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HISTORY OF INFORMATION SCIENCE

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INTRODUCTION

The purpose of this chapter is to provide a review of historical writings about the development of information science (IS) or certain aspects of it rather than to review historic events and figures in the development of IS. We have reviewed the available literature, preferring but not limiting ourselves to formal historical writing, the kind that professional historians produce. An earlier version of this review (BUCKLAND & LIU) appeared in the *Annual Review of Information Science and Technology*, which has had two prior chapters dealing, in part, with the history of IS. In 1977, in the chapter entitled "History and Foundations of Information Science," SHERA & CLEVELAND included an historical introduction to the field, and some of the literature reviewed was about the history of IS. A significant part of the chapter by RICHARDS (1992) addressed the history of information science in the Soviet Union.

It would have been foolish to have attempted to include every field that invokes the word "information." Instead this review is based on the authors' perceptions of the principal interests of the membership of the American Society for Information Science (ASIS) since its foundation in 1937 as the American Documentation Institute. In this view, IS is centered on the representation, storage, transmission, selection (filtering, retrieval), and the use of documents and messages, where documents and messages are created for use by humans. Interest extends outwards in many directions because of the need to understand contextual, institutional, methodological, technological, and theoretical aspects. We recognize that many other views are possible and hope that others will prepare reviews from other perspectives.

Within this field, from about 1960 the phrases "information science" and "information retrieval" were adopted, largely replacing the older term "documentation." We recognize this continuity by treating "documentation," when used in this context, as a synonym for IS. We have treated IS inclusively in two senses. First, we include specialized applications areas, such as archival, library, and corporate information services as specialties within a broad view of IS rather than specialties outside of it. Second, we agree with VAKKARI (1994a) that it is misguided on theoretical grounds (as well as difficult in practice) to separate the theory of library science and of documentation from that of IS. Given the limitations of space and time we have been selective in our coverage of the many application areas and the enabling techniques and technologies. Where the bibliography of topics within our scope is already well developed, notably in the history of information technology and of library services, we could afford to be even more selective. Nevertheless, this review inevitably reflects the very uneven distribution of historical writings within our scope, notably the very heavy concentration on library history and, to a lesser extent, on bibliographic control. Given our perspective, IS a dynamic but not a new field. Indeed 1995 marked the centenary of one historic event, the establishment in Brussels of what is now the International Federation for Information and Documentation in which many modern IS ideas were pioneered.

The arrangement of this review is based on the classification scheme used in *Information Science Abstracts*, as follows: Introduction; Background; History of Information Science; Techniques and Technology; Information-Related Behavior; Application Areas; Social Aspects; Education for Information Science; Institutions; Individuals; Geographic Areas; and Conclusions.

We focus on the literature from to date, with older writings included selectively. The coverage is

international, but most of the material known to us is published in the United States, and it seems impractical to separate general treatments from writings emphasizing the United States.

BACKGROUND

Sources
The number of books on the history of IS small but growing. No particular journal is dedicated to the history of IS but several carry occasional historical pieces, notably the *Bulletin of the American Society for Information Science*, the *Journal of the American Society for Information Science (JASIS)*, *Documentaliste*, and the *Journal of Documentation.* The *Encyclopedia of Library and Information Science* is a good source for historical treatment of topics in IS.

An encouraging sign is the recent publication of special issues on the history of IS by four different journals. The first appeared in 1993 in *Documentaliste* (RAUZIER). The entire contents of two of them, in *Information Management and Processing* (RAYWARD 1996a) and in the *Journal of the American Society for Information Science* (BUCKLAND & HAHN 1997), are reprinted in this volume. The fourth appeared in *Solaris* (FAYET-SCRIBE 1997b) and is conveniently available online.

Access to the literature has been improved by significant specialized bibliographies on the history of IS. See the "Bibliography of the history of Information Science in North America, 1900-1997" by R. V. Williams, L. Whitmire and C. Bradley at the end of this volume, the very extensive review, chronology, and bibliography of (mostly) French language literature by FAYET-SCRIBE (1997a), conveniently available online, and the reviews of German (HAPKE 1998) and Spanish publications (SAGREDO FERNÁNDEZ & GARCÍA MORENO, reprinted here).

Material on the history of IS can be found through general sources such *Information Science Abstracts* and *Library & Information Science Abstracts*. General works, such as the book by VICKERY & VICKERY and the *Dictionnaire encyclopédique de l'information et de la documentation* (CACALY), are likely to be of some help and, of course, a scholarly treatment of any topic is likely to include some historical background. The *Journal of Education for Library and Information Science* carries lists of doctoral research in progress. Some sources for specialized areas are noted in later sections.

