Automation, Information, and the Administration of Archives and Manuscript Collections: Bibliographic Review

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A DISCUSSION of automation, particularly as it relates to the control and use of archives and manuscript collections, must admit of some generality and inexactness. Few works have been published in this field, and automation, as a relatively new concept, is still an imprecise term. In dealing with automation we lack the uniform terminology and the widely accepted classifications and definitions that characterize older concepts of the control of information. Information itself, as a term, has assumed new and sometimes bewildering connotations. The classifications used in this essay, therefore, are intended to serve only as a convenient framework for a discussion of general trends and problems and for a brief introduction to useful and suggestive writings on automation as it relates to information problems in nonbook repositories and collections.

General literature on automation and information is readily accessible through several excellent bibliographic aids, such as the *Wiley Interscience* listings and the publications of the American Documentation Institute. At first glance, however, many of these writings appear to have little relationship or application to the problems facing the archivist or the manuscript curator, who has never considered himself an "information scientist." Indeed, many articles are so technical and specialized, and their language is so often couched in engineering and mathematical terms, that they completely discourage the newcomer to this field. A title or two will demonstrate this problem: "The Statistics of Structured Meaning," "Basic Postulates and Common Syntax," "In Search of Quantifiable Parameters of Group Performance," and "Interfixing of

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Descriptors for Row-by-Row Coded Punched Card Machine Literature Searching Systems."[1]

Too frequently in these writings automation is approached as though it were a new science, and writers appear to be less concerned with informing and enlightening their readers than with impressing their professional colleagues with mathematical calculations intended to support particular interpretations of theoretical and technical problems. At the 29th annual meeting of the American Documentation Institute, in October 1966, particular emphasis was given to this need for good general articles for the nonexpert reader. This absence of adequate communication between the scientific community and the public upon which it is dependent for support and cooperation prompted the *New York Times* to observe that the "communications problem tends to get worse as the volume of scientific data grows rapidly and as scientists penetrate ever deeper into regions removed from ordinary experience. The extreme has already been achieved in pure mathematics where there is now almost no popular understanding of what is going on."[2]

Stripped of the jargon with which it has unfortunately become associated, automation is fundamentally a mechanical or electronic extension of traditional logic—or deductive and inductive reasoning—to problem solving and the performance of work. Since archivists and manuscript curators have always used logic in establishing physical and intellectual control over the research materials in their custody, they should have an active interest in the application of techniques of automated logic to these specialized information sources. This common base in applied logic can provide the archivist and the manuscript curator with an approach to what has sometimes been regarded as a special field that may be entered only by those with scientific and mathematical training.

To appreciate fully the implications of information automation and to find practical applications suited to his needs, the archivist or manuscript curator should regard himself less as a custodian of physical entities—record groups, personal papers, manuscript collections, and miscellanies—than as an information specialist. He will then find that he is able to bring sources to inquirers and inquirers to sources in ways made possible only by the technology of electronics. He will become, in the language of the new information sciences, a communications director, enabled through technology to accumulate, to store, and to communicate information about masses

[1] Allen Kent, ed., *Information Retrieval and Machine Translation,* table of contents (Cleveland, Western Reserve University, 1960).

[2] Editorial, sec. E, p. 10, Nov. 6, 1966.

of material over which he previously had only relatively superficial control. The role of the archivist and manuscript curator, thus transformed by electronic recording and transmission equipment of millisecond speed and virtually unlimited storage capacity, becomes as a consequence an increasingly dynamic one.

The readings suggested in this essay are intended to provide a preliminary frame of reference for an introduction to the complex history of current trends in computerization of fields of interest to the archivist and manuscript curator in their changing roles. An attempt has been made to survey trends in the recent history of information control and retrieval, to review certain general aspects of data processing, and to take some notice of the equipment or machinery of information technology as it has been or may be applied to archives and manuscript collections. It should be noted that the literature cited is not necessarily the most current; it is cited as being particularly relevant for those who have not yet found reason to explore the potential usefulness of computers in their own work.

