ENCYCLOPEDIA OF LIBRARY AND INFORMATION SCIENCE

VOLUME 48

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Allen Kent

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AUTOMATED ARCHIVAL SYSTEMS

Introduction

Archivists have recognized since the 1960s that computer technology offers a host of opportunities to assist with traditional archival responsibilities and functions, as well as having the potential to expand their activities in new directions. They were quick to capitalize on the batch processing, indexing, and word processing capabilities of early mainframe and later microcomputer systems to enhance administrative control and the production, updating, and reference usefulness of manual finding aids which serve as intellectual access points to archival collections. In the 1990s, archivists continue to investigate sophisticated developments in automation such as the use of image storage technology for storing, preserving, and accessing images of archival records; and mainframe-based systems to reference archival records created and maintained in machine-readable form. The main thrust in the development of automated archival systems over the last twenty years, however, has been to utilize the processing and networking capabilities of computers to increase and standardize administrative and intellectual control over archival holdings, and to develop methods of making data on archival collections available nationally.

Overview

Archival practices have evolved in the United States in the twentieth century along theoretical concepts already established in Europe. These include the practice of appraising and developing collections on the basis of their legal, functional, and informational values and then accessioning them according to their provenance. These collections are retained and described according to the original order in which they are received from the creating agency, and such descriptions are made at collection, rather than discrete item, level. Descriptions are not static since they must reflect growth, reappraisal, and deaccessioning activities. These practices, which are peculiar to archives, have impeded the development of descriptive or bibliographic automated systems similar to, or compatible with, those of libraries.

Aside from adhering to these concepts, archival repositories (which include government agencies, historical societies, academic and religious institutions, businesses, and museums), encompass wide-ranging subject areas and missions, and traditionally have taken pride in their local idiosyncratic descriptive techniques. Many of these archival operations, when compared with libraries, are relatively small in size with a perceived narrow patron base (mostly historians and genealogists), and a low profile within their parent institutions.

The unique nature of archival materials, which include personal papers, books, maps, photographs, oral histories, computer media, and maybe even artifacts, of administrative or documentary value, do not lend themselves to standardized description nor to cost-sharing efforts such as cooperative cataloging.

Another major impediment to the development of automated archival systems has been, as a whole, the continuing absence of sustained levels of funding. Pioneering applications in automation continue to rely heavily upon grant support, but in an environment where operating budgets for basic manual functions rarely achieve high institutional priority, the costs of even the most inexpensive and standardized automation have often proved to be prohibitive. Since the introduction of the MARC Archival and Manuscripts (AMC) Format in 1983, however, automated systems for descriptive and administrative control over holdings have developed rapidly and represent the culmination of more than twenty years of professional debate, investigation, financial scrounging, and self-education.

The original incentives to automate archival activities were primarily those of process control and enhanced indexing, not resource sharing, integration, or outreach. Library control functions such as cataloging, circulation, and acquisitions were irrelevant, given the nature of archival operations. Likewise, an increased number of intellectual access points to be made available to patrons, although desirable as an aid to the archivist in reference functions, was not seen by most of the profession to be crucial. With many MARC AMC systems successfully in place and the profession becoming increasingly familiar with their functions and potentials, many of these assumptions have since been challenged by archivists.

Early Automated Systems

In the 1960s and 1970s, the need for tighter administrative control spurred some larger archives toward local developments of automated systems. Systems such as the National Archives' NARS-A1, the University of Illinois' PARADIGM, and the Smithsonian Institution's SELGEM, were generally cumbersome and batch-oriented. They resided on institutional mainframes and used locally-devised data formats. Many of them subsequently migrated to more efficient online systems or operated with parallel microcomputer systems performing the more sophisticated functions, although some continue to function quite adequately for their repositories' needs.

SPINDEX

A landmark software–hardware package in the development of archival automation was SPINDEX (Selective Permutation INDEXing). Designed to index finding aids and generate descriptive guides, SPINDEX was created in the late 1960s by the

Library of Congress and the National Archives and Records Service [now the National Archives and Records Administration (NARA)] and was used by many major repositories in the United States and Canada.

From 1977 to 1982, the National Historical Publications and Records Commission (NHPRC), which was using SPINDEX to produce the 1978 revised *Directory of Archives and Manuscripts Repositories* (an updated version of which was published in 1988), funded three statewide survey projects of descriptive data created for their collections. These projects were conducted by the Kentucky Department for Libraries and Archives; Cornell University, New York Historical Resources Center; and the Washington State Historical Records Advisory Board. NHPRC also funded the Midwest Guide Project under the direction of the State Historical Society of Wisconsin and conducted by the state archival repositories in Illinois, Minnesota, and Wisconsin. Using SPINDEX to organize the data thus collected, the NHPRC sought to develop a national database of information regarding archival collections. The project was abandoned in 1982 because of funding cuts and because the National Archives stopped supporting and developing enhancements to SPINDEX. SPINDEX still is used, however, by the Kentucky and Washington State Archives, as well as the City of Portland, Oregon and the South Carolina Department of Archives and History.

The Quest for a National Information System

The initial approach of the profession, led by the Society of American Archivists (SAA), was to develop one software/hardware configuration which could be used uniformly, both by repositories seeking to automate and by the profession seeking to develop a national database of information on archival collections.

In 1977, the NHPRC sought SAA endorsement of the SPINDEX-based project to develop a national guide to archives and manuscripts repositories and holdings. SAA traditionally had supported the development of the National Union Catalog of Manuscripts Collections (NUCMC), a manual system, as the most comprehensive resource for locating archival and manuscript holdings. In order, therefore, to assess the relative merits of the two projects and to develop the best national database of archival information, SAA established its National Information Systems Task Force (NISTF). Existing national bibliographic systems, including the Research Libraries Information Network (RLIN) and the Online Computer Library Center (OCLC), were devoted almost exclusively to published materials and were, therefore, not included in this consideration.

In 1980, Elaine Engst of Cornell University, with financial assistance from the National Endowment for the Humanities (NEH), conducted an analysis of the descriptive practices being used in a wide variety of repositories, both archival and manuscript. Despite the differences in formats and methodologies between archives and manuscript repositories, the information on data elements and descriptive terminology thus collected, and published in 1982, proved that there was, as had been suspected by NISTF, sufficient common ground to consider integrating them into one data format. A NISTF working group, chaired by David Bearman of the Smithsonian

Institution, used these data elements as a basis to begin discussions with the American Library Association (ALA) on the development of a new MARC format. It was felt that such a format should accommodate the descriptive and control needs of archival and manuscript collections while facilitating the exchange of descriptive information between different automated systems.

The new MARC format was also to replace the existing MARC Format for Manuscripts, which had worked poorly for the bibliographic needs of manuscripts, and had not accommodated the collection-level description required for archival materials at all. Consequently, although it had been made available by some bibliographic utilities such as OCLC, the Manuscripts Format was never well received or utilized by the archival community.

In 1983, the new format was accepted by the SAA and ALA and, in 1984, it was published by the Library of Congress. The AMC Format, because it permits collection-level description, accommodates all media found in archival collections and unlike the other MARC formats is not media-specific. It can be used in either a manual or an automated environment. The adoption of a standardized descriptive format which was compatible with library bibliographic systems rather than the endorsement of one archival software package or monolithic national database as a method of achieving a national information system marked a turnaround in the profession's thinking regarding automation and integration. It also produced a format which could serve to bring descriptive levels up to a standardized minimum within each repository regardless of automation status. This not only would help the archivist maintain control but would also help the user, who could reasonably expect to find similar levels of intellectual access when approaching research at each institution.

Key to the acceptance and implementation of AMC by the profession was the publication in 1983 of *Archives, Personal Papers and Manuscripts (APPM)*, compiled by Steven Hensen with the aid of NEH funding. *APPM* addressed problems and conflicts peculiar to archives and manuscript practices which had previously presented insurmountable difficulties to archivists and manuscript curators when interpreting the *Anglo-American Cataloging Rules, Second Edition (AACRII)*. A revised edition of *APPM* was published in 1989.

In 1985, NISTF was disbanded and SAA charged the Committee on Archival Information Exchange (CAIE) with responsibility for the AMC Format. CAIE is currently working with MARBI on the development of an integrated format which will merge all the MARC formats into one format. Such developments are being closely watched by archivists lest they lose many of the concessions made in AMC in order to incorporate archival practices and methodologies.

Archival Automation and National Networking

Major bibliographic utilities, including OCLC, the Western Library Network (WLN), and the University of Toronto Library Access System (UTLAS) have responded to the publication of AMC by making the Format available, although all without changing their underlying software. The exception is the Research Libraries Group (RLG) which administers RLIN. Since 1984, RLG has developed a specifically designed archival control subsystem with the aid of a U.S. Office of Education Title II-C (Research Libraries) Program grant. This subsystem is not only building a national database of information relating to archival collections and supporting direct access by researchers, it also facilitates the archival management and action reporting requirements of contributing repositories.

As a result of several projects specifically designed to develop the subsystem, and the inclusion of converted data collected by previous archival survey projects, this database is rapidly developing into what NISTF once envisaged as a national information system. The first such RLG cooperative project involved the cataloging and entry of data on collections by Yale, Cornell, and Stanford Universities, and the Hoover Institute. The NEH Research Resources Program and the Pew Memorial Trust also funded the AMC RECON Project from 1984 to 1986. This retrospective conversion project involved Brigham Young University, Brown University, Columbia University, Dartmouth College, The Johns Hopkins University, New York University, Northwestern University, Rutgers University, the State University of New York (SUNY) at Buffalo, the New York Historical Society, and the Bentley Historical Library at the University of Michigan. The project emphasized the conversion of data on collections of significant research value to scholars in the humanities.

Because many of the NHPRC/SPINDEX data elements were incorporated into AMC and therefore were compatible with the Format, it has been possible to use automated conversion programs to enter the data into RLIN and other bibliographic systems. This has been successfully accomplished by both the Midwest Project Guide and the New York State Project with the aid of NEH funding. In 1986, RLG tape-loaded records describing the holdings of New York State repositories which were originally compiled on SPINDEX for the Historical Documents Inventory conducted by the New York Historical Resource Center at Cornell University. Among other SPINDEX users, Washington State is considering using RLIN or WLN and Kentucky is switching to an in-house system to be used in conjunction with either RLIN or OCLC. NUCMC is also entering its records onto RLIN.

RLIN records of archival holdings, and those distributed across other bibliographic utilities, will become increasingly accessible to researchers and user institutions with the development of the Linked Systems Project (LSP). LSP is being developed by the Library of Congress and the major bibliographic utilities for the exchange of bibliographic information contained on each of their systems. This will be especially useful for archives with an institutional arrangement with a bibliographic utility other than RLIN, for although they will not be able to avail themselves of the collection management benefits of the RLIN subsystem, they still will be able to reference collection data on a national basis.

Microcomputer Systems

Dedicated mainframe or minicomputer systems and accounts with national bibliographic utilities are still not an affordable option for many archival repositories. The reduced costs and increased storage and processing capacity of microcomputers since 1984 have paved the way for software developers to produce customized software for archival functions and to respond to AMC. These packages provide an inexpensive and viable alternative, and are sufficiently flexible as to permit some in-house customization. They offer sophisticated report-generating capabilities, may support locally devised formats and authority files, and, because they are standalone, do not suffer from the problem of downtime so common with online systems. The most prominent microcomputer packages, each of which has a greater or lesser ability to create, import, and export an AMC record compatible with larger systems supporting the Format, are MARCON produced by AIRS, Inc.; Minaret produced by Cactus, Inc; and MicroMARC:amc, developed with NEH support by Michigan State University. MicroMARC:amc has the distinction of being the first software package ever to win the SAA C.F.W. Coker Prize for "outstanding finding aids and innovative development in archival descriptive tools." Enterprising archivists, particularly those in repositories not committed to AMC, have also customized popular off-the-shelf database packages such as dBASE to perform descriptive, indexing, and records management functions.

Local Information Systems

An increasing number of local library systems vendors have also upgraded their systems to accommodate MARC AMC, although they cannot support all the functions of customized archival software. These include LS/2000, VTLS, Geac, LIAS, and NOTIS. To maximize patron access, reference, and administrative flexibility, many archival repositories have investigated the parallel use of an existing local information system such as a library online public access catalog. This can be done by uploading some of the descriptive fields on AMC records (which tend to be too long for library systems to manipulate and display) from an in-house microcomputer system, or downloading them from RLIN or other bibliographic utility into the other information system.

The National Archives and Life-Cycle Tracking

Federal agencies generate the most extensive bulk of archival materials and constitute some of the most valuable collections in the United States. These fall under the purview of the National Archives (NARA), which has repositories located throughout the country. The successful establishment of AMC and national descriptive systems would be considerably enhanced if they were to be accepted and used by the National Archives. Between 1984 and 1986, NARA commissioned its Archival Research and Evaluation Staff (NSZ), which monitors the implications of new technologies, to investigate possible uses of MARC AMC for the development of a system that would track federal records throughout their life cycle, and to use RLIN in the investigation in order to test its potential to meet NARA's specific access and control needs. Since the life-cycle concept of records looks at the entire processes and uses of those records from the time when they were originally created, through active administrative use, to their final disposition as archival materials, the project used a retrospective modeling process to reconstruct the life cycle of selected records and agencies based on the dates when specific actions were known to have occurred.

The Final Report of the project, published in 1986, favored the establishment of an automated Life-Cycle Tracking system but found real problems with a lack of standardization and consistency across federal agencies, requiring the development of a standard exchange format. The project did not find, however, that the AMC Format was sufficiently sophisticated to handle the diverse federal information structures, and so it was deemed to be unsuitable for recording process control information. Based on the results of the report, NARA decided that when developing new information structures and automated systems in the future, data elements would be defined which are compatible with AMC, concluding that there is more to be gained from moving towards the Format than would be lost by modification of federal recordkeeping practices. A further important conclusion was that although the RLIN archival subsystem was not suitable for NARA's process control needs, descriptive records should be entered on RLIN, which should be used in the future to generate descriptive guides to federal holdings.

Authority Control and Increased Subject Access

Automated systems allow archivists to capitalize on the strengths of traditional description according to provenance through hierarchical and lateral linking capabilities. Automation also offers greatly enhanced subject access as well as many new access points such as searchable date, format, and medium fields. Some automated archival systems can incorporate administrative histories of creating agencies and biographies of individuals, using this information together with the system's linking capabilities to reflect collections with multiple provenance. Since it is much easier to update on an automated system information relating to provenance such as changes in names, titles, and charges, than it is with manual finding aids, it is becoming increasingly possible to capture all the intrainstitutional complexities and crossfertilizations which may have led to the creation of a particular collection.

Authority work has proved to be a definite stumbling block on automated systems, however, both from the point of view of creating AMC records and performing authority-based searches. In a test conducted by Avra Michelson of the Smithsonian Institution in 1987, a zero level of descriptive consistency was found in the use of Library of Congress Subject Headings (LCSH) by several repositories adding records to the RLIN archival subsystem, although each differing use was legitimate. This problem becomes even more severe when archival records are incorporated directly into library bibliographic systems because LCSH, on which such systems are based, prove to be overly general for the very specific descriptions required for archival collections.

Name authorities also pose problems since archivists use the fullest available form of a name or the name most commonly used because their holdings may relate to many members of the same family or offices with very similar titles. The *AACRII*-defined practice followed by the Library of Congress Name Authority (LCNA) files of using the last name, first name, and middle initial of a personal name may not be the most satisfactory way to record and retrieve archival data under these circumstances. The problems with name authority work may be eased now that archival repositories are permitted to contribute to the LCNA files through the Library of Congress' Name Authority Cooperative.

The development of local thesauri or authority files for archival description is required to complement the inadequacies of LCSH and are crucial to the success of local systems if they are to achieve more intellectual control and create less patron confusion than the previous manual systems. Such authority files, however, are not only expensive and tedious to create, but are either unacceptable or unsearchable on most major bibliographic systems. This problem may be eased by cooperative sharing and development of thesauri between repositories with similar collecting areas. Some vendors also include a thesaurus or the framework to create local authority files with their archival software.

Implications for Cooperative Collection Management

National automated archival systems show potential for cooperative collection management between archival and manuscript repositories since, for the first time, collection strengths can be analyzed for quantity and quality, documented, and plotted geographically. This documentation, in conjunction with a clear articulation of a repository's mission statement, could be used for selective collection development (that is, for those archival collections not created by the member institution itself). Such a proposition would only be possible if each repository were to use exactly the same subject, date, and geographic classifications for computer compilation. This raises the question as to whether or not it is useful to share appraisal information and policies with other repositories, or even with users.

An RLIN/NHPRC Project is currently looking at the relationship between archival appraisal functions and automated descriptive systems. Participating institutions are Alabama, California, Minnesota, New York, Pennsylvania, Utah, and Wisconsin. RLG has been influential because of the number of participating manuscript repositories. The RLG Conspectus ranks member institutions' collection strengths and serves to locate materials or to allocate collecting responsibilities to the most appropriate repository.

User Issues

Automation has changed the internal management, budget, personnel, and processing practices of archivists, but there also continues to be a substantial, if poorly documented, shift in both the user population and the uses to which archival materials are put as well as in the public image of the repository and the archivist. The traditional user profile of the historian researcher is altering because of an increasing volume of genealogical, administrative, and library users. The latter, in particular, are making the same sort of demands of a system for sophisticated subject access that they have come to expect from automated library systems. Users now have the capability to dial into a database locally or nationally and access information on a repository's holdings unbeknownst to the repository. This marks a substantial change from the traditional setting were a user had to interact with a reference archivist before being able to have access to archival materials. This is another area where the profession has yet to deal with the implications of such a shift in the provision of user service and to document such trends. Archivists must accept that users may not always need to see a part of an actual collection, but may be interested only in certain facts recorded in a system relating to that collection. In other words, they may be seeking the information content and not the physical documentation.

Other Automation Issues and Trends

Archivists have started also to tackle the implications of developments in automation in other significant areas. Optical disk pilot projects have been underway at the Library of Congress, the National Archives of Canada, and NARA since 1984 which are examining the feasibility of building databases of images of archival materials. These would preserve the original materials from unnecessary handling and would convert visual materials decaying because of acid or nitrate content onto an imagebase maintained and indexed on a mainframe computer and accessible from multiple locations. The National Archives sponsors a Digital Image Applications Group of users of optical disk technology and others interested.

In 1983, NARA selected optical character recognition (OCR) to be examined by its Archival Research and Evaluation Staff. Looking at OCR as a way to convert lengthy finding aids into indexable and searchable full-text databases, this group issued the *Technology Assessment Report*. Based on the Report's recommendations, NARA established two pilot projects in 1984 and 1985, the first to test the capabilities of the technology and the second to develop a contract with an OCR service. The testing and evaluation of OCR technology has been extended to include the Library of Congress, the Smithsonian Institution, the Justice Department, and the Department of Defense. Where previously implementation of OCR was dependent upon material to be converted being typed in a recognizable font and was easily thrown off by poorly aligned letters, erasures, and blots, the technology is now considerably more sophisticated and is being tested with some measure of success on cursive forms of scripts used in manuscripts. Converting such materials would not only make them accessible in machine-readable form, but would alleviate some of the wear and tear on the original documents as well.

Machine-Readable Records

Machine-readable records may pose the greatest challenge that the modern archivist has to face, and they are increasingly being created and maintained without printed equivalents. Although few archives are yet accessioning large quantities of machine-readable records, there are major questions as to how these records will be maintained, appraised, described, and accessed in such a way that they will exist to document institutional activities into the future. With little experience or knowledge of the technologies involved, the most important tool currently used by archivists for appraisal and to develop local policies has been Margaret Hedstrom's *Archives and Manuscripts: Machine-Readable Records* (1984).

Only a few major programs to cope with machine-readable records have been established, those being at NARA, the National Archives of Canada, and the Kentucky, New York, and Utah State Archives. The National Archives of Canada has established an office information project to examine how office automation systems are creating and using information and SAA has appointed an Automated Records Task Force (ARRTF). One thing that is evident is that archivists can no longer afford to wait until a record is inactive to appraise it for archival retention, nor even to schedule a record for transfer once it has been created on an automated system. Archivists must become involved in the actual conception and design of the automated information system. They must be familiar with all facets of its potential use and users and must be prepared either to relinquish custodial care and retain only dial-in privileges to a tape library, or to develop an in-house mainframe system that is capable of accessioning, preserving, updating, and testing the integrity of machine-readable records which may well still have an active life. Recognizing the differences in the usage of machine-readable records may mark the end of the 'life-cycle concept" as it has been applied to administrative records in the past.

Education Issues

Archival education for automation, both in computer and in complex cataloging skills, has posed considerable problems. Few formal graduate programs are offered in archival administration and many still maintain a strong traditional tie with history departments and the methodologies and needs of historians. Library schools have strong course offerings in automation but lack the technical perspective of archival theory and practice. A complicating factor has been the fact that the profession has been in the throes of developing a certification by examination program and thereby standards for professional education. In this light, SAA and regional archival organizations have opted for continuing education course offerings as the best means to train and educate archivists in automation. They have developed several education programs including regional workshops in both AMC and the management of electronic records programs. SAA has created, with grant funding, the positions of Automation Officer and Education Officer and has also established an automation clearinghouse.

Professional conferences and meetings regularly feature sessions on automation topics and users' groups have sprung up for most of the popularly used systems. Many of the developments in automated systems have been extensively reported in professional literature, but with the exception of the quarterly serial publication, *Archival Informatics Newsletter*, issued since 1987, articles still tend to be reports by practitioners or those who have been involved in the development of a system. As yet they lack the perspective of hindsight, or analytical depth and systems evaluation. The literature lacks coherent and thorough reviews of hardware and software, project assessments, product announcements, and conference reports, all of which are vital to support a profession not yet technically skilled or literate.

Summary

Automated archival systems developed substantially in the 1980s, as did archivists' expertise with and awareness of the potential of such systems. Automation through a MARC format has inevitably led to a greater degree of integration of the archival profession with the library community, if only because they share similar needs and concerns. Other repositories with related custodial and information functions are joining the movement too. One such is the Common Agenda Database Task Force which is working on the standardization of the descriptions of museum collections so that they will be compatible with MARC AMC. The future will bring systems developments which may include implementations of hypertext and artificial intelligence for increased user access and education, but it also will continue to raise new issues relating to the role of the archivist in the ways in which archival and documentary materials are created, made accessible, and used in the Information Age.

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CD-ROM ENCYCLOPEDIAS

Introduction

"An encyclopedia is an effort to gather information either from all branches of knowledge or from a single subject area and arrange it in alphabetical order for ready reference" (*1*, p. 177) This definition of an encyclopedia by William A. Katz, a recognized authority on information sources for reference work, refers to a print-on-paper format. With the introduction of the electronic encyclopedia in the early 1980s, and its availability online by commercial database vendors, the first part of this definition still holds true, except that the information is no longer arranged in alphabetical order. In fact, the whole concept of searching for facts has changed with the invention of the online encyclopedia.

It is probably correct to assume that the *Academic American Encyclopedia* was the first online encyclopedia made available to the general public—via Channel 2000, the videotex system initiated by the Online Computer Library Center (OCLC) in 1980 (*2*, p. 313). Despite the relatively unsophisticated videotex format, for example the numeric keypad and menu tree, the encyclopedia proved to be one of the most popular databases offered on Channel 2000 (*3*, p. 179). Since this early beginning, several online encyclopedias have been made available on a variety of online information retrieval systems. Titles include the *Encyclopedia Britannica* (via Mead Data Central), *Academic American Encyclopedia* (also available on Bibliographic Retrieval Service, CompuServe, Dow Jones, Vu/Text, and DIALOG), as well as *Everyman's Encyclopedia*, offered by DIALOG (*1*, p. 203). These information retrieval systems, or database hosts, are searched from remote terminals via sophisticated data communication networks [see Harter's excellent overview of online encyclopedias, published in the *Encyclopedia of Library and Information Science* (*2*)]. The article examines in detail the world encyclopedia concept, describing it in the context of a multivolume, online publication which, by means of sophisticated retrieval techniques enables all words in the publication's content to be used as search terms and access points.

Recently, however, an exciting publishing medium, the CD-ROM (Compact Disc-Read-Only Memory) database has been made available, which could have a major impact on the search modes of existing online encyclopedias. This development not only provides greater search sophistication than the traditional online sources, but adds exciting new applications in various areas. This article investigates the search capabilities of the CD-ROM encyclopedia in general, with special reference to the *Academic American Encyclopedia.*

Early Views on the Electronic Encyclopedia

The enthusiastic response which greeted the first online products, following the availability of the first titles on the above-mentioned international database host systems, culminated in a proliferation of published and unpublished evaluations of and comparisons between the printed and electronic formats of the encyclopedia per se. Although doubt about the capabilities of searching online for facts was expressed in the literature, one of the most vehement protests can be attributed to Katz (*1*, pp. 203–204), who argues that it is just as quick to search an alphabetically arranged (printed) set, or even to use the index when searching for specific information. The expensive online costs, as well as the incapability of transmitting pictures is also questioned. As recently as 1987, Katz's reservations about the viability of the electronic encyclopedia are reflected in the following statement (*1*, p. 203):

> ...the disadvantages are numerous—so much so that one wonders whether or not the encyclopedias, at least by themselves, will ever be a viable success online... encyclopedias, particularly the general type, still have to prove themselves.

Earlier writings have also focussed on the differences between printed and online encyclopedias. The contrasts between these two formats were often expressed in terms of physical comparisons: the printed encyclopedia is recognized by bound volumes on the shelf; the online version is typically stored on a remote electronic database, accessible via a terminal's keyboard, modem, telecommunication lines, and one or more packet-switching network(s). With regard to the way information is organized, major differences are apparent: information in printed encyclopedias is arranged alphabetically according to broadly defined topics, with access to specific information via cross-references and a general index. By contrast, information in the online equivalent is stored on magnetic disks in machine-readable form, and is rendered accessible via sophisticated search software. Print encyclopedias limit their coverage to subject matter compressed into a predetermined number of volumes; the online counterpart can be enlarged or supplemented at any time; as an example, areas in which information changes rapidly (such as space exploration), or adapting biographical entries.

The way in which people use an encyclopedia also highlights an important difference between the two formats. The familiar set of encyclopedias, creating atmosphere somewhere on a bookshelf, contrasts sharply with a computer terminal or, in more probability, currently rather an intelligent workstation in the form of a microcomputer, attached via a modem and telephone line to a remote mainframe computer. A number of published cost comparisons between printed and online versions of various information sources, clearly illustrate more differences between the two formats (e.g., *4*). Apart from such variables as housing space costs, equipment and furniture costs, as well as purchase and maintenance, it is important to realize that the unit cost of a printed publication actually decreases with usage (the more it is used the lower the price), while with the online version, search costs increase in relation to every search performed on the same database.

The advantages of searching an online reference source provided by a host are self-explanatory, namely currency, Boolean logic, proximity searching, full-text searching (specifically in natural language), fast processing time, as well as the ability to download portions of the information to reformat or integrate with local word processing or database software, are a few. The disadvantages of searching electronic full-text sources, specifically those of encyclopedias, may create obstacles for the general public, namely the end user of information sources. Apart from cumbersome dialing and network connecting procedures, a good working knowledge of the specific system's command language and search facilities is necessary to maximize the database system. The intrinsics of full-text searching, and consequently lack of adequate browsing facilities, make the learning process a challenging task. Field searching is an essential feature, for example, to be able to search for relevant words in an encyclopedia's main entries. Special search techniques are also required to retrieve isolated facts in the encyclopedia, because scrolling a complete article (one page after the other) to find a specific item of information can prove both cumbersome and expensive.

Although the market for commercial online information services is still growing, the above factors must also be considered within the context of the limitations posed by centralized access to electronic information sources: the user has no control over the environment because all the information is stored centrally on a remote computer. In spite of current marketing initiatives which are targeted directly at the end user, online searching is still a relatively specialized terrain dominated by trained information specialists or search intermediaries.

The Birth of a New Storage Medium

The widespread availability of low-cost microcomputers correlates with the everincreasing demand for greater storage capacity of both floppy and hard disk systems. Floppy disks of 1 Mb storage are already a common phenomenon, while a 40 Mb hard disk microcomputer configuration generally is purchased for today's "personal" use. Yet, even this level of data storage capacity is by no means sufficient to cope with the specifications required to store knowledge, information, or data electronically in an immediately available format (tapes are inappropriate as they can only be accessed sequentially). Furthermore, the introduction of optical scanners (now also in handheld formats for microcomputers) is simplifying the process of converting a document from paper to electronic format, thus eliminating the need to key in all the characters. The need to store graphics electronically is motivating the quest for enlarged storage capacity. Certain databases already store image information (e.g., *Trademarkscan* on DIALOG Information Services). Patents is another example where images represent a very important piece of information. Image storing consumes large amounts of disk space when downloaded from online hosts. Similarly, speech technology facilitates voice input—yet the storage capacity required represents another order of magnitude.

The medium that has merged as a contender with the potential to accommodate the long-term storage of the everincreasing volume of electronically created data and information, functions on the principle of optical storage, that is, it makes use of a laser beam to both record and read data stored on a plastic disc. The emerging developments and characteristics of optical disc storage devices are not within the scope of this article; suffice it to say that this new medium, with its ability to store large quantities of data and images at very low cost, is set to usurp the former magnetic devices. A whole range of optical storage products have been developed, which are beginning to have a major impact on various sectors of the market: the consumer video and audio playback market, the education and training field, electronic publishing, data distribution and the rapidly converging areas of office automation, data processing, and records management (*5*, p. 7).

Compact discs were preceded in the marketplace by the larger format optical videodiscs. The latter were initially unveiled in 1973 and became commercially available in the United States approximately five years later. Compact discs (for sound) were first introduced in 1980 and were launched on the market by 1983 (*10*, p. 15). This development was followed rapidly by the production and marketing of the CD-ROM disc (for text), which generated enormous opportunities for computer manufacturers, software suppliers, publishers, as well as vendors of electronic databases. The result was a spate of developments which produced a whole range and variety of compact discs, which is beyond the range of this article (for more information on CD-ROMs, see refs. *6* and *7*). However, one product which potentially may have impact on the status of the electronic encyclopedia must be mentioned here; the so-called CD-I (Compact Disc Interactive) allows for exciting search facilities by integrating text and graphics as well as sound on the same compact disc. The principles of hypertext, recently introduced as a means to permit browsing in full-text databases, and hypermedia, with which the user can integrate various formats of information sources at the same time, open new horizons to search for encyclopedic information. This ability to navigate through an encyclopedia in a nonsequential manner by means of links between associated facts, is particularly suitable in the CD-ROM environment (see e.g., refs *8-10* for further reading on hypertext).

In view of the limitations of traditional online services, with specific reference to that of the online encyclopedia, it seems reasonable to assume that the unique nature of the CD-ROM encyclopedia may lead to a far wider acceptance of searching for facts in electronic format. In contrast with online services, the CD-ROM product (similar to the paper format) is at the direct disposal of the user, in other words, neither is it accessed to an external database host via data communication lines, nor is a working knowledge of a specific host's command language necessary. In fact, although most of the current CD-ROM titles use their own search software, some of them make provision for various levels of search expertise, especially indexing and abstracting journals. The novice user can, for example, search in a basic (usually menu-driven) mode, while alternatively the experienced user may opt to search in the command language of the given database host responsible for the equivalent online reference source.

The intrinsic characteristics of the CD-ROM encyclopedia are best illustrated by a discussion of the only general-purpose encyclopedia currently available in CD-ROM format; namely the updated 1988 edition from Grolier Electronic Publishing, Inc., the *New Electronic Encyclopedia*. Special reference will be made to those characteristics which best elucidate the advantages of the CD-ROM format, compared with the print-on-paper and online versions of this encyclopedia.

GROLIER'S FIRST ELECTRONIC ENCYCLOPEDIA

The print-on-paper version of the *Academic American Encyclopedia* consists of 21 bound volumes or 10,000 pages of text, requiring two feet of bookshelf space. In its online version, the database has more than 9 million words and over 30,000 entries

(*11*, p. 5). The Knowledge Retrieval Software (KRS) was specially designed by KnowledgeSet Corporation as the search software for the first edition (1986) of the *Electronic Encyclopedia*. It was therefore designed specifically to function in and cater to the requirements of a CD-ROM environment. The same search software was consequently used for another Grolier product, the *International Encyclopedia of Education*.

Contrary to the implication in the title of the online version of the *Electronic Encyclopedia*, the content of the CD-ROM product is not narrowly focused on the United States. However, it should be noted that (*12*, p. 86)

> ...entries reflect the curriculum of American schools and universities, which is to say that there will be few items in any school or college textbook not found as either a subject entry or as a topic covered in a longer article, directly accessible by full-text searching.

A major disadvantage of the KRS software design used in the first edition of the encyclopedia is that it was based upon the principle of differentiated function keys to select the various search options (*13*, p. 186). This means that as searching progressed, the computer's function keys were constantly redefined for a completely different function as on the previous or next search screen. This constant changing of functions proved confusing as the user had to guard against selecting from a function on the previous page which was no longer valid on the next screen.

Two search approaches were possible: a browse mode and a word search mode. Browsing referred to the possibility of scanning through the titles of the encyclopedia's main articles, whereas with word searching natural language could be used to search for any given word in the database. The friendliness of the product, the clarity of the screens, as well as the standard of documentation, were probably responsible for the fact that to date Grolier's *Electronic Encyclopedia* is perhaps the best known CD-ROM application. Various reports are available in the literature about different groups using the product for experimental purposes. It has even been used for introducing CD-ROM technology at school level (see, e.g., *14, 15*).

THE NEW ELECTRONIC ENCYCLOPEDIA

The revised 1988 edition of this highly acclaimed CD-ROM source boasts a completely new software interface. This time the upgraded full-text retrieval software of Online Computer Systems, Inc. was used to further enhance the search sophistication of the encyclopedia. The success of this move was proved by the bestseller's list of the Bureau of Electronic Publishing, Inc., which lauded the *New Electronic Encyclopedia* as the number one selling CD-ROM for 1988! (*21*, p. 71). The functions of the encyclopedia will be discussed below, with reference to the various enhancements included in the new version (e.g., three search modes, pulldown windows, mouse support, hypertext functions (links), electronic bookmarks, a notepad to save parts of articles for editing and printing, automatic page and screen numbering, as well as split-screen viewing of multiple articles).

When considering the quality of a traditional print-on-paper encyclopedia, various evaluation criteria have been established. Katz (*1*, p. 182-190) for example, has identified a set of recognized criteria, used not only in library and information science schools for teaching students the basics of reference work evaluation, but also in libraries and information services for comparing similar publications, or when acquiring new reference sources. These criteria are, *inter alia*, the purpose of the publication, its scope, authority, audience, writing style, recency, viewpoint, and objectivity. To date, no such generally accepted criteria have been developed to evaluate products in CD-ROM format, and even less so for full-text databases in the form of encyclopedias. Unfortunately, the criteria used to assess the value of the printed publication are only practicable when the (visual) paper copy is at hand. Large (*17*, p. 89) endorses this view by stating that, while many clues to the quality of a source are to be found in the table of contents, introduction, or preface, and even the index,

> . . . this is admirable advice for a printed work, (but) it is clearly impossible for either an online or a CD-ROM source because none of these clues is available. Reliance instead must be placed upon any documentations provided by the database producer or host, a poor substitute for a careful examination of a printed work.

A possible solution is to establish the existence of a printed equivalent, and apply the traditional criteria to the paper edition. Care should be taken, however, to ensure that the contents of both formats are exactly the same—which is not always the case. Since this article focuses on the CD-ROM product, attention will not be given to the basic criteria for printed versions. Instead, the discussion will concentrate primarily on those characteristics typical to a CD-ROM database. These are based on the author's own experience as well as from a number of journal articles on evaluating the software interface and retrieval software of CD-ROM products (*viz.*, *18-21*). An outline of discussion points is as follows:

Installation requirements: hardware, software, multiuser access, different producers (same title)
Search modes (menu, function keys, commands)
Search levels (novice, experienced users)
Search functions: browsing, Boolean logic, field searching, proximity searching, truncation, combining search functions, term linking, search strategy saving
Output capabilities: displaying, printing, and sorting search results, strategy uploading, downloading, format choices, exporting (e.g., in ASCII), search interruption
User assistance: documentation, on-screen help pages, error messages, help desk/training, interactive tutorials
Pricing

Characteristics of the *New Electronic Encyclopedia*

INSTALLATION REQUIREMENTS

Hardware

In order to function, the *Electronic Encyclopedia* (EE) requires at least 512K RAM, DOS version 3.0 or later, an IBM PC, XT, AT, or compatibles, as well as any one of the standard CD-ROM drives (including a controller card). It is accompanied by a software program which prompts the user through a number of installation stages, including confirmation of the drive make; it also expects Microsoft CD-ROM Extensions or a compatible device driver (a list of drives is provided during the installation phase, from which the client must choose one). The novice may not understand the jargon displayed on the screen during the installation phase, but a toll-free number is provided in the manual for those unable to get the system to work.

