

Implications of Technological Progress For Librarians

MORE AND MORE, in the literature of documentation, automation, and librarianship, articles appear suggesting the possibilities of applying machines to library jobs once thought only properly filled by people. The possibilities of mechanization of library processes, and the eventual realization of an automatic library will cause problems for which the profession should prepare. Librarians must initiate the concept; scientists will create the necessary mechanical equipment.

Some form of automation or integrated data processing is evident now in nearly all facets of business life, and is only the beginning of what is yet to come. The next decade or two will see break-throughs in automatic processing and transmission of data far beyond today's imagination. These changes will be of such importance as operating tools that whole organizations will be re-planned. In business such a revolution is beginning already.

In libraries, as in businesses, entire departments will be revamped, to reappear in a different form and to perform different functions. Libraries will be much slower than business to reorganize. In time, however, libraries will be building a data-processing center in the United States, perched like a spider in the middle of its web, functioning as the hub of a vast data collection network, assimilating information and transmitting it as needed back to public information

Mr. Waldron is Administrative Assistant, Oregon State College Library, Corvallis.

units across the nation. There is as thrilling a possibility in this concept as there is in any science fiction. If librarians put their best efforts, best minds, and best aspirations to it, it will become a thrilling fact.

Automation is here today. It is manifested in automatic electric eyes, tape controls, servo-mechanisms, signalling, timing, and actuating devices, recording and filing systems, and communication networks.

In general, automation is a manufacturing concept. More specifically, it is the application of machinery to perform and control automatically the various aspects of manufacturing from raw material to finished product. It not only replaces labor, as simple mechanization will do, it also replaces the reliance on humans for memory, association, and decision.

The concept of automation in the library must be paralleled with that in the business enterprise, although machine differences will occur. The concept of automation is stressed since it is not to be confused with the machines involved.¹

The basic principle behind the need for automation is that there is too much human handling of repetitive information. Such repetitive handling can be eliminated or automatically handled to such a degree as to effect an integration in the flow of information from machine to machine, or department to department. In other words, where certain information must be handled many times,

¹ Cf. "Mechanization in Libraries," *Library Trends*, V (1956), 191-308.

that information can be recorded the first time; succeeding steps in the operational chain can take advantage of the initial step, and add mechanically only *new* information. The work or data flows through machines rather than through people.

Automation in the library is primarily this: At the first place where any function of the library originates, it should be recorded in a mechanical form and should be processed from that time on entirely by machines. The objective is faster and more accurate performance of all of the essential functions of the library—order, reference, cataloging, administration, record keeping, etc. A move along this road involves, however, extensive study and simplification of current systems and procedures. One does not achieve the same degree of efficiency by superimposing new controls on an old assembly line as is done by starting with a new approach to the production of the same product.

The nature of this equipment, whether electro-mechanical or electronic, depends upon the nature and volume of the data to be processed. Popular opinion to the contrary, a high-speed electronic computer, or one of the other mechanical "brains," is not an indispensable part of integrated data-processing in the library.

True, giant "brains" can perform a variety of accounting tasks and their ability to remember is valuable. It is possible to feed huge quantities of undigested data into these machines—far more than any human mind can hold—and then direct the machines to digest it and come up with specific answers. But not yet can they be adapted wholesale to library needs. The point at which integrated data-processing enters the machine stage comes after painstaking previous planning—always keeping in mind what is needed, wanted, and obtainable.

Automation comes in bits and pieces. First, the automating of a single process, and then gradually a tying together of several processes to get a group or sub-assembly complete. Linking together diverse operations and functions is, at present, most conveniently accomplished by a system of symbols influenced and controlled by a variety of factors. This system is generally termed "machine language."

Already manufacturers have come up with an impressive array of so-called common "machine language" equipment for industry, such as code-sensing machines, perforators, re-perforators, teleprinters, teletypewriters, tape-to-card converters, and so forth. Business concerns are using combinations of codes, multi-channel "language" transmitters, punched paper tapes, key-punches, teletypewriters, and leased communication wires. Information is taped, the tape is put into a machine and from then on all of the process is done by machine with a higher degree of accuracy than is possible with human processing. For the library, this may lead to eventual mechanization of all processes except classification of material.