The republication of historically significant but inaccessible material is important. In particular the best writings of Paul Otlet (1868 - 1944), a central figure in development of this field, are now available in English, translated and carefully annotated by W. B. Rayward (OTLET). FRANK edited a volume of 28 classic papers on bibliography, documentation, and the terminology of the field; dated 1821 - 1969, with half before 1939, some are in English, but most are in (or translated into) German. MEADOWS edited 17 pioneering quantitative studies published from 1920 to 1950.

Other recently reprinted historic texts include papers by Vannevar Bush (NYCE & KAHN, 1991), the 1992 pioneering classic on retrieval using microfilm and a photoelectric cell by GOLDBERG, and excerpts from Robert Pagès on the CODOC indexing language (DEMAILLY).

The very important archives of Paul Otlet and his collaborators have been rescued and form the basis for a research center called the Mundaneum in Mons, Belgium, under the direction of Jean-François Füeg. The Mundaneum's publications include a periodical, MUNDANÉEN, and a praiseworthy volume of papers based on research in the archives (*CENT ANS*).

A database of information on North American pioneers of IS is described elsewhere in this volume. Let us hope fro similar ventrues for other geographical areas.

Historiography of Information Science
The writing of the history of IS cannot be considered a mature area until there is also explicit attention paid to the nature of historical writing about IS. Aside from RAYWARD (1996b), reprinted here, what little we found was concerned with historical writing about libraries (e.g., HARRIS & HANNAH; KRUMMEL; MIKSA, 1982), where most of the historical work is still concentrated.

INFORMATION SCIENCE

The amount of published material on the history of IS remains small, but there has been significant growth with some important publications. HAYES (1994), INGWERSEN, and SAKURAI have each provided short, recent, general histories of IS. SARACEVIC provides a brief look at the evolution of IS through problems addressed over time. He examines the origin and social background of IS, the evolution of information retrieval, the evolution of definitions and problem orientation, and the evolution of interdisciplinary relations.

A larger class of writings are those which are not primarily historical but discuss IS and provide some historical explanation. Examples include the textbook on IS by LE COADIC, the Proceedings of the Tampere conference (VAKKARI & CRONIN), and the review of the theory and scope of library and information science by VAKKARI (1994b).

An excellent contribution about France but of general interest is by DELMAS (1992), who takes 1880 as the approximate starting date for the sustained, systematic development of documentation. The French journal *Documentaliste* devoted an entire issue in 1993 to the history of IS in France (RAUZIER). Eleven short but wide-ranging papers cover six themes: (1) the nature and history of IS; (2) the profession and professional education; (3) national information policies; (4) professional associations; (5) computerization; and (6) indexing languages. That issue provides a checklist of notable French IS publications.

A substantial contribution is a book on history of the development of IS in Germany from 1900 to 1945. Based on a doctoral dissertation and drawing very extensively on unpublished materials, BEHRENDS provides a detailed reconstruction the complex development of documentation with special emphasis on the close relationship with special libraries,

Another broadly based contribution, this time with a British flavor, is a volume of topical essays by different specialists based primarily on the articles published in the first fifty years of the *Journal of Documentation*, provides a welcome if uneven overview of the development of major themes in IS from 1945 to 1994 (VICKERY 1994).

We note a steady flow of publications on the history of IS in Spain, some of which are noted in LÓPEZ YEPES & MARTÍNEZ MONTALVO. An annotated bibliography by SAGREDO FERNÁNDEZ & GARCÍA MORENO is reprinted with additions here.

A major contribution for the United States is the study of Watson Davis and the development of the American Documentation Institute (now ASIS) by FARKAS-CONN noted below. The ASIS 50th anniversary issue published in the *Bulletin of the American Society for Information Science* in 1988 contains five brief but useful essays on the development of IS in the United States (CHARTRAND ET AL.). The book, *A History of Information Science* by LILLEY & TRICE, is primarily an uncritical account of the work of selected U.S. information scientists rather than a history of IS.

LU's article (1990) analyzes important historical events and summarized four milestones in the development of IS: (1) the study of bibliometrics and information processing; (2) automatic information searching; (3) the creation of information systems and emergence of databases; and (4) transformation of information management under the impact of new information technologies.

PETERS outlines the history of the usage of the word "information" in relation to transformations of the Western epistemologies on which scholarship has been based. Two of the most central concepts in IS, "document" and "relevance" received historical analysis. BUCKLAND (1997, reprinted here) traces the broadening scope of the use of the word "document" to deal not only with texts but any physical form of evidence word. The meaning of the term "document" expanded as the interests of the European documentalists expanded. MIZZARO, reprinted here, provides a detailed historical analysis and categorization of about 160 papers on the evolving literature on elusive notion of relevance.

FAYET-SCRIBE (1997a) provides a descriptive chronology of media, methods of representation, and finding aids for information, with an extensive discussion citing many sources. For a chronology of the international development of information science from 1945 to 1994 see MARLOTH.