General Trends in the Recent History of Automation

A review of the relevant literature of the past two decades suggests four major themes that dominate the history of information automation: information retrieval and documentation, cybernetics and other theories of control, information systems development, and data processing. The history of the application of automation to information processing can be traced directly to the rapid development of electronics and electronic communications techniques and devices that occurred during and after World War II. Vannevar Bush, on the basis of his intimate knowledge of and contribution to military technological development during World War II, first postulated the information potential of this new technology and heralded the information retrieval theme in his frequently cited article, "As We May Think," in the *Atlantic Monthly,* 176:101–108 (July 1945). The impact of the new electronic technology upon peacetime industry, particularly the chemical, medical-equipment, radio, television, and sound-recording industries, and upon the exact sciences, produced a research environment and a publications demand requiring new and rapid information services. To cope with this accelerating information explosion the very technology that helped produce it was applied to its control. The result was the rapid growth of new electronic communications techniques and the design of new electronic machines with increased capacity

for the high-speed accumulation, classification, and dissemination of scientific and technical information. The fact that the exact sciences could be communicated in symbols or numbers permitted rapid transmission and translation into machine-readable form and accounts for the predominantly mathematical character of early digital computer equipment and early computer language. A useful summary review of these developments is given in Francis Bello's "How To Cope With Information" in *Fortune,* 62:162–167, 180–182 (Sept. 1960).

Although much of the early research in information retrieval related to the physical and mechanical sciences, certain aspects of retrieval problems were basic to the needs of other disciplines, especially library science. Among those recognizing the necessity for a reevaluation of traditional library information services was Verner W. Clapp, who reiterated and enlarged upon a concern expressed earlier by Fremont Rider. Rider, in *The Scholar and the Future of the Research Library* (New York, Hadham Press, 1944), had urged an unlimited expansion and application of microphotocopying methods to resolve the increasing problem of library growth. He challenged traditional librarianship by implying that the catalog as the end product of book control ought to be replaced. According to Clapp:

> Librarians are now engineers, and no librarian worth his salt considers books as literature, but merely as the stuff (he calls them "materials" or "collections") which is to be subjected to engineering processes. His talk is not of authors, but of administration; he never mentions books but, instead, bibliographic control or organization. . . . It is true that mechanisms have pervaded almost every aspect of library work, and threaten to be even still more pervasive. The important thing to remember, however, is that library work was always dependent upon mechanisms, if only those simplest mechanisms which were required for storing materials, for assigning locations in this storage space, and for finding them when needed. These primary operations are still basic . . . and since the operations of archival and of library collections share this basis, it may be worth while to consider some of the mechanical aids to which librarians have been looking . . . .[3]

Clapp's statement of the responsibilities and challenges of the research library has been consistently and markedly influential, and his most recent summary, *The Future of the Research Library* (Urbana, University of Illinois Press, 1964), repeats his earlier endorsement of "mechanisms" while still stressing traditional library obligations.

[3] Verner W. Clapp, "Archivists and Bibliographical Control: A Librarian's Viewpoint," in *American Archivist,* 14:305, 306 (Oct. 1951).

Retrieval and Documentation

Pressure from the sciences for the abstracting, indexing, and retrieval of technical data from current publications in the most rapid and concise method possible was a dominant factor in the speedup and computerization of documentation systems. Most of the documentalists engaged in these studies, however, continue patterns of information control and logic that have always been implicit in the classification, subject analysis, and description of information from a book- and serial-oriented base. Their studies have generally been directed to specialized readers working in their same area of interest, and their studies are not easily adapted to the solution of problems involving nonbook materials. A large part of their effort has been given to translation of traditional book and serial classification systems into mathematical codes that take full advantage of the high-speed sorting, analyzing, and synthesizing features of computers; and in their writings the terms "information retrieval," "documentation," and "indexing" may frequently be regarded as synonymous.

