The Impact of Automation on Libraries—A Review

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ABSTRACT: After reviewing the problems when computers were first used for library housekeeping routines, various aspects concerning the effects on staff are discussed. Particularly relevant are the emergence of the systems librarian, new staff structures, retraining, exposure to scrutiny, and monitoring and health problems associated with the use of certain equipment. Technical developments from mainframes to microcomputers are outlined and the effect on peripherals assessed. Reference is also made to the impetus which automation has given to cooperation and standardization. References are given.

Introduction

The introduction of computers into libraries has involved a revolution which is still gathering momentum. It would be a major task to detail all the effects which automation is having on libraries, inasmuch as the ripple effect grows wider. In the interests of clarity the matter will be examined from 2 aspects—staff and systems.

Background

Until the 1960s, machines had been used to assist libraries with circulation control, serials listing, and the like. None seemed to do much more than alter the mix of aggravations.

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Being electro-mechanical, they were subject to many breakdowns and usually transferred the manual effort to another part of the system. At least their introduction showed that librarians were prepared to use machines to maintain or enhance their services. But, generally, the systems continued to be highly labor-intensive.

Fortuitously or not, the library crisis occasioned by decreasing staff, and increasing stock and users was concomitant with the development of computers. By the 1960s, computers were in their third generation, and they had entered their fourth before the end of the decade. Integrated circuits (IC) gave rise to the minicomputer, which was followed quickly by the microcomputer. This speed of development run on caused problems for librarians trying to choose appropriate equipment.

**Implications for staff**

While prestige, technical curiosity, and offers of free computing facilities have all been quoted as motives for automating, there were librarians who were very willing to try any technology which could offer good service support. Despite such enthusiasm and goodwill, when librarians and computer center staff met, new attitudes developed only slowly. It became apparent that each side lacked sufficient understanding of the other's language and approach. Librarians found difficulty in yielding to the compromises which the computer system seemed to demand as the price of its benefits, while computer/systems people found it difficult to accept the seeming intransigence of librarians over specifications or to understand the needs of bibliographic data. Often commercially proven solutions to data processing problems were employed and later found unsuitable. Nowadays libraries are recognized as users with special requirements, if only because of the size of their files and the complexity of their bibliographic data.

An aspect of the early specifications for automated systems was the lack of people in the library who could talk to the
computer systems people at the right level. Nowadays libraries recognize this need and have a new type of senior librarian responsible for automation. The schools in turn have had to ensure that such people are available with an adequate background reflected in the course content. Such staff are expected to serve as liaison between the system, the computer staff, and the library staff. This has introduced a slow change in the focus within a library staff structure. Whereas before automation each department was responsible for its own spheres of operation, the systems person now has to be consulted about the use of the automated system, changes required, and faults occurring.

The need for retraining staff to use the automated system and react correctly to faults was initially not given the importance deserved. Nowadays it is recognized that some are afraid that automation will rob them of their job, require retraining beyond their capabilities, or even reduce their tasks to the level of the unskilled. Fostering confidence and a will to cooperate becomes an important part of automated systems implementation. Sometimes, prior to automation, belief in it is suspended until the machines are delivered. However, it is a common experience that, once trained, staff gain a sense of newly-acquired skills with consequent feelings of merit and upgrading. Certainly in the case of BALLOTS, once staff demonstrated their skill, they then expected to have their jobs and salaries improved. Conversely, libraries have discovered that using automatic data capture equipment on the circulation counter makes staff bored to such an extent that it is necessary to restrict duties to fixed periods.