Intellectual Frameworks of IS

Analysis of the intellectual frameworks in IS has been neglected even though theory cannot be expected to advance unless alternative sets of assumptions are developed and compared. The long domination of "scientific" logical positivism in IS is now being questioned, and theoretical and epistemological assumptions are receiving critical attention. Historical critique provides a good opportunity for such work, and there is much to be done in analyzing, sorting, and questioning the ideas that brought us to where IS now is. A landmark contribution is the proceedings of the 1991 Conference on "Conceptions of Library and Information Science" in Tampere (VAKKARI & CRONIN), especially the article by MIKSA (1992). Some of the papers have since been revised and republished, notably those by RAYWARD (1994a) and WERSIG. The Tampere conference was exceptional in the historical awareness of the papers and in the attention to epistemological and theoretical assumptions, including attacks on the assumptions of cognitive science as well as of positivism. VAKKARI (1994b) contributes to this previously neglected area of IS history with a study that reviews the changing definitions of library/information science and provides a working definition of the broader framework of IS as a field of research.

STIELOW and MIKSA (1992) provide all-too-rare discussion of different paradigms in a critique of research in library and information science. VAKKARI (1994c) provides a penetrating analysis of the change from 18th-century thought concerning librarianship, based in the history of knowledge (*historia literaria*), to a library science, based on systems and technique, pioneered from 1790 by Albrecht Kayser, Martin Schrettinger, and Friedrich Ebert. YAN provides a good history of IS theories in China from 1949 to 1989.

In a related development, papers are now appearing that treat information systems in terms of social relations (gender, race, class). For a good example focussed on librarianship see HARRIS.

Relationships of IS with Other Fields

A wide-ranging survey of nine disciplines that study information was composed using position papers and commentaries commissioned from experts and edited by MACHLUP & MANSFIELD. It remains a good first step for finding out about information-related disciplines. In 1985 The *Journal of Library History* devoted a special issue to the relationship between library science and IS (see HAYES, 1985; MIKSA, 1985; RAYWARD, 1985; WRIGHT, 1985). In a related article, VAKKARI (1994a) makes a brief historical survey on the relationship between library science and IS, and presents some recent viewpoints. DA COSTA describes the historical development of the interdisciplinary areas of IS and presents the contemporary IS situation in Brazil.

FLANZRAICH (1991; 1993) examined the relationship between librarianship and office technology. ABBOTT, in studying the relationships between professions as the division of expert labor, comments on the distancing of information scientists from librarians after World War II.

Research and Development in IS

ALTMAN describes the National Science Foundation's (NSF) support of information research over 40 years, including the substantial removal of support for information retrieval research in the 1980s. WEST provides a broader history of financial support for IS research (primarily in information retrieval) in the United States prior to 1983.

Literature of IS

JÄRVELIN & VAKKARI used content analysis of journal articles to trace the evolution of library and information science from 1965 to 1985, noting the distribution of topics and of research methods. A similar study by AAREK ET AL. examined research in nordic countries from 1965 to 1989. Accounts of the history of individual publications include *ARIST* (HEILPRIN), *JASIS* (ELIAS), and *Library Trends* (AULD). WALKER, reprinted here, provides an analysis of the authorship and citation in the *Journal of Documentary Reproduction*, published by the American Library Association from 1938 to 1942, which was concerned with the latest developments in information storage and retrieval technology. See also BUCKLAND 1996 for a topic analysis by Liu of the contents of the same journal.

Of exceptional interest is the detailed analysis by WHITE & MCCAIN of the structure of IS from 1972 to 1995 using author co-citation analysis of the literature. What emerges is two, quite stable subfields with little linking between them: one associated with domains of discourse and the other with retrieval.

History of the Future
Envisioning the future has been more popular in IS than remembering the past. RICE reviews the aspirations of Watson Davis and the degree to which those dreams have been realized in the international information society. Both HIGGINBOTHAM and MIKSA (1988b) examine C. A. Cutter's 1883 vision of "The Buffalo Library of 1983," in which he foresaw the use of telecommunications and mechanized retrieval systems in libraries. The history of actual and imagined technological innovations as reported in the library literature by MUSMANN is a useful and readable source for visions of the future as well as for the history of technological developments in libraries.

TECHNIQUE AND TECHNOLOGY

The splendid illustrated treatment of the history of information technology by LUBAR is based on the Smithsonian's "Information Age" exhibit. Like the exhibit, it concentrates on technology (with some social commentary) and has little on the techniques of information retrieval and information service. Sources with a much wider scope than IS but that include material likely to be of interest to historians of IS include an encyclopedia of the history of technology (MCNEIL), a bibliography on the history of electrical technology by FINN, and, especially, the excellent work by HALL & PRESTON on new information technology and the geography of innovation from 1846 to 2003.

Document Representation
Central to IS is the analysis and representation of potentially informative objects. MCARTHUR provides an excellent, readable, historical account of the evolution of reference works in general. BALSAMO provides a broad historical introduction to bibliography. OSBORN interprets a century of change in library cataloging and classification, placing the major achievements as well as shortcomings in historical and theoretical perspectives.