This development may be traced in Jesse H. Shera and Margaret E. Egan's "Prolegomena to Bibliographic Control," in the *Journal of Cataloging and Classification,* vol. 5, no. 2:17–19 (Winter 1949). For the contribution of Mortimer Taube in pioneering studies in machine indexing and cataloging, see his *Studies in Coordinate Indexing* (4 vols.; Washington, Documentation Inc., 1953–57); and his summary article, "Documentation, Information Retrieval, and Other New Techniques," in the *Library Quarterly,* 31:90–103 (Jan. 1961). Additional basic studies in this area include Calvin Mooer's "Zatocoding Applied to Mechanical Organization of Knowledge," in *American Documentation,* 2:20–32 (Jan. 1951); the writings of James W. Perry and Allen Kent at the Western Reserve University Center for Documentation and Communications Research, particularly their *Machine Literature Searching* (New York, Interscience Publications, 1956); G. E. Randall's "Practicality of Coordinate Indexing," in *College & Research Libraries,* 15:417–420 (Oct. 1954); M. F. Tauber's *The Subject Analysis of Library Materials* (New York, Columbia University School of Library Science, 1953); and Brian C. Vickery's *Classification and Indexing in Science* (2d ed.; London, Butterworths Scientific Publications, 1959).

Most documentalists continue to concentrate their studies on the reduction of language to numeric symbols and a structured system of codes designed to make maximum use of the storage and retrieval

capacities of magnetic tapes, discs, cores, and variations of computer programing. Their studies of language, logic, and syntax have resulted in many advanced systems—from standard subject headings to concepts of "uniterms," "keywords," "descriptors," and other semantic devices. A valuable approach to the study of these devices, which are merely words acting as signals, is provided in two articles by Verner W. Clapp: "Indexing and Abstracting: Recent Past and Signs of Future Development," in *College & Research Libraries,* 11:197–206 (July 1960); and "Subject Controls—Nature and Levels of Controls," in *American Documentation,* 3:11–15 (Jan. 1952). Further introductory readings in this area include the American Standards Association's *Basic Criteria for Indexes* (New York, American Standards Association, 1959), an introduction to and manual on traditional indexing; *Machine Indexing: Progress and Problems* (Washington, American University Center for Technology and Administration, 1961), the proceedings of the Third Institute in Information Storage and Retrieval (Feb. 1961) at The American University; the summary article by Herbert Coblans, "New Methods and Techniques for Communication of Knowledge," in *Unesco Bulletin for Libraries,* 11:154–175 (July 1957); Charles P. Bourne's "The Historical Development and Present State-of-the-Art of Mechanized Information Retrieval Systems," in *American Documentation,* 12:108–110 (Apr. 1961); and the special state-of-the-art symposium issue of *American Documentation* for January 1962 (vol. 13, no. 1). Additional readings are summarized in a comprehensive bibliographic survey by the National Bureau of Standards, U.S. Department of Commerce, *Automatic Indexing: A State-of-the-Art Report,* compiled by Mary Elizabeth Stevens (NBS *Monograph* 91; Washington, 1965).

Theories of Control

In addition to the trend toward the computerization of information retrieval and documentation, there has emerged during the past two decades a control theory with far-reaching implications for in-depth analysis and management of information. In the cybernetic theory of control the behavior of the computer can be patterned to simulate the behavior of the human brain; the computer can also be programed as a model, performing various mechanical and feedback[4] functions simulating human performance

[4] An electrical term, used also in biological sciences, to indicate a partial return of an output element to its source; in information handling, a self-checking, self-correcting capability.

and human method in performance. As established in the work of Norbert Wiener, cybernetics was at first virtually incomprehensible to laymen. John Diebold, however, chief publicist for automation in its development in the United States, translated automata and their abstractions into the language of everyday problems. Although historically some sciences have suffered through popularization, our more advanced sciences now require an interpreter. Popularization of cybernetics, fundamentally an almost metaphysical science in its abstractions and hypotheses, has opened up with new boldness the application of scientific method to the analysis of functions and the aptitudes of the people who perform them. Diebold testified before Congress that machines could be instructed to perform many industrial operating and manufacturing functions that previously required man-effort. This startled the economic world and continues to reverberate in labor and management planning groups. As the implications of cybernetic theory have become better understood, however, a shift in emphasis has taken place, and the whole range of human information and communication problems is now being subjected to renewed analysis, evaluation, and testing. As W. Ross Ashby, another pioneer in the development of cybernetic theory, has observed: "Cybernetics deals with all forms of behavior in so far as they are regular, or determinate, or reproducible. . . . It is in this way that information theory comes to play an essential part in the subject; for information theory is characterized essentially by its dealing always with a set of possibilities."[5]

