. As microcomputer technology becomes cheaper, faster, and more powerful and as the user population and the library profession become more computer literate, the library as it is known today may be dramatically, if gradually, transformed—or it may disappear completely. The microcomputer, properly integrated into present library operations, will make it possible to do more in terms of processing materials, providing services, accounting for use of funds, and evaluating the effectiveness of activities. Microcomputers will impact the library environment physically and philosophically and will profoundly change the nature of education for the profession of librarianship.

It is likely that microcomputer prices will continue their downward trend, although there have been some counteracting factors, such as a recent, but presumably temporary, worldwide shortage of memory chips (Schier 1988, pp. 1, 112-13). IBM kept the architecture of its personal computer virtually unchanged for six years during the early 1980s, providing a static target for the manufacturers of competing clones. The result has been an abundance of affordable, dependable, generic microcomputers, allowing fiscally conservative institutions like libraries to confidently contemplate their purchase. One prediction is that the time is not far off when stripped-down PC clones will be retailed in the United States at between \$250 and \$300; other authors have estimated that the cost of computer components relevant for library operations is likely to decline about 25 percent per year without adjusting for inflation (Anderla & Dunning 1987, p. 65; Baumol & Blackman

1983, p. 184). "The movement toward small computers in libraries has meant that many institutions hitherto unable to afford automated systems now find them within reach" (Kesner & Jones 1984, pp. 13-14). The trend toward inexpensive generic computers will strongly affect which and how many computers libraries of all sizes buy, from whom, and how much they cost (Beiser 1985, pp. 42-43).

In addition to becoming less expensive, microcomputers are expected to become smaller, faster, and more powerful: "By 1990 we shall know with precision the ultimate bounds to miniaturization of electronic components and figure out the limits to the development of computer systems based on current materials, concepts, designs" (Anderla & Dunning 1987, p. 277). The development of resistance-free and heat-free superconductive circuits will affect the capabilities of microcomputers, as will the development of photonics, or laser computers, that use light instead of electricity for processing; and so-called biological computers (Carlson 1985, p. 53). It is likely that the vast research and development efforts occurring in the public sector, with the Strategic Defense Initiative, and in the private sector, where the generational turnaround in systems design is said to take place every six months, will trickle down to the larger society, but at a much slower pace (Anderla & Dunning 1987, p. 178; Kesner & Jones 1984, p. 25). When the investment in microcomputer hardware and software is made by individuals and small institutions, the tendency is to stay with their choice, even if it means staying behind when IBM announces a new "upwardly compatible" system as it did in 1987 with the PS/2 series (Beiser 1985, p. 43). In the early and mid-1980s, writers on the future of microcomputers in libraries speculated that future problems would cluster around software and staff training, not hardware power (Chen & Bressler 1985, p. 6; Kesner & Jones 1984, pp. 155, 210). For libraries, the critical need is for the capacity to store and access large amounts of information, making developments in storage more important than those in the computational ability of microcomputers (Pratt 1984, p. 261). Storage is probably the area which will see the most dramatic developments in the near future; there is a sense in the literature that we are at a watershed in the history of computers [that] presages their application as an everyday tool for work and leisure (Anderla & Dunning 1987, p. 276). Specifically, developments in high density random access memory and optical discs are expected to transform the field in the next five years or so (Anderla & Dunning 1987, pp. 175, 278; Kesner & Jones 1984, p. 25).

Microcomputers have developed and are evolving rapidly and are touching the lives of those in industrialized nations at an unprecedented rate. One prediction is that computer penetration may be 40 to 50 percent in industrial nations by the end of the 1990s, compared to the present 5 to 10 percent (Anderla & Dunning 1987, p. 277). Some writers appear certain that microcomputers will lose their novelty and become

“just another everyday tool like the telephone”; their ubiquity in peoples’ businesses and homes has already made them familiar and popular to many, at least at certain educational and socioeconomic levels (Pratt 1984, p. 263; Kesner & Jones 1984, p. 25). The gap between the computer literate and proficient information rich and the information poor—those without knowledge of and/or access to information technology—is a polarization within society which raises direct questions about libraries’ roles in meeting the needs of their users or potential users. A 1983 report on microcomputers in education stated that, although libraries have traditionally bridged the gap between rich and poor with books, it is unlikely that they can perform the same service with computers (“Legal Challenges...” 1983, p. 780). For some, especially the affluent and children who are products of well-to-do school systems, expectations of what libraries can and should deliver will be raised by their own computer literacy and familiarity. For those on the other side of the information divide, needs will be much different. Who are the libraries’ clients and how will they be served given the yawning educational gaps that exist? What are libraries’ responsibilities to meet or surmount these gaps? Should it be a mission of public libraries to strive for the spread of electronic literacy, as many have for the print equivalent? These are questions for which there are no easy solutions, but they must be posed in any discussion of the future of microcomputers in libraries. In the 1980s, libraries will be forced “to economize, standardize procedures, reduce staffing levels, and make more efficient use of existing facilities, monies, and personnel, [plus] provide a wider range of user services and enhanced administrative and intellectual control over information housed in their collections” (Kesner & Jones 1984, p. xi).