The evolution of documentary or metalanguages, such as thesauri and classification schemes used to describe documents is summarized by MANIEZ. SENGA provides a brief history of Chinese, Japanese, and U.S. classifications (see also MIKSA, 1994). BOLL gives a detailed analysis of the Dewey Decimal Classification rules and MCILWAINE, reprinted here, reviews the origins, development and influence of the Universal Decimal Classification that was derived from it. For the history of book numbers, combining classification numbers with individualizing extensions, see SATIJA (1987; 1990).

Studies about the history of cataloging include the French cataloging code of 1791 (HOPKINS), Andrew Osborn's contributions to cataloging (GALLAGHER), and the GORMAN essay on changes in Anglo-American cataloging.

SVENONIUS reviews briefly the changing views in controlled vocabularies. DEMAILLY provides an account of Robert Pagès' "code documentaire" (CODOC) that is worth attention as one of the indexing systems that incorporated a syntactical structure to represent relationships between concepts beyond the simple Boolean *AND*, *OR*, and *NOT*. Because of the human expertise required by such systems they were, with the rise of computers, abandoned in favor of simpler but more mechanizable keyword searching. WEISGERBER, reprinted here, described the history, scope, and application of the Chemical Abstracts Services Chemical Registry System, begun in 1965 to support the indexing of Chemical Abstracts, and now serving internationally as a resource for chemical substance identification.

WEINBERG's account of early Hebrew citation indexes, also reprinted here, pushes the history of citation indexing back to the twelfth century.

The special issue of *Solaris* (FAYET-SCRIBE 1997b), noted above and conveniently available online, has a number of contributions on the history of access to knowledge.

Multimedia and Hypermedia

HARTIGAN (1993b) summarizes ideas about multimedia over the past 30 years.

Writings on hypertext, non-linear writing that gives the reader liberty of movement, have long given a conventional account of its origin and the their development by Ted Nelson and Doug Engelbart, with Vannevar Bush and H. G. Wells cited as inspirational figures (e.g., ELLIS; GIORGIO; KINNELL & FRANKLIN; RAMAIAH). But a much longer and more complex history of hypertext has now emerged. RAYWARD (1994a; 1994b, reprinted here) has shown not only that hypertext notions predate Vannevar Bush and H. G. Wells but that Paul Otlet's "monographic principle" was essentially a form of hypertext and that the Institute for International Bibliography in Brussels was using a (very labor-intensive) hypertext-based information system to answer queries early in the 20th century, long before digital computers. An important study by SERRES reconstructs the history of hypertext in five strands: In computing since the 1960s; in techniques developed in documentation; in printing techniques used to support non-linear perusal of books; in utopian schemes for universal knowledge; and in techniques of memorization.

Searching and Selecting Techniques

SALTON discusses aspects of the past 30 years of information retrieval, focusing on the early text processing endeavors and various predictions made in 1960s by Mooers about the creative role of computers in information retrieval. TENNER traces the techniques of information gathering, storage, and retrieval through history. PERRY outlines briefly the historical development of computer-assisted literature searching. KILGOUR, reprinted here, reports on the origins of coordinate searching.

Enabling Technology

The range of enabling technology of interest to IS is far too large to be discussed here. We merely note a small selection of interest.

SAXBY provides an historical overview of the evolution of information technology and the information industry. MUSMANN offers an "anecdotal" history of technological innovations in libraries from 1860 to 1960 that is a readable collage of excerpts from the professional literature of that period. This is a welcome resource for a surprisingly neglected area. FREEMAN provides a thoughtful essay on two late 19th-century technological innovations in libraries: the card catalog and the typewriter.

A major development has been the detailed attention paid to a searching technology developed from the late 1920s to the early 1960s, the "microfilm rapid selector." Typically a microfilm would have opaque index codes alongside the images of documents. A photoelectric cell would recognize when an index entry on the moving film matched the codes on a search card and blocked a beam of light. This approach combined the very high document-storage density of microfilm with the speed of light in optical-pattern recognition. However, it proved difficult to develop and was superseded when indexes were stored and searched on digital computers. The microfilm rapid selector was the technological basis for Vannevar Bush's often-cited speculative essay "As We May Think." BURKE (1992; 1994) has reconstructed Bush's prolonged, expensive, and unsuccessful attempts to use this technology to build two related search machines: (1) a "rapid selector" for document retrieval, and (2) a "comparator" to search out specific characters in encrypted texts to aid the breaking of codes. BUCKLAND (1992) reported on earlier prototypes developed in Germany by Emanuel Goldberg at Zeiss Ikon and demonstrated in 1931.

TUFTE (1983; 1990) gives excellent historic examples of effective visual presentations of (mainly) quantitative information. LOHSE & WALKER provide a brief historical review of graphics including graphic methods, standardization, and training and education.