Both the librarian and the archivist are conscious of the role of behavior in reference and research work, from the moment when the inquirer confronts them with his sometimes inarticulate but demanding need to know until they respond, usually with suggestions of alternatives and sets of possibilities. Archivists and manuscript curators will indeed find that certain concepts of testing, modeling, sampling, and simulation used in demonstrating cybernetic theory hold some promise for the practical application of computer control to the storage and retrieval of undefined masses of original historical research materials. As John Diebold observed in a recent article, "the application of technology not only changes the method by which an operation is performed, but frequently changes what is performed." Diebold poses three basic questions archivists and manuscript curators might ask themselves:

[5] W. Ross Ashby, *An Introduction to Cybernetics,* p. xi (New York, J. Wiley & Sons, 1963).

"(1) Who needs the information? (2) What kind of information must be made available, in what detail, and how currently? (3) Must the system be complex enough to allow for machine guidance of the questioner if the question is unclear or unanswerable in the form presented?"[6]

It is possible to create new bases for information control in archival or manuscript work, as well as in historical search and research. Predicated not upon conversion of older methods to high-speed equipment but rather upon the application of techniques derived from cybernetic theory, means may be found by both the archivist and the researcher for more responsive searching under more effective processing controls. Speed was a major factor in the development of automation in scientific information services, for this was the necessary response to particular user need at a critical time. But the researcher in the social sciences and in the humanities is not using original source materials for "ready reference." He is generally more interested in control and synthesis of information, the boundaries of which he has established over a period of time and through the process of experience. High-speed equipment and the rapid display of single responses to single inquiries are peripheral to his central needs. Strong support for such application of cybernetic theory to historical research was given recently by J. Kabk, who observed that "only in exceptional cases" can mathematics and cybernetics "provide an historian with completely new facts and show him what he himself cannot perceive, as in the case of dating archæological finds by measuring the degree of distribution of radioactive carbon in them."[7]

Introductory reading in the field of cybernetics should include Norbert Wiener, *Cybernetics* (New York, J. Wiley & Sons, 1948), particularly chapters 3–8 and the preface to the second edition of the Massachusetts Institute of Technology Press paperback reprint (Cambridge, 1965); W. Ross Ashby's *An Introduction to Cybernetics* (New York, J. Wiley & Sons, 1963); Herbert A. Simon, *The Shape of Automation for Men and Management* (New York, Harper Torchbooks, 1965); and Stafford Beer, *Cybernetics and Management* (New York, J. Wiley & Sons, 1966). A useful popular treatment is Jeremy Bernstein's *The Analytical Engine* (New York, Vintage Books, 1964).

Integrated studies of automation and information that serve as

[6] John Diebold, "Computers, Program Management and Foreign Affairs," in *Foreign Affairs,* vol. 45, no. 1:125–134 (Oct. 1966).

[7] J. Kabk, "Mathematics and Complexity," in *London Times Literary Supplement,* Sept. 8, 1966.