Software

Installing a CD-ROM product on a microcomputer often necessitates the assistance of a person with basic technical (DOS) skills. The reason being that CD-ROM publishers observe no standards of consistency with regards to installation procedures of the search as well as driver software. Some software will automatically change or even rewrite the contents of the computer's CONFIG.SYS file, while others may ask approval to make certain changes—sometimes without informing the user of the implications involved. During the installation of the test product *EE* did not change any lines from the CONFIG.SYS file, but it must be added that this file was already set up to function with some of DIALOG's ondisc products. An example is given in the *User's Guide* of a typical CONFIG.SYS statement, but with insufficient DOS knowledge, the inexperienced user will be unable to interpret the information. Again, the same toll-free telephone number is provided if further information is needed.

Multiuser Access

The question to be asked is if multistation use can be supported? Confirmation that *EE* is licensed to be used in a local area network environment could not be established from the *User's Guide* or any other source. The client must contact the suppliers for more information.

Different Producers of the Same Title

Certain examples exist, e.g. MEDLINE, where the same CD-ROM database may be available from more than one supplier, each using its own search software and selling the product at its own price. Furthermore, and even more complicated, some products with the same title may not be an exact duplication; the client is then compelled to do a thorough investigation in an effort to establish which title will best suit the specific environment. Fortunately, no such problems exist with *EE*; the only duplication is the online version with the same title as the printed version *(Academic American Encyclopedia)*.

SEARCH MODES

As CD-ROM databases are searched locally, they are, as a rule, supplied with their own search software; either on a floppy disk which accompanies the product, or directly on the CD-ROM disc together with the database and its indexes. Unfortunately, the search software differs from product to product, which implies that the user must learn to use each database acquired. A specific product's user friendliness is therefore an important criterion when comparing various systems. The new version of *EE* represents a significant improvement over that of the earlier one. In the search mode, the rather complicated function key approach mentioned above, has been replaced by a series of pull-down menus (Fig. 1). Unfortunately, no command-driven mode is available for those users who are acquainted with the windows and various menu levels but who wish to search directly in command format.

A bar at the top of the screen lists the pull-down choices. These are activated by the Alt key and, as with normal practice, by pressing the first letter of the menu function. The basic choices are not always self-explanatory and the beginner must either use the applicable appendix of the *User's Guide* (*11*, p. 67), or page through the various options. For example, the File Menu consists of various print, save, and notepad facilities, while the so-called Tools Menu accommodates the link function, as well as a notepad, bookmark (all discussed in detail below) and an option to start a new search.

The enclyclopedia's screen layout complies with the basic requirement of reserving certain areas exclusively for standard information (e.g., the menu options and instructions for further actions). On each new screen this layout remains unchanged, irrespective of the menu position; the latter is always indicated by reverse video.

SEARCH LEVELS

Another important test for user friendliness is the extent to which a certain database provides for various levels of user experience. This implies that the novice user must be able to start using the system with the minimum of effort, but should also gradually

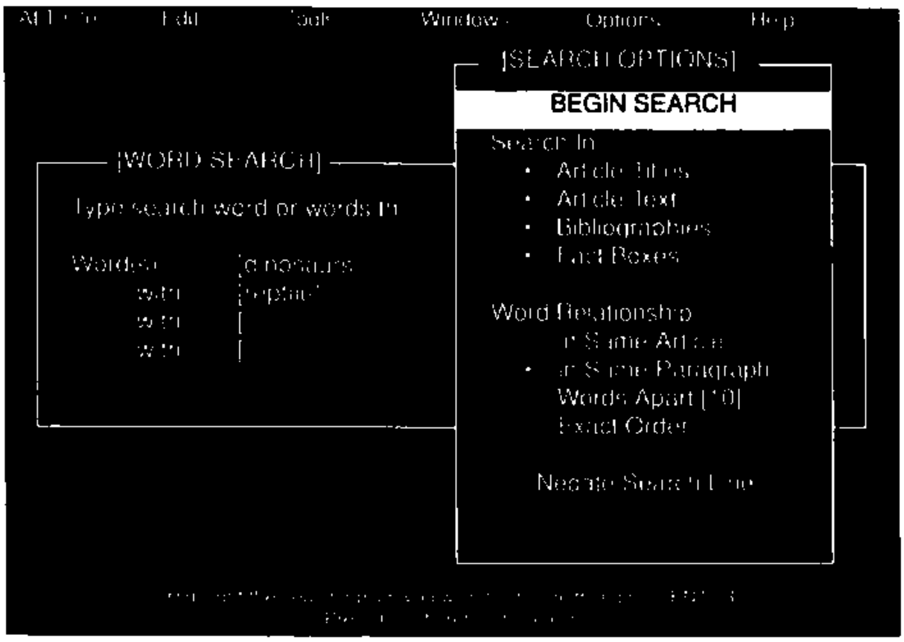

FIGURE 1. *Example of pull-down menus.*

be able to bypass cumbersome menu structures as he/she becomes more familiar with the system. Unfortunately, as with the previous edition, the product does not provide for multiple levels. The pull-down menu approach is therefore the only search level. which means that a user must study the manual and build ample experience before the system can be utilized to the maximum. A more effective approach which the *EE* could have utilized, is to assign certain keys or combinations thereof (e.g., function keys, or with Alt, Control, and even Shift) to the various search functions. An ideal program allows the user to customize the search program (i.e., the ability to create new functions, change the colour of screens, create other user-defined display or output formats, and even create program macros) (*22*, p. 120). To provide for the lack of search levels, Chapters 2 and 3 of the *User's Guide* are compiled in tutorial format, taking the user step-by-step through the basic search procedures.

Another characteristic of *EE* is its three approaches in accessing the information on the database, which could be regarded as a way of providing for multiple search levels. These are the "Browse Word Index," "Browse Titles" and "Word Search" options (Fig. 2).

Browsing the "Word Index" implies accessing an index of more than 136,750 unique words and numbers in the encyclopedia (11, p. 13). Each word is listed along with the number of articles in which it appears as well as the total number of times it is included in those articles. This is ideal for the novice user, because scrolling up or down and entering at an applicable index word, literally allows a person to search from A to Z for an item! One can, of course, type in a search term and the system will immediately display the relevant screen and highlight the word or the one alphabetically closest to it (Fig. 3).

"Browse Titles" provides access to a complete alphabetical listing of the more than 30,000 article titles that make up the encyclopedia (*11*, p. 15). Scrolling is done in the same way as with the word index, and again, the user need only to type in the first part of a title. "Browse Titles" is an effective way of looking for a complete article on a broader topic.

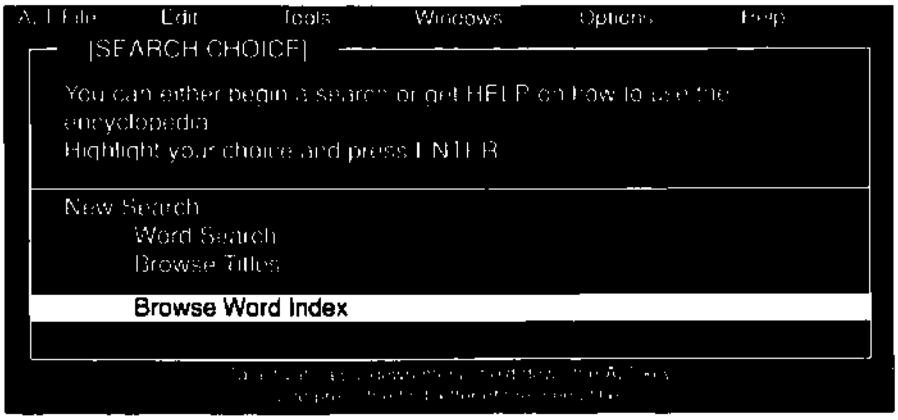

FIGURE 2. *Different search modes.*

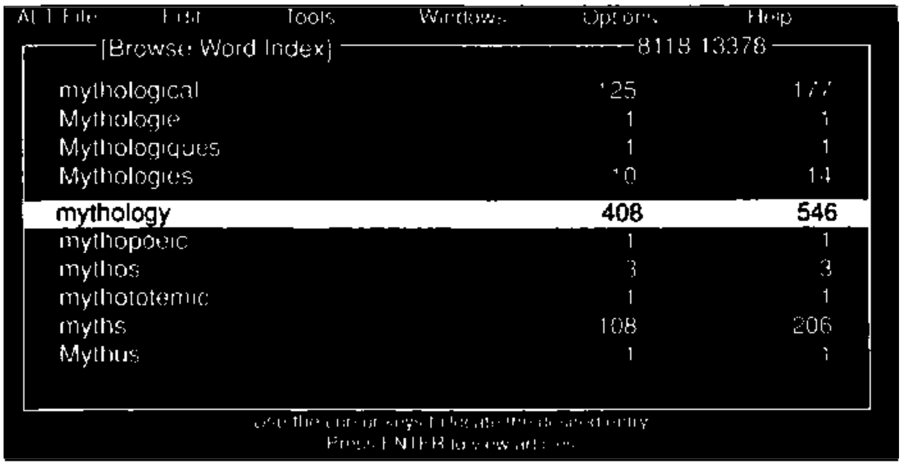

FIGURE 3. *Browsing the Word Index.*

According to the user manual "Word Search" is the most powerful search method in the *EE*. It is with this option that a whole search strategy can be created; unfortunately, however, this facility is limited to a maximum of four lines per strategy, or three Boolean ANDs (their application will be discussed below). Portions of retrieved text from "Word Search" can be marked to print or copy to a so-called "Notepad" (discussed later) or, if necessary, saved in ASCII format on the computer's hard disk. A complete paragraph, but not portions, can be saved or printed. Other facilities which also can be used with the word search approach include field searching, proximity, truncation, etc.; these will be discussed in the next section on search functions.

SEARCH FUNCTIONS

Browsing

Browsing constitutes a very important requirement of any electronic source; even more so when using a full-text database such as an encyclopedia. One can argue that the ease of browsing in a print-on-paper encyclopedia must be incorporated in a CD-ROM product by providing ample electronic browsing functions. In its broadest sense the above-mentioned features, which facilitate searching the word index as well as the titles of complete articles, represent a means to browse. More specific browsing techniques are successfully accomplished by highlighting all the search terms in an article when the "Word Search" option is used. Activating the Tab key locates the next occurrence of the term or combination of terms. Another form of browsing is to view an article's outline; with all longer entries the presence of an outline is indicated in the lower left corner of the window in which the article appears. Once an outline is displayed, applicable cursor movements allow the user to go directly to a specific subheading.

Boolean Logic

As mentioned above, under search levels, only four search lines can be accommodated; the result of this limitation is that only three Boolean ANDs can be used in one search strategy (Fig. 4). Synonyms (or similar terms) are also accommodated, but each of the four lines is limited to 60 characters. The AND operator is automatically activated when pressing the enter key to move to the next line of a strategy, while ORs are registered by separating words with a comma. A typical example of the statement ONLINE, COMPUTERIZED SEARCHING equals (ONLINE OR COMPUTERISED) SEARCHING. Adding a NOT to the string does not implement word negation. The user must first pull down the Search Options menu and select the Negate Search Line, whereupon the applicable search line changes to a negation command.

Experienced users will find the encyclopedia's method of constructing a strategy with Boolean operators exceptionally cumbersome. No provision is made to bypass the system and create strategies without first completing the four strategy lines provided for this purpose.

Field Searching

Each record of a bibliographic database typically consists of a number of fixed or standard fields (e.g., author, article title, journal title, descriptors, abstract, and so forth). Field searching is, by specifying only those fields which must be searched by the computer, a very convenient way of a devising a search strategy which will provide pertinent search results. Due to the system's unique nature, the fields of a full-text database, and specifically those of an encyclopedia, differ considerably from those of the more familiar bibliographic database.

With the *Academic American Encyclopedia* on DIALOG, a search may be limited to the titles of complete encyclopedic articles, as well as to fact boxes, the bibliography of an entry, subheadings only, the full-text, and cross references. *EE* provides for titles by means of its "Browse Titles" facility (discussed above), and descriptors (the index) by its "Browse Word Index" function. The other fields which can be specified via a pull-

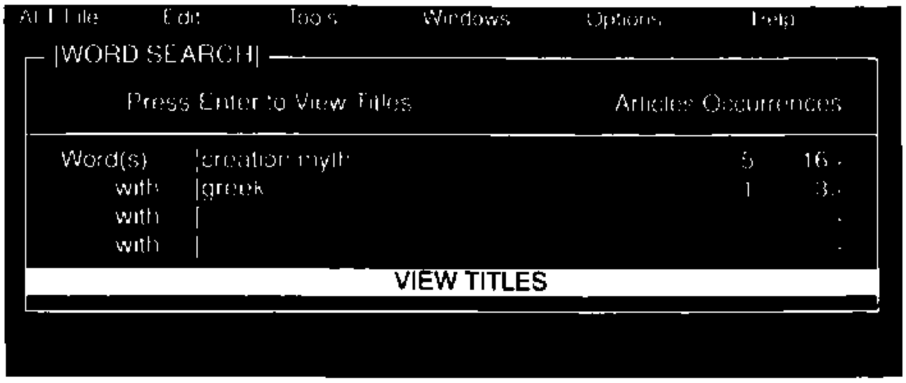

FIGURE 4. *Four lines (or three ANDS) per search strategy.*

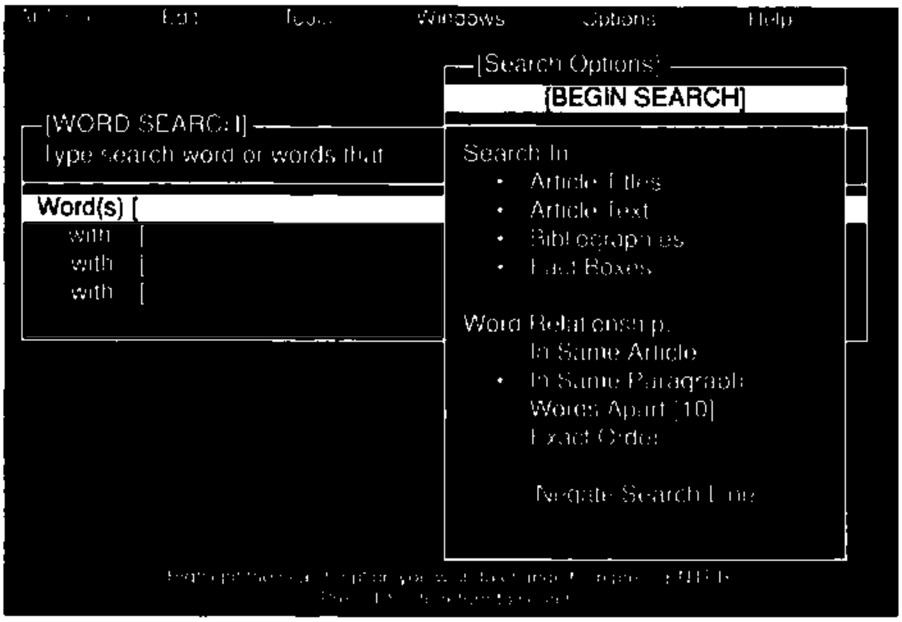

FIGURE 5. *Fields and word proximity.*

down menu, once the "Word Search" option is accessed, are in article titles (if "Browse Titles" is not preferred), article text (which is not really usable as a field specification), bibliographies, tables, and fact boxes (Fig. 5); the latter supplements an article's text by providing large amounts of statistical data in a simple to use format. Their purpose is to "summarize the meaningful data associated with an article or topic" (*11*, p. 34).

As early as 1981, prior to the introduction of CD-ROM databases, Harter and Kister (*23*, p. 1602), in an article about online encyclopedias, expressed a sincere hope for a more sophisticated level of field searching when accessing the rich resources of the online encyclopedia. They argue that certain articles, particularly biographical and geographical entries, lend themselves to the definition of fields and their subsequent searching. One of the examples cited to support this point are those entries about U.S. presidents, which mention date of birth, place of birth, education, profession, marital status, political party affiliation, etc. Harter and Kister speculate that if these were searchable, an electronic encyclopedia could provide answers to questions as to which presidents were unmarried? Born in Ohio? Lacked formal education? And so forth. Unfortunately, even the CD-ROM encyclopedia does not figure in this rather futuristic vision.

Proximity Searching

A search on *EE* can be broadened or narrowed according to the user's need (see Fig. 5). At the broader level, the first type of proximity occurs if a word appears in the same article; it is then likely that the two or more search terms will appear anywhere, and in any order, within the same article. The second category of proximity is implemented by specifying that a combination of words must appear in the same paragraph, but not necessarily in a specific order. In the third instance, the proximity between two words can be specified by any given number and in no exact order. Finally, two or more words can be specified (e.g., a phrase) in terms of their exact order.

Truncation

This facility has become a standard feature of any electronic search system. The *EE* distinguishes between truncating a single character in or at the end of a word, in which case a question mark is used, or multiple characters at the end of a word, where an asterisk is inserted. Any number of truncation variations can be implemented with most online services, for example, the DIALOG system, by using the one symbol, namely a question mark (i.e., "cat?" for all variations; "cat? ?" for cat or cats; "cat??" for cater, etc.).

Combining Search Functions

The various search options can easily be combined during a search for specific words or combinations. By using the word search screen, as well as the options window, a search strategy can be created to simultaneously apply such functions as fields, proximity, and truncated terms. This is the same procedure used in the typical online systems.

Term Linking

Recent research and development of hypertext and hypermedia systems is, to a large extent, based upon the acknowledged thoughts and ideas of Vannevar Bush who envisaged an information system similar to human thought, or more specifically, the principles of association (*24*). These ideas were developed further by Ted Nelson (*2*, p. 323). It would appear that the CD-ROM database, with its massive storage capability (currently 500 to 600 Mb) is the ideal medium with which to develop the ideal of the interconnectedness of knowledge. Although only at a very basic level, the *EE* is already applying this concept of association by means of easy-to-use "see also" references. Words appearing in capital letters throughout the text can be used to "link" other articles by means of the appropriate option of a pull-down window. A clever innovation is that a new text window opens with every link selected (Fig. 6). The size of these windows can be changed, or the user can "zoom" into one window by enlarging it to the size of the screen. No online system can, as yet, provide this linking feature.

Search Strategy Saving

Saving a complicated search strategy for later use (e.g., to consult an authority) can be helpful. However, no provision has been made to save a strategy in the *EE*; only the complete search results or a portion thereof can be saved. This will be discussed under downloading techniques.

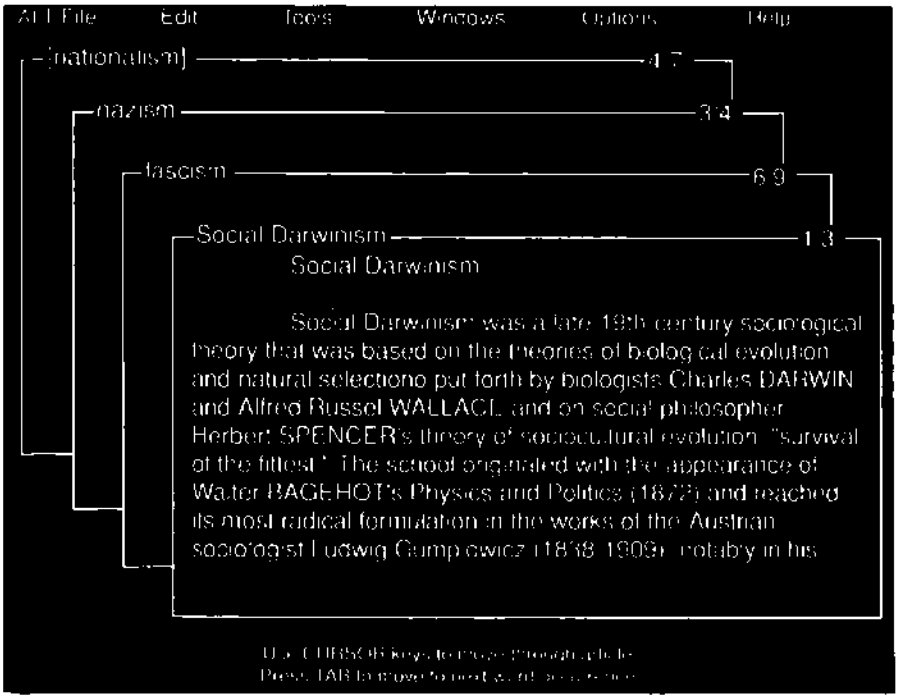

FIGURE 6. *Linking to other articles.*

OUTPUT CAPABILITIES

Displaying Search Results

As mentioned under the topic "term linking," information retrieved is displayed in the form of windows. If LINKed together, a series of windows is opened and subsequently stacked as a search progresses. Other standard information is displayed as part of the window, namely, the title of the window, screen numbers (if the text consists of more than one screen), arrows and location box (which indicates the relative location in an article or title list), as well as the existence of any article features like a fact box or outline (*11*, p. 8). Initially, the opening, closing, and size-changing activities are not very easily mastered, however, with a little experience in searching, and specifically browsing, the system becomes very user friendly.

Printing Search Results

A pull-down menu allows for printing retrieved text. A number of different settings is available from which the user can select according to specific needs such as the complete text, a paragraph, page, or only the marked text can be specified for printing in single/double mode. The lines per page and the characters per line can also be specified (see Fig. 7).

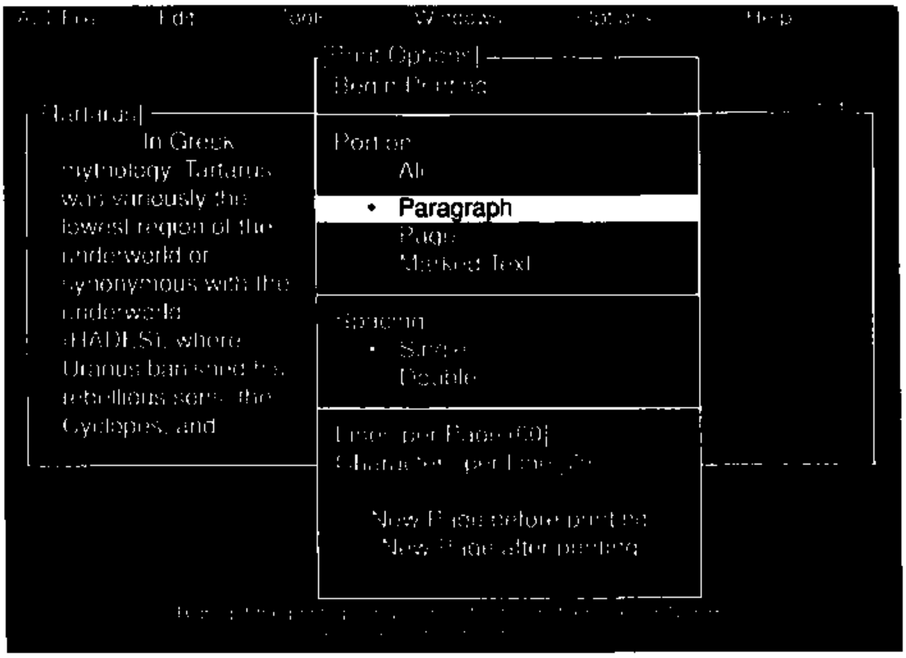

FIGURE 7. *Print options.*

Sorting Search Results

Sorting refers to the capability of the search software to arrange search results according to the options provided. The question arises whether sorting capabilities have any relevance when retrieving information from a full-text database? In the discussion on fields, reference was made to the ideas of Harter and Kister to employ field searching to its maximum when planning and developing a database of this nature. Although their ideas about sorting pertain to a factual database, they are also worth mentioning here (*23*, p. 1602). The fascinating examples provided by the authors of "another whole class of (reference) questions" include, *inter alia*, the youngest governor in the United States; a list of Greek and Roman philosophers arranged chronologically by birth date; the ten longest rivers in Europe; etc. Although these ideas were first mooted in 1981, advanced sorting capabilities are still not a reality today, even with the encyclopedia in CD-ROM format. In fact, no sorting of any kind is available on *EE*.

Strategy Uploading

In the online searching environment, where databases are updated regularly (e.g., on a monthly basis and some even daily or hourly), an important requirement when acquiring/buying a CD-ROM database is the availability of an online equivalent which can be accessed, if necessary, for updated information. Uploading (in online searching) refers to the ability to construct a search strategy offline with applicable front-end software, and upon completion transmit this to the online host (*25*, pp. 118-119). In a few cases where an online host is also publishing in CD-ROM format, the concept of uploading is taken even one step further, namely to search the disc, save the final search strategy, and then uploading this to the CD-ROM's online counterpart for the latest information. As mentioned in the beginning of this article, *Academic American Encyclopedia* is available online through a number of hosts, but unfortunately Grolier (the CD-ROM publishers) has not provided for any compatibility between the two formats. Therefore, *EE* has no facility to permanently save a strategy for later use.

Downloading

This function has become standard practice in situations where front-end software is used to copy search results (in the form of bibliographic references or the information itself) to a buffer or permanent memory of the user's workstation. This downloaded data can the be integrated with other data files, for example, a local bibliographic database for research purposes or the word processing files of the user. In CD-ROM, the term downloading could also mean that search results can be copied to memory for further manipulation (e.g., when writing a report). *EE* is part of this category; in fact a complete article, a paragraph, the current screen, or highlighted text can be saved. It is interesting to note that articles or sections can either directly be saved to a floppy or hard disk, or can be saved on a facility called "Notepad."

Information downloaded to a notepad, allows the user access to stored information without leaving *EE*. This means that saved files can be called up easily by means of the correct pull-down menu. In contrast, items saved directly to the hard disk (normally in ASCII format), can only be read via external software, such as wordprocessing, or a DOS command (e.g., TYPE or PRINT).

Format Choices

Traditionally this aspect refers to the variety of output formats from which a user can choose—especially with regard to bibliographic databases. As the *EE* is a full-text database, this does not apply. In the section on downloading, reference was made to the possibility to specify certain formats, when saving or printing certain text (e.g., the full item, only marked portions, etc.).

Exporting in ASCII

The facility to move certain portions of text to the floppy or hard disk, was discussed earlier under downloading. Exporting means that all retrieved information can be utilized outside the original software by any other software which can import ASCII data.

Search Interruption

A break key is essential to stop processing during a search. It is common knowledge that CD-ROM products, compared with online databases, are relatively slow in terms of processing speed. *EE* is no exception. Sometimes a search is too general, or too specific, when applying the maximum number of AND operators. In these circumstances the user has to wait an extremely long time for the results. With *EE*, the ESCAPE key can be used at any stage during a search to stop processing, for example, to change the strategy.

USER ASSISTANCE

Documentation

As with the first edition, the *User's Guide* (*11*) is easy to understand. Apart from some introductory pages, the balance of the booklet, some 77 pages, is devoted to a detailed description of the various functions of the search software. The content is divided into two sections, entitled "Learning the basics" and "Advanced search techniques." This means that the beginner may study the first part (about 14 pages) and proceed with basic searching. Instead of merely describing how to use the encyclopedia, each procedure is described in a few sentences, followed by sample searching; in other words, the user follows the text, repeats the instructions on the microcomputer, and compares the different screens with those depicted in the manual. The various illustrations of screens are well produced and informative.

Contrary to expectations, the manual has no index! This is rectified by the visible page layout in which about one vertical third of each page is reserved for headings. The various functions of the encyclopedia can then be located relatively easily—but the user must still page, or use the table of contents. A convenient appendix lists all the menu commands and functions; however, it would be more useful if page numbers were added to make reference to the text less inconvenient.

On-Screen Help Pages

Context-appropriate assistance is constantly available via a pull-down menu. Pressing Alt+H opens a window that gives a short description of all the choices relevant to the current menu level in the program. Additional prompts at the bottom of every screen correlate with the most likely actions of the user at a specific point of time.

Error Messages

The purpose of these messages is to warn the user that a wrong or nonexistent decision from the menu has been chosen. The warning can take the form of a message which appears at a fixed position on the screen, or in some cases even a short beep is emitted. Unfortunately, since neither one of these error messages is available on the *EE*, the result is that one is frequently left in doubt as to whether the system is in fact processing a command, or waiting for input from the user.

Help Desk/Customer Training

This facility depends completely upon the provider of the product, which is often not the producer himself. Apart from the telephone number of Grolier's Technical Service in the United States (available from 08:00 to 06:00, Monday to Thursday), apparently no customer training program is available.

Interactive Tutorials

Computer-assisted instruction is often applied to develop a training session on how to use a software product effectively. This is then sold, either separately or as part of the product. No such tutorial exists for *EE*. As mentioned in the section on documentation, the manual is to a certain extent self-instructional.

PRICING

The 21 volume printed *Academic American Encyclopedia* retails for $650; its CD-ROM counterpart is available for $395, or $100 plus proof of purchase for those who wish to upgrade from the 1986 version of the *Electronic Encyclopedia*. The price quoted naturally excludes overhead costs such as normal workstation expenses, staffing, and user education. In his cost study between print, online, and CD-ROM searching, Nicholls found that CD-ROM is presently more expensive than print, but like online searching, it offers value-added information; "... in a number of situations, the advantages are not cost savings, but involve ease of use, efficiency and a high degree of user satisfaction" (*26*, p. 120).

Conclusion

Today's CD-ROM encyclopedia, with specific reference to Grolier's *Electronic Encyclopedia*, displays considerable search sophistication, more than that of the online version, and even more than the print-on-paper edition. The various search functions described above support this statement, particularly features such as the easy-to-use pull-down windows and menu facilities, hypertext type links to access related parts of the encyclopedia, sophisticated notepad to save portions of retrieved text, extensive display and print facilities, and split-screen viewing to compare the contents of two or more articles. These technological advances reflect the superior capabilities of the CD-ROM encyclopedia over the limitations of factual searching on the online version. Grolier also added a CD-I (Compact Disc Interactive) version to its range of products in early 1990. This exciting breakthrough which facilitates the combination of text, pictures, graphics, and sound is something to anticipate in the near future.

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PIETER A. VAN BRAKEL

COMPUTER APPLICATIONS IN THE CLASSICS

History

The uses of the computer in the field of classical studies have been of interest to more than merely specialists in that one field, since important techniques for working with computers for all humanistic studies have been developed by and for classicists, as well as for other students of ancient languages. Because classical studies and the study of ancient languages are not in fact identical, "classics" should at this point be defined: it is the study of the ancient Greek and Latin languages and everything having to do with the cultures associated with these languages: the literatures, the history, the religion, the philosophy, the art, the architecture, and everything else. It therefore merges with archaeology, a field for which important computer applications have also been developed which are so different that I shall not concern myself with them in this survey.

Perhaps the first computer project begun in classical studies was Father Roberto Busa's word index and concordance of the works of Thomas Aquinas, for which plans began in 1949, the transfer of the text to punched cards was started in 1951, and the first volume appeared in 1973 (*1*). This project was of significance in a number of respects: text input continues to be of the utmost importance, and probably, it has advanced considerably farther in classical studies than in other humanistic fields; moreover, concording projects were undoubtedly the most important computer projects in the classics through the 1970s (today, they have largely been replaced, as individuals working with microcomputers have now been enabled by available software to perform their own word-searching and concording with the utmost flexibility whenever they so desire; as a result, in the 1980s, attention has focused more on data-entry projects and on concording software).

The computer was also used very early on Greek authors for literary and stylistic studies with the primary purpose of determining authorship. The scholar most associated with this sort of study has been Andrew Q. Morton, who has attempted to use such research to determine the authorship of various works written in ancient Greek. He first made headlines in 1963 (*2*). In all the various other computer applications for classical studies (the problem of entering, accessing, and displaying texts written in a non-Roman alphabet; pedagogical uses of the computer; encyclopedic studies; studies of meter and of prose rhythm; the use of the computer for editing texts), classics has been a pioneer among humanistic studies employing the computer.

Text Access

Of these applications, essential for everything else from the start was the availability of texts on computer, and this factor necessitated setting up data entry projects. These were important from the earliest days, and, with the availability of hardware and software permitting individual scholars to pursue their own projects, they have loomed ever more and more important. Not only do they permit all sorts of computer-assisted study of texts; they also make it unnecessary to possess bound volumes of all but the most essential authors.

A good deal of text entry already had been accomplished in the 1960s and early 1970s; however, since it began in 1972, the most important data entry project has certainly been that of the Thesaurus Linguae Graecae (TLG) housed at the University of California in Irvine, California, and directed by Professor Theodore F. Brunner. This project set as its initial goal the translating to computer-readable form and making available the texts of all literary authors (as distinguished from documentary sources) who wrote in ancient Greek up to the cut-off date of AD 600: this involves 18,411 works by 12,898 authors, many of whom (and of which) survive only in fragments or in references, and it represents a corpus of approximately 60 million words and 500 megabytes. Entry of all of this material is now essentially complete, and text verification has been accomplished for all but the latest and most obscure of these authors. The project is now busying itself with: (1) the remaining verification of text; (2) the entry of the texts of post-600 (i.e., Byzantine) Greek authors; and (3) the refinement and maintenance of the existing data bank (it should reflect recent scholarship in classical studies).

All of this material is available on magnetic tape or (much more conveniently and cheaply) on a single 5.25-inch CD-ROM which can be ordered from Thesaurus Linguae Graecae (TLG) project, University of California, Irvine CA 92717. Once the texts are on line, all sorts of things can be done with them on computer; most obviously, with a text-retrieval "engine" like David Packard's Ibycus Scholarly Computer, it is possible to locate all occurrences of any string, word, phrase, or combination thereof in some or all of the TLG database (and therefore of ancient Greek literature) in a matter of minutes (or, for relatively small parts of the database like single authors, even seconds). Additionally, with this sort of "engine," it is possible to display and produce hard copy of passages and even whole works from such a database. The sorts of applications that can be made of this capability are practically limitless.

The text of each work put into machine-readable form by the TLG Project is that of the edition selected by the Committee on the Thesaurus Linguae Graecae of the American Philological Association. Text editions are selected on the basis of: (1) scholarly superiority; (2) recent date; and (3) availability. Each work is represented in the database by a single text edition (or, occasionally, separately at different places as parts of two or more distinct corpora), and there is no critical apparatus. The complete contents of the TLG database, listed alphabetically by author, can be found in Luci Berkowitz and Karl A. Squitier, *Thesaurus Linguae Graecae Canon of Greek Authors and Works*, 2nd ed. (Oxford University Press, New York, 1986). The database is coded in the Beta Format, an ASCII coding scheme developed by David W. Packard and adopted by the TLG Project and also by many similar data entry projects. Unfortunately, some data entry projects, even new ones, do not use Beta Format (this drawback is most common in projects conducted outside the United States). In Beta Format, Greek texts can be handled by all sorts of computers (*3*).

It is customary to divide the study of nonliterary (i.e., documentary) texts in ancient Greek and other ancient languages into two separate categories which are studied by two different subdisciplines of classical studies; inscriptions (anything written on a hard material, usually stone, much less often metallic objects,) which are studied by epigraphists; and ancient manuscripts (normally written on papyrus, sometimes on parchment), which are studied by papyrologists. The handling of both these kinds of texts demands special expertise which has been lacking in the TLG project; consequently this sort of text is being entered by various separate projects.

Inscriptions of Asia Minor are being entered along with checklists of the inscriptions (in Greek and Latin) of the ancient sites involved for Ionia and now for Caria also by the Princeton Epigraphic Project housed at the Institute for Advanced Study (Princeton University) since 1983. This project, carried out by Dr. Donald F. McCabe and supervised by Professors G. W. Bowersock and Christian Habicht, inputs what is judged to be the best text of each inscription in the light of all the scholarship. Since 1985, the Cornell Center for the Computerization of Greek Inscriptions (Cornell University Department of Classics) has been entering the texts of inscriptions of Attica, Delos, and Delphi: this project is overseen by Professor Kevin Clinton and directed by Nancy Cooper and John Mansfield. An analogous project, began at Ohio State University under Professor Stephen V. Tracy in 1988, is inputting the texts of the inscriptions of the Peloponnese, Crete, and Boeotia. Both of these latter projects enter separately different editions of the same inscriptions and do not attempt to sort or judge the various editions. Moreover, they both include only inscriptions in Greek (as opposed to Latin) from the various provinces which they cover. The products of all three of these projects are in Beta Format. They have been made available on various earlier CD-ROMs produced by the Thesaurus Linguae Graecae project and the Packard Humanities Institute (Los Altos, CA). The Packard Humanities Institute plans shortly to produce a new CD-ROM with updated versions of the products of all three of the projects. All of this work is intended to be compatible with the products of the TLG Project and to be accessible to the same equipment and software.