These conflicting demands on most libraries will continue for the foreseeable future, and the microcomputer is a tool that can make it possible to cope successfully with this situation. While microcomputers in libraries will not take the place of staff nor do away with the mountains of paper generated by our society anytime soon, they do offer new, sophisticated modes of managing information and utilizing the intellects of those who work in libraries. Some library forecasters predict the merging of public and technical services as a result of automation (Harrington 1986, p. 18), the reasoning being the need for fewer professionals in technical services and the capacity for much more sophisticated user services. The latter is at least partially due to the microcomputer, with its potential to provide enormous increases in access to information in the library’s collection and from outside sources (Dowlin 1980, p. 2269). De Gennaro (1981) has suggested that the main impact of new technology in the future will be on reference services and access to online catalogs by the public (pp. 1045-49). The microcomputer will both enhance the traditional role of the library as a repository of books and make the development of new roles possible. Microcomputers will allow libraries to adopt the role of information

centers, should they choose to do so, providing specialized bibliographies and other more personalized services, for example, and being able to respond to user requests through the computer rather than requiring face-to-face contact (Mason 1984, pp. 1219-20). "The new technology makes possible new services which provide added richness to the options available to the user" (Mason 1984, p. 1220).

The microcomputer is a powerful information retrieval and collection management tool. Its ability to store and manipulate large amounts of data will grow as the technology develops. Resources will shift and priorities will change as microcomputers are integrated into library operations. Funds formerly allocated to technical services areas, such as cataloging, may be shifted to other areas that have a more immediate public impact, such as enlarging the collection and assisting patrons in its use (Kesner & Jones 1984, p. 7). Microcomputers are effectively used for interactive teaching, lending themselves to computer-assisted bibliographic instruction, specialized library orientations, and other forms of routine library education. Using them in this way will free the reference staff from some of their more routine duties and allow them to put time into more challenging activities. Another use of their interactive capabilities is in simulation programs for administrative planning purposes, allowing library managers to see the effects of decisions in advance and helping them to "determine how, under [any] given set of circumstances, they can maximize library services at the lowest possible cost" (Kesner & Jones 1984, p. 13). Other changes in the library management environment brought about by automation, which can be extrapolated to the influence of microcomputers, include new employee behavior and work patterns stemming from factors like improved productivity and expansion of control due to improved management data, new relationships between jobs and job classifications, new opportunities for individuals as computers expand assignments and tasks, expanded staffs including new people with skills outside librarianship, and new responsibilities for middle managers as they cope with the accelerated pace of change (Watson 1987, p. 183). Statistics collected and analyzed with the help of microcomputer software will provide an important management tool, increasingly necessary in the climate of accountability.

The microcomputer will have distinct effects in the way libraries conduct business. The change will not come overnight and will occur at different rates for different institutions, but there does not seem to be much question that microcomputers will need to be incorporated into libraries if they are to survive. "We are no longer merely automating our traditional library operations; we are multiplying our capabilities and raising the level of expectations of library staff and users alike" (De Gennaro 1981, p. 1048). This is especially true in academic and special libraries at present, where the phenomenon of end-user searching of databases is occurring most. If librarians do not provide competent

services and impress their users as being conversant with existing technology, they will lose both credibility and clientele. If the library cannot offer users access to information in an efficient, timely fashion, many will find it more expedient to bypass the library altogether and find the information themselves or do without it. Some fear that the role of the information intermediary will disappear; others foresee that "information intermediation—facilitating the flow and communication of media-encoded information—is of growing importance as the volume and complexity of such information increases, and as the society becomes more complex and more adept at using the knowledge that exists" (Giuliano 1979, p. 1838).

De Gennaro (1983) predicts that libraries will continue to participate in networks for shared cataloging and bibliographic resources, but sees decentralization as the outstanding characteristic resulting from the adoption of turnkey operations based on powerful mini- and microcomputers (p. 630). "The challenging task facing librarians in the years ahead is to determine which functions and services are best provided by local systems and commercial vendors, and which are best provided by the utilities and networks" (p. 634). The decentralized aspect of the microcomputer and its software also allows a modular approach to library automation, allowing libraries to tailor their systems to fit their particular needs, and to replace or upgrade components as they become obsolete (Swanson 1982, p. 1058; De Gennaro 1983, p. 633).

The effect of microcomputers in libraries has been, and will continue to be, a widespread redefinition of library services and user expectations, which will become ever more tied to a need for development of existing staff and to changes in the requisite minimum skills for the professional library degree. At this transitional period, continuing education, in-service and on-the-job training and retraining, and close coordination of training workshops through university computer centers or similar resources are all critical to keeping abreast of the rapidly evolving technology and its library applications. "The microcomputer environment for both hardware and software has changed radically in the last few years, offering expanding opportunities for library automation, but making it difficult for information professionals to keep up" (Bichteler 1986, p. 4). As microcomputers become common tools, as computer literacy among prospective librarians grows and evolves to proficiency, the content and focus of staff education may change but the need for it will not.

It is conceivable, and perhaps desirable, that microcomputer literacy will become a prerequisite for admission to library school. Some undergraduate and graduate programs in other disciplines now require this of students, and students are sometimes required to own personal computers (Bowe 1987, p. 57), which does not seem unreasonable for our field as well. The days have passed when the criterion for an adequate librarian was liking books. Aptitude for computer technology, though

not necessarily wizardry at it, should be required of those accepted into graduate library programs, to best train them to serve their future patrons. The present norm of the one-year master's program, already under fire, cannot really begin to address all the technological issues as well as those of traditional librarianship unless beginning students are already oriented to the electronic environment and vocabulary. Otherwise, too much time is lost in bringing them to the point where the jargon and discussions make sense. The education of librarians must include a greater emphasis on the future and on courses on all the communications technology available (Dowlin 1980, p. 2270).

Richard W. Boss (1984) wrote that "by 1990, the majority of medium-sized and large libraries in North America will be automated: by the end of the century a majority of all but school libraries will have implemented systems" (p. 1189). Given the technological developments since then, it is likely that this automation will come about through the use of microcomputers.

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