a good introduction to related theories of information control include an important early work in the application of computer science to information problems: Jesse H. Shera and Margaret E. Egan, eds., *Bibliographic Organization: Papers Presented Before the Fifteenth Annual Conference of the Graduate Library School* (University of Chicago, 1951). This useful compilation includes reviews of the status of functional approaches to bibliography, classification, and documentation; evaluations of subject approaches, indexes, and use analysis; and a final section on management approaches to information control, including mechanization. It is basically a 1950 state-of-the-art report published on the eve of the proliferation of data processing, computer, and other electronic communications equipment. A more technical survey is Unesco's *Information Processing: Proceedings of the International Conference on Information Processing* (Paris, 1959). Significant general collections of essays and lectures contributing to integrated analysis and resulting from conferences or "anthology" programs include Martin Greenburger, ed., *Computers and the World of the Future* (Cambridge, M.I.T. Press, 1962), which prints a challenging lecture by J. G. Kemeny on "A Library for 2000 A.D."; Morris Philipson, ed., *Automation: Implications for the Future* (New York, Vintage Books, 1964), which reprints the congressional testimony of John Diebold and significant statements by Norbert Wiener and Donald M. Michael, whose *Cybernation: The Silent Conquest* (Santa Barbara, Center for the Study of Democratic Institutions, 1962) is a stimulating, imaginative work; and the Spring 1966 issue of the *American Scholar,* subtitled *The Electronic Revolution* (vol. 35, no. 2), which relates the computer sciences to the humanities, particularly literature, language, and music, while underscoring several new and important trends in automation. Significant general summaries of automated techniques in information handling, written in a lucid, nontechnical style, are the series that appeared under the title "Freeing the Mind" in the *London Times Literary Supplement* (Mar.–June, 1962) and the more recent "New Ways in History," which appeared in the same periodical in April, July, and September of 1966. Attention should also be given to the special automation issues of *Library Trends* (Oct. 1956), *Navy Management Review* (Jan. 1960), *American Documentation* (Jan. 1962), *Aslib Proceedings* (Feb. 1964), and the *Wilson Library Bulletin* (May 1964).

Data Processing

Another major development reflected in the literature of infor-

mation automation, particularly applicable to actual information situations on a relatively small or local scale, is data processing. The term data processing has been used to describe the many kinds of mechanical and electronic equipment available for rapid maintenance and control of records and has long been associated with the business world. Identified primarily with the tabulation of statistics and the sorting and listing of related types of data, data processing encompasses a wide range of services performed by various types of equipment peripheral to a computer but not dependent upon it. Increasingly the term is used interchangeably with computerization and programing, but the literature cited here continues to make a distinction between the two types of activities, while recognizing their basic compatibility. The differences are essentially evolutionary. Some institutions and services that cannot afford and do not need sophisticated retrieval equipment can apply data processing procedures without foreclosing the possibility of converting to a more complicated system. Archivists and manuscript curators—in evolving from handwritten catalogs to typed, processed, and photographically dittoed, multilithed, or otherwise reproduced cards—have always processed data when they created accession records, finding aids, and catalog entries. Conversion to punched cards for some operations is entirely consistent with continued upgrading of quality and production in all such operations.

A basic reference work on data processing, as useful for the archivist or manuscript curator as for the data processor, is Charles P. Bourne's *Methods of Information Handling* (New York, J. Wiley & Sons, 1963). In nine chapters this work summarizes the history of mechanized equipment in information and administrative control situations. Particularly useful are chapters 4 through 9, which are concerned with machine language, manual and punched-card systems, computers (primarily as processing equipment), magnetic and paper tape, and microfilm and other image-handling equipment. A pioneer work, outdated in some respects but extremely informative (particularly for persons new to the field), is R. S. Casey *et al.*, eds., *Punched Cards: Their Application to Science and Industry* (New York, Reinhold Publishing Co., 1958). Special studies in this area include B. R. Faden's "Information Retrieval on Automatic Data Processing Equipment," in *Special Libraries,* 50:162–165 (Apr. 1959); C. C. Gotlieb and J. N. P. Hume's *High-Speed Data Processing* (New York, McGraw-Hill, 1958); Louis A. Shultheiss' *Advanced Data Processing in the Library* (New York, Scarecrow Press, 1962); I. A. Warheit's "The Librarian and the Development of Machines," in *Special Libraries,*

44:272–273 (Sept. 1953); and a special issue of *Library Trends* (Jan. 1960) that gives a summary of microforms and their relationship to developments in handling information.

Systems Studies

> Today one can no longer think of just the computer. One must think in the more comprehensive terms of information technology or information systems. . . . The computer is emerging from its glassed-in throne room, and, as it becomes increasingly accessible to those needing its services, the links between it and society proliferate both in number and in complexity.[8]

The truth of this statement is being increasingly demonstrated. The more institutions and services use data processing, photocopying equipment, and general or multipurpose computers, the closer they come to being explicit in the analysis of their needs. Actual experience, even in local data processing operations, reestablishes a principle that has always controlled the handling of information: all aspects of information service are interrelated. If the emphasis in repositories is put upon the information in their custody rather than upon the form that that information takes, ways can be found to bring the information under centralized control.