There are various other projects involving putting epigraphic information on computer. For prosopographical projects, see below. Teams under Professor Gerhard Thür at Munich and Professor Frank Kolb at Tübingen are putting on line texts of the inscriptions of Northwest Anatolia (Mysia and the Troad) and Southwest Anatolia (Lycia and Pamphylia), respectively. Many European projects are involved in putting on computer texts of inscriptions, often from the regions in which the projects are working. They typically include, besides the text of the inscriptions, a great deal of information about each inscription and the stone (or other medium) on which it was written. There has been little or no attempt to make the product compatible with the standards of the TLG Project. Such European projects much more commonly involve inscriptions in Latin than in Greek. Probably the most ambitious and promising of them has been that under Geza Alföldy at Heidelberg and other places in Germany which has had as its first goal the putting on computer of a great deal of information about (including the text of) the inscriptions in Latin which have been published in the *Année Epigraphique*, a publication which since 1888 has made it its task to republish and thus to make more accessible to scholars newly discovered inscriptions (in both Greek and Latin) from throughout the Greco-Roman world of importance for the history of Rome and the Roman Empire. The work of such projects is typically only available in printed form so far.

As the study of ancient manuscripts requires a different expertise, papyrological texts (insofar as they are not literary: many papyri contain texts of literary authors and so are or ought to be reflected in critical editions of those authors; in this way, these papyri are ultimately reflected in the author-texts produced by the TLG Project) are being put on line by separate projects. Of these, the most important is that of the Duke Data Bank of Documentary Papyri (located at Duke University, Room 201B, Perkins Library, P.O. Box 4762 Duke Station, Durham, NC 27706), which since 1983 has been putting on line the texts of documentary papyri with the exception of the large number of papyri found at Oxyrhyncus and published by the Oxford University Press. The products of this project are compatible with those of the TLG Project. These papyrological texts, like those of the first three epigraphic projects discussed, have been included on various CD-ROMs produced in the past few years by the TLG Project and the Packard Humanities Institute; the plan is for them to be included on future CD-ROMs produced by the Packard Humanities Institute. The Oxyrhyncus documentary papyri are to be put on computer by the Oxford University Computing Service.

The entry of Latin texts and authors has only begun to be standardized. In the past, machine-readable texts of some Latin authors have been made available by such groups as the American Philological Association. Latin texts of this sort (as well as texts in such other ancient languages as Hebrew and Coptic) have appeared on early CD-ROMs produced by the TLG Project and the Packard Humanities Institute. At the moment, the Packard Institute is involved in a project for putting on line and making available through CD-ROMs all the texts of Latin literary authors in the way that the TLG Project has done for Greek authors. The Princeton Epigraphic Project is including, for the sites on which it works, inscriptions in Latin as well as in Greek (the small number of inscriptions found at these sites in other ancient languages—Anatolian, Semitic, and Egyptian, so far—are mentioned in the checklists which the project produces.) Unfortunately, other epigraphic projects seem to be confining themselves to either one or the other of the two languages of classical Greco-Roman antiquity.

CD-ROMs have become the standard medium for the distribution of machine-readable texts. However, most of the projects mentioned thus far will send persons data on magnetic tape and/or floppy discs. Additionally, tapes of various texts and authors can be ordered from the Oxford University Computing Service (13 Banbury Road, Oxford OX2 6NN, England) and the Center for Computer Analysis of Texts of the University of Pennsylvania (P.O. Box 36 College Hall, Philadelphia, PA 19104). The latter organization has also been involved with the Packard Humanities Institute in the production of CD-ROMs.

Most of the data entry for all of these projects has been done manually. The TLG material was entered twice manually by operators working as contractors in South Korea and the Philippines. The two versions of each text were then compared automatically at Irvine, California, and gave near-perfect spotting and correction. The ongoing process of data verification has now resulted in texts which are substantially superior in accuracy to those of the printed editions from which the texts were originally taken. The TLG Project has experimented repeatedly with optical scanning, but found that the large number of errors which result constantly, and thus necessitate much more careful editing negates the cost-effectiveness of such scanning. My own experience at the Princeton Epigraphic Project supports their conclusion: I have found optical scanning to be less efficient; not only are excessive errors introduced which prove hard to eliminate, but I have found that understanding of the conventions of epigraphic editing is very important for proper initial entry of the data, so that it is my experience that it is far preferable to have the texts entered manually by trained assistants. The epigraphic projects at Cornell and Ohio State have indeed been using Kurzweil optical scanners for their initial data entry (which they then edit and correct), but it probably is largely for this reason that their products remain so close to the printed editions on which they are based (thus, among other problems, there is serious inconsistency: if two different editors have represented the same symbol on a stone in two different ways in their printed editions, these projects maintain the inconsistency; it therefore becomes impossible or very difficult to conduct a search for that symbol) and that the very architecture of the projects (with different editions of the same stone appearing at different places in their product, with nothing except the identity or possibly only vague similarity of the texts to indicate the identity) has been designed in the way that it has.

One type of automatic data entry, now only in its first stages, will undoubtedly prove very important in the future. This is the on-line entering of actual images of the materials bearing the ancient texts: the stone or the like on which inscriptions were carved; the ancient manuscripts (usually papyri) or Medieval or later manuscripts on which documents and literary texts were written. The Center for Computer Analysis of Texts of the University of Pennsylvania has recently been entering on-line images of Biblical manuscripts. A project recently begun by the Universitat Autónoma de Barcelona and the Programa de Medios Audiovisuales of the Department d' Ensenyament of the Generalitat de Catalunya has started to do the same thing with inscriptions. The CD technology exists for distributing such images and is now being used, for example, by Harvard University's Project PERSEUS (see below.)

Word Studies

STRING PROCESSING

Once texts are entered and available, the next step is to make use of them for study and analysis. In computer jargon, ordered sets of numbers considered to be characters are called "strings." Texts, including ancient texts, when on computer are long strings. All sorts of string-processing procedures are now possible, but the most basic is at the level of single words (in general, strings marked at beginning and end by spaces), and the most important such procedure is undoubtedly what is called the word search, although it is normally possible to use the same means to search for strings which are shorter than (usually parts of) single words or which are longer than single words, consisting of more than one whole word or word part. The capability of conducting searches on line makes the conventional hardcopy concordance obsolescent. As a result of this ability, all sorts of vocabulary studies become possible. Suitably designed word searches, either for appropriate single words or for two or more carefully chosen words occurring in proximity, can allow the scholar to find many, most, or all passages about a desired subject. With so many texts, especially inscriptions, on line, studies of dialects, particularly Greek dialects, can be pushed further than they have been up to now. All sorts of other scholarly projects become possible.

Since its appearance in 1986, the best machine for conducting most string-processing operations that a classicist might desire to perform has been the Ibycus Scholarly Computer (produced and marketed by IBYCUS Systems, P.O. Box 1330, Los Altos, CA 94022). It "can (1) display up to 4,096 unique characters on-screen in a single document, (2) work with up to 15 different windows, and (3) search texts at high rates of speed for multiple character strings" (*4*). It "(4) supports recent CD-ROM and laser-printing technologies and (5) is designed to work with the data bases of the TLG and similar projects of machine-readable ancient texts." It "is a computer system that, among other things, is designed for multilingual word processing." It uses a read-only memory- (ROM) based, text-mode approach to displaying characters on-screen. Because it allows composite characters to be created by superimposing two characters at the same screen location, the Ibycus Scholarly Computer makes it easy to create accented letters and to properly place diacritical marks. At present, Roman, Greek, Hebrew, and Coptic character sets (including all Western European symbols and all vowel, breathing, and diacritical marks) are included. The displays are of very high resolution and clarity. There is a rather primitive and limited word-processing capability. However, because of the ease with which non-Roman alphabets can be handled, it is an excellent machine for inputting texts in ancient languages. Documentation is quite spartan. There are few off-the-shelf programs, but one of these is truly spectacular. The *cdu* program for handling CD-ROMs in the TLG format permits, in its search mode, extremely rapid searches for multiple character strings in all of the literature available in an ancient language, in single authors and works, and in sets of authors and works which can be specified on the spot; in its browse mode, the same program permits display on screen and printing on hard copy of specified passages or even whole works of authors. Most additional programs must be written by the user, either in the assembler language for the system or in IBYX, which is the higher-level language similar to Pascal which has been written by David Packard and is supported by the Ibycus Scholarly Computer; it is relatively easy to learn to write programs in IBYX *(5)*.

The Ibycus Scholarly Computer is probably the best tool for dealing with TLG materials and all the other material available in a compatible format, but other systems have been devised for accessing this data. For example, the PERSEUS Project centered at Harvard University has created and is continuing to improve the Pandora program, which is designed to access and search TLG texts in their CD-ROM form on Macintosh computers. It consists of retrieval software written as a series of extensions to *Hyper-Card1*, a standard Macintosh program. In its current form, it can search for a character string in any or all of the works of one or more Greek authors and display the results as references and in context. It is possible to export the references found to a variety of formats. Additionally, it provides the ability to browse through texts, beginning at any reference, and to search through the whole TLG corpus. Plans for improving the program include giving it most of the still missing features of the Ibycus *cdu* program and to add at least one boolean operation (the *not* operation, so that one can search, for example, for contexts where one Greek word occurs where another Greek word does not) not supported by the *cdu* program, at least in the form in which it is available to me.

MORPHOLOGICAL ANALYSIS

Another type of computer work done at the level of the single word consists of morphological analysis of words: except in the case of homographs (different words or word forms with identical spellings), it is possible to program a computer to do this automatically. By the early 1970s, a program had already been written to do this for Greek with about 95% accuracy by David Packard (*6*). A considerably refined program of this type, called *Morpheus*, has been written for the PERSEUS project. *Morpheus*, written in Lightspeed C, analyzes Greek morphology by using rules of inflection. To analyze a word, *Morpheus* consults its own data base of approximately 7,500 endings and another database that is being extracted from the 40,000-word Liddell & Scott *Intermediate Greek-English Lexicon*, a machine-readable version of which will be available as part of PERSEUS. After consulting these two databases, *Morpheus* knows how a stem can be inflected. This means that *Morpheus* may be used as a parsing/analysis tool which can break most forms down into their component parts (it cannot, however, disambiguate homographs). It allows users to select a particular stem and see all the occurrences of its forms or only all occurrences of certain specified forms. *Morpheus* is being written in such a way that it can be used in conjunction with *Pandora*, the search program of the PERSEUS project, and to take account of the many complications of Greek inflections, including, most excitingly, the fact that different forms of a word are used in different Greek dialects. Work has also been done on the automatic lemmatization of Latin, but it is considerably less advanced (*7*).

Another method that has been devised for dealing with Greek morphology has been to tag each word of an on-line text with information about its parsing and/or grammatical function. For example, Project GRAMCORD (directed by Professor Paul A. Miller at the Trinity Evangelical Divinity School, Deerfield, IL) consists of a morphologically and syntactically tagged machine-readable version of the Greek New Testament and several programs that manipulate that database. The CATSS (Computer-Assisted Tools for Septuagint Studies) project directed by Drs. Robert A. Kraft and Emanuel Tov (Department of Religious Studies, University of Pennsylvania) has been producing morphologically analyzed machine-readable versions of single books of Rahlfs's text of the Septuagint; words of these texts are tagged at the textual, morphological, and syntactic levels. Such tagging is of obvious pedagogical use, but also it permits the scholar to search for instances of morphological and syntactic phenomena.

STATISTICAL STUDIES

The most publicized early use of computers in classics was for determining authorship. Andrew Q. Morton claimed to be able to use statistical studies of stylometry to distinguish between truly Pauline and non-Pauline epistles of the New Testament. His studies have relied on the frequency of certain Greek particles (function words serving much the same role as intonation in such a language as English) and on sentence length: both of these are subject to conscious control by an author and can thus be varied, for example in different genres or merely to create a different effect; sentence length in Greek has the additional defect that it is seldom absolutely clear where one should say that a new sentence starts; much punctuation is at a level equivalent to the English semicolon, and thus the determination of sentence boundaries is at least partly subjective and a matter of editorial discretion. Morton has ignored the importance of difference of genre in attempting to show that Plato's Seventh Letter is not a genuine work of that author. Comparison with analogous arguments drawn from English-language authors in cases where authorship is known has shown the treacherousness of arguments of this kind (*8*).

Anyone who studies elementary statistics and probability quickly comes to see that apparent statistical differences can very easily be due to change. For it to be statistically demonstrable that they are significant and not due to chance, they must be greater than common sense tends to suggest. Under criticism from statisticians, Morton quickly came to use the statistically respectable chi-square test, which is a relatively easy way to determine whether there is any statistically significant difference between two groups of data. This test should always be based on absolute counts, never on percentages or proportions, and it should not be used where the value in any category is too small (usually taken to be less than five). As the example of Morton indicates, this and all other statistical tests must not be used blindly: the user must bear in mind what the actual significance of the existence or absence of statistical significance is in the case under examination. Thus, significant difference between two texts may indicate authorship by different writers, but it may also be due to a difference of genre, or to authorship by the same writer at a different phase of his stylistic development, or to different editorial procedures by two different modern editors.

Thus, for example, in Donald McCabe's study of the prose rhythm of works in the corpus of Demosthenes (*9*), it proved impossible to use the chi-square test to demonstrate difference or identity of authorship for the doubtfully Demosthenic works in that corpus. The problem arose that statistically significant differences of rhythmic patterns existed even among those orations which scholars all agree were written by Demosthenes in his prime. These differences were smaller than the difference between works by other authors (the roughly contemporary orator Isaeus and the works in the corpus of Demosthenes that scholars agree are certainly spurious) and a large sample of genuine Demosthenes, and it was thus possible for McCabe to argue that some of the doubtful works in the corpus were by Demosthenes and some were not, however, because the chi-square test showed significant difference even where authorship was presumably the same, these arguments lacked the force of statistical demonstration. This problem existed because difference of authorship is not the only cause of statistically significant difference.

A study of this sort which concerned not authorship but the difference between two works by the same author was A.J.P. Kenny's study of the books which appear in the manuscript traditions of two works of Aristotle, his *Nicomachean Ethics* and *Eudemean Ethics* (*10*). Using word frequency counts, he established that the differences between the disputed books and the *Nicomachean Ethics* are much greater than those between these books and the *Eudemean Ethics*. Chi-square tests showed that for a large proportion of the common words, the difference in usage between the disputed books and the *Nicomachean Ethics* is too great to be attributable to chance, whereas there is such statistically significant difference between the books and the *Eudemean Ethics* for very few of the common words. Less common words distinctively characteristic of one or the other of the two ethical works turned out to occur in the doubtful books with much the same frequency as in the *Eudemean Ethics*. Study of word length, sentence length, the last word in a sentence, and choice of synonyms all led to the same result. Kenny's work established beyond any doubt that the doubtful books properly belong to the *Eudemean Ethics*. One should point out that determining in which of two places (in this case, two works) to classify a body of data is a much simpler problem than determining authorship if there are many possible authors (indeed, if one takes into account the possibility of a work's having been written by an unknown author, indefinitely many).

The use of statistics is thus treacherous and should only be approached with care. If one does choose to use such methods, statistical packages are now available with a number of systems and software packages. For example, *Micro-OCP*, the microcomputer version of the Oxford Concordance Program, has a statistical capability which permits the user to obtain a set of vocabulary statistics including word frequency, relative frequency, number of unique words per frequency, number of occurrences of unique words per frequency, vocabulary total by frequency, word total by frequency, percentage of vocabulary by frequency, percentage of words by frequency, percentage of words in frequency, type/token ratio, and word count tables (*11*).

CONCORDING

Micro-OCP is an advanced, recent concording program with a number of other capabilities. It is one of the most recent tools for doing something; concording, which figured very prominently in the early use of the computer in classical studies. Before large numbers of scholars gained easy access to computers, it made a lot of sense to produce hard copy for their use in bound concordances of authors and corpora of a sort which heretofore had been produced by scholars manually through their own reading of texts long before computers existed. At least in classical studies, there were many authors for whom such concordances either did not exist or were unsatisfactory; thus, the computer offered an obvious way to produce them. Robert Busa's work on a word index of Thomas Aquinas was the first application of the computer to literary research. David Packard produced a concordance to Livy very early in computer studies (*12*). Now that so many scholars have such easy access to computers and can conduct their own word searches whenever they want, published concordances and lexicons have become much less important. Concording programs like *Micro-OCP* remain an important means by which scholars can conduct word searches for themselves.

There have been and are a number of problems in automatic concording. Normally, it does not lemmatize different forms of the same word. In Greek especially, but in Latin to a lesser extent, different forms particularly of verbs can occur at quite different positions in alphabetical order. With a morphological analysis program of the sort described above, it does, however, become possible to sort such forms under a single canonical form. There then remains only a difficulty which exists for all automatic concording, namely, the fact that the computer cannot distinguish between homographs (two different words or word forms with identical spellings). This problem can only be handled by decisions made by a human being, who can determine which word or word form is being used in each individual case. Software does, however, exist or can be developed to facilitate this task. Finally, for concordances, which, as opposed to word indices, give contexts as well as locations within the text, there is the problem of determining how much or how little context to give. Concording programs generally allow one to specify how much context one wants. Word search programs allow one to alter the quantity of context at will.

Encyclopedic Studies

A relatively new use of the computer for classics has been the development of what one can call an encyclopedic study by the PERSEUS Project at Harvard University under Professor Gregory Crane (Department of the Classics, Harvard University). The primary goal of the PERSEUS Project is to develop a set of texts and images about classical Greece to use in teaching university level graduate and undergraduate courses in subjects concerning or including aspects of the ancient world which may or may not require the use of the ancient Greek language. Its secondary goal is to enable scholars and researchers to study materials in their own disciplines and to branch out into related disciplines by using PERSEUS's crosslinked database. The project's data are arranged in Hypertext form: on a given subject, information (including images) at different levels of sophistication can be accessed; additionally, cross-references are automatically suggested. As mentioned above, the project includes development of the PANDORA program for accessing and searching texts and of the MORPHEUS program for morphological analysis. So far, what the project has produced has chiefly been relevant only to pedagogical use, as is consistent with the fact that the assistance of teaching is the primary goal of the project and the assistance of scholarship only its secondary goal. It has already become clear, however, that the project has the potential of revolutionizing the very concept of reference materials within a scholarly field. Both hypertext organization and the easy accessibility of images in addition to words are of the utmost importance (the future will undoubtedly see the images of manuscripts, inscriptions, and the like suggested above organized within this sort of framework). In the words of John J. Hughes, "when completed, PERSEUS will be the world's largest and most complex hypertext/hypermedia data base, and, from the perspective of academic computing, one of the most useful" (*13*). This project almost certainly represents the future of what has in the past been accomplished by encyclopedias.

Text Entry

One chief use made of personal computers by classical scholars, as by other scholars, has been for word processing, but classicists have a problem shared with scholars in only a limited number of other fields that texts which they want to enter either into work produced in hard copy or into computer files contain not only the diacritical marks used in various foreign languages but also text in a non-Latin alphabet, namely, the Greek alphabet. A great deal of work has therefore gone into permitting word processing and display of Greek. There are many general word processing programs allowing word processing in Greek; NOTA BENE is probably the best of these, at least for scholars, since it was designed by academics for scholarly use. Merely for the production of files of ancient text, the Ibycus Scholarly Computer, despite its primitive word processing capability, has remarkable advantages: it allows for such diacritical marks as dots under letters and for very easy switching between alphabets. Moreover, the display and printing of letters in Greek, Hebrew, and Coptic are very clear.

Other Uses

EDITING

Computer-assisted editing so far has been largely experimental, but it shows great promise. Robert L. Oakman has broken this process down into six separate steps (*14*). (1) collection; (2) collation; (3) establishment of relationships between texts; (4) emendation of copy text; (5) compilation of critical apparatus; and (6) printing of text and critical apparatus. It would appear to be possible to use the computer to greatly facilitate all of these steps except the fourth, for which the critical judgement of an editor is essential; so far, however, the computer has been used for only some of these steps. It has not so far been applied significantly for the first step. A great deal of work has been done by scholars in other humanistic fields to apply the computer to collation, but I am not aware of any such work on classical texts (*15*). Promising computer applications, especially of a statistical nature, have been made in Step 3, the attempt to determine the relationships among different manuscript traditions of the same text; this has included work on Juvenal and on the Greek New Testament (*16*). Not much work has been done to my knowledge in applying the computer to Step 5, but the fact that the critical apparatus of the Göttingen edition of the Septuagint is being included in the machine-readable text being produced by the CATSS project at the University of Pennsylvania shows that this is possible. Wilhelm Ott has developed a system for using the computer to produce a photocomposed final scholarly text, Step 6 (*17*).

PEDAGOGICAL USES

Many of the other uses of the computer described in this article have had as a primary or secondary goal the assistance of teaching courses in the languages and culture of classical antiquity. Pedagogy probably has been the driving purpose of the development of programs for the automatic morphological analysis of words in ancient Greek. Many systems and programs for computer-assisted language learning of ancient languages have been devised and are available (*18*). Pedagogical use is the primary purpose of Harvard's PERSEUS Project, perhaps the most promising project now at work for the application of computers to classical studies.

ICONOGRAPHIC

The U.S. Center of the Lexicon Iconographicum Mythologiae Classicae project, working under Jocelyn Penny Small at Rutgers University (New Brunswick, NJ) is creating a machine-readable database from 7,500 cards and photographs of the objects of ancient Greco-Roman art now present in the United States. This is part of the work of an international team with central offices in Basel, Switzerland, which is producing the Lexicon Iconographicum Mythologiae Classicae, a pictorial dictionary of classical iconography. The PERSEUS Project is including in its products images of such things as Greek art, architecture, and topography.

BIBLIOGRAPHICAL

Bibliography programs, which allow users to create, search, sort, and print bibliographical information in various formats, are of great use to classicists, as they are to other scholars. They have not, however, to my knowledge, been designed by classicists or for the exclusive use of classicists. They permit the user to search large databases and to extract bibliographical information from them. They also provide a convenient way for users to continue adding to their store of bibliographical information (*19*).

PROSOPOGRAPHY

Prosopography is the study of individual humans considered as items in a dictionary or the like. Prosopographic dictionaries containing the names, career outlines, and other information about persons mentioned in ancient literary texts, inscriptions, etc. have long been an important scholarly tool in classical studies, particularly in ancient history. Computers have an obvious application here. For the past several years, Professor John Traill at the University of Toronto has been directing the ATHENIANS project, which is producing a computerized database of all persons attested for ancient Athens; this project is now about two-thirds complete, with approximately 80,000 entries. A similar computerized prosopography of Attica (the Greek province centered at Athens) is being produced under Professor Michael J. Osborne at the University of Melbourne in Australia. This work in Australia is in connection with the production of a five-volume *Lexicon of Greek Personal Names* by Oxford University Press.

DICTIONARIES

The different volumes of the *Lexicon of Greek Personal Names* are being prepared in different places, and their work has been computerized to different degrees. Work on the *Diccionario Griego-Español* (under Francisco R. Adrados at the Consejo Superior de Investigaciones Cientificas in Madrid, Spain) has only been computerized to a limited extent. The Aramaic and Sumerian dictionaries now being produced at the

Johns Hopkins University and Cornell University (respectively) have been computerized to a much more thorough-going degree. This will obviously have to be done for classical studies in the future.

SOUND PATTERNS

A great deal of work has been done on the use of the computer to study the sound patterns of ancient Greek and Latin texts (*20*). It has turned out to be possible to automatically analyze the meter of verse in both the classical languages: pioneering work in this field has been done by David Packard and Stephen V.F. Waite. It has also been possible to use the computer to analyze prose rhythm, at least in ancient Greek: in a study of the corpus of Demosthenes, Donald F. McCabe was not able, as he had hoped, to prove beyond doubt the authorship of some doubtful works in the corpus, but he did reach important conclusions about the length of certain kinds of syllables of doubtful length (*4*). The computer has also been used to measure the frequency of alliteration and of various sound patterns once considered distinctive.

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DONALD F. MCCABE

COMPUTER USAGE IN SPECIAL LIBRARIES

While much has been written about the computer and its importance to not only the special library, but to all libraries, it sometimes is difficult to define the structure of the use of computers or information technology (IT) in libraries. Does IT use affect the library manager? If so, how? What does IT mean in terms of the staff? Do libraries using IT need more staff? More nonprofessional staff? What skills do staff members need?

The nature of the special library* is such that special librarians have been quick to adopt tools which assist in performance of library tasks. Because of this, they were quick to recognize the potential of the computer. Murphy pointed out that "special librarians were among the very first to turn to computers to enhance the client orientation and fast turnaround time that are their hallmarks" (*1*, p. 3).

Laver has explained *why* the computer was a useful tool (*3*, p. 6);

> (w)e manage to use computers quite successfully because, although they cannot avoid subtracting very slightly from the quantity of the information they possess, they add greatly to its value by presenting it in more palatable forms, by fishing out items of importance from a torrent of largely irrelevant data, or by detecting significant coincidences and correlations.

White said that special libraries were able to take advantage of technological evaluation and application of computers because of (a) limited access to computers which were not being fully used for organizational functions in parent organizations and could perform library functions involving repetitive applications; (b) small collections which could be automated rather quickly; (c) specialized collections often not already cataloged or analyzed elsewhere; (d) little managerial oversight, allowing experimentation (provided there was no extra cost); (e) limitations on library space which could be overcome by computer use; and (f) staff limitations (*4*, pp. 67–69).

The literature is full of descriptions of *how* the special library uses computers. It is difficult to find an issue of a special library-oriented journal that does not have at least one article related to computers in special libraries; more often, one finds several. A quick look at the index to the four issues of *Special Libraries* (*5*) published in 1988 finds nine articles which obviously deal with computer issues, with three articles on searching either online or compact disc-read only memory (CD-ROM) databases, two on developing databases, two on the use of telecommunications in some form, and two on integrated library systems utilizing computers. This does not include those articles which deal with such peripheral subjects as technology transfer.

Wood pointed out that "special libraries and information centers are usually defined in *negative* terms, that is, anything which is *not* a public, academic, school or

*There is some discussion as to whether "special library" or "information center" is a more appropriate term. While Jackson and Jackson (*1*, p. 19) have pointed out that "most persons think of the library as a *passive* service and the information center as an *active* service," this article will not differentiate between the two.

national library" (*6*, p. 2; italics added). However, there are some identifying characteristics by which special libraries can be differentiated from other kinds of libraries. These characteristics include differentiation by (*4*, p. 5; *7*, pp. 1–2):

1. Where they are found, that is, in businesses or private organizations
2. Limitations on subject scope; their collection objectives are guided by the needs of the parent organization
3. The kinds or groups of people who are served by them; because their users are the employees of the parent organization, their needs are also guided by the needs of the parent organization
4. The predominant characteristic of smallness, i.e., small collection; small space occupied; small staff
5. Their emphasis on the provision of information and service, *not* of documents

Which are the attributes of the special library that make the computer potentially so useful? The special library is a part of a larger organization, bound by the administrative practices of that organization. It must operate in an atmosphere in which the aims and objectives of the library may not be understood by those in the organization; at the same time, it must justify its existence to its management in order to obtain funds. Special libraries are "dependent on the support of top management for the level of funding they receive" (*8*, p. 5).

Introduction

The literature which has been reviewed for this article has looked at the following areas: the management relationship of the special library to its parent organization, the use of computer technology in special libraries, and the computer-related skills needed by library staff.

Ferguson and Mobley discuss the concept of the "library manager as part of the organization team" (*9*, p. 96). They are concerned with the significance of the special librarian's position in the corporate environment, an environment in which they have dual loyalties. As manager of the special library, the director must manage those library activities of which he/she is in charge. At the same time, he/she is subordinate to another managerial level in the parent organization; part of the librarian's responsibility is to bring "professional expertise to bear on solving company problems" (*9*, p. 96). Further, "a high position on the organization chart is advantageous to the work of the library" (*9*, p. 98).

White suggests that the continued use of computer technology is an important consideration for the special library. He feels that "the greater emphasis on professional personnel and professional activities should contribute greatly to the increased status and visibility of the library" (*4*, p. 80).

Management in Special Libraries

Literature reviewed here deals with: (a) the library as function of an organization, with materials written for management within the parent organization, not for the librarian; (b) the library as function of an organization, including materials intended for the special librarian; and (c) sources which deal with the process of management of the library itself. The review focuses primarily on the first two areas.

THE LIBRARY WITHIN THE ORGANIZATION: MATERIALS FOR THE CORPORATE MANAGER

Meltzer's work, *The Information Center: Management's Hidden Asset*, was addressed specifically to corporate management, rather than to management within the library. His intent was to "introduce managers to some of the basic concepts of establishing a management and technical information center and to describe methods of improving, expanding and evaluating existing information centers" (*8*, p. 5). The Special Library Association published a monograph intended for the corporate manager who will be in charge of the information function (7, discussed later). Meltzer's work remains the only complete work in the field written for the corporate decisionmaker, rather than the corporate manager.

Some material intended for the corporate manager tends to be public relations oriented, encouraging managers to use the library. An example of this is the article by Armstrong presented originally at the Financial Times Conference on Information Services held in London in May 1973. He pointed out that "it has taken a long time to convince the businessman that the company library is not for education or recreation—but purely for exploitation" (*10*, p. 206). He then described the services available to the businessman from the library.

The current American Management Association view of the special library, taken from the *AMA Handbook*, comprises 17 lines, part of 89 pages devoted to "General and Administrative Services." Specific to the topic of this work is the following excerpt from those lines (*11*, pp. 10–48):

> Corporate libraries support current research performed in the day-to-day course of business. Consequently, most sophisticated corporate libraries are using computers to generate catalogs and indexes to conduct information searches, and to access specialized data bases outside the organization.

It is interesting to note that within those pages are two full pages on "Central Information Services," which includes other information services.

Ahrensfeld's work is the latest revision of a publication written for and published by the Special Library Association. Written for the corporate manager, it is "directed primarily to the individual or group of individuals who have been charged with the task of finding solutions to the organization's information problems" (Foreword), that is, to the corporate manager in the company who will have operational responsibility for the library. The work addresses three broad questions: "1) How is a special library started? 2) What does a special library do? and 3) What resources does a special library require?" (Foreword). The work's guidelines for organizational placement for the library suggest no specific location for the library. They do suggest, however, that whatever its location, its reporting structure should put it no more than two levels away from the administrative head of the unit of which it is a part, whether the unit is department, division, or company (7, p. 33).

THE LIBRARY WITHIN THE ORGANIZATION: MATERIALS FOR THE SPECIAL LIBRARIAN

McCormick makes the comment that "librarians are inclined to view their jobs in terms of their traditional activities, such as acquisition, cataloging, [etc.]" (*12*, p. 206), (all internal library activities), while managers tend to look at the librarian's job in terms of such traditional management activities as planning, organizing, staffing, directing, and controlling (*12*, p. 208).

There are works in the literature of librarianship which address the role of the special librarian as a part of corporate management. Echelman points out that in addition to knowing how to manage the library, the special librarian needs to know and understand the parent organization. For this reason, the librarian needs to establish and maintain liaison with other managers within the organization in order to ascertain needs and to evaluate trends within the organization (*13*, pp. 409–410).

Strieby stressed the importance to the special librarian of organizational climate, and commented on the "dearth of literature contributed by special librarians on the concept of their organizational relations" (*14*, p. 174). She felt that the absence of standardized terminology in organizational operations made it difficult to compare activities, and that corporate organization might be meaningless to those without corporate experience. Although written more than 30 years ago, her work is a useful overview of the special librarian in the organization.

In discussing the placement of the special library within the corporate structure, she pointed out that "everyone in a supervisory position wishes to report to someone as high in the chain of command as is possible since he feels he can do more effective work with fewer hurdles to negotiate in securing approval for his ideas" (*14*, p. 175). While many organizational theorists feel the organization chart doesn't describe power accurately, since the informal organization may generate more power than the formal, she felt that the organization chart "may also indicate management's concept of the relative importance of the library's function in relation to all other units" (*14*, p. 176).

Crum analyzed the relationship between the librarian and the library's immediate supervisor, pointing out that special librarians have dual loyalties. He also pointed out the importance of overall relationships within the company; "success means rapport and financial support from management and failure spells discord and stunted library development" (*15*, p. 486).

Much early literature on the special library opted for placement within the research and development function of the organization, arguing that research and development staff were the library's greatest users. However, White points out that (*16*, p. 143)

> in times of trouble, placement within the research and development organization may be a disservice—in part because the library manager may have become lulled into a false sense of security, in part because reporting to R&D will frequently monopolize all of the library's time and attention, and in part because in times of stress and difficulty your very best users are too powerless and too preoccupied to help you.

White's attitude is pragmatic; the library must be "geared to making itself indispensable" (*16*, p. 144) to the people who make the decisions.

Yates addresses library location in terms of its status, its maintenance of lines of communication within the company, and its relation to management. He points out that "status will be enhanced if the unit reports directly to a director" (*17*, p. 432), and that the library would have "better status if it had an appeal to all departments in the company, technical, production and marketing, rather than just one department" (*17*, p. 434). A library well-placed within the organization is more likely to have a healthy flow of information into the library; there does not, however, seem to be a consensus on the definition of the term *well-placed* in this regard.

Three research studies address the location of the library within the organizational structure. Bedsole's research was a survey of libraries in Fortune 500 companies. He wanted to find out (a) the number of libraries in large industrial corporations; (b) characteristics of those libraries; (c) their similarities and differences; (d) the types of library organizations; (e) differences between libraries in different organizations; (f) if there were branch libraries; (g) cooperation and assistance among libraries within the company; and (h) cooperation and assistance outside of the company (*18*, p. 615). He found that the pattern of libraries in organizations is one of four (*19*, p. 1): a single library within the organization, several autonomous libraries within the corporation, a main library and branches, and a mixture of the three. While Bedsole hoped to find out about the reporting structure by asking for the department responsible for the library and the title of the supervisor, only 21 libraries responded to this question.

Matarazzo examined and described "the events surrounding the decision to eliminate the position of librarian and/or close the library in five corporate settings" (*20*, p. 124). His findings indicated that the decision to close the library was made by senior management, who not only were not likely to be library users but "also were likely to have little direct knowledge of the value or use of library services and collections" (*20*, p. 127). While library users might support continuance, they did not seem to be high enough in the managerial hierarchy to even know when reductions were being considered, much less to affect the outcome of such decision-making (*20*, p. 127).

MacDonald investigated the attitudinal relationship between special librarians and corporate managers. Her population was a sample of special libraries from corporations located along the eastern seaboard. She surveyed the librarians and their corporate managers, comparing actual situations to preferences of librarians and managers in several areas. Actual library placement was about equally split between placement in general administration hierarchies and in research and development (R&D) hierarchies; managers and librarians were about equally split in their preferences, also, with librarians preferring "other" in 16.1% of the instances. Respondents indicated that the placement was less important than the attitude of the manager or supervisor toward the library and/or the librarian. Other comments indicated that those preferring R&D emphasized support by the R&D staff as being important; those preferring administrative support felt that such placement increased the ability of the library to gain access to resources because of greater visibility among decision-makers (*21*, pp. 37–39).

MacDonald found that corporate managers report at upper middle levels of management rather than at top management levels. "This finding indicated that the libraries in the population were placed well below the level at which any direct access to decision-making could be achieved by the library manager" (*21*, p. 38). A majority of the libraries were placed at the supervisory level, and reported to individuals in middle management levels.

Dias studied the content of the jobs of managers in special libraries and information centers in Brazil. His perceptual study found no significant relationship between the library in an organization and perceived importance of the roles or role groups of the librarians (*22*).

MANAGEMENT FOR THE SPECIAL LIBRARIAN

The third area of management addressed in library literature deals with the management of the library itself. While it is not the concern of this research to explore management of the special library, the works in this section point out that a part of the management process includes the relationship between the librarian as administrator and the librarian's supervisor as corporate manager.

In 1970, the Maryland Library Manpower Research Program produced the results of a study which had surveyed the characteristics of library administrators in academic, public, school, and special libraries. The purpose of the study was to "analyze the characteristics of administrators and of the organizations and the environments in which they function" (*23*, p. 1).