The general history of technologies used in imaging, reprography, printing, and the storage of data and documents is beyond our scope. Readers should consult such standard sources as the text by JENKINS. Other examples include historical studies of microcard (JAMISON) and microprint (LANDESMAN), optical disc technology (HARTIGAN, 1993a; HOLTZ; MORROW), databases (NEUFELD & CORNOG), computer output printing (WIESELMAN & TOMASH), and word processing (EISENBERG).

Historical studies of the use of these technologies in information services include the account by CRAIG of the introduction of mechanical copying devices into the British Civil Service (1877 - 1889) and the description by HIRTLE of the life and work of Atherton Seidell (1878 - 1961), who was active in documentation and was concerned with using microfilm to distribute library materials.

An exceptional contribution is made by WHITE in his history of the microdot, the extreme-reduction microfilming popularly associated with World War II espionage. This work contains important information by and about René Dagron, Adolphe Miethe, Emanuel Goldberg, Walter Zapp, and J. Edgar Hoover. It also shows how extreme-reduction machine-readable codes are extending this approach into the future.

Communications. MATTELART provides an exceptionally wide-ranging historical introduction to the rise of modern communications, indeed of modern society. For the history of communications research see DELIA and ROGERS. HOLZMANN & PEHRSON, OSLIN, and POHL provide major, extensive historical material on telecommunications. Among works on specific technologies HUNKIN provides a history of facsimile from 1843, and DOUGLAS describes American radio broadcasting from 1899 to 1922.

In the library field, KREITZ provides a bibliography on library networks. The chronological arrangement of items shows clearly the evolution of thoughts and action in library networking. LEARN examines the role of telecommunications in library networking.

Data processing and computing. The *IEEE ANNALS OF THE HISTORY OF COMPUTING* is a valuable source for the history of data processing and computing. CORTADA (1990b) offers a bibliographic guide to the history of computing and computers and to the information processing industry; this work is supplemented by his guide to archival sources (CORTADA, 1990a).

Among general works on computing is the heavily illustrated 1973 history by EAMES & EAMES, which has been republished with a brief epilogue. ASPRAY provides a concise survey of computing before modern computers and relates technical innovations to their intellectual, social, and institutional contexts. Among specialized histories we recommend BAWDEN on output devices and KISTERMANN on the Hollerith punched card. PRESS describes nine early ideas about personal computers and the individuals behind them. This article is a good overview of the evolution of the personal computer to remind us that today's models were inspired by effects over 20 years ago. SAMMET considers approaches to the history of programming languages. GULL takes a close look at work by Mortimer Taube and Alberto Thompson and presents the development of computerized techniques for information storage and retrieval. TEDD describes the use of computers in libraries from 1966 to 1987.

SWANSON, in an article of exceptional interest entitled "Information Retrieval and the Future of an Illusion," provides critical reflection on the deficiencies historically inherent in automatic indexing and information retrieval research over the past four decades.

INFORMATION-RELATED BEHAVIOR

There are numerous works on the impact of information technology on society, typically making assertions about the past. For the most part, they are not historical works and are only loosely concerned with IS, yet they often contain material of interest to those concerned with the history of IS.

BENIGER, extending the earlier work of Alfred Chandler, traces the origins of the information society and discusses technological innovations in information storage and retrieval systems. BROWN presents a well-written history of the diffusion of knowledge in the United States from 1700 to 1865.

WILSON provides an excellent account of research since 1945 on information needs and uses. An unusual, historically based study of individuals' information-related behavior is the book of case studies by VINCENTI, illustrating knowledge acquisition by aeronautical engineers.

BROOKES, himself a significant contributor to the field, provides a wide-ranging historical introduction to infometrics, bibliometrics, and related topics. HERTZEL provides an outstanding historical account of the development of bibliometrics. If only we could have more work like this. BROADUS traces the lines of research leading up to and forming the subfield of bibliometrics from

earliest times to 1969, when this term was proposed as a substitute for "statistical bibliography." W. WANG and WU also provide brief accounts of the development of bibliometrics. SHAPIRO examines the historical roots of bibliometrics and draws attention to the law literature. PIERCE examines the history of bibliometric indicators. TAGUE-SUTCLIFFE provides an excellent review of bibliometrics since 1945.

The evolution of bibliometric analysis of the dispersion of literatures with domains, usually known as Bradford's law of scattering, is examined by OLUI‚ -VUKOVI‚ (1997), reprinted here.

APPLICATION AREAS

Because we cannot summarize the history of all application areas of IS, readers should consult chapters in this and previous *ARIST* volumes and other sources. Here we give a sample from selected areas. Most accounts chart progress. For an antidote, try *Great Information Disasters* (HORTON & LEWIS).