Systems studies of this type have been made and should be reviewed, if only to indicate the rapid progress that has been made by libraries and other institutions in response to and in anticipation of technological developments. Introductory reading on systems development should include National Bureau of Standards, U.S. Department of Commerce, *An Orientation in Systems Analysis,* by Vico Henriques (NBS *Report* 6834; Washington, 1960); Paul W. Howerton, ed., *Vistas in Information,* vol. 1 (Washington, Spartan Books, 1963); H. W. Laden and T. R. Gildersleeve's *Systems Design for Computer Applications* (New York, Sperry Rand Corp., 1962); Allan D. Meacham and Van B. Thompson, eds., *Total Systems* (Detroit, American Data Processing, Inc., 1962); C. W. Cleverdon's "The Evaluation of Systems Used in Information Retrieval," in *Proceedings of the International Conference on Scientific Information,* 1:687–698 (Washington, National Academy of Sciences—National Research Council, 1958); William H. Desmond's *Computers and Their Uses* (New York, Prentice-Hall, 1964); Documentation Inc., *The Logic and Mechanics of Storage and Retrieval Systems* (*Technical Report* 14; Washington, Feb. 1956); and Peter Wegner's *Introduction to System Programming* (New York, Academic Press, 1964).

[8] Diebold, in *Foreign Affairs,* vol. 45, no. 1:130.

Information Control and the Administration of Archives and Manuscript Collections

Although archivists and manuscript curators share with librarians and documentalists a concern for establishing intellectual or subject-content control over their holdings, traditionally their primary concern has been for establishing physical control—control in terms of the form and identity of the unpublished units of research material in their custody. Of basic importance is the recognition that what is involved is not two mutually exclusive types of control, but rather two levels of control that necessarily complement each other. Thus accession inventories, registration statements or similar accession controls, and finding aids of all types—guides, catalogs, descriptive and series-title inventories, registers, special lists, calendars, etc.—which may or may not contain indexes, are intended in varying degrees to establish both types of control over unpublished materials. In fact, identification for physical control is impossible without some degree of description, which contributes to intellectual control. A major problem thus far has been the lack of a uniform terminology and methodology in the creation of these controls for the many varieties of unpublished research materials in archives and other repositories. To utilize automation effectively—to capitalize upon the mechanical or electronic extension of logic that automation represents—will require the application of logic to collective descriptive practices to secure at least the same degree of uniformity that characterizes traditional library classification, cataloging, and indexing.

Because of the lack of uniformity in descriptive terminology and methodology, very little has been written on the direct application of automation to the control and use of archives and manuscript collections. Indeed, the issue of the *American Archivist* for which the present essay has been prepared is intended to help fill this gap in the literature. There is some awareness of the basic problems in Murray J. Lawson's "The Machine Age in Historical Research," in the *American Archivist,* 11:141–149 (Apr. 1948); Evelyn Hensel's "Treatment of Nonbook Materials," in *Library Trends,* 2:187–198 (Oct. 1953); Thomas Wilds' "Information Retrieval," in the *American Archivist,* 24:269–282 (July 1961); and Edward Heiliger's "Application of Advanced Data Processing Techniques to University Library Procedures," in *Special Libraries,* 53:472–475 (Oct. 1962). For a discussion of these problems from the user-inquirer point of view, see Mary Francillon's "Information Retrieval: A View from the Reference Desk," in the *Journal of Doc-*

umentation, vol. 15, no. 4:187–198 (Dec. 1959). Applications of a total systems approach to information retrieval as applied to office filing systems are given in Richard F. Neuschel's *Management by System* (2d ed.; New York, McGraw-Hill, 1960). Also suggestive is Morris Rieger's "Archives and Automation," in the *American Archivist,* 29:109–111 (Jan. 1966).