All this change has created a challenge for the library administrator. The computer gives rise to a different pattern of work, staff structure, controls, responsibilities, and pressures. Such matters as data input checks have to be instituted but must not overload the input routines to the extent of nullifying the intended economic advantages of automation. Similarly with on-line systems it is necessary to decide on levels of access for each member of the staff. Authority to change
records on file or add new ones has to be restricted in the case of cataloging data. With all this movement there remains the matter of staff welfare. Up to now manual systems have not involved library management in anything more than the usual humane concern for staff health and problems generally affecting their performance. Now, the computerized system can create many unforeseen problems. Just now there is a lot of research in the UK at Loughborough University and the Institute of Ophthalmology, at IFRA in Darmstadt, in France, Sweden, and Austria to determine the hazards to operators using VDUs for any length of time at a stretch. Operators complain about dizziness, feeling sick, and eyestrain. Often they end up having to wear glasses for the first time. Effects of VDU displays have as much to do with the contrast, brightness, and light conditions in which they are used, as with the layout of the data, size of text, and use of flash indicators. Although staff members have proved very adaptable, the library administrator is now forced to take note of the effect which automatic equipment is having. In some cases inefficiency has arisen from the use of inappropriate equipment. COM catalogues on cassetted film became popular because of ease of loading onto the viewer and file integrity. Unfortunately many libraries went for the cheaper manual viewer, which, for the cataloging department, became a real trial when half a dozen cassettes were involved. Since the BUCCS (Bath University Computer Catalogue Study), it is accepted that the direct access which fiche provides is more satisfactory and faster in use, though again, there is a problem in keeping the fiches in the correct order and even preventing single ones from being taken as souvenirs.

**Systems**

The design, operation, and control of the system are changing radically as automation is applied to more libraries. It is also apparent that the accumulation of experience is affecting the view which both librarians and their supporters have towards the way in which the service is organized,
Attitudes to investment

Traditionally the library, being labor-intensive, was not expected to spend much on equipment. The main costs were related to staff and stock. By the end of the 1960s library authorities had accepted that librarians would ask for sums ranging up to £50,000 for installing mini-based systems. Although economic stringencies had curtailed development, such proposals are accepted as a sensible method of running a library service efficiently yet effectively. Such dependence upon machines has introduced a new set of problems for library administration. These systems required regular and proper maintenance and needed to have someone on hand capable of sorting out breakdowns quickly. Nevertheless, however well looked after, these machines have to be replaced and it is obviously now a necessary part of the budgetary procedure to agree on a write-off period and amortize for the cost of replacement. As with computers themselves, replacement can also involve redesign of the system, with consequent extra expenditure. Unfortunately, sums involved amount to thousands of pounds. One thing seems certain: among all those who have been involved in the establishment of automation systems there is agreement that once the machines are installed there is really no question of returning to a manual system. So the initial capital investment is the first in a continuing expenditure. Few librarians expect to restrict automation to one or two operations. Most intend and expect to have all housekeeping operations automated eventually. With the growth in the size of such systems, which this implies, we can expect that the automation team will have to include technicians able to provide a continuous maintenance and testing service. Interestingly, OCLC (Ohio College Library Center), like BALLOTS, placed orders for terminals of their own design and run their own maintenance, testing, and development workshops. The full cost implications of totally automatic systems have not yet been explored publicly.
Costs

A novel feature of the debate which surrounds the automation of library operations is the continual demand for detailed cost analyses of each task, e.g., cost per catalog entry, per item entered on file, and file maintenance. However, when such figures are produced it is seen that there are few comparable figures for the manual systems being explored. So their value is in assisting the selection of the cheapest system rather than offering satisfactory comparisons with manual ones. Inexorably, librarians have begun looking at each process in the system wanting to know more about its characteristics and cost. Automation persuades them of the need to develop an awareness about the system not engendered by traditional systems. Automation incurs calculable costs at every stage and is harsh on the extravagant or poor design. For example, data structures, running times, file life and sizes, output frequencies, formats, and quantities all have price tags. As a result of automation, librarians are becoming very cost-conscious. They now expect to demonstrate the cost benefits accruing from automation, in terms of staff savings, increased productivity, and enhanced service.

Accuracy

If faults are not to be rapidly compounded through the system, check procedures have to be provided throughout. Centralization of files containing data generated at a number of linked points requires that validation procedures, software-based, for all such data, need to be activated at the input stage. This can be done on a line-by-line or complete record basis. However, there can be a heavy price in productivity, if there are many software checks. What is sure, is that there cannot be any really satisfactory checks for spelling and such elements as dates and pagination. Unfortunately, the effects of corrupt data can seriously threaten the whole system. In the case of OCLC, for which entries are not checked, the
errors in the files have caused problems, not least in the multiplication of entries for the same work entered in a number of ways.