Organizational Information Systems

The book by YATES (1989), *Control through Communication: The Rise of System in American Management*, is a wonderful contribution. It includes an excellent and detailed account of how formal methods for handling messages and records gradually evolved in step with the rise of scientific management and the increasing size of firms. An example of technology transfer noted by YATES (1989) and also by FLANZRAICH (1993) was the influence of library techniques on the development of modern office systems, especially through the diversification by Melvil Dewey of the products marketed by his Library Bureau.

In a well-researched case study, YATES (1993) describes the constructive relationship between life insurance companies and the tabulator equipment industry in developing better information systems. CORTADA (1993) describes the rise of data processing and the office equipment industry (1856 - 1956), and the increased use of punch cards in business and government (1900 - 1940) is described by NORBERG. LU (1991) provides a good history of management information systems (MIS).

Bibliographical and Reference Services

As already noted, MCARTHUR provides an excellent introduction to the historical development of various kinds of reference works. He relates reference works to their intellectual contexts. By tracing the development of encyclopedias from the ancient Greeks to the present day, KRZYS concludes that encyclopedia development has responded to user needs and the expansion of knowledge, and that encyclopedias have incorporated technological devices to further their informational and instructional ends.

BOURNE and HAHN write on the history of online services in science and technology. Nearly all the basic current functions and features of online text retrieval were developed in the 1960s. MEADOW (1988b) provides a timeline of major events in the development of online databases from 1945 to 1988 and a commentary on that timeline (MEADOW, 1988a).

Among discipline-based information services, medical services have received the most attention recently, notably with publication of the 1987 Association for Computing Machinery (ACM) conference on the history of medical informatics (BLUM & DUNCAN). Topics covered include historical studies of computing systems, signal and image processing, clinical data processing, health-care information and patient-management systems, and clinical decision-support systems. Shorter, more recent contributions include an historical review of clinical research databases (COLLEN) and informal reflections on the development of medical librarianship (BUNTING & DARLING).

Libraries

There is a large and long-established literature on the history of library services, sometimes extending to information science generally. The periodical *Libraries & Culture* specializes in library history and offers reviews of the literature of library history every two years (e.g., PASSET, 1992; 1994). The library

field is also blessed with a series of specialized encyclopedias. The *Dictionary of American Library Biography* (WYNAR) is a model of its kind. The outstanding *Histoire des Bibliothèques Françaises*, edited by POULAIN, with 2,500 large pages in four volumes, has good coverage of documentation and IS in the fourth volume (see especially DELMAS, 1992). The recent *Encyclopedia of Library History*, edited by WIEGAND & DAVIS, has broad coverage but tends to emphasize institutional history rather than ideas or techniques and, although international, emphasizes North America. The history of the library field also benefits from a guide to the literature (DAVIS & TUCKER) and a bibliography of dissertations and theses (YOUNG). This specialty within the history of IS well served by general bibliographies such as *LIBRARY & INFORMATION SCIENCE ABSTRACTS*. The book by BIDDLE, on academic library planning, is a good example of how a text that is not a historical treatment can have a good historical component. Similarly, WINTER places his analysis of the effects of information technology on librarianship in historical perspective. For an excellent analysis of the historical development of great national libraries of France, the U.K. and the U.S.A. in relation to cultural and political changes see WILLISON.

The relationship between special libraries and documentation in the U.S.A. from 1910 to 1960 examined by WILLIAMS (1997), reprinted here, and, in Germany, by BEHRENDS. In France the situation, examined by FAYET-SCRIBE (1997b) reprinted here, is particularly rich complex of relationships between public libraries, academic libraries, the national library, U.S. influences, and with the same individuals often working within multiple organizations.

Archives and Records Management

DURANTI (1993) provides a wide-ranging history of archives. COX and O'TOOLE also provide recent historical accounts, and IACOVINO addresses the history of archival appraisal. BERNER analyzes the problems faced by the U.S. archival profession.

HANNESTAD provides an extensive summary of the historical foundations of modern archival practices, archives administration theory in the late 19th century, and the foundations of the archival profession in the United States.

Public and Community Information Services

For the United States, KIELBOWICZ (1989) in his book, *News in the Mail: The Press, Post Office, and Public Information, 1700 - 1860s,* provides a well-written history of postal services and news agencies and examines their roles in disseminating information in the early American. MACIUSZKO notes the origins of community online services. For a brief history of bulletin board systems see BALAS.

Publishing

In the general area of printing, publishing, and the book, the outstanding recent event is the new edition of the multivolume *Lexikon Der Gesamten Buchswesens* (CORSTEN ET AL.), an historical encyclopedia of the highest standards of scholarship. Other material can be found in and through the *WOLFENBÜTTELER NOTIZEN ZÜR BUCHGESCHICHTE.*

ARNOLD (1995) examines the evolution of publication media and concludes that impediments to change are cultural rather than economic or technological. HARA & SATOH (1996) attempted to examine characters of Japanese scientific journals (which were published after 1868) under the influence of both Western and Japanese traditions. Brief histories of electronic publishing are given by REYNOLDS & DEROSE and C. WANG. CASE (1994) examined the origin and historical development of videotex over three decades (1964-1993) and described how it was shaped by social, economic, and political forces as well as by technical constraints.