The survey was sent to a sample of 150 special libraries and information centers reporting staffs of 10 people or more. When asked to indicate a preference within the administrative or research (R&D) hierarchy, respondents were evenly divided in their preferences (*23*, pp. 36–38). Those preferring administrative hierarchy felt they had more power and there were fewer obstacles in their way to accomplishing their needs; those preferring R&D felt that researchers had a better understanding of and empathy with the library, and were the primary user group. A third group had no preference, but felt that the library should report at least to the vice-presidential level. The study also asked about staff involvement in decision-making. Results indicated that most library administrators made final decisions, but often relied on staff for advice. There was no indication of involvement of the corporate managers in decision-making.

Mount's text deals primarily with the nuts and bolts of managing a special library. He lists major responsibilities of special library managers; the first is that the library manager (*24*, p. 24)

> must be adept at working with top management and executives. Top management makes decisions about budgets for departments, approves plans for expansion, and agrees to the creation of better facilities. If the manager is not successful in convincing the upper echelons of the worth of the library/information center, it is possible that when their support is needed it may be withheld.

White's text on management of special libraries is intended for the individual with "at least a basic understanding of librarianship as a profession" (*4*, p. vi). He points out that "special librarians operate in environments in which the need for a library is not always assumed" (*4*, p. vi). While he does not address the question of the location of the library in the parent organization, the whole work focuses on the special library as part of a larger organization which will support libraries only to the extent that they are perceived to contribute to the overall organizational mission; whose management may have no interest in or understanding of libraries and who may have been assigned management responsibilities arbitrarily; and which provides a set of organizational policies to which the library must adhere in addition to its own internal policies (*4*, p. 7).

Bailey discussed library organization for all types of libraries. When speaking of special libraries, she point out that librarians "may be classified in the job-classification scheme of either the parent organization or of the library suborganization' (*25*, p. 134). She reported that for her study she was unable to find research analyzing "changes in both the focus and the activities of libraries" (*25*, p. 134). Because of this, librarians were "unable to find data to support their recommendations to their managements on the level in the organization at which the service should report" (*25*, p. 134).

Bailey's discussions on management make clear her belief that librarians in special libraries deal in two environments: that of the library, in which the library director is top management, and that of the company, in which the library director is a corporate manager at any of several levels. She also points out that there is "controversy [among librarians] of whether or not management is a professional activity" (*26*, p. 1) with one view that "any administrative responsibility merely detracts from professional status" (*26*, p. 1), and the other that "any activity which resembles that of a business executive can only enhance the professionalism of librarians" (*26*, p. 1).

Martin's work on management, addressed to all types of libraries, discusses internal library organization. Reporting structure of the library is shown in a series of organization charts, rather than in discussion. In the short section devoted to special libraries (*27*, pp. 111–114), he points out that special libraries "can be orphans in the organization, attached to divisions or placed under corporate officers to which they are not intrinsically related" (*27*, p. 112).

Two authors have written reviews of the literature of management. O'Connor examined research in library management in the United Kingdom and the United States beginning with 1970. The work, commissioned by the British Library Research and Development Department "to assess the role, objectives and activities of the Library Management Research Unit" (*28*, p. 1) based at Loughborough University, explored research needs in the area of library management. He discussed management theory and practice, and identified as areas critical to management, organization, finance, operations, and personnel. Of his 20 research recommendations, the one most pertinent to this discussion is that "there is a need to examine the role of leadership in library management with particular reference to the leaders' relationship with staff, users and *the larger organization within which the library functions*" (*28*, p. 70; italics added).

Wood reviewed the literature on management of special libraries published since 1970 in North America, Australia, and the United Kingdom (*6*). She discusses management within the four areas outlined by O'Connor: organization, finance, operations, and personnel, adding user studies as a fifth area. She found it "impossible to ascertain a general picture [of organizational relationships] in the special library sector.... Virtually nothing has been written about special library and information service structures" (*26*, p. 10) of the parent organization. She points out that a part of the role of special librarians is "to see themselves and their services as an integral part of the total organization" (*26*, p. 13).

Technology and Skills

This section reviews the use of technology in the special library. It addresses (a) computer and information technology used in special libraries; (b) computer applications found in special libraries; and (c) skills needed for use of computers in special libraries.

COMPUTER TECHNOLOGY IN SPECIAL LIBRARIES

Larson, in a review of reference and information services in special libraries, pointed out that distinctions between special library, information center, and technical information center are becoming more blurred as "improvements in technology increasingly permit the economical addition of new and sophisticated products and services to the repertoire of those traditionally provided by the library" (*29*, p. 477).

Wood reviewed the literature dealing with information technology "relevant to management in its capacity as decision maker" (*6*, p. 40). She pointed out that the amount of information available in the area is "clearly enormous" (*6*, p. 40). Pinpointed as problem areas (*6*, pp. 41–42) are (a) decision making on equipment to purchase to perform tasks required; (b) use of microcomputers and assessment of applications software; (c) use and interpretation of statistical output; and (d) use of online databases.

White discusses the importance of technology to the special library. He points out the importance of the library manager's role, emphasizing the interrelationship of special library and parent organization. "Selection of computer hardware is in many organizations a centralized responsibility of the computer services department.... Special library and information center managers...must...assure that the equipment selected will be adequate, if not optimal, to meet their library's objectives and needs" (*4*, p. 75).

He suggests (*4*, pp. 76–79) that the use of technology affects the special library in the areas of document delivery; document formatting for delivery, use, and storage of material; electronic journals (including videotext and videodisc); manipulation of "marginal" information, including internally produced information, which may be among the most current and important information in libraries; information delivery to a (geographically) diffused population; and compilation of cumulative indexes.

Originally presented at IFLA, Cveljo's report on the developments in information activities and technologies and their implications for libraries in other countries is intended to present activities which might be useful for information management in developing countries. At the same time, she provides a useful version of current developments affecting American libraries. In her definition of special libraries, she points out that a characteristic of the special library is that it "is changing rapidly, particularly under the influence of, among other factors, a continuous development of new information technologies" (*30*, p. 331). She feels that the greatest impact has come about due to (*30*, p. 333)

> (a) development of different means of technology appropriate for information handling; in particular a tremendous growth in electronic techniques for the handling of documents; (b) greater reliance on rapid and accurate scientific and technical communications; . . . (c) the early utilization in scientific and technical libraries of appropriate new bibliographic apparatus and computer technology and data processing equipment; . . . and (d) heavy use of online databases.

Bailey summarizes the use of information technology in special libraries in the following (*26*, pp. 39–40):

> In many organizations there has been so much dissatisfaction with the central computer services that library managers, along with other department heads, are purchasing their own equipment. Supervisory and middle managers must work with computer systems that are designed for production, accounting, or research data, not bibliographic information. The programs may be limited to those which are compatible with the central computer system. . . . Although numerous programs are available which are designed specifically for information services, the central system managers may refuse to purchase them. In recent years the relatively inexpensive personal computers (PC) have enabled managers to regain control of their data and to utilize the services of the database vendors. Some libraries/information services hire their own programmers while others use those who are employed in the central computer service. Others may have their own systems analyst, as a middle manager in their organization, or at least an automation coordinator to interact with the central computer service.

COMPUTER APPLICATIONS IN SPECIAL LIBRARIES

The second group of technology-related materials include those which deal with applications. A review of six years of journals in the area of special libraries and information technology discovered that there was a great deal published about computer technology in all kinds of libraries. It tended to fall into four areas: (a) "how-we-do-it" articles (i.e., articles relating to large-scale applications; circulation systems, integrated systems, etc.); (b) description of computer software applications; (c) opinion articles; and (d) little research, with none of it applicable to this work.

One piece of research which provided some insight into applications was published in the Bowker Annual (*31*). The mail survey of academic, public, school, and special libraries contained questions about microcomputer hardware and software applications. The survey found that, in special libraries, 37.9% used micros; and that in 83.8% of those, librarians were involved in software selection and purchase. Applications included word processing, data storage, database management, online access to internal and external databases, budgeting and forecasting, book publishing and indexing, personnel records, and fund accounting.

COMPUTER APPLICATIONS IN LIBRARIES IN WESTERN PENNSYLVANIA

A recent survey by the Pittsburgh Regional Library Center investigated the needs of the libraries in their service area in terms of microcomputer training. Their report indicated that, among other areas, librarians needed "a good basic understanding of microcomputers and operating systems for loading and configuring the software, updating versions, adding and managing hard disks and other peripherals, and troubleshooting." (*32*, p. 7)

COMPUTER SKILLS IN SPECIAL LIBRARIES

White has suggested that the continued use of computer technology will force the development of in-house expertise, and will change the mix of professional/clerical staff. As he points out, "the greater emphasis on professional personnel and professional activities should contribute greatly to the increased status and visibility of the library" (*4*, p. 80).

Murphy (*1*) in a study of managerial competencies of corporate librarians, referred to work by Koenig (*33*). He reported results of a survey of special librarian/information officers in major industrial corporations, in which "*technology* and management/administration continue to head the list of critically needed knowledges and skills" for special librarians"(*33*, p. 186; italics added).

Summary

The review of the literature in the two areas, management and use of computer technology in libraries, has brought out several factors.

The placement of libraries within the information structure is varied, both in terms of level of hierarchy and in departmental affiliation. Many authors spoke of this variation; two research studies, those of Bedsole (*19*) and MacDonald (*21*) queried practicing special librarians about the realities of placement. MacDonald suggested also that "the whole question of the placement of libraries in corporate environments is deserving of further, more detailed study" (*21*, p. 40).

Library directors must function as management of the library, but must also be aware of their responsibilities as subordinates to corporate managers in the parent organization. Corporate managers may well be unaware of the goals and objectives of the library, but are responsible for decision-making which will affect the library. They also are the link for the library with upper management.

It is important that the library serve all areas of the corporation. Service to a single department/division limits the library's contact with decision-makers and to lines of communication within the corporation. This contact is important for the effective operation of the library and for its continuance as part of the organization.

New information technologies are affecting the way in which special libraries provide service (*30*, p. 334).

> A continuing challenge for the library manager lies in: (a) keeping abreast of the developments made in the emerging information technologies; (b) understanding information technologies and indicating that understanding to management; and (c) assuring the management that the application of technology will result in benefits.

Slater said that "not only do librarians suffer from an undesirable image, susceptible to stereotypic caricature of the buns, beads and glasses variety. They also suffer from an anaemic, low profile, shallow image. In a noisy, dynamic, complex setting, like the average firm, this can lead to virtual invisibility" (*34*, p. 336).

Olsgaard has pointed out that the process of change has come under active investigation. "[Various] disciplines have devoted considerable energy to the study of the process of change, specifically the kinds of change induced by the introduction of computer-based systems" (*35*, p. 20). His review of the literature of automation as a "socio-organizational agent of change" (*35*, p. 19) addresses the effect upon the organization of the introduction of computer-based systems. He recognizes three problem areas: (a) inadequate planning linked to inadequate training of organizational managers; (b) leadership, described as commitment that decision-makers must have in order to implement change; and (c) the potential for conflict arising between those who favour change and innovation and those who favor maintaining the status quo (*35*, p. 21).

The research that has been done in the area of management and/or of the use of computer-based technology has not addressed the real relationship between the library and its management. If it is true that the computer is changing the special library, as White posits, then that change should be visible (*4*). One of the places where a visible change might show up is in the relationship between the special library and its parent organization.

For a research project addressing the use of information technology (IT) in special libraries, a questionnaire was sent to all libraries in Western Pennsylvania identified by the investigator as independent special libraries, that is, libraries reporting to an organization which was not another library (*36*). Respondents were asked to describe libraries, parent organizations, and staff, and to provide detailed information on the library's possession of IT equipment. Also requested was a detailed description of IT applications and on-staff skills needed for use of IT within each library. The information gathered was used to develop a typology of IT usage in special libraries.

SUMMARY OF FINDINGS: SPECIAL LIBRARIES IN WESTERN PENNSYLVANIA

From the data analysis has emerged a picture of special libraries in Western Pennsylvania and their use of Information Technology (*36*). Of the 72 special libraries responding to the survey, 60 (83.3 percent) used some level of IT. The following description of these special libraries points out the variety of special libraries and their parent organizations.

The special library may be categorized in one of six categories: *Corporate, Education, Government, Law, Medicine,* and *Research.* Of those special libraries responding to the survey, 18 designated themselves as Corporate, two as Education, four as Government, nine as Law, 29 as Medicine, and seven as Research; three did not fit into any of the above classifications, and were considered Other.

Respondents were given the same choices for categorization of the parent organization; however, the two, library and organization, did not always match. Of 20 corporate organizations, only 16 had libraries so categorized; only two out of six education libraries were similarly categorized; and only three out of seven government; three out of four research; and three out of five other libraries fell within the same category as the parent organization. For the two groups of parent organizations law and medicine libraries were classified in the same category as the parent organization.

There is also great variety among IT-related attributes among special libraries. Of the responding libraries in the survey, not all libraries use IT. However, 60 libraries used some level of IT. Each category of library included some libraries within both groups except for education, in which all libraries used IT. Except for research libraries, all categories had more libraries using IT than libraries not using IT.

Overall, more libraries were located within the administrative services division of the parent organization than in any other division. Among individual categories of libraries, this was true for corporate, government, and medicine. Research libraries were more often located in R&D; education, law, and other were located in equal numbers in at least two divisions.

For all special libraries considered together, there were an average of two administrative levels between the head librarian and the division head, in which case the head librarian reported directly to the division head. For government libraries using IT, and for research libraries not using IT, the head librarian was, on the average, the division head.

The average number of administrative levels between the head librarian and the head of the organization was three, in which case the librarian reported to a supervisor who reported to the head of the organization. For individual categories of libraries, the average reporting level was varied; only for those libraries in the categories medicine and other was the average three. For other categories of library, the average number of reporting level differed both for individual category and within individual categories according to use or nonuse of IT.

Overall, users in more libraries fell within the category professional. This was true for 46 (64 percent) of all responding libraries; this included four libraries not using IT and 42 libraries using IT. For nonusing libraries, an equal number fell within the category of R&D users; for libraries using IT, the second largest categories included management and R&D.

In terms of total numbers of staff members, the smallest staff is composed of 0 staff members, in a library whose activities are performed by a staff person from another department. The largest is composed of 33 staff members. In terms of average numbers of staff members, the staff in libraries using IT is larger than in those not using IT, with averages of 4.517 in IT-using libraries and 1.750 in non-IT settings, respectively. For both libraries using and not using IT, the average nonprofessional staff is larger than the average professional staff.

Because of the overwhelming predominance of female staff members and professionals in the study population, it was not possible to determine if use of IT was in any way gender related.

As indicated before, special libraries were compared according to their use or nonuse of information technology (IT). Descriptions of library, parent organization, administration, users, and staff have been for all libraries responding to the survey questionnaire. The descriptions of equipment number and type, skills, and software applications beginning here will be only for those libraries which use IT.

The type of equipment found most often in the special libraries in the survey population is the standalone computer (microcomputer or PC), found in 44 (73 percent) of those libraries using IT. Dedicated terminals were used by 30 libraries (50 percent); fax machines by 15 (25 percent); organizational local area networks (LANs) by 12 (20 percent); optical disks by 8 (13 percent); and library LANs by 5 (8 percent).

The average number of pieces of equipment in all categories of library, whatever the type, was 4.667. The largest range of pieces of equipment was found in medical libraries, which had both the largest number, with 38 pieces, and the smallest, with zero pieces. Medical libraries also had the largest range of types of equipment, with at least one using IT but reporting zero equipment in the library, and at least one having at least one of each of the six types of equipment.

More libraries reported ownership or responsibility for equipment than shared or organizational responsibility. Of the 60 libraries using IT, 44 (73 percent) reported library ownership; 11 (18 percent) reported shared responsibility, and 3 (5 percent) organizational responsibility. The remaining two libraries used equipment that either was leased or on loan.

The five software applications used most often were online searching, used by 52 (87 percent); word processing, 46 (77 percent); database/library by 31 (52 percent); original cataloging by 28 (47 percent); and interlibrary loan, by 26 (43 percent). Least often used were online public access catalogs, bulletin boards, desktop publishing, serials binding, and machine translation. The area of applications most used were public service applications; its 11 applications were used by 57 (95 percent) of the libraries. Administrative applications accounted for four applications, used by 46 (77 percent) of the libraries; and technical services, with eight applications, were used by 44 (73 percent) of the libraries.

A variety of IT-related skills are needed by staff. Nonprofessional staff are more likely to need skills in data entry; professional staff skills in usage of software packages. The professional librarian is more likely to need some sort of IT-related skills than any other level of staff in 56 (93 percent) of the 60 libraries.

In addition to skills involved with hands-on usage of IT, staff have other IT-related responsibilities. The Library Director is more likely to be involved in software and hardware selection than is the staff, but is less likely to develop software than consultants within the organization. Also, while training was provided by the organization, in 28 of those libraries, training was provided by the library. This adds, or augments, the dimension of training in special libraries.

CONCLUSIONS

Both library and popular literature speak of the ways in which use of information technology (IT) will change the workplace. However, little has been written that documents such change in libraries. This work has been an attempt to develop a taxonomy of IT use in special libraries, a way to compare special libraries in terms of their use of IT.

Tiryakian (*37*, p. 179) described a taxonomy, or typology, as

> one in which the fundamental categories of ordering the types are inductively arrived at rather than formally deduced a priori; they are taken as 'natural' groupings. [His requirements for a typology were that] (a) each and every member of the population may be

classified in one and only one of the major types delineated . . . ; (b) the dimension(s) which is (are) differentiated into types must be explicitly stated; (c) this dimension must be of central importance for the purpose of the research.

For the analysis and summary of information gathered for this research, the special libraries were divided into two groups, those not using IT and those using IT. This division of two types of IT usage in special libraries has met these requirements in that (a) each member of the population fits into only one of the types; (b) the dimension by which they are divided, numbers of types of equipment, has been explicitly stated, and (c) the dimension is of central importance to the purpose of this research. However, the two-way division does not allow for a differentiation among libraries using IT.

After analysis of the data retrieved from survey questionnaires, the original division was refined by dividing the IT-using group according to numbers of kinds of IT equipment used. This expanded types to three: libraries not using IT, libraries using only one kind of IT, and libraries using two or more kinds of IT. The refined typology therefore became the following:

Type 0: Libraries not using IT. This group of libraries included 13 libraries, encompassing six of the seven categories of library.* It did not include any *educational* libraries.

Type 1: Libraries using only one type of IT. Of these, ten libraries had only dedicated terminals and 19 libraries had only standalones (micros or PCs). The 29 libraries in this group did not include any *educational* libraries.

Type 2: Libraries using two or more types of IT. Of the 30 libraries using two or more types of IT, only one library had all six types of IT; sixteen libraries had two types of equipment, six had three, six had four, and one had five types.

While the three-type taxonomy has merit as a useful tool for differentiation of special libraries according to their use of information technology, it is a rough gauge needing refinement. Those libraries having more IT may be able to perform a larger variety of activities. However, it may be that there are other elements at work. Several libraries having only one type of equipment were able to perform a variety of activities. Also, the survey instrument used did not ask that libraries not having IT indicate their capacity to perform manually some of the activities/applications performed by libraries using IT.

The population considered in this research was composed of more libraries using IT than not using IT; however, the population may have been self-selected. Those special libraries not using IT may not have been as likely to respond as those who do use IT. Even so, 60 libraries (41 percent) of the original special libraries contacted for this survey, make use of some sort of information technology in their workplace.

FURTHER RESEARCH NEEDED

The literature speaks often of changes in the library brought about by use of IT. What are the changes? In what areas of activities of special library activities do these changes occur?

*The seven categories of libraries included Corporate, Educational, Government, Law, Medical, Research, and Other.

This research has shown that there are some special libraries which do not utilize computers, or IT, in their activities. It may be that noncomputerized libraries are manually performing as many of the applications noted as are the libraries using IT. Does information technology enable the special library to perform more of these applications? Or does it enable the library simply to perform a variety of activities more quickly?

Libraries using IT in this study did not exhibit major differences in terms of library–organization interrelationships. Regardless of library type or of use or nonuse of IT, libraries tended to look similar in terms of location in organization and of distance from management. This does not rule out the possibility that the use of IT in libraries might bring about some changes in these relationships, depending on the need for the library to depend on organizational staff for IT support; the opportunity for library staff to *provide* IT support to organizational staff; and the use of such organization wide tools as local area networks and electronic mail. A recent article (*38*, pp. 45–50) extolls the use of industry electronic mail, but what is happening *internally*? For example, does use of e-mail allow the library to serve its patrons more effectively? More quickly?

Does IT use change staffing? White (*4*, p. 80) claims that use of computers in libraries will change the professional/nonprofessional ratio, with an increase in nonprofessional staff. This research has found that libraries in both categories, have larger nonprofessional than professional staff; but is this generally true?

Use of IT calls for a new variety of skills in terms of keyboarding and use of software. Does it also call for more skills in the way of evaluation of systems and applications? What about the need for staff with appropriate skills? If special libraries find themselves with more nonprofessionals, what are the implications for education, both for the special librarian, who might need to train staff members in a variety of activities, and for staff members themselves, who might need continuing education activities as much as the professional?

Further research should address these areas and possible appropriate responses by the special library to the changes.

One question in this project asked respondents to indicate if applications were self-developed, developed by the organization, or developed by a vendor. Answers to the question were such that it was clear that many respondents considered use of a vendor-developed software package for a library application to be "self-developed," while others considered only those in which the original software was developed in-house. It would be useful to be able to further differentiate these.

This research has begun the development of a taxonomy of special libraries according to their level of use or nonuse of information technology. One question which should be considered in further research is whether this is a legitimate typology, one which can be used with another group of special libraries or with another kind of library.

IMPLICATIONS FOR SPECIAL LIBRARIES

What are the implications of this research for special libraries? What are the characteristics of an effective special library? Is the use of IT the *cause* of a more effective organization? Is it an *indicator* of effectiveness? Much more research should be undertaken to pinpoint the effects, positive or negative, on IT usage in special libraries.

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PHYLLIS D. FREEDMAN

THE CURRENT STATE OF COMPUTING RESOURCES IN ANTHROPOLOGY

The State of the Art

In the introduction to a 1965 volume *The Use of Computers in Anthropology*, its editor concluded that "...the development of the electronic computer, and the diffusion of it among the sciences concerned with man, confront anthropology with a challenge that must be met, yet whose full nature is not yet generally grasped" (*1*). Thirty-odd years later with the development of highly portable laptop computers, powerful text management programs, and alternative storage devices like compact disc read-only memory (CD-ROM), the technology has pressed far beyond what anthropologists could have envisioned in 1965. Yet the role and place of computing in anthropology remains ambiguous, particularly in the realms of information retrieval

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and processing. On the one hand, computers have proved immensely useful analytical tools—holding together many otherwise difficult and previously implausible projects. On the other hand, they have the potential to become driving forces within anthropology—the ability to alter the very nature of the questions asked.

The importance of emphasizing potential over accomplishment lies in the fact that computing specific to anthropology remains an immature field, particularly outside of archaeology. Each year produces some new software, advances in hardware durability and portability relevant to anthropology, and conference sessions. Yet, sadly, outside of word processing, database management, and statistical analysis—applications obviously not specific to anthropology—anthropological computing continues to have little impact on the research conducted or the classroom. Phrased in different terms, there is, at present, substantial use of computing within anthropology, but relatively little anthropological computing. True anthropological computing remains a small proportion of total disciplinary use. This distinction is highly indicative of the degree to which the technology has failed to penetrate anthropological thinking and direction.

Certainly there is a dedicated core of anthropologists proffering the virtues of computer-assisted research or instruction, but the fact is that they remain a small and circumspect group. Few anthropological dissertations feature computer applications, computer-assisted curriculum development remains a largely unfunded personal activity, sessions at professional meetings continue to be small in number, and a major publishing vehicle specifically for computing in anthropology has not yet appeared. If anthropology is to move toward a true anthropological computing, these are key problems in need of thorough examination.

In short, any discussion of computing resources in anthropology must resist the temptation to venture far afield, including all applications of possible relevance to the anthropologist and student. As a "general" and diverse discipline this would be an impossible task (*2*). Therefore, rather than focusing solely on an inventory of current applications, this article instead discusses the current state of computing resources within anthropology by examining some of the boundaries within which the field has evolved. These boundaries are largely defined by disciplinary history, orientation, and funding priorities. The conclusion advanced is that although the computer has begun to make an impact within anthropology its potential within the discipline has not yet been realized. We end by exploring some recent trends which promise to address some of the widely held reservations limiting greater development of computer resources within anthropology. Lists of additional references, resources, and anthropology-related software follow the notes.

Impediments to the Rise of Computing in Anthropology: Boundaries

Traditionally anthropology has been a holistic and qualitative discipline poorly positioned for the ready acceptance of computer technology. Even prior to the advent of personal computers, anthropology had lagged far behind other disciplines in development of online and mainframe databases. The 1989 *Director of Online*

Databases listed only 10 online sources dedicated primarily to anthropology or archaeology (*3*). Notably, all are bibliographic or referral databases, and only one is in English.

Computerization of qualitative data, and the pigeonholing it normally implies for information retrieval systems, run counter to a disciplinary perspective seeing the whole as greater than the sum of its parts. As a discipline, anthropology has evolved with an organismic perspective toward culture and society which is antagonistic toward examining individual parts out of context. For example, The Human Relations Area Files (HRAF), a pre-eminent anthropological and cross-cultural research institute housed at Yale University, is often criticized for the way it partitions ethnographic text into discrete subject categories with concomitant loss of contextual information. Critics would argue that a thorough understanding of religious practices can only come from a complete examination of ecology, medical practices, and other cultural practices as well. One cannot, they maintain, understand religion by only looking at religion.

From a holistic perspective this is not an invalid criticism, although its relevance has become muted with the rise of a more problem-oriented perspective within anthropology itself and powerful hypertext facilities for text retrieval now incorporated into many text management programs, including those used in HRAF databases.

As noted, many anthropologists use the computer for database management, statistical processing, and/or word processing. But the computer remains largely a tool of convenience, not a topic of research, nor a driving force in determining the research conducted. The prevailing attitude, demonstrated by a number of publications (*4*) remains one of doing old things in a new, better, and faster way.

Going through the *1989–1990 Guide to Departments of Anthropology* (*5*) is one way to illustrate further this point. Departments may be increasingly prone to list access to computer facilities as a resource (*6*), but this does not reflect a pervasive interest in computer applications. Attached to each of the nearly 7,000 individuals listed are their research emphases—everything from general interests like "religion" and "symbolic anthropology" to specific topics like "pilgrimage" and the "structure of emotion." Yet I could find fewer than three dozen full-time faculty, plus a smaller number of part-time and research professionals, who listed some type of computer interest as a research focus. Most commonly listed were "computer applications" and "simulation." Smaller numbers listed emphases like "computer cartography" and "computer methods."

While these figures do not accurately reflect the actual use of computers within the discipline, they do provide a clue about the weight given by the discipline to computer applications as a legitimate scholarly interest. The vast majority of anthropologists continue to gain employment through where their fieldwork was conducted or what they studied—not the sophistication of the technology employed nor the development of computer databases and tools for computer-assisted instruction (CAI).

In the same vein, the Anthropology Program at the National Science Foundation (NSF, the major source of government funding in the United States) has placed little emphasis on the development of computer-assisted instructional aids for use in anthropology courses (*7*). Summer anthropology workshops funded by the NSF have resulted in some tools useful within the curriculum (some of which are discussed below), but the enhancement of social science education tools remains a low priority when compared with field research. No doubt some of this reluctance to fund curriculum development in the social sciences dates to the controversy generated by the NSF-sponsored MACOS *(Man: A Course of Study)* project of the 1960s and 1970s (*8*), however, this is only a partial explanation. The cultural relativism offered by MACOS was greeted with a storm of criticism from conservative and religious groups which ultimately resulted in the termination of the program in 1975. Films produced under the program for use in secondary education showed a number of what were considered unsettling and disturbing images—among them Inuit (Eskimo) spearing caribou from a kayak and Inuit children snaring gulls for food. And, although programs funding curriculum development have continued in the "hard" sciences through the Directorate for Science and Engineering Education, only the Instrumentation and Laboratory Improvement program is currently accessible to anthropologists.

In graduate courses, the employment of computer methodologies for research and teaching continues to receive little emphasis. Many of the largest graduate departments in the United States (as measured by students enrolled) do not list courses in which computer applications are emphasized (e.g., University of Arizona, Michigan, New School for Social Research, University of Texas–Austin). Even at UCLA, where anthropological faculty are very involved with anthropological computing, such a course is not part of the permanent curriculum (*9*).

One final example is the paucity of computer-aided analyses (in any form) evidenced by anthropology dissertations produced between 1985 and 1988. Of the 1705 dissertation abstracts listed by University Microfilms *(Dissertation Abstracts on Disc)* (*10*), only 34 (2%) make any mention of computer-aided analysis. More importantly, however, only four dealt the with development of computer techniques with application to anthropology, and all of these were archaeology dissertations. Only Markel's (*11*) dissertation critically examined the history of computer applications in archaeology.

Nonetheless, perhaps the most critical impediment remains the lack of organization among computer-literate anthropologists themselves. There is, at present, no section of the American Anthropological Association (the primary professional organization in the United States) dedicated to computer applications in anthropology nor a major journal committed to publishing articles on the same. This is not to disparage the contributions of the small newsletters which have emerged in recent years (e.g., *Computer-Assisted Anthropology News (CAAN), Cultural Anthropology Methods Newsletter (CAM)*, or *Bulletin of Information and Computing in Anthropology)*. It is to point out that they are not extensively circulated. *CAAN*, for example, currently has a circulation of about 250 (*12*). Widely circulated publications like *Academic Computing* (adv. circulation 100,000) (*13*) only occasionally publish articles specific to anthropology (*14*). And, as noted by O'Neil (*15*) and Ellen and Fischer (*16*) the number of articles carried in the major disciplinary journals remains discouraging.

The ramifications of this situation for the development of computer resources are multifold and self-perpetuating. In an academic setting encouraging, if not actually requiring, publications in referred journals as the way toward tenured security, it is highly understandable why many anthropologists would be discouraged from heavily investing in the time to get their computer methods, ideas, and innovations into print or software resources. Some anthropologists working on computer-assisted instruction packages refer to this work as "putting their careers on hold." By the same token, the discipline is not large enough to attract much attention from the commercial establishment.

Advances in Anthropological Computer Resources

OPTICAL DISKS

One of the most exciting potentials to emerge in recent years is the development of optical disk technology for anthropological applications. These include both single site and commercially available products. Many museums, for example, have been working over the past few years to make their holdings accessible through videodisc workstations. The most extensive application to date is being developed at the National Museum of Ethnology in Osaka, Japan. Through this system the visitor will eventually be able to view all museum holdings, especially those not currently on display. As this constitutes the vast majority of the museum's holdings at any given time, this will significantly increase access. For example, the entire holdings of tribal masks may be viewed from several color workstations located in the museum (*17*). Each artifact has been visually cataloged from four positions and is stored on one of many three gigabyte optical disks.

Another museum application is the Burke Museum's project placing their entire holdings of 13,000 Northwest Coast artifacts on videodisc. The Burke Museum's project uses Questor's Argus system for both entry and retrieval from four videodisc workstations. A number of other cultural and art museums are currently in the process of converting their holdings using the same system (*18*).

Other groups have also shown interest in the medium as a way of preserving visual information and increasing access. The African Studies Association has been studying the feasibility of using videodisc to maintain an archive of aging African photos (*19*) while the University of Cambridge now has a videodisc project integrating film, still shots, and text material on the Naga (*20*).

J. Jerome Smith's SPICE (Self-Paced Interactive Curriculum Enhancement) videodisc project was classroom tested in fall 1990. Integrated into the junior level survey course, SPICE eventually will be self-contained and include student testing. Access to *Faces of Culture* footage contained on the discs will be from eight workstations running IBM Infowindow (*21*).

The First Emperor of China: Qin Shi Huang Di is a set of two 12" NTSC CAV videodiscs, each with 108,000 visual images and a one hour narration in both English and Chinese (*22*). PROJECT EMPEROR-I is supported by the National Endowments for the Humanities and reports on the archaeological excavations of the terracotta figures from the tomb of Qin Shi Huang Di at Mount Li.

CD-ROM DATABASE APPLICATIONS

The Human Relations Area Files, a cross-cultural research institute centered at Yale University, is currently engaged in several CD-ROM database projects. The first is the *Cross-Cultural CD* series developed in association with SilverPlatter Information Systems. These topical text databases, which contain extracts from the 800,000 page full HRAF microfiche archive, are to be published semiannually. The first on Human Sexuality became available in Summer 1989. A second installment on Marriage followed in 1990. Eight more will follow over the next four years: Family Life, Crime, and Social Problems, Old Age, Death, and Dying, Childhood and Adolescence, Socialization and Education, Religious Beliefs, and Religious Practices. Each will contain from 6,000 to 15,000 pages of ethnographic text describing the cultures in the HRAF Probability Sample. This sample is comprised of a geographically diverse set of 60 of the best documented traditional cultures. Retrieval software is available for both IBM-PC compatibles and Apple Macintosh.

The second project, involves the updating and eventual distribution of the *Ethnographic Bibliography of North America* on CD-ROM. Funded jointly by NSF's Anthropology Program and NEH, the first part of the project developed a 25,000 citation supplement to the fourth edition which will be distributed on both IBM compatible floppy disks and hard cover (*23*). The floppy disk version contains ASCII files suitable for importation into a number of text management programs with Boolean logic-operated retrieval.

The second part of the project, funded by HRAF and NSF, is developing a comprehensive fifth edition of EBNA which eventually will be distributed on CD-ROM. This database will contain an estimated 55,000 to 60,000 citations (*24*).

ADVANCES ON TRADITIONAL MAGNETIC MEDIA: OTHER HRAF COMPUTERIZED DATABASES

HRAF has developed a number of cross-cultural databases now marketed as the *HRAF Research Series in Quantitative Cross-Cultural Data* through National Collegiate Software Clearinghouse. The first two volumes contain 207 coded variables (general cultural and life-cycle data) for the 60 cultures in the Probability Sample files (the same societies used in cross-cultural CD). The third contains 260 variables on magicoreligious practitioners and practices in 45 societies from the Standard Cross-Cultural Sample.

HRAF is also distributing the studies from UCLA's cross-cultural time allocation project. Two volumes on the Machiguenga (*25*) and Yukpa (*26*) are now available.

HYPERTEXT AND HYPERCARD APPLICATIONS

Although first described by Nelson and Englebert in the 1960s, hypertext is only recently finding a niche in microcomputing. In addition to the facilities now widely available on CD-ROMs, like *Cross-Cultural CD*, a number of text management programs (e.g., ASKSAM, V4.0) offer the data linkage capabilities necessary to making fuller use of ethnographic data.

Hypertext is an important advance in addressing frequently raised reservations about data access and context. Douglas White's ETHNOGRAPHIC HYPERTEXT contains exercises both created with an illustrating Neil Larson's PC-HYPERTEXT. PC-HYPERTEXT allows the author to create small hypertext systems in regular word processors (*27*).

While Apple's HyperCard is capable of hypertext functions, its use in this respect remains constrained (*28*). Its graphic abilities, however, are exceptional. Coupled with the support given by Apple for the development of courseware, Apple is beginning to make greater inroads at the postsecondary education level that have relevance to anthropology. For example, Brian Fagan (University of California, Santa Barbara) is developing a project combining HyperCard and desktop publishing. Scheduled to go into the classroom in winter 1990, ANTHROPOLOGY 3 contains slide/tape narrations, and problem-solving exercises for a lower division archaeology course. Apple Corporation provided the hardware (*29*).

Apple has also provided the hardware for Barry Lewis' (University of Illinois at Urbana-Champaign) project to develop aids facilitating access to the Human Relations Area Files Archive. Lewis feels that the computer-based aids will help alleviate student anxiety about utilizing the 800,000 page archive. His approach is to adapt a problem-specific perspective which guides students through the design of gathering and analysis strategies examining cross-cultural questions (*30*).

STACK (Steven Marquese, Potsdam College) is software for simulating archaeological projects from grant preparation through excavation and dating.

TEACHING APPLICATIONS AND RESOURCES FOR COMPUTER-ASSISTED INSTRUCTION

While small when compared against other disciplines, commercial software applications for use in computer-assisted instruction are still substantial and growing. Cognitive Development has recently expanded its ShowCase series to include several lines based on the Ethnographic Atlas. The STANDARD CROSS CULTURAL SAMPLE SHOWCASE contains over 200 variables for 186 preindustrial societies in the Atlas. They also market the WORLD ATLAS SHOWCASE (563 societies) and six regional Showcases (Sub-Sahara Africa, North America, South America, East Asia, Insular Pacific, and Circum-Mediterranean). Although the series virtually requires color graphics to be useful and some problems have arisen in adapting the software to anthropological data, these are useful additions to computer-assisted instruction in anthropology.