While training and continual consultation can diminish the occurrence of inaccuracies, the administration has to institute check procedures throughout and at all levels. Such precautions underline the inability of automatic systems, in marked contrast with the flexibility and hospitality of manual systems, to absorb a remarkably high degree of error. Such is the case with serials receipt records, which often have to be severely edited and updated prior to keyboarding for a computerized system.

**Work flow**

A particular effect of automation has been to change the divisions within the library system. Previously people could be allocated to acquisitions, cataloguing, loans, etc. With the use of MARC at the ordering stage, divisions between that and cataloging become blurred. Similarly, the provision of recall and reserve notices automatically has done away with some of the duties undertaken by circulation assistants. With the online system at Ohio State University, for instance, readers can use the VDU terminals to find out the status of any book in the system. Should the one required be on loan, the reader places a reserve on it without any help from the staff. Obviously, with phased implementation, the work pattern will change a number of times. An aspect of such changes is the increased mobility of staff. Those once involved exclusively in one activity are now released for use elsewhere. One would hope that eventually library staff could spend most of their time out front looking after readers, rather than on the clerical work usually conducted behind the scenes. The reason for having groups was often the need to consult files associated with a given task. With on-line systems, particularly, access to files can be achieved from any authorized terminal,
Controls

Although not fully exploited, there is no doubt that the computer has brought to the library an unprecedented ability to monitor its operation. All data processed can be tagged, cumulated, and analyzed to produce regular statistics about finance, volume, and type and frequency of use. Less popular are the checks which are possible on the staff using the system. Those entering data can be monitored for error rates, speed of operation, and productivity. Those on circulation counters could be monitored for loading and possibly bonus payments for throughputs is excess of agreed-upon numbers. All this information means that, for the first time, librarians have the ability to react quickly to changes in the system.

The need to determine grades of access to the system was mentioned earlier. Controls of this kind allow discrimination amongst staff such that senior librarians may be allowed to change data, interrupt transactions, or even override normally protected data or routines. But as on-line systems increase, more staff will have access to the non-confidential files, which means that, in contrast to previous systems, those normally responsible for each part do not have to be committed. So people throughout the system have to be informed about the whole of it and thereby become more independent.

Technical aspects

When investment involves tens of thousands of pounds it is not surprising that libraries are expected to use equipment for most of its useful life. So, like the printing and bottling industries, libraries are inherently unable to take quick advantage of technical advances. In the fast-developing field of electronics the barriers to achieving some operations economically or at sufficient speed are continually changing. Reliance on mainframe services, as many public library systems have experienced, can often prove unsatisfactory. Yet stand-alone
systems seemed to be costly and too restricted to cope with large files. Initial use for circulation control systems has been promising. But even here, the minis used were rapidly superseded, yet could not be changed. In such a fast-moving field, any purchase is outdated within eighteen months.

It is, therefore, essential that librarians tackle the problem of keeping up to date on advances which will alter the configuration and capabilities of future systems. Minicomputers and microcomputers are rapidly becoming indistinguishable, while even small main frames are being challenged. But things are changing all the time.

While ICs (Integrated Circuits) came out in the 1950s, the LSI (Large Scale Integrated) circuits were a phenomenon of the 1960s and gave a tremendous boost to miniaturization; hence the flood of pocket calculators. Presently the Japanese are working on VLSI (Very Large Integrated) circuits which will eventually pack even more instructions noto a silicon chip. As far as libraries are concerned, however, the significant aspect of LSI development is that micros will soon be capable of handling most housekeeping operations, depending on how much peripheral storage is provided. RAMs (Random Access Memories) are increasing from the initial 1K (1024) bytes to 64K bytes. Obviously this will go higher as soon as microprocessors can handle the larger amounts of store. In turn, ROMs (Read Only Memories) were limited in application and offered no flexibility. These, too, have been improved so that not only are they programmable (PROM) but also electrically (within a minute) erasable (EEPROM). Chips such as the ubiquitous Intel 8080 operating with an 8-bit word and developed from the 4040 can provide over 70 instructions and handle 64K bytes of RAM and offer 265 I/O (Input/Output) ports. Already this has improved in speed (the 8085) while other companies are also offering a 16-bit word handling chip. Both Intel and Data General, for example, can be expected to be marketing a 32-bit word chip. The problem with the larger word is that while offering faster processing it also requires more complex instructions and therefore more power consump-
tion. All these improvements mean that a microcomputer of
the near future can offer processing capabilities traditionally
associated with a mainframe. But the computer is not the
only limiting factor in the miniaturization configuration. Pe-
ripherals have tended to form an important part of library
housekeeping operations requiremets. Recently disc storage has
improved so much that floppies which began by offering 1/4
million bytes (¼ MB) capacity are now on to ½ BM and will
soon increase to 2 Megabytes. Hard diskettes are expected to
go up to 10 Megabytes. Cartridges, too, show similar trends
in density increases.