Museums

The educational, political, social, and technical aspects of museums have become a particularly rich and interesting area of IS. HOOPER-GREENHILL provides a highly readable, historical account of the theory and practice of how museums have been used to shape knowledge.

SOCIAL ASPECTS

SCHEMENT (1989; 1990), like BENIGER, explores the origins of the information society as enabled by the development and adoption of information technology. ZUBOFF has interesting observations on historical changes in how work is performed and on the impact of technology.

By tracing the efforts to reform the postal policy governing periodicals, KIELBOWICZ (1990) examines postal subsidies of the press and the business of mass culture from 1880 to 1920. SAVOLAINEN notes developments in the history of charging fees for information. STROM explores the economic and historical reasons for the evolution of the American office work structure and examines the impact of information technology on office practice. MACLEOD provides a revisionist view of the industrial revolution by studying the relationship between patents and inventions in the 17th and 18th century England.

WOOSTER provides a list and summary of reports on national information systems and a chronology of U.S. federal involvement in science and technology. HERNON & RELYEA summarize the development of U.S. federal information policy. OBERLY provides an interesting account of the pre-Civil War Federal Pension Bureau, showing how government officials defined information policy in a context of illiteracy.

WARNER has traced the development of significant terms in copyright in the United Kingdom and the United States. He noted that the United States inherited some patterns of copyright law from the United Kingdom, and that increasing transnational exchange of information seems to have enforced further convergence. TEPPER provides an historical survey of U.S. copyright in relation to library photocopying.

EDUCATION FOR INFORMATION SCIENCE

The history of education for IS in France is reported by MEYRIAT (1993a; 1993b) and by DELMAS (1993). RICHARDS (1992) reviews the literature on the Soviet Union. No similar history of education for IS in the United States has been found. However, education for U.S. librarianship has been documented thoroughly. In the field of librarianship, the centenary of formal professional education in the United States stimulated a flurry of publications in 1986 and 1987, notably special issues of the *Journal of Education for Library and Information Science* (PATTERSON) and *Library Trends* (DAVIS & DAIN). GOGGIN traces the professional education of archivists in the United States from 1930 to 1960.

A steady flow of descriptive and largely uncritical histories of educational institutions continues. Publications of above-average interest are: the account of the Institut National des Techniques de la Documentation (INTD, Paris) by DELMAS (1993); the book on the University of Chicago Graduate Library School from 1921 to 1951 (RICHARDSON, 1982); a reconsideration of the Columbia School of Library Economy in its first year, 1887 - 1888 (MIKSA, 1988a); and a history of the Association of American Library Schools (DAVIS).

Individual educators highlighted recently were overwhelmingly educators of librarians e.g., Pierce Butler of Chicago (RICHARDSON, 1992), Melvil Dewey of Columbia (MIKSA, 1986), and Sydney Mitchell of Berkeley (BRUNDIN).

INSTITUTIONS

Considerable historical information about institutions in IS can be found in the sources noted above. The major recent separately published contribution to the history of institutions in IS is *From Documentation to Information Science: The Beginnings and Early Development of the American Documentation InstituteóAmerican Society for Information Science*, by FARKAS-CONN, based on her doctoral dissertation. She examines the role of Watson Davis and the organization he founded in 1937 and sets both in their contexts.

WILLIAMS & ZACHERT wrote a history of the U.S. Special Libraries Association (SLA), 1909

- 1984. KNEPPER offered a brief historical overview of the Society for Information Display. He also included information on the Society's national officers, international symposiums, and awards.

DEBONS & HORNE (1997) describe the series of major conferences sponsored by NATO to study IS.

INDIVIDUALS

The most important recent development concerning an individual is the transformed understanding of Vannevar Bush (1890 - 1974), a much-cited icon of IS. NYCE & KAHN (1991) edited a selection of papers by Bush and of papers essentially sympathetic to him. SMITH (1991) updated her study of how Bush's article, "As We May Think," is cited, often pointlessly. ZACHARY (1997) published the first comprehensive biography of Bush, tracing his career and especially his influence on American science and technology during the second World War. BUCKLAND (1992) described Bush's technical and technological context and re-raised earlier questions concerning the originality and adequacy of his ideas. However, all understanding of Bush in relation to IS now has to be seen in the light of BURKE's (1992; 1994) very detailed reconstruction of his work in developing machinery (microfilm, circuitry, and photoelectric cells) for the related problems of cryptanalysis and information retrieval. Drawing heavily on archival and oral sources to supplement the meager published accounts, Burke's (1994) book is a landmark in IS history and a model for others.