Limited but significant projects in the application of computer techniques to the specific problems of archives and of other nonbook materials have produced several studies, particularly in the area of machine indexing. These include Rita R. Campbell's "Machine Retrieval in the Herbert Hoover Archives," in the *American Archivist,* 29:298–302 (Apr. 1966), which describes an indexing program at the filing-unit level; Elizabeth Ingerman Wood's "A New Method of Indexing," *ibid.,* 25:331–340 (July 1962), and her more comprehensive *Report on Project History Retrieval* (Philadelphia, Drexel Institute of Technology Graduate School of Library Science, 1966); Fred Shelley's "The Presidential Papers Program in the Library of Congress," in the *American Archivist,* 25:429–432 (Oct. 1962); J. Atherton's "The Application of Mechanization to Manuscript Catalogue Production in the Public Archives of Canada," in the *Canadian Archivist,* vol. 1, no. 4:3–7 (1966); Phyllis Platnick's "Proposal for Automating a Manuscript Repository," in *Progress in Information Science and Technology; Proceedings of the 1966 Annual Meeting of the American Documentation Institute* (Santa Monica, Calif., Adrianne Press, 1966); and W. L. Rofes' *Applying New Technology to Traditional Archival Problems* (New York, IBM Archives Conference, 1965).

As has been previously indicated in this essay, if the full potential of information science is to be realized by the archivist or curator, his initial recognition of the possibility of simply automating existing controls for purposes of information retrieval must be broadened to a full awareness of the fact that information retrieval is but one aspect—only one level—of a multilevel management problem. To achieve the optimum benefit of automation requires a total systems or management approach to all functions. Thus far there has not been a single systems study of this type, a study that would recognize the particular hindrances confronting the archivist and the curator as opposed to those confronting the librarian and the documentalist. Since we do not begin with a book-oriented base, we must first identify material in our custody in terms of the entity it represents and on the basis of criteria derived from the material itself. Next we must establish the subject scope of that material. Finally, we must relate the identification criteria

and subject scope to a control system keyed to the full range of management functions. Since we are dealing with unique research resources, this control system must be keyed to a wide range of user needs and situations. Unlike the automation of book- and serial-based systems, the use of automated techniques for control of archives and manuscript collections must necessarily suggest and direct retrieval patterns, rather than merely respond to traditional needs and requests. Because of the nature and the sheer volume of material involved, there is every indication that automated retrieval as applied to archives and modern manuscript collections must be a selective retrieval, a retrieval not so much of precise data but of categories of data from which more precise information may be derived.

Suggested Further Readings

Charles P. Bourne, in his *Methods of Information Handling* (New York, J. Wiley & Sons, 1963), makes the following observations regarding the need for sound teaching and reference tools in the field of information science:

> Information science may someday be a profession in its own right. The aim of this series [*Wiley Interscience*] is to bring together the inter-disciplinary core of knowledge that is apt to form its foundation. Through this consolidation, it is expected that the series will grow to become the focal point for professional education in this field.

Bourne's work meets many of these needs, as do other monographs issued as part of the same series of automation studies: *Computer Data Processing, Management Sciences, and Computer Applications: Advances in Documentation and Library Science,* under the general editorship of Jesse H. Shera; and *Library Science and Documentation,* presently available in four volumes. Detailed descriptions and tables of contents for this series are available in *Wiley Interscience Books, 1966,* a 512-page catalog.

The work most resembling a textbook for the entire field is a volume in the Wiley series, Joseph Becker and Robert M. Hayes' *Information Storage and Retrieval: Tools, Elements, Theories* (New York, John Wiley & Sons, 1963). Specifically designed for teaching purposes, this work effectively demonstrates that information does represent an interdisciplinary effort, as do the *Proceedings of the Symposium on Education for Information Science of the American Documentation Institute* (Washington, Spartan Books, 1965). Other useful manuals include Daniel Melcher's "Primer in Machine Information Storage and Retrieval," in the *Library*

Journal, 85:909–912 (March 1, 1960); Freeman H. Dyke's *Reference Manual on a Practical Approach to Information and Data Retrieval* (Boston, Industrial Education Institute, 1963); and William F. William's *Principles of Automated Information Retrieval* (Elmhurst, Illinois, The Business Press, 1965).