If the concept of a "machine language" were reduced to an objective, rather than a current actuality, a "common" language would be a symbol system that would actuate all pieces of equipment, including communications equipment. Memory units need a "language" to express basic ideas in key words or phrases. Such a language is not now in existence, although magnetic tapes and punched cards are a primitive language which actuates equipment.

An actual machine "language" may be developed eventually. It will link human thinking with machine operations. It will serve to identify and select documents and records pertinent to a specific situation or question. Machine "lan-

guage," to be effective, must provide a connecting link between humans and machines. Knowledge in a specific field must be systematized in such a way that any individual original item of information within the machine mind can be instantly available, and any conceivable arrangement of individual items of information can be found. This concept of "machine language" must also be able to achieve rejection of information not pertinent to a given problem or question.

Consider a few basic facts about the electronic equipment in general. First, there are two types of electronic equipment common to automation—the memory units and the computers. They may be used singly or combined. If combined, the memory unit is called a storage unit. Memory units consist of magnetic drums, disks, tapes, or vacuum tubes. Facts are impressed on the units in a manner similar to that of the tape recording machine, with facts directed to specific, coded areas. These facts remain permanently available until intentionally erased. The memory unit thus serves as a repository of facts. With new kinds of memory units being developed along radically different lines, present disk, tape, and drum concepts soon will be as obsolete as the Stanley Steamer.²

It is probably true that the first development in library automation will be between a central storage center and the larger research libraries throughout the nation. A private wire service plan will play an all-important role: first in the transmission of information, and second in providing for the automatic routing, selecting, editing, duplicating, perpetuating, and storing. Industry and business are utilizing private wire services for these very functions. And libraries will be able to distribute information speedily among the various component parts

² Albert Pleydell. "The Future in Automation," *Office Executive*, XXX (1955), 13-15.

of a system, no matter how widespread it may be. Once such information is recorded at the storage center it can be transmitted to any or all points, automatically, without further manual copying or retyping.

Business has found, and libraries will find too, that the perforated tape is the heart of the operation and that it is a "common language" which can be read and understood by electric computers and other modern business machines. Once the essential information is placed on the perforated tape, in any part of the system, the information is transmitted, edited, sorted, routed, duplicated, and stored, automatically.

Consider an example of integrated data processing in the catalog department of a very complex state system of higher education, consisting of a central library office and a dozen or more colleges and universities of varying size scattered over a single state.

Cataloging is done by professional personnel. As the typist originates the proof copy, the catalog card is punched into a multi-channel tape. Typing errors are easily corrected upon paper copy and in the tape before transmission. Basic codes are entered mechanically from a master tape.

The cataloging procedure refined even further eliminates the typist. The professional cataloger dictates the information into a machine which codes it and types the master tape. This eliminates the human error made possible by the typist between basic step and automation. The master tape feeds from a machine in the department into the central communications network where the information is routed to the proper subordinate unit by use of a code entered mechanically from the master tape. Adequate machines already exist to perform this operation.

By automating, librarians can spend

more time with their books and their contents—returning to the age when the librarian was an intellectual, a knower of literature, and spent less time with clerical mechanics.

Right now complete automation is impossible, but the use of tabulators, punched cards, and sorters proves that the services of human beings may be reduced in order-processing systems.

Development must proceed tentatively, in other library activities, step by step, and system by system, integrating on a small scale and building up gradually. The time will arrive when all basic handling will be done electronically and mechanically. Instead of the conventional local or county library with incomplete bookstock, films, pictures, and phonograph recordings, a "storage center" will include the entire gamut of public needs. Such a center would locate and store for every library in the area. Under complete automation, the building required would be small; personnel requirements would be very few; and the equipment would be mechanized. Here is the library of tomorrow—an "information center" for difficult-to-find material, for reference sources, for storage of vast quantities of information. Such a "center" eliminates the small library and all of its costs and problems.

The "storage center," containing the visual and graphic knowledge of mankind, will operate via a closed TV circuit to the individual home or to research centers located on college campuses, industrial establishments, etc. From the "storage center," by direct facsimile transmission, the patron may obtain what he wishes on his television screen. With such easy access to the recorded knowledge of man, everyone will have a "library card" in his TV set.

Memory units by themselves will soon have a special place of their own in a wholly new and unique field—the elec-

tronic recording of important facts for quick reference. Chemists are already pioneering in the area. Chemical abstracts are being recorded in a special electronic machine that will quickly report all formulae already developed for given chemicals.³ It is expected that studies now going on will lead to major advances whereby laws and patents can be recorded electronically.