Meanwhile, National Collegiate Software Clearinghouse (NCSC), which was recently incorporated into Duke University Press, remains the leader in distributing instructor-authored software for the social sciences. The 1989 catalog contains 250 MS-DOS applications and three libraries of Apple II software (60 programs), including 22 titles for anthropology. Some of these are cited in the software list following the text.

Nonetheless, there are several other organizations that also act as distributors for anthropological academic software. Among these are Wisc-Ware, which also offers FUGAWILAND (T. Douglas Price and Michael J. Kolb, University of Wisconsin–Madison), using graphics to present perspectives and problems in archaeological excavation, and CONDUIT which offers the DIFFUSION GAME (Christopher Lovelock and Charles Weinberg).

The Library-Anthropology Resource Group (LARG) is currently developing a computerized biographical dictionary project which is to contain 500 word biographies of anthropologists, travellers, administrators, and others who contributed to anthropology's development. This promises to be a major resource for increasing contacts between anthropologists worldwide (*31*).

Robert Trotter (Northern Arizona University) currently has a matching grant through NSF to develop an "Ethnographic Data Processing Laboratory" at the university. Ultimately the lab will have 12 workstations, each with access to word processing, a statistical package, text and database management, as well as programs like ETHNOGRAPH and ANTHROPAC. In addition to serving as a resource for students, the facility will be useful to faculty interested in creating advanced ethnographic tools (*32*). Development of such labs on other campuses would spur computer resource development.

Nonetheless, software development for computer-assisted instruction remains a largely unfunded personal activity. Many faculty and researchers have developed their own packages to accompany introductory texts, provide interactive exercises, and test student knowledge. Some have made these available to the public and are included in the list following the text.

Conclusions

Despite the impediments outlined above, it is likely that computing will play an increasingly significant role within anthropology. New media intergrating sound, video, and text are one reason. Hypertext and HyperCard facilities are another. Together, they provide the anthropology student with an experience not possible from text or text-based exercises alone. At the same time, the number of research applications specific to anthropology is growing. Still, anthropologists interested in computing need to take greater responsibility for seeing this happen. Support for incorporation of a 'Computers in Anthropology' unit within the American Anthropological Association, greater exposure at national meetings, attempts to generate financial support from nontraditional sources, and participation in publication efforts are all important to the success of anthropological computing. Additionally, the discipline should encourage recognition of courseware authorship as a legitimate scholarly interest for anthropologists. Hopefully, the next several years will see a movement from computing in anthropology to a true anthropological computing.

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RICHARD A. WAGNER

ELECTRONIC DICTIONARIES IN MACHINE TRANSLATION

Introduction

With the rapid advancement in electronic and computer technology, traditional dictionaries of various types are now becoming available in different electronic media. The complete set of the world-famous *Oxford English Dictionary* has been available since 1987 on CD-ROM (Compact Disc-Read Only Memory). Another CD-ROM, the CD-WORD, containing thirteen bilingual and multilingual dictionaries in eight languages has also been on the market since last year.

Furthermore, electronic dictionaries in the form of reusable computer storage devices such as magnetic tapes and discs have been in existence since the birth of machine translation in the late 1940s (*1–8*). These were bilingual dictionary database systems created exclusively for their respective machine translation systems. The complexity of these dictionaries varies according to the designated needs of the translation designs. In other words, each dictionary system could be used for only one particular machine translation system. However, in recent years, monolingual dictionary systems have also been available on floppy discs for spelling corrections in word processors such as WORD-PERFECT. In a sophisticated system such as IBM's EPISTLE, not only can the spelling of the word be checked, but also the syntax of the sentence including subject–verb agreement and misuse of pronouns and articles can be verified.

A dictionary entry in a bilingual or multilingual dictionary may contain simply the keyword or headword in the source language, along with one or more of its equivalent words in the target language or languages. However, most of these dictionaries have included a combination of linguistic information such as word classes, various forms of prefixes and suffixes, other grammatical markers, compound words, and even some examples of usage in order to facilitate translation needs.

During the first generation of machine translation from the late 1940s to the mid-1960s, the electronic or machine-readable dictionary was the heart of all machine translation systems (*8–10*). These systems were classified as the Direct Model of machine translation. Their major component was the direct replacement of source language words with equivalent target language words. The operations were called dictionary or table lookup procedures and were used for searching through the electronic dictionary to match and retrieve the translation equivalents. The engineering approach is also known as word-for-word translation although some local word reordering may also be performed.

For the second generation of machine translation from the mid-1960s to the 1980s, the transfer module was introduced as the centerpiece of the system. These systems were grouped under the Transfer Model with three major components: analysis, transfer, and synthesis. In the analysis module, heuristic as well as algorithmic

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procedures have been applied to the parsing of the source language sentence. The resulting syntactic structure of the sentence along with its constituents and their linguistic information is then transferred into the syntactic structure of the target language in the transfer module. Finally, the synthesis module is given the responsibility to replace constituents in the source language with their target language equivalents. The specially designed bilingual dictionary is searched in the analysis module to match the input sentence and may be consulted again in the synthesis module for final output generation. Alternatively, since the transfer module serves as an intermediary between each language pair, two independent monolingual dictionaries may be used for multilingual translations as suggested in the Eurotra project (*8*, *11–17*).

From the late 1970s to the present, the third-generation systems under development focus on the semantics and pragmatics rather than the syntax for machine translation. Some sort of universal knowledge representation scheme has been sought to be an interlingua or intermediate language between all natural languages (*8*, *18*, *19*). Thus only the analysis and synthesis modules are needed to perform a meaning-based translation. The syntactic information is integrated into semantic and pragmatic requirements in the analysis module for the source language input and in the synthesis module for the target language output (*20*). For each language, one or two monolingual dictionaries are used for input/output, either jointly or separately.

Due to the current shifting of emphasis from syntactic grammar to semantic meaning, relationships between words, concepts, and messages are being re-examined closely in light of the intended information content (*8*, *21*, *22*). Since concepts are the basic unit of information and are usually represented in keywords and phrases, a return of the dictionary to its primary importance as in the first-generation systems is only natural (*20*, *23–27*).

Early in 1988, Systran Japan obtained major contracts from the U.S. Department of Defense and the European Economic Commission for machine translation between Japanese and Indo-European languages (*28*). The Systran Company, headquartered in the United States, has the most successful commercial machine translation system based upon bilingual dictionaries on mainframe computers (*8*, *29*). In addition, Japan's Fujitsu uses its mainframe machine translation system to translate manuals at three seconds per page (*28*). Fujitsu also claims quality translation can be achieved with computer-aided translation at 20 percent human time savings. The translation system is also used for information seeking and retrieval in Japanese language databases to identify potential articles for translation. There are also some microcomputer-based practical machine translation systems primarily using electronic dictionaries from Bravice International, Sharp, and other companies in Japan.

In particular, the recent development in terminological databanks and the introduction of electronic dictionaries on CD-ROMs have opened new avenues of application for machine-aided human translation (MAHT) with significant implications for human-aided machine translation (HAMT) (*1*, Chaps. 2–4). This is a very significant transition from the traditional way of utilizing the dictionary primarily as an intermittent reference tool. The printed dictionary is not designed to facilitate in-depth references and/or research interests.

With the new electronic dictionary, in-depth reference and research interests can be accommodated with ease since information retrieval capabilities and continuous updatings are now available from the dictionary database. The conventional organization of almost all types of dictionaries by alphabetical order is still the most efficient for printed dictionaries in terms of easy access. The cost of this access efficiency, however, is the great sacrifice of close associations among semantically and syntactically related words or lexemes.

It is interesting to note that the serious drawback of alphabetical ordering of dictionary entries was discussed painstakingly three decades ago by Melton (*30*) in relation to the Semantic Code Dictionary project. As a counter example, Melton illustrated the nonalphabetically ordered Chinese dictionary with a much more sensible organization. Until recently, all Chinese dictionaries were indexed and arranged by radicals, which are the smallest meaning units in Chinese (see Chinese Word Knowledge Base).

The problem with alphabetical ordering that has most concerned lexicographers is the search and retrieval of multiword units or compound words. With alphabetical ordering of entries, compound words may only be found according to the first word of the compound. For example, "electronic dictionary" would be listed under "electronic" but not under "dictionary." To remedy this deficiency, massive redundant listings would be necessary. The economics of a single volume multifunction printed dictionary prohibits this expensive treatment with acceptable consistency. Users are either short-changed with a no-show or required to make repetitive trials under other entries. It would be interesting to search for "drug dealing" either under "drug" or "dealing" for the result.

Monolingual Dictionaries

For machine translation, the monolingual electronic dictionary might be used in the input phase to match the source language text to identify constituent words and phrases and obtain their respective linguistic information for further processing. This is true for all three generations of machine translation. However, because of operational convenience and efficiency, bilingual dictionaries were popular and the monolingual dictionaries were not known in use until the early 1980s. The European Economic Commission (the Common Market) faces the difficult task of translating all official documents into the nine languages used by its member countries (*1*, Chaps. 3 and 4; *8*, *11*). In the planning and design stage for the joint venture Eurotra machine translation project, a decision was made to deliberately separate the source language in the analysis module from the target language in the synthesis module. There were at least two good reasons for doing so: (1) This would facilitate the natural division of labor for each member country to develop an analysis and a synthesis module for her own language. (2) The concurrent development and implementation locally in each member country would result in considerable savings in time, effort, and money.

At the center of these two modules are the two monolingual dictionaries, one for input analysis and one for output generation of that particular language. These two dictionaries would have some limited redundancy regarding their keywords and linguistic information contained. Nevertheless, the functional separation into two dictionaries should allow for more effective and efficient processing.

A more commonly acceptable usage of the monolingual dictionary for machine translation is in the editing of texts (*1*, Chap. 2; *8*, Sections 5 and 6). The monolingual dictionary may be utilized in the pre-editing of source language text to premark rough spots for a smoother machine translation. It can also be used in the on-line editing during the translation process, most likely for the target language. For postediting, it can be used for corrections in the target language. The recent development of interactive machine translation, such as in the CULT and CMU-CMT projects, may use the dictionary for pre-editing and/or on-line editing (*31*, *32*) with little or no conventional postediting.

OXFORD ENGLISH DICTIONARY

The best example of a modern electronic monolingual dictionary is probably the well-known *Oxford English Dictionary* recently available on CD-ROM (*1*, Chap. 2; *9*). The CD-ROM contains the complete original set of the 1933 edition, twelve-volume dictionary. Funded by the British government, the Oxford University Press is in the process of revising and enhancing the original dictionary to incorporate four volumes of supplements and other new materials. The *New Oxford English Dictionary* (second edition) consisting of twenty volumes was published in the Spring of 1989. The new edition is also available on CD-ROM for machine searches.

In the machine-readable form, this *Dictionary* offers researchers as well as the general public new ways to utilize this excellent dictionary. One major contribution of the electronic version is the new capability of information retrieval through Boolean combinations of keywords or concepts. In other words, new or related concepts may be retrieved in terms of other existing or known concepts. This is possible because words or concepts hidden inside each dictionary entry may be searched electronically for comparison.

For every dictionary entry, there are several distinctive fields, including the definition and etymology fields, which are most relevant to its meaning. The definition field is common for all types of dictionaries although it varies in detail and completeness. This dictionary is unique since the etymology field contains the structure and history of words tracing their origins from other Indo-European languages including Greek and Latin. Boolean operators such as AND, OR, and NOT may be used intermixingly to formulate a logical expression of keywords to uniquely specify the intended scope of searches. Reverse dictionary searches from meaning are thus possible regressively to find an unknown word through a Boolean combination of its origins and/or related concepts. A good example illustrated by Gray (*9*) was the word nyctalopia ("night-blindness") which might be found from the Indo-European root "NEKWT (night)." The etymology of "NEKWT" will further detail the history of its Greek origin from "nuk" to "nyc" to "nyct."

Another obvious advantage with the electronic version of the dictionary is the possibility and convenience of continuous updating and revision of dictionary entries to keep up with the ever-changing world of English language usage. With the current advancement in computer technology, the automation of the dictionary updating procedure is the only sensible alternative in comparison with the traditional cut-and-paste approach. The 1933 printed first edition with its four subsequent volumes of supplements can hardly catch up with the rapid changes in the past half century. This is a particularly serious shortcoming in the fields of science and technology where constant revisions are necessary.

Although the printed dictionary is not a satisfactory reference tool as pointed out by Gray (*9*), its shortcomings are not due to its "strict linearity" but rather its inability to permit Boolean expression searches and quick cross referencing. However, a printed dictionary with numerous pages does not require the linear search for a given word as in the case of a magnetic tape file. Since it is arranged alphabetically, a pseudo-random probe to the approximate page of the searched word is usually performed with a few more trials necessary to narrow the scope. This is not a strict linear search but rather analogous to the binary search as in a computer file (*33, 34*). Nevertheless, the electronic version is undoubtedly a versatile reference and research tool offering the unparalleled power of Boolean as well as the direct random access to headwords and other keywords. In essence, this is an innovative integration of the traditional dictionary and modern computer technology to implement a sophisticated information retrieval system augmented with database management capabilities.

CHINESE WORD KNOWLEDGE BASE

Another monolingual electronic dictionary outside the Indo-European language system is currently under construction in Taiwan (*13, 14, 35–38*). It is named the Chinese Electronic Dictionary (CED) in the Chinese Word Knowledge Base system carried out jointly by the Academia Sinica Computer Center and the Electronics Research & Service Organization of Industrial Technology Research Institute. The first objective of the system was to classify Chinese words in order to create machine-readable files. The system is divided into two subsystems: the Chinese character subsystem and the Chinese word subsystem. The latter is built upon the former due to the unique construction of Chinese words usually by combining two or more Chinese characters together (*8, 30, 39–42*).

In Chao's (*39*) authoritative book on Chinese grammar, he stated the closest linguistic unit to the Chinese "tzyh" ("tz'u/ci") is the "morpheme" which is the smallest unit of meaning in Indo-European languages. (Note: There are two types of Romanized Chinese transliteration systems, i.e., Wade-Giles/pin-yin, in use today.) Analogous to English words which are usually composed of two or more morphemes, Chinese words may frequently consist of two or more "tzyh"s. It is quite reasonable and natural for Chao to assume that "morpheme" can be treated as the translation equivalent of the Chinese "tzyh." Since this Chinese project follows Chao's book closely, the word "morpheme" is being treated as the same concept represented by "tzyh" throughout the first research report by Chang et al. (*35*).

However, as discussed by Melton (*30*), a Chinese character is an ideograph which frequently contains two or more parts called subcharacters. The subcharacters are commonly called radicals in Chinese lexicography (*41*). In turn, each subcharacter or radical has its own meaning and may often be used independently as a Chinese character or even a Chinese word. In addition, almost all Chinese dictionaries are compiled and indexed according to the number of strokes in the dominant radical contained in a Chinese character. A dominant radical is usually the left or upper one within the square-shaped Chinese character. All Chinese characters with the same dominant radical are listed together in the index according to the ascending order of their number of additional strokes present in the character. In this case, would the Chinese radical be more compatible to morpheme than "tzyh"?

Furthermore, Chao extended his theory of Chinese morpheme or "tzyh" to include multiple-character terms or concepts (*35*, *39*, Chap. 3; *43*). The strongest case and thus most interesting example is the; "pu'-t'ao/pu-tao (grape)" which is composed of two Chinese characters. Chao considered "p'u-t'ao" as a single-morpheme word because it was borrowed from the single-morpheme English word, "grape." Chao reasoned that these two characters cannot be used individually, one without another, to yield some meaning. (But the second character "t'ao" is listed separately in a popular Chinese word dictionary named "TZ'U-HAI/CI-HAI" as one kind of grass.)

A close look at these two characters reveals that each one is composed of a few radicals just as in any other Chinese character. The first character "p'u" consists of the dominant radical on top of the ideograph, the simplified character of "ts'ao/cao (grass)." Its middle part is a radical "p/b (first phonetic symbol in Chinese chu-yin/zhu-yin system." Its bottom (lower left) part is another Chinese character "fu/fu (start/begin/just)." The second character "t'ao" has the same top and middle radicals as in the first character "p'u" but has another simplified character "t'ao (ceramic container)" on the bottom left-hand corner.

Thus these two characters can be found separately under the radical "ts'ao (grass)." The second character "t'ao" is listed in the index before the first character "p'u" because its bottom part has six strokes instead of seven for the first character. The construction of these two characters may be explained as an indication to something which is a grass-based plant and shall be pronounced according to the lower-left part of the imbedded Chinese characters. Clearly these radicals and imbedded characters are smaller meaning units than each of the two characters "p'u-t'ao (grape)." Then, how can we say that "p'u-t'ao (grape)" is a single-morpheme word in the Chinese language? This same analysis can also be applied without difficulty to other two- or multicharacter morphemes in Chinese such as "mei-kui/mei-gui (rose)" and "ch'iao-k'e-li/qiao-ke-li (chocolate)."

Another question arises when a Chinese word is implanted into the English language. For example, "coolie" (hard labor) is a single-morpheme word in English. Its origins in Chinese are two characters "k'u/ku (bitter)" and "li/li (strength/labor)." The first character "k'u" has on its top the radical of simplified "ts'ao (grass)" while the rest is another character "ku/gu (ancient/old)." Through its composition, this character implies the taste of grass is bitter and it should be pronounced as the bottom character "ku." This bottom character may be further decomposed into the upper radical of "shi/shi (ten)" and the lower radical "k'ou/kou (mouth)." Should we notify all English dictionary publishers that they should indicate that "coolie" has two, three, or four morphemes? Is there a principle in lexicography that the number of morphemes of a foreign-borrowed word should follow whatever is defined in the original language?

If this is not the case, then why should we justify awkwardly that "p'u-t'ao" is a single-morpheme word which has two Chinese characters? One suggestion may be that since "p'u-t'ao" means grape and these two characters are not used separately, one without another, it should be treated as a single morpheme without any question.

Further decomposition of each character into subcharacters and radicals is unwarranted because the composition of a Chinese character should not be linked with its meaning. In other words, Chao's approach to identify "tzyh" with morpheme is satisfactory and acceptable. Yeh and Hsu (*44*, Chap. 4) also stated that most of the time each Chinese character is the smallest language essence, but "p'u-t'ao" is a single essence word in Chinese.

With all the discussions above about "tzyh" and character and morpheme, it is suggested here that a "tzyh" should be treated and translated as a Chinese character (i.e., ideograph) and not be equated with morpheme. An English morpheme may consist of a few English characters (letters). But a Chinese character may contain several language essences or meaning units, for example, morphemes, as subcharacters and radicals. Furthermore, each square-shaped Chinese character can be arranged without spacing either in traditional form from top to bottom and then from right to left in columns, or in Western style from left to right and then from top to bottom in rows.

New Chinese words may be formed with old combinations of Chinese characters such as "yuan-tzu-tan/yuan-zi-dan (atomic bomb)" and "tian-s'uan-chi/dian-suan-ji (computer)." Occasionally, new Chinese characters may be constructed using existing subcharacters and radicals. For example, the character "lu/lu (aluminum)" is made of a left-side radical of "chin/jin (gold/metal)" and a right-side subcharacter of "Lu/Lu (legal last name)." It contains the same radical "k'ou (mouth)" on the top and in the bottom, linked by a slanted stroke in between. The composition of this character indicates this is one kind of metal and should be pronounced as right-side subcharacter "Lu."

These and other unique properties of the Chinese character should be sufficient enough to distinguish itself as a different linguistic unit. The linguistic analyses in the Chinese language does not require the substitution of Chinese characters by English morphemes. An obvious example is that the analyses of free morpheme versus bound morpheme may be carried on with free characters versus bound characters without any difficulty. It is therefore, unnecessary to identify or equate the "tzyh" (Chinese character) with the English morpheme.

Multilingual Dictionaries

CD-WORD

On a single CD-ROM disc, thirteen bilingual and multilingual dictionaries with five million words and five hundred million bytes (characters) of data are stored for ready reference in seconds. This modern product, CD-WORD, is the first multilingual electronic dictionary, available from Sansyusya Publishing in Japan since 1987 (*45*). It includes eight languages: Chinese, Dutch, English, French, German, Italian, Japanese, and Spanish. The most amazing part is the ideograph of Japanese and Chinese characters which are nicely encoded for sharp display and printout. These nonalphabetical characters are much more complicated than Roman alphabets, and are numerous in number (i.e., about 10,000 characters). Around 2,000 of them, called Kanji in Japan, are used in the Japanese language in addition to Japan's own 50 ideographs. The Chinese and Japanese characters can be entered on the keyboard with the English alphabets as phonetic transliterations. Printouts of the Chinese and Japanese characters on paper require a NEC PC-9800 series computer system. A CD-ROM disc drive and an IBM personal computer system or its compatible will be sufficient for other languages.

Three modes of search are available: lookup dictionary, display translation, and display synonym. In the lookup dictionary mode, one may specify the desired dictionary and language to look up the full entry of a specific search term. Search terms may be entered as a single word or compound word. The search range may be selected as a headword only, subheadword with example only, headword and subheadword with example, reverse search, or search according to the last compound element. The search system will either find the location where the term should be in the alphabetical list with a blinking cursor or it will indicate that it is not found. For convenience, two or more search terms may be blocked together in the list for a single search, for example, science and scientist. The cursor may be moved to another more desirable term in the list for a full entry display. It is also possible to shift to translation mode to specify a display of translation equivalents in another language.

In the display translation mode, with additional specification of source and target languages, the search system will find and display all translations available for that term. The alphabetical list will be displayed to allow the selection of alternatives. With the same search term, one may switch dictionaries to find translations in any one of the seven desirable target languages. The display synonym mode will provide a list of synonyms in the same language for the search term.

These features offer flexibilities which are either absent or difficult to use in the printed bilingual and multilingual dictionaries. Presumably they will be incorporated into the CD-WORD-8 word processor. Its editor will allow the insertion or replacement of words in another language into a given sentence. This would facilitate the word-for-word, computer-aided-human translation using a word processor. However, this word processor with its editor is far from complete. The CD-WORD thus is currently used primarily in Japanese high schools for second language learning. It serves exactly as a multilingual electronic dictionary with no functional integration with a word processor.

Fortunately, a new version named CD-WORD 12+1 with eighteen dictionaries in twelve languages and seven million words on a single CD-ROM became available in early 1989 (*46*). The languages included are: Chinese, Danish, Dutch, English, Finnish, French, German, Italian, Japanese, Norwegian, Spanish, Swedish, and the additional American idioms in English. Correspondingly another range of search is added to allow the search of the idiom elements.

In this new version, popular word processors such as Word Perfect, Word Star, etc. may be used in conjunction with the CD-WORD search capabilities. In other words, one may compose a document using a word processor with on-line consultations to the CD-WORD for definitions, examples, synonyms, or translations. A multilingual front-end processor performs this linkage to furnish a split screen with the lower half for

CD-WORD displays. Translations or synonyms may be selected for insertion or replacement in the upper screen document.

TERM BANKS

Term bank is the short form of technological databanks which have sprung up in most industrialized countries over the past two decades (*1*, Chap. 4). The term banks are natural extensions particularly for bilingual and multilingual electronic dictionaries specializing in some technological domains for translation and other information needs. The existing printed version of the specialized dictionary can never keep up with the rapid changes in the terminologies used by a highly specialized domain whether in science and technology or in business. Certainly, the advancement of computer technology and the growth of user-oriented information science are also important contributing factors to the development of term banks. Users in volatile and sensitive areas such as national defense and international affairs face the requirement of up-to-date information for strategic planning and decision making.

Several user groups of term banks have been identified by Sager and McNaught (*47*) and Bennett et al. (*1*, Chap. 3). They are: (1) professional communicators such as technical writers, abstractors, journalists, translators, and interpreters are the largest user group whose major responsibility lies in the transmission of messages to information seekers; (2) information and documentation specialists such as information counselors and brokers, librarians, and indexers who need to identify documents and to construct thesauruses accurately for the public; (3) standardization experts who establish and publish precise standards with unambiguous terminologies; (4) lexicographers and terminologists who collect, record, and disseminate existing usages of terminologies; (5) applied linguists, language planners, and educators, and machine translation researchers who require statistics on the usage of terminologies; (6) dictionary publishers who depend on the database management capabilities of the term bank for data manipulation; (7) customs officials who have to verify on the spot, the labels and documents of imported goods; (8) news reporters, legislators, and government officials who need to familiarize current usage of terminologies in their foreign visits; (9) manufacturers and marketing specialists who rely on popular and effective terminologies for foreign exports; (10) insurance agents who deal with insurance policies as well as claims in a specialized field. Other user groups may also be identified when term banks are accessible to others involved in any specialized area such as professors and students, consultants, managers, newspaper editors, television anchor persons, etc.

Equipped with database management capabilities, the term bank is a collection of database files with millions of records (i.e., entries) divided into multiple fields for data manipulation (*8*, *33*, *34*, *48*). The term bank is thus a multifunctional tool capable of various types of information retrieval and computer-aided translation. Cross reference may be achieved instantly either by terminologies (headwords or keywords) for the complete record (entry), or by attributes (fields within an entry) and values (words in the field) across all records in the file. With additional user specifications, cross reference across different files is also possible if this feature is also available in the system.

For each record of a terminology, the properties, features, translation equivalents, examples of usage, and/or synonyms may be listed as separate fields as facets, or attributes of that record (*1*, Chap. 3; *8*, Section 7). The number of fields of facets may vary greatly from as few as six to as many as 76 per record entry. A typical term bank may have one million records with an average of three hundred characters per record for a total of three hundred million bytes for one database file.

Unlike the fixed number of twenty-five facets for each mathematical concept in Davis' TEIRESIAS system for mathematical discoveries (*22*, *49*, *50*), the fields in a term bank are not fixed while the individual field length may also vary. Bennett et al. (*1*, Chap. 3) suggested a list of twenty-four fields which would be common to a typical term bank. They are: (1) record identifier; (2) record originator; (3) date of input or update; (4) language or country code; (5) entry term; (6) source of entry term: (7) note on usage; (8) grammatical information or quality code; (9) scope note; (10) full synonyms; (11) abbreviated form; (12) synonyms; (13) conceptual links; (14) subject field; (15) definitions; (16) sources of definitions; (17) contacts; (18) sources of contacts; (19) foreign language equivalents; (20) sources of foreign language equivalents; (21) foreign language equivalent note on usage; (22) foreign language equivalent scope note; (23) foreign language equivalent context; (24) foreign language equivalent source of context. Additional fields may of course be added as the need arises, for instance, inference, class—member relationship, similar or related terms, etc. The goal of information retrieval has always been aimed at high recall and precision ratios. The recall infers the exhaustive retrieval of all relevant and pertinent data in the database file. The precision refers to the accuracy and correctness of retrieved data in relation to search request, whether it is a single keyword or a formulated Boolean expression. In addition to bibliographical and document retrieval systems, other systems such as the expert system and computer-aided instruction (*1*, Chaps. 4 and 5) may be considered specialized information retrieval systems augmented with other intelligent capabilities. However, as pointed out by Bennett et al. (*1*, Chap. 3), the success rate was averaged at 50 to 60 percent for general term bank searches. Some term banks in specialized fields may reach a success rate of 75 percent to satisfy users' requests. This clearly indicates that there is much room for improvement.

As for computer-aided translation, whether it is a machine-aided human translation (MAHT) or a human-aided machine translation (HAMT), the new development and resurgence in the past decade are yet to be implemented and verified (*8*, *51*). The 80 percent rate of acceptable translation for the TAUM-METEO English-to-French weather reporting system of the Transfer Model rooted in syntax since 1977 is still the only exception due to a highly specialized and limited vocabulary of 1,500 phrases.

Experimental translation systems under the new Interlingua model based on knowledge representations of concepts are at various stages of theorizing, hypothesizing, experimenting, or preliminary testing. No production system of this type is known for implementation. Interestingly enough, as mentioned in the introduction, the Systran systems for various language pairs under the oldest word-for-word Direct Model of machine translation continue to expand their market of productional machine translation systems (*28*). Needless to say, the demand for machine translation is there and the need for more improvement is great.

Dictionary-Based Machine Translation

AUTOMATIC SEGMENTATION FOR TRANSLATION

In a broader sense, all machine translation systems were based on one or more dictionaries or lexicons. The electronic dictionary was in essence the foremost fundamental tool for machine translation. It is much more important than in the case of human translation because words in the text cannot be recognized as meaningful units and need to be segmented (fragmented) or grouped into concepts and terminologies for further processing (*20, 40, 43, 52–55*). This preprocessing could be performed manually by human pre-editing as in earlier machine translation systems (*8*). Pre-editing would allow manual markings of phrases so that the dictionary may be used sparingly for consultation only.

One workable automatic segmentation procedure started three decades ago for the word-for-word machine translation with the Direct Model was the use of the longest-match principle for dictionary lookups (*56*). It is believed that the commercially successful Systran bilingual machine translation systems are built upon this principle. In order to have the longer text strings recognized automatically rather than the shorter string with identical characters or words, the longer string was arranged ahead of the shorter string as headwords or keywords in alphabetical ordering of all dictionary entries.

If A, B, C, and D each represent a Chinese or Indo-European language character or word, the longer string of ABCD would be placed in front of the shorter strings in the sequence of ABC, AB, and A. A text string of CABD would be automatically segmented and looked up under three separate dictionary entries: C, AB, and D. An English word example may be: "He almost kicked the bucket twice on the highway." The phrase "kicked the bucket" would be recognized and looked up in the electronic dictionary properly instead of being treated as three separate words.

In oriental languages such as Chinese, Japanese, and Korean, the need for segmentation is much more serious since there are no spaces used in the text as word delimiters. An example in Chinese may be: "Hsiao/Xiao (small/little) lung/lung (dragon) yen/yen (eye) hen/hen (very) hao/haw (good)." These five Chinese characters are a legitimate Chinese sentence even without a verb. Depending on the arrangement of dictionary entries, that sentence could have two meanings and thus two different translations: (1) The eyes of little dragon (nickname of a boy) have very good (vision); or (2) The small dragon's eye (name of a Chinese fruit) is very good (tasty).

The first translation was the result of matching "hsiao lung" first as a popular boy's nickname. The second translation was due to the match of "lung yen" first (or the lack of the entry "hsiao lung"), which indicates the name of a popular Chinese fruit. Correspondingly, the single character word "hao" may refer either to good vision for the boy or tasty for the fruit. It may be noted too that "yen" gives no indication of singularity or plurality, and no subject-verb agreement in number, gender, or tense is necessary.

Furthermore, incorrect matches from the dictionary may be corrected by adding new entries in the proper sequence, for example, "hsiao lung." However, there are cases which may still yield incorrect matches, for example, if both "hsiao lung" and "lung yen" are in the dictionary but the match of "hsiao lung" first is incorrect for the sentence "hsiao hsiao lung yen hen haw." Assuming "hsiao hsiao" is the name of a local fruit store and absent from the electronic dictionary.

One semantically intersting solution is the use of contextual information including local objectives and topics, and global goals, plans, themes, and subject matters. The translation of "The eyes of little little-dragon (boy's nickname) are very good" should be recognized as incorrect. The translation should be corrected using contextual information as "The dragon's eye (a Chinese fruit) of hsiao-hsiao (a fruit store) is very good."

Viewed from another angle, if the last character "haw (good)" in the five-character Chinese sentence is being replaced by another character, the segmentation of the first three characters "hsiao lung yen" may be determined. If "haw" is replaced by "jing (sharp)," then the first three characters should be correctly segmented as "hsiao-lung (little dragon) yen (eye)." This is because the word "sharp" can be used to describe the human vision but not a fruit. On the other hand, if the last character is replaced by "tien (sweet)" then the correct segmentation should be "hsiao (small) lung yen (dragon's eye)," The reason is that "sweet" is often used to describe the taste of a fruit, but unlikely to describe the eyes of a human or animal.

With automatic segmentation to identify concepts in words or phrases, a minimum level of robustness in machine translation is guaranteed even without a syntactic and/or semantic grammar. For users who are experts on the subject matter but with little or no knowledge of the foreign language, ungrammatical translations with basic phrases and special terminologies would be sufficient to reveal the topical information and even the theme of the subject matter (*1*, Chap. 4; *8*, Section 5).

This is particularly useful in information retrieval question—answering and expert systems from a foreign language database (*1*, Chap. 5; *57–59*). In order to provide some translations rather than no translation at all, grammars used in a machine translation system should be forbidden to stop the output due to parsing failures. Otherwise, the five-character Chinese sentence illustrated above would never be translated simply because there was no verb in existence. Similar disruptions would also occur due to missing subjects and articles, and hidden tenses, genders, numbers, and so on in Chinese as well as other oriental languages including Japanese (*52a*).

LEXICON-DRIVEN TRANSLATIONS

Since a natural language evolves over hundreds or thousands of years, language expressions which cannot be governed by grammar are commonplace rather than exceptions (*8*, *20*, *22*, *49*, *52a*, *60*). For any machine translation system, dictionary lookup procedures were performed first at the input stage for automatic segmentation and the last stage for final output generation. During the translation processes whether in the analysis, transfer or generation module, the dictionary might often be consulted repeatedly for further clarifications.

Word-specific grammar information might be contained in the dictionary entry as facets or fields along with semantic information (*30*). Other less obvious information such as word orders, contextual relations, subject matters, and speaker's attitudes should also be recorded and updated as many times as possible with the word or phrase entries in the dictionary. This would reduce the loss of information in machine translation. Knowledgable human translators always have most of this information available to perform the translation or interpretation.

Grammatical rules represented by annotated parsing trees may or may not be necessary for dictionary-based machine translations. Under the Transfer Model, translation systems such as Eurotra in Europe and MU in Japan depended heavily on tree-to-tree transfers or transformations in the translation process (*52a*). As systems developed under the Direct Model, recent experimental systems under the Interlingua model were attempting to provide alternatives to reduce or eliminate complicated and not quite successful grammar-directed translations (*8*). In other words, since human translators are not driven by grammar but rather by words or phrases from the source language to the target language, dictionary or lexicon-driven systems may serve information needs adequately.

The dictionary or lexicon-driven systems might appear less intelligent and thus uninteresting. This should not be of great concern. In fact, as pointed out bluntly by Nagao (*52a*) and others, machine translation systems in general do not require total understanding of natural languages. Interpretations of sophisticated sentences in a particular context can and should be left with the translation users. Excessive inferences made by the intelligent machine translation system could be misleading and even erroneous. Once again, human translators would not and should not use their full intelligence and world knowledge for translation tasks for the same reasons.

Furthermore, Cullingford and Onyshkevych (*20*) discussed the serious problems of grammar-driven systems. One major drawback was the insensitivity or lack of robustness in translation due to the popular top-down parsing strategy. This was particularly true for irregular but common language expressions such as idioms, phrases and incomplete sentences. Another more serious problem was the de-emphasis of the importance of concept and message transfers between languages. The perfectly grammatical sentences without useful information content should not be translated in the first place.

With their experimental systems, Cullingford and Onyshkevych (*20*) suggested that a dictionary or lexicon-driven system would preserve the meaning in the translation. Difficult problems in the grammar-driven systems such as word sense disambiguation, anaphora resolution, and the lack of translation equivalent may be resolved. The use of the bottom-up approach for input language analyses would allow automatic fragmentation or segmentation of conceptual units in word groups or phrases. This would provide the opportunities for diagnostic evaluations and modifications to preserve the original readings of meaning.

The simplistic model of surface semantics presented by Cullingford and Onyshkevych was indeed very interesting. Without the transfer module, the analysis module for the source language and the generation module for the target language were based on word meanings alone. In place of the interlingua, an annotator bridged these two modules by annotating surface semantic forms for output. The conceptual analyzer creates a meaning structure which is a knowledge representation for each input sentence. This meaning structure is kept in the surface semantic annotator for slight modifications of concepts in order to neutralize their differences in modes of expressions among languages. The neutralized meaning structure will then be sent to the conceptual generator for the generation of target language expressions. The word sense database, namely dictionaries or lexicons, is linked to both analyzer and generator for frequent on-line consultations.

The use of surface semantics as the interlingua, furnishes a unique means to neutralize unnecessary language-specific differences. Traces from source language conceptual representations such as suffixes, cases, and functional words may be discarded since they are contained in the dictionary entry and may be looked up for target language generations. Important information such as people, time, place, and things are recorded in the annotator for future references until they are replaced by the new corresponding information.