Even those using mainframes may find themselves able
to rethink about on-line use with the improvements in exchange-
able discpack density. ICL 1900 systems offered 60 Megabytes,
while the 2900 series have 200 Megabyte units. Soon we can
expect to have 500 M Bytes. This means that, assuming
records of 5,000 bytes, the library could expect to get the
catalog on one disc pack. Even magnetic tape used for spool-
ing onto for archive, back up, and buffering purposes, is
expected to increase in density up to 6K bite per inch giving
1 billion on a standard reel of ½ inch tape. The economies
in space and speed of processing can be appreciated when
considering OCLC's tape file of over 9,600 reels! Such ad-
varces also would help to batch systems which rely so much
on tape files. Further developments also hold possibilities for
libraries. BMDs (Bubble Memory Devices) requiring low power,
which are light and cheap, will be able to increase from the
present 256K bits capacity to between 1 and 3 Megabytes.
Being non-volatile and exchangeable, BMDs may well be the
future path of library exploration.

A system developed by Intelligent Systems Corporation is
an Arabic/Farsi intelligent terminal also offering English. Based
on the 8080 chip, it gives 4K bytes of RAM and 24K of EPROM.
Display is in up to 8 colors and allows composition from left
or right according to the language being used. Such develop-
ments create further possibilities of cooperative information
exchange or file access. The color display is now more widely
available. Such micros as the Apple II offer color graphics using a domestic TV and a tape recorder for home use. Faced with all this changing technology, the librarian might be tempted to postpone automation. The criterion for purchase, however, must be that the system chosen does the job and is the most suitable out of all that is available. Any choice is bound to seem obsolete in a couple of years but this need not matter so much if the system is cost-effective. In such a technical survey it would be unsatisfactory not to mention Teletext services. The British Post Office Prestel Service, the Independent Television Authority's Oracle, and the BBC's Ceefax systems will enable anyone with an appropriate TV set and telephone to access many files of information. Businessmen, and presumably libraries, will be able to obtain a special desktop terminal incorporating a telephone and dialing facilities, black and white screen, and optimally a printer. This service, if providing as much information as has been predicted, may well preclude the need for shelves of annual reference works such as timetables, directories, biographical works, and even dictionaries. The problem then facing the library, as it does now with on-line database use, is how the service is to be costed. Some libraries are already assuming that once a terminal in the library is offered on public access, then it must be as free as the use of the book or abstract services on the shelf. However, libraries may be faced with cost increases which would put considerable pressure on the book fund. And so, it will be necessary to determine the best way of accessing information. Just as a National Health Service cannot provide as prompt a response as the private sector, so the users of publicly-supported library services could expect to have their enquiries assessed to determine which on-line costs should be incurred. An example of the difficulty is shown by the possible cost of scanning advertisements on a teletext service like Prestel versus the cost of using a national daily paper.

It is certain that advancing technology will force libraries to formulate codes of practice regarding decisions on what information sources shall be offered free against any given
enquiry. For instance, as the network systems grow, there will come the time when users will be tempted to put long searches through the library service, while using their home terminal only for the short and less costly searches. Libraries, having completed the search, could transmit the result to the reader's home terminal. While it may be possible initially to insist that only personal callers will be allowed such on-line searches, this must give way eventually to convenient ways of providing information. It will be yet another uncertainty of role which the librarian of the future will have to face.