The most significant reason why librarians should seriously consider automation in their libraries relates to the old problem of proper assimilation and transmission of technical information. The problem has reached the stage at which even major improvements in existing communication techniques cannot keep pace with the proliferating information which must be immediately available to the modern scientist.

During the last decade the unprecedented increase in the publication of chemical information has increased the number of abstracts and index entries in *Chemical Abstracts*. The publishers found it necessary to make the first step toward automation, because of the increased publications in the field and the increased complexity of chemical literature and because skilled people familiar with chemical terms were difficult to find. The present technique entails the *dictation* of index entries into magnetic records, requiring only one team of personnel to be familiar with the language of the field.⁴ Automation has reduced personnel costs and streamlined production.

As late as 1952 it was pointed out that the mechanical aids already available for classifying and transmitting information were not being used intelligently and more important, no fundamental research on mechanical and intellectual schemes for digesting and storing tech-

³ Albert Pleydell. *op. cit.*

⁴ "Indexing Is Becoming Mechanized," *Chemical and Engineering News*, XXXI (1953), 4910.

nical information was then being done.⁵

Librarianship, basically, is a technique for the organization of information. It is not meant to belittle the important educational function of the library but to point out that there exists a number of basic library problems concerning organization, dissemination, and retrieval of information. Librarians must keep step with science and become interested in fundamental research in the techniques for organization of information. Moreover librarians must realize there are ways of organizing information other than our present methods of classifying. Automation appears to be not only the answer for taking the clerical aspects out of librarianship, but it opens a new avenue for the storage and organization of information.

Printing presses, micro-reduction shops, and mimeograph machines are going too fast for libraries to keep up without adding more and more people using the present manual methods (methods which are leaving libraries behind) and more and more space to accommodate the accumulation of materials. With the help of scientists and engineers, librarians must develop electronic techniques for the organization of this knowledge and the ready-retrieval of it. "The occupational disease of librarians, the tendency toward the encyclopedic"⁶ can be overcome by relegating petty routines and memory work to machines. Memory work and the knowledge of book and periodical titles can no longer be encompassed by any one scholar, much less by any librarian who must also find time and energy for administrative duties.

Most of the mechanical techniques required for searching the literature are available, notwithstanding recent com-

ments to the effect that there is a paucity of machines "suitable to reference needs" of a library.⁷ The proper reduction and classification of information to fit a mechanical system is needed. But this problem, too, is only temporary. Many agree with Vannevar Bush when he states:

. . . I believe we shall advance our mastery over the records we create, rendering them easier to consult by means which would now seem strange and bizarre to us, which will make obsolete much of what we now do, but which will give a new power and freedom to the creative mind and thereby open the way for another spurt forward of civilization. For civilization advances only as it acquires new experience and only as it makes its experience available and useful.⁸

The first steps in library automation must be taken before we arrive at the ultimate. TV facsimile transmission may be the ultimate in library service.

How does the library profession make an automation study? Undoubtedly, the studies sponsored by the Council on Library Resources, Inc., should help in this respect. But the American Library Association might set up a committee to study every possible application of integrated data processing, at all levels—from administration to paging. This committee after studying standard systems and procedures, forms, and records, would call in manufacturers of equipment and tell them what is wanted. Librarians generally are not competent to evaluate the possibilities of machine operation. It requires qualified engineers. Equipment manufacturers should be able to determine, function by function, what machines can do in the library program. They should be able to lay out in sequence the functions which could be transferred to machines;

⁵ "Executives Learn That Operations Research Is More Than Mathematics," *Chemical and Engineering News*, XXX (1952), 2600-05.

⁶ Georg Leyh. "The Education of the Librarian," *College and Research Libraries* XV (1954), 140-47.

⁷ Mortimer Taube. "Machine Retrieval of Information," *Library Trends* V (1956), 301-308.

⁸ Vannevar Bush. "Data Handling Advance," *Automation* II (1955), 4.

they should eliminate bottlenecks and reduce repetition.

Automation in the future will help solve many library problems: storage, personnel shortages, declining budgets, rising overheads, and repetitious procedures.