For example, the tense case information in English is not needed for the Chinese translation just as in the Ukranian-to-English translation. In Chinese an indication of time alone, e.g., yesterday, is sufficient without further tense information to modify the verb, e.g., "-ed". The same is true for information on person, number and gender which should be stripped from the English concept words. Thus the surface semantic annotator is language independent and needs no replacement when other languages along with their conceptual analyzers and generators are included for translations. However, some additional guidelines may be added to the neutralization process when necessary. The goal is to keep the annotator small and simple by leaving all syntactic and semantic information in the concept words or phrases in the dictionary entry for output generations.

An important class of simpler inferences could be achieved with words and phrases without the use of world knowledge. These inferences include the selection of appropriate word meanings, the resolution of anaphora references, and the process of distributed target realization (*20*). The distributed target realization refers to the possibility and ease of expanding single word source language concepts into multiple words and/or clauses in the target language. The same is true for the contraction from multiple word concepts to the single word concepts. This is a clear advantage of the lexically driven system over the syntactically oriented transfer system. No complicated transformation rules are required to perform the expansion or contraction. The target language expressions are realized by distributing or redistributing the concept words in the annotator through dictionary lookups in the analyzer and generator.

There are several distinctive features in the generation phase. The most unique feature in comparison with the majority of machine translation systems is the presence of a well-formed thought or message for output generation. No syntactic structure is present for the sentence. The thought or message consists of concepts organized as a meaning structure. Concepts are placed in a stack to be examined and augmented with functional words required for the target language expression.

Another important feature is the use of the top-down approach totally different from the bottom-up strategy to recognize the input concepts. This permits a total freedom to generate the output expression based on the thought or message and its concepts. Features or facets of concepts may be checked for consistency or agreement to select the most appropriate form for a given concept. This also allows for possible verifications with the theme and subject matter of the context to make sure no conflict messages are given unintentionally.

Conclusion

In view of the recent advancement and new developments in electronic dictionaries, a dictionary-based machine translation system presents to itself new opportunities to integrate the Direct Model with the Interlingua Model. The concept-based word and terminology databases such as the Chinese Word Knowledge Base and many terminological databanks collect and organize various aspects of word meanings for future references. The availability of monolingual and multilingual dictionaries on the high capacity CD-ROMs such as the *Oxford English Dictionary* and the CD-WORD is a blessing for further research in machine translation on economical microcomputers.

The return to the dictionary-based system from the grammar-based system was caused by two factors. The first is due to the fact that syntactically oriented systems do not make headway in high-volume production quality machine translations. Then endless linguistic irregularities and complications can never be covered substantially simply because of the evolutional nature of language development. The theoretical foundation for the Transfer Model is sound for multilingual translation systems. But its successful implementation depends heavily upon the success of the language-dependent transfer module for each one-way translation of the language pairs as specified in the gigantic Eurotra project.

Another reason was the search of knowledge representation schemes which lead to the re-examination of semantic units of concepts as in words and phrases. Properties or facets of concepts are explored and recorded. Relations between words as well as across sentences are probed for a more meaningful representation. A shift of emphasis from syntax to semantics and pragmatics in machine translation research is underway to facilitate a more useful communication over language barriers. The use of world knowledge in human translation is analyzed and compared with the needs in machine translation.

With dictionary lookup procedures for automatic segmentations, a dictionary-driven machine translation system is possible to integrate with the Interlingua Model for new alternatives. Monolingual databases and multilingual term banks may be stored on CD-ROMs and updated periodically as new releases to the public. A multidisc CD-ROM drive system such as the InfoTrac Reference Center may be used for concurrent access to different CD-ROM dictionaries and databases for cross references during the translation process. This should provide an excellent environment for the design of an informative and message-oriented dictionary-based machine translation system.

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ELECTRONIC PUBLISHING: SIGNIFICANT LANDMARKS

In the past decade, the literature related to electronic publishing has grown rapidly. Many monographs and new journals have appeared every year. This article highlights the significant landmarks pertaining to electronic publishing. It covers many important ideas, visions, and actual experiments. Its purpose is to help the readers interested in the subject understand the historical development of electronic publishing.

It is well known that paper and printing were originated in China in the second and fifth century of the Christian era, respectively (*1*). It is also known that there is a "wordless heaven-book" (無字天書) "published" in oral or paperless form among the Chinese. The wordless book is actually an adaptation and extension of "The Song of Baked Dough by Pei-Wen Lu" (劉伯溫燒餅歌) (*2*) of the fourteenth century. The "elite" in every generation have access to the timelessly flexible text of the heaven-book, to interpret the contents, and to predict accordingly the great events of the world, particularly when it is in chaos. The world refers to, of course, the "Middle Kingdom," which is China in Chinese. Although the work is only a legend, the wordless heaven-book can be considered as the pioneer prototype of modern electronic publishing and as the earliest idea of the recently developed hypertext.

Another classic concept of electronic publishing can be traced in *Gulliver's Travels* by Jonathan Swift. First published in 1726, the work has a passage describing a writing machine developed by the Lagadonians in the Grand Academy of Lagado. "The superficies was composed of several bits of wood, about a bigness of a dye.... They were all linked together by slender wires." By this contrivance, "the most ignorant person at a reasonable charge... may write books in philosophy, poetry, politics, law, mathematics and theology, without the least assistance from genius or study." The Lagadonian writing machine used the method of a fixed syntactic structure and the filling in of that structure with contents by a random procedure (*3*).

Recently, Edwin B. Brownrigg and Clifford A. Lynch of the Division of Library Automation, University of California, Berkeley declared that "electronic publishing was established . . . in East Pittsburgh in 1919–1920 with Frank Conrad's music broadcasts at radio station KDKA . . . " (*4*). Joseph Becker, President of Becker and Hayes, claims that, in 1944, he applied punched card machines to a file of information about enemy ordinance. He used the punched cards to code indexed information and to store bibliographic citations and abstracts (*5*).

In 1945, Vannevar Bush, then Director of the U.S. Office of Scientific Research and Development, envisioned a machine he called "memex." It "is a device in which an individual stores his books, records, and communications, and which is mechanized so that it may be consulted with exceeding speed and flexibility." He further described that:

> It consists of a desk. . . . On the top are slanting transluscent screens, on which material can be projected for convenient reading. There is a keyboard, and sets of buttons and levers. . . .

He continued that "encyclopedias [are] ready to be dropped into the memex and there amplified" (*6*). Later, Bush and Ralph Shaw, then the librarian of the U.S. Department of Agriculture, built the Bush–Shaw rapid selector, a database of the abstracts of the *Bibliography of Agriculture* (*7*).

In the 1950s, James W. Perry at Western Reserve University invented a machine for information searching using relays as switches and punched paper tape as the medium for storing abstracts, index terms, and search requests. The machine was able to search an abstract a minute and handle ten questions simultaneously. It is considered the forerunner of today's high-speed text array processors. At about the same time, Fred Jonker built the Termatrex, a machine to facilitate the process of coordinated indexing founded by Mortimer Taube (*8*).

In the Fall 1960, Theodor Holm Nelson, then a graduate student at Harvard University, announced as his term project a writing system for the 7090 computer. The idea of the project was to store "manuscripts in the computer, change them with various editorial operations, and print them out." He called the process "text handling," and named it Project Xanadu. A prototype of the system was developed and put online for experimentation in January 1987.

Nelson claims that Project Xanadu "is the first hypertext system to be so called," although he recognizes that actually the first hypertext is the NLS system created at Stanford Research Institute by Douglas Engelbart, the inventor of electronic text systems. Later, Nelson broadened his concept of hypertext and coined the term "hypermedia." The idea of "hypertext" is essentially "non-sequential writing—text that branches and allows choices to the reader, best read at an interactive screen" (*9*).

In 1965, Joseph Carl Robnett Licklider, Supervisory Engineering Psychologist of Bolt, Beranek, and Newman Inc. of Cambridge, Massachusetts, conceptualized "separating the information in books from the pages." He demanded that (*10*):

> We need to substitute for the book a device that will make it easy to transmit information without transporting material, and that will not only present information to people but also process it for them. . . . To provide those services, a meld of library and computer is evidently required.

It was in the 1960s that System Development Corporation (SDC) demonstrated the first online bibliographic text search system (*11*), and the Mead Data Central (MDC) developed LEXIS, one of the first full-text databases (*12*). Also in the 1960s, computers were first used to drive photocomposition devices in the print process. This primitive electronic publishing generated machine-readable databases, which, in turn, were used for computerized literature search.

In the 1970s, computers, telecommunications, televisions, and software were further developed and converged. Now, technologies were ready for the complete process of electronic publishing. With this background, the New Jersey Institute of Technology launched the Electronic Information Exchange System (EIES) in 1976. The EIES provided its participants with the capabilities of personal communicating, group conferencing, document publishing, word processing, text editing, etc. (*13*).

By means of the EIES, the entire publishing process was facilitated. Writing, revising, transferring, reviewing, editing, publishing, and reading were done through the electronic communication system. There were four prototypes of electronic journals for experimentation: newsletter, paper fair, mental workload, and legitech (*14*). Richard M. Dougherty and Wendy P. Lougee at University of Michigan Libraries consider the EIES as relatively successful in comparison with other systems, such as the ADONIS (Article Delivery Over Network Information Service) project, which was scaled down from its original conceptualization (*15*).

In 1980, the University of Birmingham and Loughborough University of Technology in England jointly announced the Birmingham and Loughborough Electronic Network Development (BLEND) project. The aims of the project were to study the problems of setting up an information community and to establish an electronic journal. The concept of the electronic journal was described as (*16*):

> Using a computer to aid the normal procedures whereby an article is written, referred, accepted, and published.... The editor, referees, and alternately the readers, as well as the author, can have access to the text at their computers.

The BLEND experiment was completed in 1984. During the four-year experiment, it received over forty papers; published two issues of *Computer Human Factors* (CHF), a topical journal in the system; and entered twenty-one unrefereed papers in the "poster paper" section. It was reported that the system experienced many technological, "organizational, bureaucratic, social or psychological problems." It was also reported that the Loughborough Information Network Community (LINC), which was established to study various types of journals and to produce CHF on the system, was abandoned (*17*, *18*).

In the mid-1980s, a wide variety of electronic publishing and networks mushroomed due to the emerging capability and availability of personal computers, artificial intelligence, software packages, and other innovations. The various forms of electronic publishing include the continuous experiment of electronic journals, desktop publishing (*19*, *20*), video magazines (*21*), and disk magazines (*22–24*), to name a few. The electronic networks were primarily demonstrated in electronic or wired universities and libraries.

In 1983, David S. Backer, Director of Video Disc Research at Mirror System, Inc., presented the *Movie Manual*. This prototype electronic book originated from his doctoral thesis for the Massachusetts Institute of Technology. It is patterned after the traditional book but is read on a touch-sensitive television screen. It employs the videodisc as the publication surrogate. It shares the features inherent in a traditional book, including text structure, letter-type variety, even edge-marking. It also has the merits of containing audio and visual tracks and its video pages are dynamically "type set" (*25*).

Also in 1983, Robert J. Spinrad, Director of Systems Technology at the Xerox Palo Alto Research Center, published his article, "The Electronic University." In his vision, all activities of faculty, students, and administrators at the wired university can communicate with each other via electronic means (*26*). In the same year, Ronald E. Rice, Visiting Professor at the Annenberg School of Communications, University of Southern California, and his coauthor presented the use and utility of electronic message systems at a west coast university (*27*).

Again in 1983, Brown University began the Scholar's Workstation Project, according to a report by Barbara B. Moran, Professor at the University of North Carolina's School of Library Science, and her coauthors. The goal of Brown's project "was to experiment with, shape, and evaluate new types of computer and communication tools that might have a profound effect on future education and scholarship." Brown University originally envisioned that by 1987, the project would have 10,000 workstations including those located in faculty homes.

According to the report, Brown University was "wired," installed with a campus network of over 3,200 personal computers. The wiring, however, extended only to "the outside of the building," and the Scholar's Workstations were not yet operational in the Fall of 1985. Furthermore, there were other obstacles to the implementation of the project, such as faculty opposition (*28*).

In the following year, Learned Information, Ltd. launched *The Electronic Magazine*, an all-electronic database. News items from Europe and the United States are assembled in microcomputers and transferred by telecommunications to Oxford, where they are processed and merged with other news items received from other locations. After processing, these new pieces are uploaded onto disks in Rome, which then contain the magazine ready for online reviewing. The magazine is comprised of news, announcements, short articles, book reviews, advertisements, and so forth (*29*).

Learned Information's primary aims in introducing the electronic magazine were to create a viable online database that would complement existing paper sources, and to create a working and efficient shell system into which additional databases could be plugged. The online file was reportedly working well on the host system. However, disappointingly during the first year, only about a fifth of its searchers were regular users; others were all casual users. It was also found that its online software packages had compatibility problems with those of many other online vendors. This fact would certainly hinder it from reaching a broader market (*30*).

In 1985, Warner Books published *The Policeman's Beard Is Half Constructed* (*31*), a book generated by the program Racter. This is considered to be the first book written by a computer. When Meredith Merritt discusses how to catalog the book, her suggestion is to take Racter, the computer program, as the main author, with William Chamblain and Thomas Etter, the creators of Racter, as the coauthors (*32*).

Carlo Vernimb of the Commission of the European Communities (CEC) announced that APOLLO (Article Procurement with Online Local Ordering) services were likely to start in 1986 (*33*). Later, David I. Raitt said the services were "expected to get under way in 1987." The APOLLO project was sponsored by the CEC and, according to Raitt, was intended as a system for the electronic delivery of full-text documents from document centers to remote users such as local libraries. In the early stage, the project was expected to have the combined resources of the British Lending Library Division, Europe Data, and Fachinformationszentrum Karlsruhe (*34*).

Frederick G. Kilgour, OCLC (Online Computer Library Center) Founder Trustee, expected that a pilot model of EIDOS (Electronic Information Delivery Online System) would be available in 1988. Kilgour claimed that he envisioned the system in 1983 and OCLC, Inc. developed it later. The system "was designed to enable libraries to move out beyond bibliography by furnishing users directly with information."

He further illustrated the system and said that operating electronically, EIDOS would supply comprehensive data, information, and knowledge to information seekers of all sorts. Sources of information, in electronic form, would be comprised of books, journal articles, numeric databases, maps, and charts. The EIDOS' major goal was to provide immediate availability of information in electronic form to every user at any time (*35*, *36*).

Optical publishing has grown rapidly in recent years. David C. Miller, Managing Partner of DCM Associates, describes many formats of optical publishing, such as videodisc, compact audio discs, compact discs with read only memory (CD-ROM), and optical digital discs, tapes, and cards (*37*). They are classified as optical because they are optically sensitive materials to store information. They may use lasers for recording and reading. They are exceptional media with enormous storage capacity; for example, a simple 4.72 inch CD-ROM disc stores 550 megabytes of data, that is equal to the data contained in 250,000 printed pages, or equal to those in an entire encyclopedia set (*38*). Lois F. Lunin (*39*), Judith Paris Roth (*40*), as well as many others have published different works intended to introduce the technology and basic understanding of optical publishing particularly in the CD-ROM area.

Optical publishing products have found application to business (*41*), education (*42*), law, medicine, science, and engineering (*43*), for research, training, and decision-making situations. Libraries have also widely applied the new products to their operations. Le Pac (Local Public Access Catalog) from the Brodart Company and Bibliofile from The Library Corporation are two major CD-ROMs that have found useful application by many library systems (*44*, *45*).

In the meantime, many indexes and databases previously available in print or online now have been published in CD-ROM format. Titles of these CD-ROMs cover almost every subject field (*46*, *47*). The Grolier's *Academic American Encyclopedia* (*48*), Information Access Company's *InfoTrac* (*49*), *NewsBank*, and *Wilsondisc* are a few popular examples of these products.

Because of the importance of the new information technology to business, education, economy, and research, a plan was initiated in the United States in 1988 to sponsor research of high-performance computing and on the development of the national research network. It is expected that the development and linkage of supercomputers eventually will serve as the building blocks in the construction of the information superhighways of the future. It is envisioned that the new computers will be able to study various scientific and medical concepts, to create new engineering and mechanical designs, and to access information thousands of miles away with accurate and vivid details. "A surgeon in Nashville can send a CAT scan picture to a colleague at the Mayo Clinic and get a second opinion instantly." "A particle physicist in California can check up on an experiment being run at Fremilab in Illinois without having to leave his office" (*50, 51*).

The reality of information superhighways originated many years ago when ARPANET was created to advance networking and data communications R&D and to develop a robust communications network that would support the data-rich conversations of computer scientists. Following the ARPANET, other specialized networks, such as USNET, CSNET, NSFNET, BITNET, Usenet, etc. were developed among many research communities (*52*). Readers are referred to the article by John S. Quarterman and Josiah C. Hoskins for details of the development and characteristics of many notable computer networks (*53*).

As part of the high-performance computing plan, the National Research and Education Network (NREN) has gained substantial support from the federal government. The network is projected to cost $400 million during the first five years. It is expected to link together thousands of campuses and research laboratories, providing its users with high-speed access to enormous resources of computing power and enabling them to exchange huge quantities of electronic information. Its transmission speed is projected to reach 3 gigabits per second within the near future. The current state-of-the-art capacity is 1.5 million bits per second, a speed capable of sending 50 pages of text per second.

Once this high speed capability is realized, NREN will be able to transmit 100,000 typed pages, or the text of an entire *Encyclopedia Britannica*, in a second. In addition to bibliographic data, NREN will also be able to transmit three-dimensional x-rays, CAT scans, and satellite photographs (*54, 55*). This capacity will make it possible to transfer the information contained in a library anywhere in the world within minutes. It will, of course, provide access to online public catalogs in various libraries and other information resources of special projects for library users (*56*). Eventually, NREN will become "the virtual library" that combines an onsite collection with an electronic network (*57*).

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CHIH WANG

ERGONOMIC ASPECTS OF COMPUTER USE

Introduction

Ergonomics, deriving from the Greek word "ergon" work is now mainly considered to mean "the science of designing machines and environments that are most suited to the efficiency, comfort, safety, and peace of mind of those working with them." The widespread introduction of computer technology into the working environment of those who previously have had little exposure to working with machines, such as librarians and information professionals, managers, clerks, and typists, has led to an increased interest in the subject of ergonomics. In particular, individuals are concerned that the use of computers does not pose a new health hazard in the workplace. But ergonomics goes further than the prevention of health hazards, it aims to optimize the fit between people and technology within the working environment. As such it sees the possibility that the introduction of technology can make a positive contribution to the health of people at work. This is pertinent if one considers that the World Health

Organization defines health as being a state of complete physical, mental, and social well-being, not merely the absence of disease and infirmity.

Ergonomics in the broad sense of the word includes all the physical, social, and psychological aspects of work and workplace design. The concept is important in all types of work environments, however, this article focuses on computer-based work. Paying attention to ergonomics can benefit everyone in the workplace. The employee who is physically and psychologically more comfortable is more likely to work more effectively. The organization benefits in terms of reduced absenteeism, improved employee morale, and greater job satisfaction which ultimately is reflected in better performance and, in the case of private sector, increased profits.

In considering how the introduction of new computer technology can be ergonomically sound, it is necessary to look at four different elements:

Machine design
The physical design of the workplace
Software
Job design and work organization

Before considering each of these aspects however a brief review of some of the health concerns in relation to the use of computers will be given.

Computers at Work

Computer technology, specifically the use of visual display units (VDUs) has been implicated in a number of reports as causing a variety of medical complaints from adverse reproductive outcomes to eyestrain, skin rashes to stress. It will be seen that many of the problems mentioned can, and indeed should be avoided by the adoption of sensible policies for the use of computers at work, including proper attention to ergonomic considerations. However, it is worth bearing in mind that even if all the "ergonomic problems" have been sorted out there still may be some complaints about the use of computers. The reason may well be that health issues are seen as being one of the legitimate areas of work that people can complain about—concern about health can often mask a deeper concern and fear about the introduction of technology in general and the ability of the individual to cope with it.

The most pervasive type of computer technology used at work is the VDU. This is basically a screen-based device with a keyboard. Currently most of these screens are based on cathode ray tube (CRT) technology which enables text, numbers, graphics, and in some cases images to be represented electronically on screen. Keyboards tend to follow the standard QWERTY layout sometimes with the addition of a pointing device or "mouse." While all VDUs share these same basic components the same is not true of the jobs for which they are used. Computers can be used for a wide variety of tasks from programming to word processing, online searching, to data entry. Thus tasks can vary dramatically and differ along such dimensions as:

Skills required
Visual emphasis of the task

Pace of work
Length of time spent at the machine
Control which an individual has over the work being done

Each of these factors is important in influencing the extent to which an individual feels "healthy" at work. The point to note is that many of the problems reported to be associated with the use of computers arise not from the machines themselves, but from the nature of the jobs for which they are used.

Health Issues Associated with the Use of Computers

The most discussed health issues relating to the use of computers at work come under the following categories:

Adverse pregnancy outcomes and the related question of radiation emissions from VDUs
Eye strain and visual fatigue
Migraine headache
Photosensitive epilepsy
Muscle pain, aches, and strains
Skin rashes
Stress

Each of these will now be considered.

PREGNANCY

One of the most controversial issues raised in relation to the use of computers at work has been the question of the effect of VDUs on pregnancy outcome. Reports of "clusters" of miscarriages and birth defects among groups of female VDU operators led to fears that VDUs are in some way connected with adverse pregnancy outcomes and that the link may be a causal one. Several important issues are raised by this. First there is a need to thoroughly investigate this "health hazard" to determine if such a link exists. No one could justify allowing women to face a possible health risk to themselves and/or their unborn children, nor is it desirable that they face increased anxiety and insecurity as a result of questions as to the safety of their using a computer at work. On the other hand, the wholesale "banning" of pregnant women from VDU work, a proposition some would favor, is not an attractive prospect since it would make the already considerable difficulties which many women face in obtaining employment even more insurmountable. What is needed is an evaluation of the research already conducted to establish whether risks are indeed present.

From some reports of "clusters" of miscarriages and birth defects among VDU workers it would appear that the use of the VDU was responsible for these adverse outcomes and that a high proportion of pregnant VDU workers had such experiences. The question here is one of establishing whether such conclusions are justified.

As with any particular group of workers experiencing ill health, it is first necessary to see whether the cause was an occupational one. This is usually done by comparing the incidence of ill health in an occupational group, in this case VDU workers, with the incidence in the population as a whole. If it is then found that the rate of ill health in the occupational group is significantly greater than that in the population as a whole then the cause of that ill health is usually thought to be an occupationally related one.

In relation to adverse pregnancy outcomes among VDU workers such comparisons have proved difficult to undertake. Problems of definition arise; for example, what is a VDU worker? Should that include all individuals who use a VDU even if infrequently? Should it include those who work in the same vicinity as the machines? Indeed what is an adverse pregnancy outcome? These can cover a range of things from: spontaneous abortions or miscarriages, birth defects, low birth weight, to still birth.

A third problem lies in establishing the control group, should this include all women of reproductive age or only working women? The only baseline figures available for adverse pregnancy outcomes against which the experience of VDU workers can be assessed relate to all women, not just those in the workforce. They show that pregnancy is a hazardous affair in its own right with 15 to 20 percent of all known pregnancies resulting in miscarriage, 3 to 4 percent of all births producing a child of 4 lbs or less, 2.5 percent of all babies being malformed.

The current known occupational risks to pregnancy are: (1) exposure to radiation and (2) exposure to chemical and biological agents. However, there are a number of other well-known risks to pregnancy which include:

- Maternal age (miscarriages are more common among the under 20s and over 30 age group)
- Maternal abnormality and disease
- Number of pregnancies (the likelihood of miscarriage increases with the number of pregnancies)
- Socioeconomic class
- Exposure to infectious agents
- Provision and quality of the antenatal care
- Delivery methods
- Smoking and alcohol

In establishing if adverse pregnancy outcomes had an occupational cause, all such other causes would have to be eliminated.

A further problem in evaluating the evidence relates to the methodology of the study in question. Some of the studies on "clusters" of miscarriages have dealt with sample sizes which are too small to be statistically valid. Doctors at the Occupation and Health Unit at the University of Toronto estimate that in order to evaluate a "cluster" and to avoid statistical coincidence it would be necessary to study 12,000 working women over a two-year period—half of whom used VDUs in their work and half who did not. Since the distribution of adverse pregnancy outcomes in the population will follow the normal bell-shaped distribution curve, and given the ever wider usage of VDUs by women of reproductive age, together with the well-established risk of miscarriage in early pregnancy, it is thought that many "clusters" are to be expected on the basis of chance alone.

There have been some well-constructed studies of the effect of VDUs on pregnant women, most recently by the National Board of Occupational Safety and Health and

National Social Welfare Board in Sweden. This study is using the Swedish Miscarriage register to examine pregnancy outcome in occupational groups which have a low, medium, and high exposure to VDUs. Their preliminary findings do not indicate that there is a relationship between the use of VDUs and adverse pregnancy outcomes.

In the United Kingdom, the Health and Safety Executive reports that of the three reliable epidemiological studies which have compared the reproductive outcome in VDU workers as against non-VDU workers, none has indicated an excessive rate of adverse pregnancy outcomes among the former.

Concern over adverse pregnancy outcomes arose because of the fact that computers emit radiation, which is known to have adverse effects on health. It is true that VDUs do emit radiation, but so do microwave ovens, televisions, the sun, and nuclear explosions. Radiation is an emotive term and it is important to realize that there are a number of forms of radiation, not all of which are harmful. Broadly, radiation comes in two types; ionizing and nonionizing. It is generally accepted that while VDUs do emit some ionizing radiation it is well below background levels. The Health and Safety Executive in the United Kingdom reports that in the case of ionizing radiation: (1) the level of x-ray emissions found from VDUs is substantially below background level and does not add significantly to the latter and (2) in relation to ultraviolet emissions, only UVA type emissions have been detected from VDUs. UVA can be hazardous, but only in very large quantities. Such quantities are not found to be emitted from VDUs.

On the question of nonionizing radiation emissions from VDUs, these are of three types: visible light, microwaves, and electromagnetic emissions. Visible light must be emitted from a VDU in order for it to function. However, with a full screen of characters and at maximum brightness, the light emitted from a VDU has been found to be of negligible risk to the eye. With regard to microwave emissions, the U.K. National Radiological Protection Board in the U.K. has found such emissions from VDUs to be barely detectable and not hazardous to health.

Any concern left about radiation in relation to VDUs has centered on the discussion of the effects of low-frequency electromagnetic emissions. Such electric and magnetic fields can be detected in the vicinity of a computer or indeed from any electrically powered device (a hair drier or shaver). Such fields are difficult to measure but are thought to be well below levels thought to be hazardous. VDUs also emit VLF (very low frequency) and ELF (extremely low frequency) electromagnetic emissions. It is agreed that these do occur; where scientists differ is as to whether such radio waves cause changes in the human body. A study by Delgado generated concern when he claimed that chicken embryos exposed to such emissions had been altered. A number of studies are attempting to repeat Delgado's work on chicken and mice embryos. Initial reports suggest that his findings cannot be replicated and therefore cannot be substantiated. Still other research suggests that the type of emissions used by Delgado are not similar to those from a VDU.

The widely accepted consensus on the subject of radiation and VDUs, therefore, is that there is no evidence to suggest that the radiation levels emitted by a VDU pose a health hazard. This is supported, for example, by both the Health and Safety Executive and the National Radiological Protection Board in the United Kingdom. To summarize, then, the issues of adverse pregnancy outcomes and the use of computers we can say: (1) VDUs do not appear to emit levels of radiation likely to adversely affect the outcome of a pregnancy and (2) none of the reliable studies conducted on pregnancy and VDU work has shown there to be any link between such work and adverse pregnancy outcomes.

One other point remains to be made on this subject. Anxiety and stress resulting from uncertainty about the health hazards of VDUs can of itself be inimical to a successful pregnancy. Making women aware of the reliable evidence on the subject can allay such fears. However, it is not unreasonable to suggest that some women, despite being given reliable information, will retain their fears. For that reason, many employers are now giving pregnant women the choice to transfer off VDU work for the duration of their pregnancy should they so wish and many trade unions are including this clause in their negotiations.

While adverse pregnancy outcome is the most emotive of the health issues raised in relation to the use of computers at work, and therefore was the first to be discussed, it is not the most common or frequently raised one. Complaints of eye strain or muscle fatigue are more usual. These are discussed below.

EYE STRAIN AND VISUAL FATIGUE

The introduction of computers has raised questions about the effect of screen-based work on eyesight. For example, in November 1985, the results of a survey of computer terminal users were published in *Health and Safety at Work* magazine. The study found that 70 percent of respondents experienced eyestrain and 34 percent reported blurred vision. It is important in this context to distinguish between eye damage and dysfunction and eyestrain. Medical evidence suggests that screen-based work does not damage eyesight nor aggravate existing eye problems. Evidence does suggest though that it can lead to short-term visual discomfort or visual fatigue; that is eye strain. Such a conclusion is hardly surprising when we see the type of work which some people are asked to do on a computer and the environmental conditions within which the machines are operated.

Eyestrain and visual fatigue are largely preventable if attention is paid to the visual environment within which the computer user works. The most common source of eyestrain comes from glare; glare from the screen itself, the lighting in the room both artificial and daylight, and from the room surfaces. Avoiding glare via the proper positioning of the VDU unit and the provision of appropriate lighting can go a long way toward reducing visual discomfort. Traditional office lighting was designed for desk work and is generally too bright for reading characters on a reflecting vertical surface which computer-based work requires.

The quality, as well as the quantity, of lighting is also important; certain types of lighting are more restful to the eyes than others. Additional factors influencing the extent to which visual fatigue is experienced by the computer user are the screen display (its colour, contrast, and stability), the length of time that an individual works on the machine without a break, and the type of work a person does. The eye, like any other muscle, will tire if held in the same position for long periods of time.

It should also be remembered that eyestrain is not a new phenomenon brought about by computer-based work. Many other industrial and clerical tasks make similar visual demands upon individuals. People who wear glasses experience particular difficulties when using computers especially those whose lenses are designed for a narrow range of reading distances or who wear multifocal lenses. Such glasses are not designed to cope with work involving varying visual distances such as VDU work. Such problems can be overcome easily by making modifications to their prescription and consulting with an optician before starting screen-based work.

On the question of administering eye tests for computer users in general, there are differing viewpoints. Many trade unions recommend that their members have their eyes tested before starting such work with regular follow up examinations thereafter, so that any deterioration can be monitored. On the other hand, bodies such as the Health and Safety Executive in the United Kingdom do not feel that the wholesale preemployment testing of eyesight of VDU users and its subsequent reassessment is really justified. It should be remembered that individuals may have eye defects of which they are currently unaware but which could be highlighted once a VDU is used because such work presents different and often new visual demands to the user. Therefore, consultation with a qualified practitioner is a sensible precaution to take before embarking on computer-based work. Screen design and visual environment factors which need to be taken into account when introducing computers to the work place so as to avoid visual fatigue are discussed later. Employers in Europe will have to provide periods of eye rest for computer screen workers beginning in 1992, when a European Directive on VDU use becomes effective.

MIGRAINE

There is some concern that screen-based work can be particularly aggravating to migraine sufferers. More specifically it is speculated that the screen light/flicker might trigger such attacks. This is difficult to prove or disprove as migraine is a generic term covering a wide range of symptoms. Its known causes range from factors as diverse as specific foods (e.g., chocolate or red wine), to low blood sugar, fatigue, light patterns. The cause of migraine even in particular individuals is difficult to isolate. However, adequate consideration of the visual environment in which the computer user will be working probably can go a long way toward avoiding such attacks being triggered by computer use.

PHOTOSENSITIVE EPILEPSY

A final issue relating to the visual demands of screen-based computer work and health concerns photosensitive epilepsy. Using a computer does not cause epilepsy. However, some people who suffer from a comparatively rare form of epilepsy known as photosensitive epilepsy may be at risk of inducing an attack when using a VDU. In this form of the condition, seizures can be triggered by a flickering light source or in some cases from viewing striped light patterns. This type of epilepsy is most likely to have its onset in individuals between 10 and 14 years, with most first attacks occurring before age 20. Therefore the likelihood of someone experiencing a first-time attack while using a computer is extremely low.

Doctors have found that word processing presents little or no hazard; however, theoretically, graphic displays could present a problem. In an article in the *British*

Medical Journal, Professor Lee states that the physical features of the stimulus of VDU work such as brightness, screen size, frequency of picture repetition, and viewing distance make it unlikely that work with VDUs will provoke an attack. However, it is wise that victims of this syndrome consult a doctor before commencing computer-based work.

MUSCLE AND BODY PAIN

A study by the Swedish Board of Occupational Safety and Health of operators engaged in full-time sedentary VDU work revealed the following results:

55% felt discomfort in their backs and shoulders
32% felt discomfort in their head and neck
25% felt discomfort in their arms and wrists and
15% felt discomfort in their legs

A survey conducted by Britain's *Health and Safety at Work* magazine showed similar results; 53% of VDU users experienced pain in the neck or shoulders, 43% suffered some degree of back pain, 14% had hand cramps, and 58% said they experienced a feeling of general fatigue. Such findings indicate that muscular fatigue can be a problem for some computer users.

Two factors influence the extent to which muscular fatigue is experienced in computer work. The first relates to the demands of the job itself: does this require the computer user to sit or stand over prolonged periods of time, possibly with continual repetitious movements? The second relates to the type of office furniture used with a computer, particularly the chair and desk.

Normal muscular work requires the alternate contraction and relaxation of muscle. This increases the rate of blood flow which easily removes the waste products (lactic acid) which cause tiring of the muscle. When a muscle is, for example, held in the one position over a period of time it remains contracted, receives little blood flow, and tires easily as waste products are not removed. People carrying out repetitive movements such as keyboarding, filing, sitting or standing for long periods and in one position are likely therefore, to experience such muscle fatigue.

Since the late nineteenth century, information work (largely office based) has been sedentary in nature. This often entails a worker adopting a stooped posture, with head advanced and the back curved. Working in such a position for lengthy periods means that the stomach often is compressed against the desk; this is bad for posture and lung function and interferes with normal abdominal movements. Prolonged sitting in poorly designed chairs can lead also to swollen feet and ankles.

The design and selection of office furniture which computer workers will use is therefore a vital factor in maintaining a preventive approach to complaints of muscular aches and pains in computer users. The physical dimensions of chairs and desks are very important since they affect the posture adopted and ease of work. Any posture which is maintained over long periods creates "static" load on the body which is much more tiring than the load created by movement. Therefore chairs should permit shifts in posture so that the load is distributed to different parts of the skeletal and muscular systems.

Highly repetitive jobs requiring people to remain in fixed postures for long periods of time or those entailing fast repetitive movements of the hands and wrists are more likely to give rise to complaints of fatigue and pain than jobs where a variety of different tasks are performed which do not require such restricted movement. Paying adequate attention to ergonomic factors in the computer user's workplace can therefore prevent unnecessary muscle fatigue and aches and pains.

Less common and less likely to be heard among computer users are complaints of chronic musculoskeletal pain referred to as "repetitive strain injury" (fondly known in Australia as kangeroo paw). Strictly speaking, such conditions should be known as occupationally related upper limb disorders and they include such things a tenosynovitis, writer's cramp, and carpal tunnel syndrome. Repetition of movement is not necessarily sufficient nor the only cause of such conditions. These are medically recognized complaints and should be distinguished from short-term muscular discomfort. Again, attention to the ergonomics of the workplace should go a long way toward avoiding or at least reducing the number of such complaints.

SKIN RASHES

Some computer users have reported experiencing facial skin complaints ranging from itchiness to redness to distinct rashes. As yet no direct link with the use of VDUs has been established. The cause is thought to be more indirect and due to either excess static in the work environment and/or low humidity. Computers, since the machines give off heat, can increase the static in the atmosphere and reduce the humidity. Overall, the number of individuals complaining of skin irritation as a result of using computers is low, and such cases have been resolved by either reducing the static or raising the humidity levels through such measures as treating carpets with antistatic fluids, improving ventilation to prevent buildup of particle deposition, and introducing indoor or house plants to raise humidity levels.

STRESS

Stress is a complex issue with which to deal and certainly stress and related illnesses are to be found in many occupations other than among computer users. The physical and mental symptoms associated with stress are numerous and can vary considerably from person to person, so too can the degree of stress tolerance. While occasional stress can be conducive to good work, prolonged stress is not.