A further uncertainty is that of software. An examination of current systems suggests that languages used depend largely on the machine and the capabilities of those doing the programming. It is sometimes said that high-level languages like COBOL or Fortran are most suitable and provide portability from one system to another when it is necessary to upgrade or change a machine. But many have chosen assembly or even machine code to give maximum control and efficiency. Surprisingly, OCLC uses assembly language for its system, and it considers that machine changes, though requiring complete rewrites, do not constitute any great problem and are outweighed by the efficiency of the programs. If current machine developments continue, languages available on micros should soon be extended. With the advent of the 16-bit and 32-bit wordhandling ROM chips the present restriction to BASIC (albeit extended versions) should be removed. If press announcements prove correct, an all-purpose language called POBOL, which can be run on any machine and by anyone, is soon to be released. In effect, it is software which has prevented the fulfillment of many cooperative hopes. Systems tend to generate a certain idiosyncratic behavior promoted by adaptation to or implementation of the operating system, and by the limitations of the compilers on various installations. All of this has meant that software often cannot be transferred from one installation to another of the same make and model, without some alterations. Different models or makes usually involve so many changes that it is easier to rewrite the entire system.
Cooperation and standards

Ever since the 1965 report of Inforonics on a possible format for bibliographic data, there has been activity to cooperate and in turn to gain agreement on data structure sufficient to promote exchanges. Interestingly, just as OSTI (Office for Scientific and Technical Information) in the UK funded major projects in the automation field, so in the US, the Council on Library Resources provided most of the funds for the MARC project. During 1967 there was much activity to establish the MARC format using tags to identify elements. However, the implications of having a national library with as large an intake as the Library of Congress determine such a format gained the interest of standardizing bodies and others likely to be affected. At this time, too, the BNB was involved, and so, by 1968, the MARC II communications format for bibliographic data was published. The real impact of this “standard” has since been demonstrated with its adoption, with variations, by other countries, so that now we have MARC-based services for an increasing number of countries: Israel (MARCIS), Australia (AUSMARC), Canada (CANMARC), West Germany (MAB 1), France (MONOCLE), and others. In 1973 the format was further endorsed with the publication of ISO 2709 Format for bibliographic information interchange on magnetic tape. With the ever-widening adoption of the MARC format many countries have set up their own magnetic tape service to distribute bibliographic data nationally and internationally, and as part of this exchange across frontiers a further format called UNIMARC is being worked out. However, national bibliographic services will need to negotiate further if local differences are not to cause serious difficulties. For example, the ISBD standards, while providing for a degree of conformity in the bibliographic description, at the same time allow differences sufficient to create problems when exchanging data. Certainly, the repercussions of exchange-ability are still to be seen. As a recent paper from the IFLA office for UBC has stated, it now becomes a matter of urgent international
concern. Although some persons fear that large countries may impose their wills in negotiations, there is always going to be a national approach to bibliographic databases. However, the development of networks like EUORNET, which will link up with others—SCANNET, TRANSPAC and TYMNET—giving on-line access, will necessitate agreed-upon protocols and command languages. Such a MARC network requires an agreed-upon character set to cover Roman, Cyrillic, Hebrew, Greek, Arabic, and symbols with a fully reversible system of transliteration. International access to these databases could well lead to the establishment of regional or even centralized files, if only to provide satisfactory controls on such things as the input, access, or transfer of local information. Similarly, renewed problems arise out of the decision to store one title in a database serving many libraries. Decisions have to be agreed upon about authority to alter a record. But this assumes centralized cataloging, which has disadvantages over shared cataloging. The latter promotes a wider coverage and often the smaller contributors process their material faster, thus enhancing the currency of the database. There is, too, the need to control duplication of records—a matter which plagues the OCLC system and the merged BNB/LC records. All of this activity arising from the introduction of computers into the library environment makes it essential that our professionals know about the computer, its capabilities and limitations. It also means that there must emerge from the library schools specialists who, having the interest and aptitude, are educated to an advanced level in aspects appropriate for those expected to design, develop, and maintain automated library systems. This task and the rapid changes which must be encompassed provide a challenge to library schools to offer students the opportunity to participate fully in an exciting future.

References

Inasmuch as a great number of news items and general reports were used to support this article, it was thought more useful to provide a selection of the more appropriate sources covering the period from 1976 to the
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present.

Serials


Special works