It is the need for greater efficiency, lower operating costs, and the problem of an inadequate labor supply which will stimulate automation in the library. Librarians who do not look into the future, who do not plan for automation well may be permitting future libraries to become as functional as is the manually operated traffic signal or the horse and wagon today.

True progress requires adjustment. Librarianship will have to adjust. For so many librarians who think something is done the right way "because that is the way it has been done over the years," the adjustment will come hard. Remarks of "automation is not practical," or "automation is still in the dream stage," are of course not based on true understanding of the subject.

Scientists have already provided some of the inventions needed for complete automation and truly efficient library service. Other problems are being rapidly conquered. Even now, a special vacuum tube is in production and new equipment is being devised to solve the random selection problem. Just as progress is being made in the improvement of memory units, machines able to receive material directly without benefit of codes are on the way. The first machine of this type will be able to read "yes" and "no" check marks on questionnaires. It is intended for analyzing the 1960 census returns. Military inventors have developed a machine able to read the ordinary printed page and accept the information as data.⁹

Some day whole libraries may be

⁹ Arthur Pleydell. *op. cit.*

stored electronically in a relatively small space, thus bringing together the entire world's knowledge for the immediate use of scholars and scientists. Some day, patrons will be able to borrow a book from the library by telephone connection with the right memory unit, causing the pages to appear on a home television screen.¹⁰

The concept of automation in the library will undoubtedly influence the educational and personnel requirements for librarianship.

Sir Robert Alexander Watson-Watt, the developer of radar, stated that automation would change our entire way of life for the better, and everyone, including educational institutions, should be planning for the change. But with all the potentialities of machines, they cannot do original thinking. It will still take human planning to keep them in operation. The button-pushers activating the machines must know what they are activating and the job will have extreme responsibility. These "educated" persons must know something about both the physical sciences and liberal arts.¹¹

As most library administrators are well aware, the labor supply is putting the squeeze on demand. The low birth rates of the depression years, the high standards of living that allow people greater choice in jobs and more liberal retirement policies make some of the lower-paying professions hard put to compete in the labor market. Society's need will be for engineers, electronic experts, electricians, mechanics, subject specialists. Libraries will want managers and creators who can take advantage of the promised efficiencies of automation. Under these conditions, library schools face a real challenge.

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¹⁰ Arthur Pleydell. *op. cit.*

¹¹ Robert Alexander Watson-Watt, president, Logistics Research Inc. Address at Oregon State College, Corvallis, Oregon, January 23, 1956.

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brarians suggests that the reasons are overwhelming. The writer entertains few hopes that the situation can be improved. What is fervently to be hoped is that the researcher understand why the librarian has been forced to put certain difficulties in his way. Without this un-

derstanding, a growing hostility is inevitable between these two, whose cooperation is a *sine qua non* of successful research. It is a subject that ought to be aired. Some librarian can do us all a great service by presenting the facts of this matter from his point of view.

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With the rapid change around us, it is no longer enough to train our library workers of tomorrow for today's jobs. Observed objectively, the best, most flexible library training possible would be a solid grounding in fundamentals, particularly mathematics and sciences. Fundamentally trained, the library school graduate may thus be able to take advantage of the specialized jobs that develop. Inadequate preparation could mean shortage of personnel to man the machines providing the library service, even as it is today. Today, there are professional routines so close to the clerical routines that even the inadequately trained professional may find placement because the supply is smaller than the demand. In automated libraries this might not be possible.

Librarians are feeling the pinch today for top-caliber personnel. This shortage, which will grow, soon will force additional streamlining of procedures, short cuts in indexing, cataloging, and increased salaries. Personnel shortages will *force* the first automation. And before automation becomes a significant part

of library procedures and routines, librarians and library schools must face up to the problems of preparing within their own ranks sufficient technically trained people able to perpetuate the advances made and to add others.

It is very necessary that library schools be well aware of developments in the field of automation—where they can be applied, and where they may be improved. Most librarians, however, are unaware of the magnitude and complexity of the problem of switching from present-day libraries even to partially automated libraries. The significance of scientific advances, particularly in the field of electronics, requires re-emphasizing and re-examination of the basic principles of librarianship from which the every day struggle for space, personnel, and money has distracted us.

If librarians do not learn to extend their techniques and develop the new techniques required, other agencies, or new professions, will be created to do the job. If librarians restrict their activities to fit within the present framework and structure of librarianship, they will fail in their obligations to society.