Changes in work practices, brought about by the introduction of new computer technology into the workplace, especially when those who are to use it have no previous experience of computers, can be stressful. Inadequate training of employees can exacerbate the situation. In a Labour Research Department survey of 17,000 workers, a third of the respondents found that using computers in their job introduced more stress than their previous working situation.

Several other factors in the work situation can contribute to stress. Insufficient physical space in which to work comfortably can generate stress in some individuals. Computers often are "added on" to an existing work environment and equipment without any extra space being allocated for them. Poor lighting, excessive noise, inadequate heating and ventilation systems, and "inhuman" surroundings can further aggravate a stressful situation. The type of computer equipment used, its design, response time, reliability, and ease of use of the software are all factors influencing stress levels of users.

The types of jobs employees are asked to do; specifically the extent of task variety, use of skills, level of concentration required, and the physical effort involved in the job are all factors which can compound stressful situations. Finally, the way work is organized, including such factors as the standards required, the type of supervision provided, the training undertaken, and the extent to which individuals feel in control of their work situation can influence the degree of stress experienced. Care in selecting computer equipment and software, designing work environments and jobs, and implementing technology are all necessary if undue stress on employees is to be avoided.

Application of Ergonomic Principles in the Workplace

Computers, as can be seen from the above, have been implicated in a range of medical complaints. It is the contention of the author, however, that such problems as those outlined can be avoided or negated if sound and intelligent ergonomic practices are employed when computer technology is being introduced to the workplace. The remainder of this article provides ergonomic guidelines for the use of computers at work. A list of further suggested reading on the subject is included for those interested in pursuing any of the various courses of action open to them. It should be remembered, however, that the aim of ergonomics is a positive one—not merely to avoid hazards at work but to improve the efficiency, comfort, and safety of people at work, which in turn should lead to positive benefits in terms of their effectiveness and indeed health. Applying ergonomic principles to the use of computers can add to the costs associated with their introduction to the workplace especially where major changes to the environment are concerned. It also requires a considerable expenditure of time to plan and implement the introduction. Some argue against such trouble and expense; others feel that the fuss over adverse health effects of computers is a short-term reaction to technological change which, if left to itself, will peter out.

Such attitudes are shortsighted and unfair. The health hazards are apparent and very real. If equipment is not properly designed, installed, and used, many more people will suffer ill effects as the use of computers increases. What of the indirect costs of ill health to the employer: increased absenteeism, people operating below capacity, low morale? Such costs are not so easily quantified but they too are real. Many experts writing on the benefits of computer technology feel that they will only improve productivity significantly if people use the equipment creatively—they are unlikely to do so if the equipment makes them sick.

Many of the ergonomic practices recommended below have applicability to non-computer work also. Increasing use of computer technology underscores the fact that many working environments are less then adequate from the point of view of health (in the broadest sense) and that many jobs are not "designed" at all but rather evolve, often in a haphazard fashion. Applying ergonomic principles then can benefit every worker.

There are many checklists available of ergonomic standards for visual display units. Indeed Sweden and West Germany have compulsory standards to which VDUs must conform. A common problem with standards though is that their use of technical language can be confusing to the layperson. These checklists can be helpful though when choosing a VDU, as the manufacturer's specification can be checked against the recommended standards. Furthermore, they can be of assistance in negotiations about the use of new technology. There is a danger, however, of getting absorbed in the detail of the standard/checklist and neglecting its intention; at the least that computers be introduced in such a way as to ensure hazards are avoided and at best that their introduction lead to positive enhancements in jobs and the working environment.

For these reasons the recommendations cited here are in nontechnical language and concentrate on what the author considers to be the most important ergonomic factors to bear in mind when selecting and implementing computer technology at work. The recommendations are in several parts. First the computer, with its components of screen and keyboard, is discussed. The key features to consider for these are highlighted together with an explanation as to why such features are important from an ergonomic point of view. Then the immediate workplace within which the computer system is sited together with the general work environment comes under scrutiny. This is followed by a section on software ergonomics and job design both of which contribute to the physical and psychological well-being of the computer user. Finally there is a section on managing the introduction of new technology to the workplace with special emphasis on the role of training.

SCREENS AND KEYBOARDS

The characteristics of the screen used with a computer system are a significant influence on whether users suffer from eyestrain and visual fatigue. Fundamental to the screen design is the concept of adjustability; the computer user should be able to adapt technology to meet their visual requirements, not vice versa. One aspect of adjustability concerns screen position. The screen should be easy to swivel to the left or right and to tilt up and down so that the user can achieve the most comfortable position for him/herself. Ideally the screen should be positioned at or below the eye level to avoid strain to eye muscles by constantly looking up at it. Antireflection treatments or the provision of an antiglare filter on the screen can cut glare, and thus reduce possible eyestrain. Another aspect of adjustability concerns screen image. Controls for adjusting the brightness and contrast should be easily accessible. Furthermore, users should be shown how to make adjustments to the screen; anecdotes abound of computer users working with badly contrasted screens over many months because they didn't know that the contrast could be adjusted.

The color of the screen is largely a matter of personal preference, and it is hard to be dogmatic about this. Increasingly, color monitors are becoming standard on many computer systems. White, yellow, amber, or green characters on a neutral background are generally considered most restful to the eye. More important for avoiding eyestrain are the display characters and image stability. All computer screens flicker to some extent; but there appear to be individual differences as to a user's threshold of awareness of any flicker. When selecting computer equipment it is important to observe the screen under actual operating conditions to look for signs of flicker. The characters on the screen need to be of adequate size and of good presentation. They should be easy to read, clearly formed, and well defined. Some screens have poor definitions whereby Bs can look like 8s, U like V, and 5 like S, such displays make onscreen proofreading very difficult and tiring for the user.

Keyboards are a very important part of a computer system since the dominant form of person–machine interaction is via this device. Keyboards should be detached from the screen, thus allowing the user to adjust their position on the desktop. They should be stable and well balanced so no movement occurs even when the keys are pounded. A shallow sloped, thin keyboard (thin refers to the height of the keyboard above the desktop) lessens the likelihood that excessive loads will be placed on the hands and arm of the user; thus muscle ache or strain is prevented. Unnecessarily wide keyboards should be avoided as these can lead to fatiguing of the neck-torso should the user reach for paper/books lying on an adjacent desk.

Ease of use of the keyboard is affected by layout. The alphabetic keys should follow the standard QWERTY positions, as this formation is familiar to most users. If the task requires substantial entry of numeric information, a separate numeric pad, adjacent to the keyboard (either to the left or right of the alphabetic keys, depending on whether the user is left or right handed) should be available. Function keys, those that perform specific tasks, are useful on the keyboard but they should be clearly differentiated from the alphanumeric keys either by size/color or location.

The keys themselves should serve as an aid to accurately locate keys by fingertip. Square keys with a concave (dished) top are ideal for this purpose. The legends, that is, what is printed on the key, should be easily legible and molded onto the key surface to resist wear and abrasion. A maximum of two legends per key is a useful guide; more legends will only confuse the user as to the key's function.

Matte finished keyboards and keys with low reflectivity, reduce glare in the vicinity of the computer user. The act of keyboarding is a complex process whereby the movement of the hands and fingers are activated and controlled by signals from the brain in response to a variety of stimuli. Some kind of feedback from the keying in process is necessary to inform the operator that the intended action has been taken and to aid in the detection of errors. Keyboards should therefore provide some kind of auditory and/or tactile feedback to the user.

Selecting computer screens and keyboards of good design incorporating the features outlined above can reduce the likelihood of the computer user experiencing eyestrain and/or muscle fatigue. Good design of screens and keyboards can also contribute positively to the psychological satisfaction derived from computer-based work and so reduce stress.

SITING THE COMPUTER: PERIPHERALS: FURNITURE

The immediate working environment will influence the degree of comfort the computer user experiences at work and thus affect his or her efficiency at performing work tasks. The screen and keyboard, together with peripherals such as disk drives and printers, take up a lot of room; usually they are an addition to existing equipment rather than a substitute for it. Extra space in the immediate work environment may be necessary to accommodate the computer system. All items should be positioned for the user's convenience and in such a way as to avoid unnecessary stretching and possible strains when users need quick access to frequently used materials.

Printers can be a particular problem; the noise they generate can break concentration and increase stress, not only of the computer user, but of those working in the vicinity especially if large amounts of printing are undertaken. Unless printing functions are infrequent, short-term occurrences, acoustic hoods set atop the printer are vital accessories. If an acoustic hood cannot be used, then the printer should be situated away from the immediate work environment; where printers are used as a shared resource among a number of computer users this is a most desirable alternative. Provision of a simple document holder can greatly ease input of material to the computer and counter strain to the neck-torso which can occur when users read input documents from the desktop. These holders should be nonreflective and matte paper should be used, again to cut down on glare.

Ideally, the desk should be adjustable so that users can position the computer and themselves at the correct height for efficient working. A lower desk height is required for keyboarding than for writing. There needs to be adequate knee clearance beneath the desk and more diminuitive users should be provided with a foot rest. Desk tops should be matte so as to cut down on glare.

Chairs are perhaps the single most important item in the prevention of back pain, one of the most frequent complaints of computer users. Swivel chairs with a stable base and an adjustable seat height are best. When seated at the computer the user's feet should be planted firmly on the floor (or footrest). The chair must give adequate support to the spine; a backrest should support at least the lumbar region of the back (the lower back). This backrest should also be adjustable both for height and for moving backward and forward. It should be curved so as to avoid catching on the shoulder blades. Again, users need to be shown how to adjust this furniture to take advantage of its flexibility.

Two other points about the immediate working environment of the computer user need to be made. The first concerns wiring and safety. Computers seem to spawn a spaghettilike mess of wires. These should not be let to trail or hang where they may cause accidents. Power points should not be overloaded and the use of extension boards is to be avoided, if at all possible, as they add to the proliferation of wires. Some newer computer desk furniture contains channels along which wires can be run to keep them out of the way of traffic. Such furniture can be expensive. The second point concerns the level of concentration required for some types of computer work. If it is very high, then the user may require high levels of visual and auditory privacy. This can be achieved by giving them separate offices or, in open plan layouts, by erecting partitions to deaden sound and provide visual privacy.

THE AMBIENT WORK ENVIRONMENT

The best ambient environment (sound, light, temperature, and air quality) for computer and other forms of sedentary work is one that is draught free with a comfortable and stable temperature, high-quality lighting, and no intrusive noise. Like other types of machinery, computers generate heat, and particularly in warm weather with several computers operating, this can raise temperatures to excessive highs, which can lead to drowsiness or irritability on the part of users. Adequate ventilation and reasonable controlled humidity can alleviate these problems. Generally, most offices are too dry rather than too moist. Controlled humidity will help avoid itchiness and possibly skin rashes or facial dermatitis and dryness/irritation of the eyes. Humidification and adequate ventilation will also reduce static in the environment. Excessive static has been implicated in facial rashes as well as causing unpleasant "shocks" to individuals. Antistatic treatment of carpets in rooms with VDUs can further reduce this problem.

One of the biggest factors contributing to eyestrain in computer users is the visual environment. Desk illumination for computer work should be below that of a normal office environment to reduce glare. However, some local task lighting in the vicinity of the machine may be necessary to facilitate the reading of source documents. Quality as well as quantity of light is important. Artificial lighting in the form of a totally illuminated ceiling where the lighting is diffused to reduce glare is suitable for computer work as is the use of "up lighters" which bounce the light up off the ceiling. Lighting should also be adjustable so that individuals can set their own desired level of illumination. The position of the computer in relation to the light source is also important. To avoid glare computers should be placed between, rather than under, rows of lighting with the line of sight parallel to the light fittings. Computers should also be placed parallel to windows to avoid outside reflection in the screen. Glare from windows can be further reduced by installing blinds, curtains, or even light-absorbing film. Where possible nonreflective surfaces should be used throughout the computer site environment. Muted matte colorings on the walls can reduce glare and provide a restful work environment.

SOFTWARE ERGONOMICS AND JOB DESIGN

If a job involves the use of a computer, then it will involve the user in interaction with software. In fact, software is at the heart of computer-based work; it commands the users' immediate attention and is at the forefront of their consciousness. This cognitive interface can determine how individuals react to working with a computer, and in particular the degree of stress they experience. Software ergonomics covers such things as the presentation of information on the screen, the way information is input to the system, the task sequence or actions required of the user to manipulate the system, error messages, and help facilities, etc. Poorly designed software can be frustrating for the user, lead to increased training time, increased error rates, and even to the abuse of systems. "User friendly" is a much maligned term with regard to descriptions of software. As one computer user put it, software can be about as user friendly as a cornered rat!

The level of experience of the user also plays an important role in users' response to software. Novice users may welcome step by step menus, experienced computer users, on the other hand, may find such an approach tedious and time consuming, as they already know precisely what they wish to do. Some software is flexible enough to allow different levels of users to choose their mode of operation, other packages do not have this flexibility.

Ideally the applications software chosen/written should be specific for the type of tasks the user wishes to undertake. It should have a good screen format and presentation to enable the user to see at a glance what is going on. In some software packages the screen is cluttered, in others especially where color is used, the information content is obscured through poorly designed screen displays. Software should be transparent enough to allow the user to focus on the work itself rather than on manipulating the interface with the computer. Ideally it should be natural to the user in the sense that the actions required to do a task are similar to those with which the user is familiar. It should have predictable responses and provide feedback to the user on their actions.

Software should be relatively easy to learn and to use, though the two are not necessarily always compatible. Those very features which make a package easy to learn can become frustrating once the user has gained the skills necessary to manipulate it. Easy to learn does not obviate the need for proper training either. While self-teach can be a useful method for some people it is not always efficient either in terms of the time taken, or, more importantly, the kind of understanding and methods of use of the package which the user ends up with. Error messages are another important feature of any software package. They should be intelligible—in a form that users can understand and informative, ideally explaining why the error occurred and how the user can correct it.

Manuals can help or hinder in the use of computer systems and software packages. They should be well written, with minimal jargon, comprehensive indexes, and quick reference sections. The sheer bulk of many manuals is enough to put off many users! Finally the response time and system mode is important. For many users it is not the length of time that it takes for the computer to do something that they find frustrating (and this is often dependent on the hardware), it is not knowing what is going on. Software which provides messages to the user even if only to alert them to the fact that something is happening (e.g., PROCESSING PLEASE WAIT) is infinitely preferable to those that provide no messages at all.

As the use of computers spreads so too does concern over the nature of computer-based work. A common distinction which is made is between those jobs where people work *with* computers, that is where the computer is just another tool to help in the task of performing a job function, and jobs where people work *at* computers, where the operation of the machine seems to be the end in itself and the user is paced and controlled by it. There can be an important difference in attitude between those who use a VDU out of choice and those who "have to." Acting as a terminal minder can be as boring as working on a production line. There is also considerable evidence accumulating to indicate that people who work *at* computers are more likely to suffer from physical complaints and mental stress in their job than those who work *with* them.

Whether a person works at or with the machine is largely a question of how a particular job has been designed and the extent to which the person feels in control in the work situation. In considering the design of jobs involving the use of computers the following factors are useful to bear in mind.

Firstly, there should be a mix of work, some computer-based, some not, and preferably some which enables the person to get up and move around thus avoiding muscular and eye fatigue. The content, frequency, and sequence of the tasks done on a computer need to be considered. Doing many boring repetitive things is likely to be just as stressful and frustrating as doing one. Jobs should contain some variety, a variety which enables an individual to use or acquire different skills. The introduction of computers to the workplace often provides opportunities for job enrichment, enlargement, and rotation, all of which should be considered. The concentration level and the physical effort involved in the job need to be taken into account so a change of work or rest breaks can be instituted if necessary during the day. Finally, jobs should provide some potential for self-development and job satisfaction and these obviously will depend on the individual's own preferences and needs which should also be considered.

MANAGING THE INTRODUCTION OF COMPUTERS: TRAINING

Computers can inspire fear; fear of job loss, deskilling, inability to cope, loss of status are commonly found among those using computers for the first time and among all levels of the organization hierarchy. How computers are introduced is as important as what is being introduced. The process of change, as well as the product, requires preparation and planning. Ergonomic considerations are just some of a myriad of factors to take into account.

In general a participative approach to the introduction of computers will do much to alleviate fears and inspire confidence. Individuals need to be informed at an early stage about planned changes and how they will be affected by them. Opportunities should be presented for people to discuss any proposals, to air their fears and grievances, and to make their suggestions known, especially in the area of job design. For many, new technology is synonymous with redundancy and there may be misconceptions about what the technology does as well as what it is unable to do. Changes in job content and working practices can seem threatening, and time is needed to allow people to become accustomed to the new arrangements. Changing technology is as much about changing attitudes as it is about selecting computer hardware and software.

Education and training play a vital role in the successful implementation of computer systems. Education about why the change is necessary is as important as education about the capabilities and limitations of the system being used. Training in specific machines and software will help to ensure that computers are used effectively and user satisfaction is obtained. Too often people are given a manual and told to "get on with it," or sent on intensive two-day courses which are expected to turn them into experts on their return. This can be extremely stressful and can color employees' attitudes toward new technology.

Ideally training should be job related so that the benefits from using the computer can be made apparent in the context of the user's own work. Training should also be phased, with time between sessions to allow for the consolidation of the material learned before moving to progressively more difficult aspects of the machine and software use. Health and safety matters and good ergonomic practice relating to computer use should be incorporated into the training, not only so that users are sufficiently educated to the "health hazards" but so that they learn how to maximize their interactions with the machine to increase their own comfort and efficiency.

Conclusions

Applying good ergonomic practice intelligently in respect of computers is a prerequisite for their effective use. Such practices may not always be cost effective to apply, but neither are the costs of ignoring them. The justifiable concern about the "health hazards" of computer technology is unlikely to abate and indeed may increase as their use widens. Applying ergonomic principles such as those outlined here makes economic and social sense. Technology can enable us to advance only if it is applied wisely. If computers are used in such a way as to improve the quality of working life and make a positive impact on the health of users, then indeed they can be seen as of revolutionary nature.

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EVALUATION OF ELECTRONIC MEDIA AS REFERENCE SOURCES

Introduction

Alongside print and microform sources of information are now a variety of machine-readable sources using magnetic or optical storage media. At least 5000 online databases stored on remote mainframe computers and accessed via data communication networks are publicly available around the world. These databases contain a wide variety of information but can be broadly categorized as bibliographic, full-text, numeric, or transactional (some exhibit characteristics of more than one category).

A number of countries, including Austria, Australia, Germany, France, Italy, Sweden, and the United Kingdom offer videotex services. Originally such services could be differentiated from online services by their hardware (an adapted television set and telephone rather than a microcomputer and a modem) (*1*). Nowadays, however, the main differences lie in the type of information found on the two services. Videotex tends to provide such things as train and air timetables, telephone directories, weather forecasts, travel information and financial data (exchange rates, share prices) rather than bibliographic or full-text information. Videotex may also be used for teleshopping and electronic mail services (*2*).

Many organizations and individuals now store information directly on their own computer. Such local databases can therefore be designed and created by the same people who search them. Users can add their own information to the database as well as downloading data from external databases to the local database. Communication networks are not normally required to link the information requester to the local database (although in practice a short but high-speed local area network may link the user's terminal with the data store).

Finally, large external databases may be imported into the organization or the home on compact disc-read-only memory (CD-ROM) for installation on a local microcomputer. At least several hundred databases are already available in this optical format and the number continues to grow (*3*). In this article these diverse means of storing and retrieving information are collectively described as electronic media.

A reference source might be defined as one whose information content and internal organization (order of content, indexes, typefaces, etc.) is designed to facilitate the rapid retrieval of discrete items of information to answer specific questions. While any information store might be used to answer a reference question, then, certain kinds such as bibliographies, directories, encyclopedias, and dictionaries are primarily intended and designed for this function and these are designated as reference sources. Traditionally, printed reference sources have been clearly delineated from other kinds of work and maintained in libraries as a separate "reference collection" rather than being located with other titles according to their subject content.

The ease of locating discrete information elements from electronic media, however, makes any such distinction between reference sources and other sources misleading and unhelpful. Specific concepts can be quickly and simply identified and retrieved from entire articles or books in order to answer specific reference questions, because it is normally possible to search for occurrences of words or phrases anywhere in the text. This is quite different from searching a journal or book in print where the only access points other than browsing the entire work are a contents page or a very restricted index. Perhaps the best example of the distinction between print and electronic media as regards reference function is provided by newspapers. Printed newspapers contain a vast amount of information not only on current political affairs but on the performing arts, sports, literature, science, fashion, commerce, finance, and so on. This mass of information, however, is practically useless for retrospective searching because very few newspapers publish indexes to their material (although newspaper publishers themselves recognize its reference value for journalists and often create their own private news clippings libraries). Furthermore, even those newspapers like the London *Times* for which printed indexes are available cannot be used very effectively as reference sources because of the long delay before the appearance of the index and its lack of detail.

Newspapers online are quite different. The *Guardian* (on Profile), the *New York Times* (on NEXIS), or the *Toronto Star* (on Infomart), for example, can be searched to answer specific reference questions, although for most of us they are less satisfactory than the printed copy for reading the latest news stories over breakfast or on the train en route to the office (indeed records normally comprise individual news items and an entire daily issue could not easily be retrieved). The retrieval capabilities of electronic media, then, demand that a much wider range of sources be considered reference tools than is normally the case with printed equivalents. Indeed, it can be argued that most electronic databases can be used as reference sources to locate specific items of information on demand.

Reference works are typically expensive for either the library or the individual purchaser. Although not all titles are as expensive as *Science Citation Index*, *The Oxford English Dictionary*, *Chemical Abstracts*, or *Encyclopedia Britannica*, few are cheap. In many cases there are competing titles from which only one is to be chosen and the purchaser must decide how best to use scarce resources. Furthermore, an answer to a reference question is expected to be correct and therefore the currency, accuracy, and reliability of reference works are particularly crucial. Reference works, then, must be evaluated prior to both purchase and use; this applies as much to electronic as printed sources. The criteria for evaluating printed works have been suggested by a number of authors including Katz (*4*). Some of these criteria can be applied equally to electronic sources (such as scope and authority) but online, videotex and CD-ROM pose their own problems which must be considered in any satisfactory evaluation of their suitability to answer reference questions.

Evaluation

Electronic media are usefully evaluated under six main headings: Content, Retrieval capabilities, Hardware/software requirements, Costs, User support, and Availability.

CONTENT

Of the six evaluation criteria, content must rank first. No matter how satisfactory a source might be in other respects, if its content is in any way questionable then its reference value is severely undermined. Yet in some ways the content of a database is more difficult to check than a printed work. The pages of the latter can be scanned to gain a sense of its scope, authority, and audience but scanning screens of information is much less practical and certainly much slower. The quantity of information which can be held on each screen is very limited and to scan at all it is first necessary to retrieve particular subjects: a database cannot be browsed from A to Z like a book. Accuracy is of primary importance, whether it be in the presentation of bibliographic data, numeric information, names and addresses, historical facts, or whatever. In this respect, no distinction can be made between electronic and print media. No author or editor would be so unwise as to claim complete accuracy: like godliness, it is a virtue to be sought but never perfectly attained. Regardless of the medium, errors can appear at any point from the initial collection of raw data, through its analysis and compilation into the production process. Unfortunately, the consequences of errors at the data input stage are particularly far-reaching for electronic media. This is because, as mentioned above, the actual content—words (or numbers) and phrases—can often be used as retrieval devices. If words have been entered incorrectly on the database then a search on the correct spelling will fail to retrieve them. A glance at the basic index of any online database (this index typically includes all words found in subject fields except for a small number of stop words) should quickly reveal misspelled words which are then lost to all but searchers inadvertently entering as a search term the very same misspelling. Figure 1 shows the result of EXPANDing (looking at) the basic index of the ERIC database on Dialog (a database produced by the U.S. Department of Education's Educational Resources Information Center and dealing with all aspects of educational research and resources). This index is automatically generated by Dialog's software from the words included in the database and these words are added to the index just as they appear in the database. In Figure 1 the basic index has been EXPANDed around "questionnaire" to list those terms alphabetically related to it. The printout shows that a search on this term would retrieve 21,825 records which contain it in the title, abstract, or assigned index (descriptor and identifier) fields of this bibliographic database. In most records the term has been correctly input when the bibliographic data were added to the database and no problems should be encountered in retrieving records about "questionnaires." A number of records, however, may be lost to the searcher because in these cases the term has not been correctly spelled when first input to the database: 28 records contain the word "questionaire," 21 "questionniare," 20 have "questionnaries" and so on. A search on the correctly spelled word will fail to find these misspellings in the basic index and therefore will not find the actual records in which they occur (unless by chance these records also contain the correctly spelled version). It must be emphasized that ERIC was chosen at random and not because there is any suggestion that it is particularly prone to such errors. Errors of this kind would be even more serious if occurring in numerical databases.

Items	Index-term
2	QUESTIONABLY
1	QUESTIONAINAIRE
28	QUESTIONAIRE
14	QUESTIONAIRES
1	QUESTIONAL
1	QUESTIONE
1097	QUESTIONED
26	QUESTIONER
18	QUESTIONERS
3946	QUESTIONING
1	QUESTIONING BEHAVIOR
4	QUESTIONING STRATEGIES OBSERVATION SYSTEM

Items	Index-term
1	QUESTIONNABLE
1	QUESTIONNAIR
20031	QUESTIONNAIRE
1	QUESTIONNAIRE (BIGGS)
1	QUESTIONNAIRE ATTITUDES ENVERS L EVALUATION
1	QUESTIONNAIRE DESIGN
1	QUESTIONNAIRE FOR INTERACTIONAL TEACHER BEHAVI
1	QUESTIONNAIRE FOR PARENTS (PURDUE EDUC RES CTR
1	QUESTIONNAIRE FOR PARISH LEADERS
3	QUESTIONNAIRE ON RESOURCES AND STRESS
1	QUESTIONNAIRE ON RESOURCES AND STRESS (SHORT F
1	QUESTIONNAIRE ON TEACHER INTERACTION

Items	Index-term
1	QUESTIONNAIRE UPON MENTAL IMAGERY
1	QUESTIONNAIRED
21825	QUESTIONNAIRES (STRUCTURED SETS OF QUESTIONS ON SPECIFIED SU...)
1	QUESTIONNAIRIES
1	QUESTIONNAIRING
1	QUESTIONNAIRS
6	QUESTIONNARE
3	QUESTIONNARES
13	QUESTIONNARIE
20	QUESTIONNARIES
5	QUESTIONNED
21	QUESTIONNIARE

Items	Index-term
3	QUESTIONNIARES
10	QUESTIONNING
11	QUESTIONNNAIRE
2	QUESTIONNNAIRES
1	QUESTIONNNARIES
1	QUESTIONNSIRE
30104	QUESTIONS
1	QUESTIONS (LANGUAGE)
1	QUESTIONS INTO PARAGRAPHS
1	QUESTONNAIRE
1	QUESTONNAIRES
2	QUESTOR

FIGURE 1. *Extract from the basic index of ERIC.*

Locally created databases are likewise dependent upon accurate data input; typographic errors, if not identified and corrected, may conceal vital information from the searcher. Printed works are quite different. Misspellings in the text may be annoying but they do not usually affect retrieval of information, partly because the human eye (unlike the computer) is good at identifying words even if misspelled and partly because in any case only very small parts of the text (headings, index pages, etc.) are typically used as retrieval devices.

For many types of reference work the currency of the information is vital in its evaluation. Unfortunately, the production process for print products is so slow that information can already be outdated at publication time. Online databases can be updated with much less delay and there is no doubt that some are very current indeed. A press agency database such as REUTERS on Dialog might be updated every 15 minutes or so. It may even be possible to get real-time information: share prices can be obtained from British Telecom's CITYCALL PORTFOLIO by dialing the computer and entering a four-digit code for each share using a keypad. Share details are constantly updated on the computer and the relevant information is "told" to the inquirer by voice-processing equipment. Likewise, some financial databases on a videotex service like PRESTEL are constantly updated.

This kind of immediacy, however, is the exception rather than the rule. Nevertheless, some databases are updated more frequently than their print equivalents: for example, KEY BRITISH ENTERPRISES is updated more often (monthly) than its printed version (annually), and LIBRARY LITERATURE is updated twice weekly online, bimonthly in print, and quarterly on CD-ROM. It would be a mistake, however, to think that all online databases are updated more frequently than their print equivalents. In many cases the updating takes place at the same frequency (and not necessarily very often: EVERYMAN'S ENCYCLOPEDIA has not been updated online (or in print) since 1978 and the BIBLE (KING JAMES VERSION) is some centuries old. Typically CD-ROM databases are updated less frequently than the same title online (as in the above example of LIBRARY LITERATURE) although the trend is to update more frequently than in the medium's early days as pressing plants become more widespread and production costs fall. In-house databases, of course, can be updated as often as desired.

Many titles are simultaneously available in print, online, and on CD-ROM. Furthermore, more than one version may be available in each of the latter two formats. MEDLINE, for example, is available online from BRS Information Technologies, Dialog, DIMDI, JICST, and the National Library of Medicine, Télésystémes-Questel; in CD-ROM format it is supplied by SilverPlatter, Cambridge Scientific Abstracts, Dialog, Aries Systems Corporation, and CD-Plus.

It should not be assumed that a title is identical in coverage regardless of publication medium. *Psychological Abstracts* in print ceased to include bibliographic references to non-English language literature in January 1988, whereas its online equivalent on Dialog, PSYCINFO, has not followed suit. Only a part of the online PRENTICE HALL INFORMATION NETWORK, which provides tax information, is available on the CD-ROM version. PASCAL, a science and technology database, is online from 1973, in print (as *Bulletin Signaletique*) from 1973 until 1983 and on CD-ROM since

1987. In some cases the lack of retrospective online coverage is very dramatic: The READERS' GUIDE TO PERIODICAL LITERATURE is online only from 1983, but its printed form has been available since 1900. CA SEARCH is available on a number of online hosts but in each case is broken down into individual files in different ways; on BRS Information Technologies, for instance, it appears as two files (1970–1976 and 1977 to the present) whereas on Dialog there are six files (1967 to the present, 1967–1971, 1972–1976, 1977–1981, 1982–1986, and 1987 to the present). Information may also be packaged differently. OSH-ROM, a CD-ROM containing bibliographical information dealing with occupational health and safety, comprises three databases which are available as separate entities in their online versions; the MCGRAW-HILL SCIENCE AND TECHNICAL REFERENCE SET on CD-ROM contains articles drawn from the print versions of the *McGraw-Hill Concise Encyclopedia of Science and Technology* and the *McGraw-Hill Dictionary of Scientific and Technical Terms*. The quality of graphics is improving on electronic media but still rarely matches that traditionally offered by print. Some encyclopedias available on CD-ROM (such as COMPTON'S MULTIMEDIA ENCYCLOPEDIA) do include maps and pictures (15,000 in its case), but they cannot match the photographic reproduction in printed versions (and illustrations are absent from online encyclopedias). On the other hand, graphics can be manipulated electronically in ways which are quite impossible in books. On COMPTON'S MULTIMEDIA ENCYCLOPEDIA, for example, it is possible to zoom on maps to alter the scale, thereby varying the geographical coverage and level of detail displayed on the screen. This particular encyclopedia also includes 45 animated sequences. On another CD-ROM, SUPERMAP, the user can create color-coded maps to plot a wide and detailed variety of U.S. census data (e.g., the distribution of family incomes by county in Kentucky). Some CD-ROMS even include sound; COMPTON'S has 60 minutes of sound on its disc. Users, then, must consider any variations in coverage when evaluating individual products whether they be online, on CD-ROM, or in print.

Online search costs are relatively high and it is particularly unfortunate that in some subject areas there is considerable overlap, especially when considering bibliographic databases. A search carried out on two different databases, in other words, can retrieve a considerable percentage of duplicate records (*5*). In some cases, as with the agricultural databases, AGRICOLA, AGRIS, and CAB, several are attempting to cover more or less the same ground. In other instances, the very broad remit adopted by the databases creates overlap at their subject margins. Literature on library and information science can be traced not only on LIBRARY LITERATURE and LISA, but also on INSPEC (primarily concerned with electrical engineering but also covering information technology) and ERIC (education), to name but two. In other cases, the frontiers of several disciplines overlap as with BIOSIS PREVIEWS (biology), MEDLINE (medicine), and PSYCINFO (psychology). Finally, the databases dealing with traditional disciplines are overlapped by those dealing with multidisciplinary, mission-oriented areas like POLLUTION ABSTRACTS or ENERGYLINE. Any search undertaken in several related databases to ensure that as many relevant references as possible are retrieved must risk finding duplicates. Conversely, a search restricted to just one database may overlook relevant information which could have been found on other databases. Software is now available to identify duplicates (but only once retrieved) and this can be used to ensure, for example, that records downloaded into a local database are not duplicated.

Although many examples can be cited of titles on electronic media which are also available in print, a growing number of titles such as MUNDOCART/CD, a digital cartographic database of the world, can be used only from a computer. The number of unique titles on CD-ROM, in particular, expanded rapidly at the end of the 1980s. In such cases, of course, evaluation is still necessary but ultimately the user must resort either to the electronic medium or nothing at all.

RETRIEVAL CAPABILITIES

The most striking difference between electronic and print media can be found in the means of retrieving data. Electronic media typically provide a much more flexible approach. First, it is not too unusual for an online database to provide more controlled index terms than its print equivalent (examples are ERIC and MARQUIS WHO'S WHO). Second, many databases (and especially full-text) offer natural language as well as or instead of controlled language searching. Third, databases usually enable searches to be conducted on nonsubject or author fields such as language, publication year, document type, or institutional affiliation.

Such access points can transform the use to which the stored information can be put (as in the example of full-text newspaper databases referred to above) or can facilitate searches which would be difficult or impossible in a printed source. Access to a printed encyclopedia is limited to searches through subject headings or an index; the electronic versions often allow searches to be made on words or phrases within the text, words which might not have been included in a printed index. *Everyman's Encyclopedia* on Dialog provides an example. A search to identify Russian poets killed in duels is difficult in the print version because the approach provided is by poets' names. It is assumed that information will be sought on individual poets and therefore a request for subject information about them (how were they killed?) can only be attempted by the user thinking of as many Russian poets as possible and then looking each up in turn. This slow and unreliable approach can be circumvented online by conducting a search for all records containing the words "poet," which also contain either "duel," "duels," or "duelling" undertaken as one step by use of the truncation symbol) and have Russia in the country field. The OXFORD ENGLISH DICTIONARY on CD-ROM can be used to trace all English words derived from, say, Japanese or to track down quotations, the kinds of tasks which would be impossible in the printed version. On the other hand, the browsability of the 12-volume printed set is infinitely superior and would probably be the preferred medium in which to check quickly a definition or spelling.

Electronic reference sources, then, must be evaluated according to the access they provide to their store of information. Do they allow searches to be made on both controlled and natural language terms, what nonsubject fields are searchable, is there an up-to-date print or online thesaurus of controlled terms, etc.? The online user must very largely sacrifice browsing as a retrieval device and the quality of the specific retrieval keys is therefore crucial.

Online and CD-ROM systems typically provide access to information through an inverted file structure. Videotex services like PRESTEL traditionally opted for a tree-structured index of precoordinated terms. The user would search by inputting the first letter of the sought term, then the first two letters, and so on, gradually (and slowly) narrowing the number of possible terms until the screen of relevant information is eventually found. Not only is this slow, it is also rather hit and miss in the selection of correct index terms. The index terms assigned by different information providers (of whom there were several hundred on PRESTEL) were not consistent and it was not necessarily straightforward to guess the term which would ultimately lead to the right screen (*6*). The best way to circumvent this slow and unreliable process was in fact to consult a printed list of index terms which PRESTEL fortunately published. PRESTEL has more recently tried to tackle this access problem by providing a simple keyword search facility which displays increasingly more detailed lists of subjects and enabling searchers to combine such terms with an implicit Boolean AND.

The output formats in which retrieved records can be displayed, printed, or downloaded vary from database to database and, in the case of online, from host to host. Users may be able to choose from a series of standard formats and/or create their own formats. In the case of full-text databases it is useful to have a format which includes only that part of a long record to be displayed which is wrapped around the search term; this enables the user to grasp the context in which the term occurs and to decide on the record's relevance without the expense of viewing it in its entirety.

Information can normally be retrieved from online databases at high speed and all but the most complex of searches involving several very highly posted terms will be accomplished within a few seconds. The same is not necessarily true of CD-ROM. Complicated (and in some cases even relatively straightforward) searches can take minutes to complete. Although a search on CD-ROM will not incur monetary penalties for slowness (as would be the case with many online services) it is still frustrating and time-consuming for the user. Videotex services (for which a charge per minute is made) can also be slow because of the necessity to page through many index screens to get to the actual screen(s) containing the information (see above).