Of pioneers of IS, the Belgian Paul Otlet (1868 - 1944), tireless investigator of IS problems and the co-founder in 1895 of the International Federation for Information and Documentation (FID), has received long-overdue attention, notably in a selection of his essays (OTLET). RAYWARD (1997) examined ideas and practices developed by Paul Otlet and his colleagues in the context of their work in and through the International Institute of Bibliography. He argued that the novel ideas and practices of "documentation" constituted a new discursive information, a new way of thinking about what we now call IS. RAYWARD (1997), reprinted here, examined ideas and practices developed by Paul Otlet and his colleagues in the context of their work in and through the International Institute of Bibliography. He argued that the novel ideas and practices of "documentation" constituted a new discursive information, a new way of thinking about what we now call IS. RIEUSSET-LEMARIÉ (1997, reprinted here) examined how positivism, centralism, and monumentalism influence Paul Otlet's schemes for the storage and dissemination of knowledge. DAY (1997), reprinted here, argued that Paul Otlet was remarkable for the extent to which he perceived texts as having both complex social origins and also extensive possibilities for influencing social development. Although his ideas originated in 19th-century positivism, Otlet can be regarded as being engaged in a proto-deconstructionist understanding of textuality. For more on Otlet, Henri La Fontaine (1854 - 1943), their collaborators, and their context see several of the papers in *CENT ANS* and also NEMOTO.

The penetrating ideas of the French librarian and documentalist Suzanne Briet (1894 - 1989) concerning the wide potential scope of IS have also received fresh attention (BUCKLAND, 1991; 1995).

An autobiography of the Indian librarian and classificationist S. R. Ranganathan (1892 - 1972), with supplementary material, has appeared (RANGANATHAN; see also MOHANRAJAN, RAJAGOPALAN, SATIJA 1992; SHARMA). Biographical studies have appeared of three influential U.S. figures, Pierce Butler (1884 - 1953) (RICHARDSON, 1992), Melvil Dewey (1851 - 1931) (WIEGAND) and Jesse H. Shera (1903 - 1982) (NEMOTO ET AL.; WRIGHT, 1988). There is a steady flow of reminiscences of U.S. pioneers, especially in *JASIS*, as well as the biographical accounts in LILLEY & TRICE.

Material on Albert Boni, publisher of microprint, can be found in LANDESMAN, and information on microfilm pioneer Atherton Seidell (1878 - 1961) is available in HIRTLE.

Within initial funding from the American Society for Information Science, Williams has established a database, described elsewhere in this volume, of individuals and institutions that pioneered IS in North America.

GEOGRAPHICAL AREAS

Many of the items already noted are largely or primarily limited to a single country, most often the United States. We have noted DELMAS (1992; 1993) on documentation in France and BEHRENDS on Germany. Other items that address some aspect of IS in a country or region include SPINK on the Australian online information industry, AGRAWAL on the development of documentation in India, LIN (1992; 1993) on the automation of library and information services in China, AAREK ET AL. on Nordic countries. *CENT ANS* is largely but not exclusively concerned with Belgium. Papers on the history of librarianship in Australia, with special reference to the work of John Metcalfe (1901 - 1982) were edited by RAYWARD (1993). HAPKE (1998) offers an evaluative review of selected German literature on the history of information and documentation as well as on the history of the media (instruments) of scholarly information and communication. He finds that serious research is being produced in Germany, although the quantity of publication is not large. See also FIETZ. BUCKLAND, reprinted here, for a discussion of information science, librarianship, and technology during the twentieth century.

LIU provides a cross-country comparison in a brief history of the professional relationship between China and the United States over the years.

Richards has continued her specialized studies of international science activities and propaganda during World War II: the information-gathering efforts of the U.S. Office of Special Services (RICHARDS, 1988), Aslib (London) as a hub of Allied scientific intelligence (RICHARDS, 1988; 1989), and the measures taken by the Britain, Germany, and the United States to procure foreign scientific intelligence during the Second World War (RICHARDS, 1994).

CONCLUSIONS

Information science has for decades been ahistorical. The collective memory had been dominated by events after 1945, and much of the historical commentary has been anecdotal, superficial, or uncritical. The main exception has been in writings on the history of library services, where institutional history is emphasized. We believe that the past five years has seen an important change. The quantity of work in the history of IS that would command respect from professional historians is still small, but we are encouraged for the following reasons:

• Careful historical scholarship is being produced (e.g., BEHRENDS; BURKE, 1994; RICHARDS, 1994; YATES, 1989);

• The period before 1945 is getting the serious attention it deserves (e.g., FARKAS-CONN; OTLET, SERRES), and the notion that IS began in or after 1945 is fading.

• Some of the work is broadly based, ranging over time and specialties, addressing both ideas and techniques (e.g., RAYWARD, 1994a); and

• We detect a greater historical awareness in general discussions of information science (e.g., VAKKARI & CRONIN).

It is also clear that there is much more work to be done.

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