Preliminary teaching efforts in the area of information retrieval have been of necessity keyed to the acute technical demand for programers. Although the instructional aids designed for programers are highly technical and in the specialized language of electrical engineering and computer mathematics, the publications and manuals of IBM, Sperry Rand, Thompson Ramo Woolridge, Inc., and other computer manufacturers, designers, and research specialists represent important contributions and are readily accessible. The IBM *Journal of Research and Development* is a particularly informative publication, as is the IBM series of *General Information Manuals.* Other periodicals that should be reviewed regularly include: *American Documentation, Aslib Proceedings, College & Research Libraries, Communications of the Association for Computer Machinery, Computers and Automation, Data Processing, Journal of Cataloging and Classification, Journal of Documentation, Library Resources & Technical Services, Library Trends,* and *Special Libraries.*

Most of the studies cited in this essay are well indexed and contain valuable bibliographies. The scope and applications of information science are so wide and diverse, however, that certain bibliographies should be listed as basic tools, particularly for those first surveying the field to find applications for their own work. Among these are the bibliographies of Mary Elizabeth Stevens of the National Bureau of Standards, which thus far cover three major fields: *Information Selection Systems Retrieving Replica Copies, Automatic Character Recognition,* and *Automatic Indexing.* These are state-of-the-art reports issued as monographs in the technical notes and monographs series of the Bureau between 1961 and 1965. Other basic bibliographies include Charles F. Balz and R. H. Stanwood, comps., *Literature on Information Retrieval and Machine Translation* (White Plains, N.Y., IBM Corp., 1962); Charles P. Bourne's *Bibliography on Mechanization of Information Retrieval* (Menlo Park, Calif., Stanford Research Institute, 1958–1962), somewhat outdated but still useful for those entering the field; Paul C. Janaske, ed., *Information Handling and Science Information: A Selected Bibliography, 1957–1961* (Washington, American Institute of Biological Sciences, 1962); Helen E. Loftus and Allen Kent, comps., "Automation in the Library—An Annotated Bib-

liography," in *American Documentation,* 7:110–126 (April 1956); *Bibliography of Bibliographies on ADP* (Special Report, March 1962) issued by the Task Force on Bibliography of the U.S. Interagency Committee on ADP; Jean M. Wayne, comp., *Indexing With Emphasis on Its Technique: An Annotated Bibliography* (New York, Special Libraries Association, 1966); and *Computer Literature Bibliography, 1946 to 1963,* compiled by W. W. Youden for the National Bureau of Standards in 1965. A new publication that promises to become a primary source of bibliographic and computer project information is the American Documentation Institute's *Annual Review of Literature in Information Science and Technology.*

It is hoped that a review of the literature of information science, particularly as relevant to the problems of archives and manuscript repositories, will be continued on a regular basis. Publications of articles and books on the application of computers to nonbook research materials are increasing as the feasibility of approaching the computer in plain language, without excessive coding or mathematical symbolism, is being more widely demonstrated. If computer technology and information science are to have maximum impact on the administration of archives and manuscripts, prompt and thorough communication between sources of technical information and interested repositories must be firmly established and maintained.

Artificial Intelligence

What is the future impact of artificial intelligence on the human mind?

One of the most sophisticated technological peaks of this century will be reached in the development of computer machines capable of intelligent behavior and efficient performance. The accomplishment of mathematical calculations and control of complex systems by computers implies that these machines, in many cases, are capable of outperforming the human brain.

There is a unanimous area of agreement between informed philosophers and computer-trained technicians that artificially intelligent mechanisms will force basic changes in concepts of rational behavior in the human being and that there are few intellectual operations that will not eventually fall within the ability range of a skillfully programmed machine.

—UNIVERSITY OF NOTRE DAME PRESS, *Books Spring 1967,* p. 8, with reference to Frederick J. Crosson and Kenneth M. Sayre, eds., *Philosophy and Cybernetics,* to be published on April 27.