In order to find information stored on electronic media the user must be able to interrogate the database. This might be seen as the electronic equivalent of taking a book from a shelf (logging on to a computer via a communications network) and finding the right page, but it can require training and practice. How easily can the database be searched? Traditionally online databases were searched through a command language—a language with a small number of words (commands) and rules for using these words (a syntax). An incorrectly added or omitted space, for example, could prevent the computer from "understanding" the request. These command languages, of which there are many, were often inconsistent in application and intolerant of errors. Mistakes all too frequently generated incomprehensible error messages which confused rather than enlightened the user. Since the early days of online systems, command languages have tended to become more tolerant of minor deviations such as inclusion or exclusion of spaces and error messages have generally improved in intelligibility, though still often leaving something to be desired (*7*). Little progress has been made, however, on the adoption of a common command language for all hosts and many command languages have to be mastered by users who aim for comprehensiveness in their database searching (*8*). Furthermore, the growing sophistication of retrieval techniques has tended to increase the number of commands which the searcher must learn to take full advantage of the service.

In an effort to simplify the task of online searching (and particularly to attract end users who are less willing to cope with command languages than information professionals), some hosts such as BRS now offer menu-driven searching as well as command-driven searching. Menus can be slow and tedious, especially for the frequent user, but they do obviate the need to learn a command language. Many CD-ROM producers have opted for menus rather than commands (some, such as Whitaker's BOOKBANK offer both); the relative slowness of menus matters less here as online connect costs are not incurred.

Although menus remove the need to learn a command language they do not help the user to select the best database to answer the information query, the best search terms in which to encapsulate that query, nor the best strategy in which to employ those terms. In order to tackle these problems hosts such as WilsonLine have designed front-end software which users can install on their microcomputers (*9*). An alternative is to use an intelligent gateway service such as Easynet which acts as an intermediary to a number of online search services. It will select the "best" database for the search, help to construct a search strategy, translate that strategy into the command language of whichever host it chooses to use, log on to that host, and download the results (*10*). The most ambitious approach is offered by expert systems which attempt to convert a natural language information request into a series of search terms, these in turn being assembled into a strategy complete with the necessary commands. Tome-Searcher is an example of such a system which operates in the electrical engineering and communication technology fields as an interface to the European Space Agency's Information Retrieval Service (*11*). So far, however, no software has managed to equal the skills of an experienced human searcher (*12*).

Ease of access is an important consideration in any evaluation, especially if the source is only to be used occasionally or if end users are likely to be involved. CD-ROMs which offer both menus and commands should be checked to make sure that the same operations can be accomplished in both modes; in some cases the command searching mode offers more flexible (and faster) retrieval than the menu mode. Some CD-ROMs also offer various menu levels. BOOKBANK, for example, has a novice mode and an intermediary mode (as well as the expert command mode); the novice mode is more straightforward to use but it cannot accomplish all the kinds of searches possible through intermediate mode.

Hardware/Software Requirements

The hardware requirements of online and videotex systems are now fairly standard. In most cases users employ a microcomputer equipped with an RS232 port and linked via a modem to a telecommunication line. It would also be normal to have access to a printer of some kind. The main decisions to be taken are the choice of communication speed (1200 bits per second or faster), which affects the choice of modem, and the communications software to be employed. Such software may do as little as enable the microcomputer to function as a terminal and communicate with another computer, or it may store passwords for various networks/hosts, dial up, log-on, download, reformat downloaded records, and so on.

The somewhat newer technology of CD-ROM is manifest in the lack of industry standards. Each CD-ROM will have its own requirements in terms of the microcomputer storage medium, CD-ROM drive (player), microcomputer operating system, random access memory, and support software (like Microsoft CD-ROM Extensions). Most discs demand the MS-DOS operating system (and even specific versions of it) found on IBM and compatible machines, but some require the MacIntosh system (like MACINTOSH SHOWCASE), and a few like THE NEW ELECTRONIC ENCYCLOPEDIA, can be bought in both versions. Although memory requirements vary, to be safe the microcomputer should have at least 640K random-access memory (RAM) available; documentation accompanying CD-ROMs cannot always be relied upon to state accurately the minimum memory required by the disc. Not all products require hard disc storage for their programs, auxiliary and temporary work files, but even those which claim to work with diskette storage only are best used with hard disc machines. Just about all CD-ROMs make good use of color in their retrieval menus and therefore a color monitor is strongly recommended. Products which make good use of graphics may require an EGA adaptor and a color graphics plotter to get maximum benefit from the facilities. Least problematical is the drive (player); most discs work on the drives built by the well-known suppliers like Philips and Hitachi, but this should be checked with the CD-ROM producer if in doubt. Finally, it will be necessary to install an interface card in the microcomputer when setting up the CD-ROM drive.

The installation of individual CD-ROMs can be fraught with problems, especially when a number of discs are to be installed on one microcomputer. Users unfamiliar with the operating system and batch file functions of their microcomputer may well encounter frustration and setback before the task is successfully completed (*13*).

Costs

It is no longer possible to generalize about online search costs. The variety of criteria used by different hosts has increased from the early online days when costs were almost entirely related to connect time with a small element related to the amount of data transmitted and received. An element of connect time remains for all online searches because the communication network through which the user accesses the host computer will charge by time. Additionally, many hosts include a connect charge but it may now only be one element (and possibly a minor element in the total search costs). Charges may be made for the number of hits, the number of records displayed or printed (possibly also varying according to the record format chosen), the number of commands used, a session rate for connecting to the database and so on. Additional charges may be added for offline prints and downloading data. Some databases, including the specialist financial services on PRESTEL and PETROLEUM INTELLIGENCE WEEKLY CRUDE OIL PRODUCTION on I.P. Sharp impose an annual subscription as well as charging for usage, while others like Reuter's

TEXTLINE charge an annual fee but do not demand additional payments for use. Hosts may also offer various discount incentives for prepayment or heavy use, educational rates for instructional purposes, free time on new databases, and so on. Heavy users of a particular database might find it financially beneficial to choose the option (if available) of leasing for searching in-house on a local computer or via a host service like Dialog: in such cases costs will be fixed rather than varying according to usage. In a few cases the database producer offers a lower access rate to the online database if the user's institution also subscribes to the equivalent print product (as with the Institute for Scientific Information's citation indexes).

A database which is available on more than one host (of which there are many) may incur quite different charges on each host, and the user must evaluate carefully which gives best value for money. This is not necessarily the same as calculating which offers the lowest rate (*14*). When comparing services, for example, the telecommunication rates as well as the database access rates must be considered. It should also be borne in mind that the searcher may be more proficient on one host than another and therefore may work faster and more successfully on that host even though its rates are somewhat higher than the other. Finally, the hosts compete with one another in retrieval software; it may be possible, for instance, to use a particular facility (like left-hand truncation, potentially useful on chemical databases among others) on one host but not on another.

CD-ROMs are normally sold (like a book) or offered on subscription (like a journal) and no incremental search costs are incurred. Prices may range greatly from product to product from a few dollars to several thousand dollars.

A title which is available in print, online, and on CD-ROM will usually have a quite different pricing structure for each medium. If use is likely to be infrequent then online, where a pay as you go policy applies, might be the cheapest. Heavy users would be drawn to a leased database, CD-ROM, or print, where costs are fixed rather than variable. The price of the product, of course, should not be considered in isolation from other evaluation factors.

User Support

The first-time user of a printed reference source would be well advised to consult its preface and introduction to establish the scope, arrangement, indexing, etc. In the case of electronic media, preparation may be more prolonged. The online host normally provides a user manual which explains in some detail the command language. It may also produce documentation on the individual databases which can be accessed. Many hosts publish quick reference summaries of their command language and regular newsletters informing users of system developments, training sessions, etc. The host may also supply training software for use on a local microcomputer or online training files. The database producer likewise may provide manuals, newsletters, etc. CD-ROM products usually are supplied with a printed manual and many have extensive on-screen help pages or even tutorials. The quality of this printed documentation and software is variable and needs to be carefully evaluated as it plays no small part in determining the success or otherwise of database searching.

Online hosts, and to a lesser extent, database producers provide training courses (typically lasting one or two days) for both beginners and for more advanced students. The frequency of such courses varies as does the geographical (and linguistic) distribution. Many hosts and some database producers also offer help desks which can be telephoned when the user encounters a problem. Again, these support services should not be overlooked when evaluating electronic media. CD-ROMs are considered simple enough to use that training courses and help lines are not normally provided by the suppliers. In practice, a library deciding to offer its clients direct access to CD-ROMs may have to be prepared to give introductory training sessions as well as specific help on occasion. It may also need to install a front-end (like a menu) to its CD-ROMs so that patrons can easily load and start searching the database; this is especially useful if a number of discs are to be accessed at the same workstation.

Availability

One virtue offered by CD-ROMs is their constant availability; short of a malfunction in the player or microcomputer, or an electricity blackout, the information is accessible at all times. It is not quite so straightforward with online services. Local hardware or electricity failures can prevent use, as can telecommunication problems or difficulties at the host's computer. Of these, telecommunication malfunctions account for the vast majority of failures.

Furthermore, hosts are not always available for 24 hours each day 365 days a year. Routine maintenance may necessitate closing down the host computer for a short period each day or week; although this time will be chosen so as to cause least inconvenience to national users (typically the middle of the night), overseas users might encounter considerable inconvenience because of international time zone differences. Foreign users likewise suffer most when hosts suspend their operations for local holidays (e.g., Thanksgiving in the United States) which are not celebrated elsewhere. It is less common now for hosts to operate a five-day, 9:00 a.m. until 5:00 p.m. day, but it should not be assumed that all hosts are available outside local office hours: the user manual should give online access times (*15*). On the other hand, online (and CD-ROM if linked to a local area network) services can be used remotely; users need not visit the library in order to undertake a search.

A few databases are available only to certain categories of users. The series of databases produced by NASA, for instance, can only be accessed by NASA installations, NASA contractors, other U.S. government agencies and their contractors, and selected university libraries.

ELECTRONIC MEDIA IN REFERENCE WORK

During the 1970s, reference librarians, along with other information workers, began to integrate online databases into their arsenal of information sources. A 1978 report based on experiments conducted in four California libraries concluded that "The traditionally trained reference librarian is already expert with complex manual tools . . . and the skills developed with these tools are transferable to computer database searching. There is considerable evidence that traditional reference librarians are willing and able to learn database search techniques" (*16*).

Despite such early interest in the new technology, however, reference librarians in practice proved rather slow to replace traditional with electronic sources. A survey in 1981 of almost 400 university and college libraries in the United States and Canada found that more than a third provided no online searching and in a further quarter the reference librarians spent less than five percent of their time doing online searches (*17*). Similar findings were reported in the United Kingdom (*18*).

The reasons for such slow take-up are not too difficult to identify. First, the early databases were typically bibliographic in form and scientific or technical in subject. Therefore, they could be used to answer only a small percentage of questions typically posed to reference staff. Second, almost all these databases were new electronic versions of existing printed abstracting or indexing services for which many libraries would have subscriptions. Third, the high and extremely visible variable costs associated with online searching made reference librarians think twice about using databases, especially when the print copy could be used without incurring incremental costs and when any such costs could not be passed on to the client. Online databases were most likely to be used when the client wanted a comprehensive and retrospective search for scientific/technical references for which payment would be made.

A much richer variety of information is now available in electronic form, and pricing systems are beginning to reflect more closely the needs of online users. Indeed, in the case of CD-ROMs price structure is little different from that of traditional journals. Furthermore, titles are regularly appearing which have to be used in electronic format as they do not exist in other media. Electronic media are now commonly used in reference situations; however, they have not supplanted print but rather complement it. There is now a growing interest in determining the kinds of reference questions which are best answered by online and CD-ROM sources in contrast to those best handled by the older medium. According to Grogan there is "general agreement" on a number of ground rules when using online services: "Searches have to be brief, lasting no more than five to ten minutes. The response should be limited to five or at most ten citations in the case of a search of a bibliographical database or an equivalent assembly of data from a non-bibliographical database. The decision to search online must always be entirely at the discretion of the librarian, who invariably carries out the search, normally alone" (*19*). Havener conducted an experiment to discover whether the format (print or online) in which information is stored can influence the outcomes of ready reference transactions. He found that print sources were more efficient in answering factual questions but online was more efficient in answering conceptual questions (requests for bibliographic citations). He concluded from this that online bibliographic sources should be preferred to print and that this is particularly the case when the question involves more than one concept. Simple factual queries could be answered more quickly, however, using print sources. Finally he concluded that using the most efficient technology did not harm success rates: the choice of technology had no effect on the success rates for factual questions, and in the case of conceptional questions the most efficient treatment, online, was also the most successful (*20*).

Electronic media are not an integral part of reference service, although the wilder claims made in the 1970s that print sources were on the point of extinction have not been borne out. The relative strengths and weaknesses of electronic and print media in various reference contexts require further investigation, but for the time being both continue to be used by reference librarians in their quest to supply answers to their clients' questions.

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FACULTY STATUS FOR ACADEMIC LIBRARIANS

Introduction

Library literature is replete with references to the status of librarians in the academic community. The academic status that librarians have within academe has been of enduring concern to them since their emergence as an autonomous professional group in the late nineteenth century. Thus, one of the most controversial issues in academic librarianship is the issue of faculty status for academic librarians. The preparation of librarians, their status, responsibilities, and rewards are intertwined (*1*). The interrelatedness of all these factors has been the focus of a variety of authors in the field of academic librarianship. There has been a proliferation of writings dealing with faculty status. The quest of the librarian to gain full acceptance in the academic environment has been a long and constant struggle.

Faculty status for librarians is defined as "the possession of all or most of the privileges of the classroom teaching faculty, including faculty rank." Whereas academic status, an often substituted concept, "is held to be the possession of some but not all of the usual faculty privileges, with a definite classification as academic but always without faculty rank" (2). Thus, academic status is seen as a reduced form of faculty status. Moreover, faculty status is defined as "an official recognition by an institution of higher education that librarians are part of the instruction and research staff by confirmation of ranks and titles identical to those of faculty, with commensurate benefits, rights, and responsibilities" (*3*).

Faculty status was first espoused at the University of Montana in 1902. However, the earliest recorded granting of faculty status occurred at Columbia University in 1911 (*4*). As early as June 1878, H. A. Sawtelle espoused the value of college librarianship. He advocated that "college librarianship ought not be annexed to a professorship, but be itself a professorship" (*5*). Faculty status is still an unresolved issue within the academic community even after four decades of heated debate. Josey indicated that "there is a body of opinion from some quarters in academic librarianship that does not believe in faculty status for librarians" (*6*). This statement still rings with pungent truth, possibly not as dramatic as when it was first stated. Conversely, recent reports indicate that the number of institutions granting faculty status to its librarians is at an all time high, 79 percent. Yet, more and more librarians are beginning to reject its tenets themselves (*7*). Controversy exists concerning this subject today as it did when the Association of College and Research Libraries (ACRL) began the fight for the endorsement of faculty status by its parent organization, the American Library Association. The driving force began in 1959; consequently, in 1971, the "Academic Status Committee drafted Standards and an official statement on the issue" (*8*).

As one examines faculty status over the years, there are other relevant historical events that are noteworthy of reporting. Arthur McAnally indicated that, as academic librarians considered their status during the postwar period, they saw an increasingly complex role and became dissatisfied with their relatively low status. During the 1930s and 1940s, status was important, but faculty status was not advocated per se. Yet, some designation was sought to elevate the image of library work in the academic environment. This movement for elevation of academic librarians gained impetus, and the faculty alignment became to be accepted as the most appropriate form as early as the late 1940s (*9*).

During the period between 1945 to 1965, there was increased recognition of the importance of the librarian in higher education and the profession (*10*). The Higher Education Act of 1965 added an incentive as reflected in the fact that libraries and librarianship were included. The acceptance of librarians, as members of the American Association of University Professors in 1954, was invaluable (*11*). An age-long criticism against librarianship is that its activities are too routine, and thus are not considered to be academic. Nevertheless, admission into the profession hinges on a sound college education. Many librarians have earned two masters' degrees, one in a subject specialty and the other in library science (*12*).

Because of the increased gains, during the mid-1960s, in the academic recognition of librarians in colleges and universities, Robert Downs reported that much diversity "exists among the forms of recognition received... and acceptance of the principle of academic standing for librarians has been limited or qualified." Downs concluded that the struggle, in 1964, was encouraging with better prospects for faculty status on the horizon (*13*).

The Association of College and Research Libraries', "Standards for Faculty Status for College and University Librarians," were adopted in 1971. These Standards provide that librarians should receive the same rights and privileges as other members of the faculty. In the years following the adoption of the Standards, there was a great proliferation of literature on faculty status. A comprehensive bibliography by Nancy Huling covers the period from the late nineteenth century to 1973 (*14*). Although it would be difficult to detect a general consensus on the subject, a majority of the authors in this bibliography indicate that the major problem in the investigation of faculty status lies in the lack of a precise definition of all that is implicit in the term. Most of the librarians writing on this topic, during this period, advocate some sort of improved status whether it is equity with the teaching faculty or an elevation of librarianship as a more worthwhile profession. Furthermore, the writers concur that the institutions must decide the type of status allowable since they normally operate under autonomous administrative policies. Furthermore, these articles, books, and research reports tend to be descriptive and not evaluative (*14*). Much of the reviewing in this survey will draw upon the writings of Huling, the writings of Emily Werrell and Laura Sullivan (*15*), and other salient authors in the field.

The principal reason for reviewing the literature related to faculty status of academic librarians will be to assess the existing knowledge of this area of inquiry. The organization of this review of relevant literature will give a historical perspective from the early nineteenth century through the 1980s and will relate the various ideas presented therein.

Earliest Citing Through the 1960s

An early proponent of the value of college librarianship was H. A. Sawtelle, who noted that the good librarian must guide students in the use of library materials, a function which requires much skill. The author concluded, therefore, that librarianship itself should be a professorship and not annexed to to a professorship (*5*).

One of the earliest proponents of faculty status was W. E. Henry in 1911, who stated that the librarian is central to the role of education. Therefore, the librarian must be of equal rank with the faculty. The librarian, asserted Henry, is "quite as necessary as the teacher and quite helpful. Neither could do his work without the other." Furthermore, the educational preparation of the two is essentially the same, but differs in slightly different ways. He insisted, however, that the library staff must be equal in scholarship and preparation to that of the faculty. If this is not the case, Henry contended, the library will fall short of the work that should be done in higher education. This proponent of faculty status also insisted the work of the librarian is as scholastically helpful as that done by the classroom teacher. Thus, the rank of librarians should be comparable to those of faculty, and those members of the library staff "not fitted to be so ranked should not be considered members of the staff." He finally suggested that librarians be given the title "Professor of Reading and Books" (*18*).

In 1922, Edith Coulter examined the important role of the university librarian. It was not a matter of academic status, but a question of recognition of equality with faculty, which is necessary to render the greatest service to institutions. She stated that academic librarians must be scholars and possess a degree recognized as the equivalent of the Ph.D. The education of the librarian must be commensurate with that of the professor (*17*).

The first full exploration of the status of professional librarians was undertaken by George A. Works, in his *College and University Problems* published in 1925. In a chapter devoted to the subject of faculty status, Works reviewed types of library work, factors affecting the status of a library staff, current conditions, the relative preparation of library and teaching staffs, comparative salaries, work schedules, and retirement conditions. He concluded: (1) insufficient distinction is made in libraries between clerical and professional types of service; (2) wide differences were found among librarians who held faculty rank to others with clerical and classified ranks; (3) in some universities there was equivalent status but librarians were not considered members of the instructional staff; (4) salaries of the library staff were generally lower than those of comparable members of the faculty; (5) the academic preparation of faculty members was more advanced than librarians; (6) periods of service for librarians were longer than teaching staff; and (7) retirement provisions varied (*18*).

In 1935, C. E. Friley discussed the status of academic librarians. The librarian, stated Friley, must be "thoroughly trained in his field and keenly alive to the opportunities for service to students and faculty." Furthermore, the librarian should be professionally trained, and have an active interest in scholarship. This involvement will gain him or her respect and esteem from teaching colleagues and students. Friley insisted that the 1930s were the important formative years for faculty status (*19*).

In 1939, a study was conducted to determine the status of librarians and how many had attained faculty status. This survey was one of the earliest efforts to collect information from library practitioners. This surveyor attempted to determine the number of college librarians who had the same status as members of the faculty; the number with nominal faculty status and not commensurate benefits and privileges, and the number having some different ranking. Miriam Maloy concluded that faculty status is desirable, but librarians must also raise their own standards (*20*).

In 1946, the librarians at the University of Illinois were accorded faculty status. Robert Downs, one of the early prominent writers in the area of faculty status, discussed staff classification and stated that the salaries of librarians should correspond to the teaching staff salaries. Librarians worked to attain faculty status because they discovered that they were the only university group engaged in nonclassroom teaching that did not have academic recognition. This fight was grounded on the early belief that librarians were entitled to full recognition as an integral part of the academic community (*21*).

In 1946, Thomas Barcus dealt with what was to be one of the tenets of faculty status: the incidental duties, namely those other than the regular duties of academic librarians. His survey of 52 librarians revealed a consensus that librarians will profit from membership on committees that affect the library most closely; the library committee, the executive council, the curriculum committee, and the committee on publications. Furthermore, his respondents concurred that a wider acquaintance with student needs and interests would prove worthwhile, as well as those duties connected with training and teaching. Ultimately, asserted Barcus, the individual librarian must choose which of the possible incidental duties would pay the greatest dividends and concentrate his/her efforts accordingly (*22*).

An article by Morris Gelfand in 1949 presented results of a questionnaire survey in which 70 college librarians participated. Librarians and faculty members offered their conceptions of the place of the library in the college. Where faculty rank is accorded, it is usually granted only to the chief librarian and one or two assistants. Most librarians received lower salaries than teaching personnel of similar academic rank. Gelfand concluded that if the primary purpose of the college library is to advance the educational program of the college then the professional librarian would have the same status as the members of the college instructional staff. This participation by librarians would further the attainment of the aims and purposes of the faculty status (*23*).

There appeared two important articles in 1951, by Frank A. Lundy relative to faculty status of librarians. The first article outlined the reasons for librarians' attainment of faculty status. It pointed out the important role the librarian plays in the educational function of the university and also stated that faculty status would bring the faculty and the librarian closer. Furthermore, rank should correspond to teaching faculty with the same education. The second article discussed faculty status in several institutions which associate the professional librarian with the teaching and research staff. In the 35 institutions studied, the educational functions of the library and the academic responsibilities of its professional staff appeared now to be clearly established. The assignment of rank with its attendant privileges had been accepted as the most appropriate means of expressing the close relationship with the teaching and research staff (*24*).

Another salient article appeared in 1952 which discussed the evolution and general trends in the history of library education. Although there appeared to be a movement toward the granting of academic rank to professional librarians, the general position of academic librarians remained ambiguous. Thompson concluded, however, when we know why librarians are successful, the library educators will be in a better position to train future professionals who can then demand salaries and status which they feel were denied previous librarians (*25*).

In 1955, a significant contribution to the literature tracing the history of faculty status by W. H. Carlson also appeared. This author reviewed the evolution of the trend toward recognition of the academic contributions of college librarians. He felt that the attendant assignment of faculty status and rank was important and determined that academic librarians were finally moving toward full acceptance as members of the academic faculty. He noted that, unlike earlier times, all librarians, not just the chief librarians, were increasingly gaining faculty rank and academic status (*26*).

Another notable early proponent of faculty status for librarians was Arthur McAnally. His 1957 article, "Dynamics of Securing Academic Status," cited the various forces to be reckoned with in attempting to secure academic or faculty status that included: (1) institutional, (2) administrative and financial, (3) pertaining to the faculty, (4) originating in the library, (5) other intrainstitutional forces, and (6) extrainstitutional forces (*27*).

In 1957, Robert Downs again spoke out on the issue of faculty status. In this article, Downs reviewed the status of university library staffs (professionals only) and concluded with a summary of current opinion among library administrators as to the most desirable type of personnel organization. In this summation, he admonished the library community to strive for those attainments similar to those of the teaching staff. These included: educational and professional attainments, professional involvement, research in problems of librarianship, writing for publication, as well as other evidences of professional maturity (*28*).

Vivian Boughter dealt with many of the eventual tenets of faculty status. She conducted a survey to determine salaries, work week, vacations, and benefits and privileges of the academic librarian. The 1958 survey concluded that library salaries were not comparable to faculty, but status was improving as academic librarians became more qualified (*29*).

In a 1958 monograph entitled *The Status of American College and University Librarians*, Robert Downs devoted his attention exclusively to all aspects of status for librarians during this period (*30*). In considering the status of librarians, Downs surveyed conditions of librarians in 115 American universities and discussed three discernible patterns of how universities rank librarians. These were: (1) academic or faculty status, (2) a separate professional group, which may be called administrative or professional, or be without any special designation, and (3) civil service or other classified service plans. He argued for faculty status, indicating that this would improve the quality of librarians. The academic librarian must offer commensurate qualifications. The reasons for awarding librarians faculty status was to achieve a clear distinction and separation between clerical and professional duties in libraries. Furthermore, granting librarians faculty status served as a uniting factor with the rest of the academic staff. Downs addressed convincingly the need for librarians to receive comparable salary rates, vacations and holidays, sabbaticals, and retirement. The library community was admonished that not just the library administrators but all academic librarians are deserving of faculty status. Finally, the author asserted that librarians should acquire more degrees in order to emulate faculty (*31*).

Henry Scherer's unpublished dissertation, *Faculty-Librarian Relationships in Selected Liberal Arts Colleges*, studied 367 colleges. The author found that relations between the library and faculty members were favorable, and that librarians were generally accepted as faculty members (*32*).

One relevant study that did not reflect current thinking on faculty status for librarians was performed in 1961 by Jane Forgotson. She defined status as the position an individual occupies with relation to a social group or organization. It also assigns rights, duties, and values. She stated that librarians are not granted social acceptance commensurate to faculty; rather, their positions were often nebulous. Forgotson promoted some type of status rather than faculty status for librarians. This was an unusual stance when compared to most of the writers during this time. The author foresaw the time when librarians would be accorded equal rights, however (*33*).

Russell Seibert asserted a view similar to that of Robert Downs, when he stated that, to attain faculty status, librarians must be willing to meet the same qualitative standards, or their equivalents, as those which are expected of the faculty at large. This author outlined these standards as educational, professional, and institutional (*1*).

The founding dean of the School of Library and Information Science at the University of Pittsburgh, Harold Lancour, was not a proponent of faculty status. In a 1961 article, he discussed the status of the librarian in general and the attempt to improve it. He noted college librarians work the hardest to ameliorate their status. The author believed that academic librarians should improve their own profession rather than becoming professors in another field (*34*).

The same article appeared in a 1962 publication also entitled the "Librarian's Search for Status." Harold Lancour described status in a general sense and narrowed it to the profession of library science. He analyzed the intellectual nature of librarians in their pursuit of knowledge and examined their role as educators. College and university librarians were singled out as those most deserving of academic status, thus better fulfilling their purpose and objectives in an institution of higher education. The author concluded that the highest status can be gained by: (1) strengthening the educational requirements, (2) strengthening the professional associations, (3) emphasizing the intellectual character of the librarians' work, (4) librarians valuing their abilities, and (5) taking pride in the work, the positions, and the title librarian (*35*).

Arthur McAnally was a strong proponent of faculty status. As a major writer on the subject in the early 1960s, he discussed particularly the components of faculty status and what it meant to the academic librarian. The privileges and obligations of academic status can be differentiated into three categories: those that are of general interest to librarians, those of interest to library administrators, and those that may be categorized as the newer duties of librarians. This was one of the earliest articles which delineated the components of faculty status giving the pros and cons for its adoption (*36*).

In 1964, Robert Downs presented the results of a survey conducted of state institutions (California, Ohio, Washington, Kansas, New York, Minnesota, Wisconsin, Illinois, North Carolina, Tennessee, Texas...) from 1957 to 1964. He found that the national trend toward academic recognition of university librarians and the forms of recognition achieved by librarians differed, but that institutions granting faculty status were reported to be on the increase. Downs admonished librarians that they must be willing to accept the responsibilities as well as the privileges (*13*).

Vincent Negherbon's 1964 article supported faculty status, stating that the librarian was involved in indirect teaching. He discussed what faculty status meant to librarians, when he stated, "the college library must be an integral part of the institution of learning if that institution is to be a good college." When faculty status is obtained, the librarian should use the privilege to the fullest (*37*).

In a 1965 article, Lewis Branscomb, an outspoken proponent of faculty status, asserted that, because professional librarians were involved in intellectual tasks, they needed an atmosphere of freedom. Branscomb outlined the librarian's tasks, and stated they should have tenure to ensure intellectual freedom and should not be harassed by adversaries who may be opponents of intellectual freedom. He also outlined a tenure procedure for librarians (*38*).

In 1966, Jean Perreault stated that much discussion of academic status had proceeded from an emotional rather than a rational base. He attempted to analyze the "formal environment" of academic status. He concluded that the librarian "is in a sense the academic environment himself, and is accordingly pre-eminently academic" (*39*).

Downs, in 1967, discussed where the librarian belongs in the academic community, and related it to the question of faculty status. He believed the library community must define what is meant by an academic professional librarian, for on this hinges whatever claim librarians may have to faculty status (*12*).

Downs presented a series of preliminary statements in a 1968 publication prepared by the Committee on Academic Status of the Association of College and Research Libraries. A century ago, few, if any, American academic librarians held faculty rank by virtue of their library rank. Slowly some came to be recognized as responsible academic officers, usually at first without rank, and subsequently, increasing numbers of them were accorded full faculty status and rank. The struggle continues, stated Downs, but with more promise for acceptance (*40*).

Another aspect of the status of academic librarians, was examined in a 1967 conference paper by William Goode. Goode a sociologist, analyzed the qualities which characterize "a profession" and described how a librarian fits these criteria and concluded that librarians fail to meet the necessary qualifications. It contained a brief discussion of how professionalism was directly related to the question of faculty status (*41*).

An article published in 1968 that addressed professionalism was written by Edwin Posey and was entitled "The Librarian and the Faculty." It outlined problems between the librarian and faculty, the attempt to define professionalism in librarianship, and the obstacles to faculty status. He asserted that most of the problems librarians face with status was because of the fact that the librarian was not entirely certain of his or her proper role in the college or university. He also cited as another cause of friction the librarian's weak position on the university organization chart (*42*).

An abundance of articles were found in the literature on the status of academic librarians during the late 1960s. It was indeed an opportune time for the adoption of a national policy on the status of college and university librarians. A noteworthy work by Fay Blake in 1968 outlined the purposes and history of academic freedom and tenure for teaching faculty and related those factors to the academic enterprise. She further pointed out the similar and growing need for such freedom and tenure for college and university librarians and cited examples of how the absence of these items can be detrimental to an institution (*43*).

A publication in 1970 entitled *The Case For Faculty Status For Academic Librarians* was commissioned by the Universities Library Section of the Association of College and Research Libraries Ad Hoc Committee on Academic Status. The publication, edited by Lewis Branscomb, is a series of papers which provided assistance and information to librarians who were actively campaigning for full academic status including rank and title. Thirteen topics were presented, eleven of which subsequently appeared in *College and Research Libraries* from 1959 to 1968. However, only those papers which presented a favorable stance on the topic of faculty status were included in the monograph (*44*).

Massman wrote prolifically during the late 1960s on academic faculty status. One example, "Consideration Regarding Faculty Status" addressed: (1) how and why does academic freedom affect librarians?; (2) possibly, it is not advantageous for librarians to equate themselves with faculty members, since often the librarians do not have as much formal education as faculty; (3) how does faculty status affect recruiting outstanding librarians?; and (4) should librarians be granted faculty status? (*45*).

The 1970s

The Association of College and Research Libraries' "Standards for Faculty Status for College and University Libraries" were adopted in 1971. These Standards provided that librarians receive the same rights and privileges as other members of the college and university teaching faculty (*8*). The following is a summation of its basic tenets: (1) assignments of professional responsibilities only, and review by a committee of peers; (2) governance by a library faculty; (3) membership in college governing bodies; (4) equal compensation for equal education and experience, academic year appointment, salary adjusted upward for extra contract days; (5) eligibility for tenure; (6) eligibility for promotion, with titles and ranks identical to those of other faculty; (7) eligibility for leaves on an equal basis with other faculty; (8) equal access to research grants; and (9) academic freedom.

The literature that covers the issue of faculty status during the early 1970s to the mid-1980s tended to be the result of survey research. Janet Krompart and Clara DiFelice reviewed 36 major surveys on faculty status, which provided information on the application of the nine ACRL Standards in academia for over a decade (*46*).

In 1970, Virgil Massman completed a dissertation on faculty status, entitled *Responsibilities and Benefits of Faculty Status for Librarians: A Review of Related Literature and a Survey of Librarians and Faculty Members in Nineteen State Colleges and Universities in Michigan, Minnesota and Wisconsin* (*47*) which subsequently was published as a monograph in 1972 (*48*). The survey was not based on the Standards. However, the author discussed the Standards in general terms. Massman's work was a comparison of librarians and faculty in the areas of education, salary, experience, scholarly activities, tenure, sabbaticals, and university governance. The librarians queried were from nineteen institutions in Michigan, Minnesota, and Wisconsin. The departments represented by the faculty were: English, Sociology, Economics, History, Physics, and Biology. The return rate for librarians was 79 percent, compared to 60.5 percent for the faculty. The results showed that 92.9 percent of the librarians possessed academic rank. None of the librarians without rank was found to be eligible for tenure or sabbaticals. The greatest differences between the respondents with rank to the ones without rank were in the areas of tenure, salaries, and sabbaticals. Simultaneously, librarians with rank compared to teaching faculty were found to have few differences in their eligibility for tenure or sabbaticals. The rank and salaries of librarians were lower than responding faculty, but so were the degrees held by librarians. It was reported that 66.5 percent of the librarians had contracts of 9 or 10 month terms, and that 78.6 percent were eligible for research funds. The ACRL Standards had not yet been formally adopted. The meticulous Massman study comparing faculty with librarians gave credence to the intent of the soon to be adopted Standards.

An instrumental and precedent-setting survey was conducted by Josey in 1972 entitled "Full Faculty Status This Century," it elicited opinions of librarians regarding their support of the Standards through a mailed questionnaire. The nine Standards were used in querying the heads of reference or reader services librarians in 215 postsecondary institutions in New York. Josey contended that "considering the large participation (47.0%) by such an assortment of librarians representing a wide range of types of institutions, we may review the findings as significant." Of the respondents, 98 percent favored faculty status. In light of the individual Standards the results were: (1) professional autonomy 72.2 percent; (2) librarians organized as faculty 72.2 percent; (3) eligibility for membership in academic senate 95.4 percent; (4) academic year contract 86.3 percent; (5) tenure 92.2 percent; (6) same rank titles as faculty 76.2 percent; (7) sabbaticals and other research leaves 95.1 percent; and (8) protection of academic freedom 93 percent. The respondents expressed optimism (41.5%) that by 1975 librarians would achieve full faculty status (*6*).

Another significant article by Josey, "Faculty Status for Librarians," was an attack on the attempt by the governor of New Jersey to revoke some of the benefits the New Jersey academic librarians had recently received as a prerequisite of faculty status. The attempt to return librarians to a twelve-month contract was an issue of major concern. Josey asserted that librarians must not be passive, must avoid clerical routines, and must not resist change. Self-esteem and the worthiness of librarianship as a profession were stressed (*49*).

Further significant work by Josey, during the 1970s, was a study entitled "Toward a Solution of Faculty Status for College and University Librarians." Here he discussed the need for faculty status by all academic librarians, and the struggles to be expected in attempting to achieve it. Furthermore, this strong advocate urged support of the ACRL Standards for faculty status (*50*).

In 1972, the Ad Hoc Committee on Faculty Status of the Virginia Library Association published the study entitled "Results of the Questionnaire on Faculty Status of Virginia Academic Librarians." It indicates that the purpose was "to determine which institutions give librarians faculty status, and exactly what such status means." Although the Standards were not used per se, the tenets of the Standards are applicable.

The library directors were queried at 66 public and private, two- and four-year academic institutions in Virginia. The returned questionnaires totaled 66 or 62.1 percent. The items relative to the ACRL Standards are: peer review, 26.8 percent; faculty governance, 78 percent; nine-month contracts, 14.6 percent; tenure eligibility, 65.9 percent; synonymous promotion criteria and titles as classroom faculty 53.7 percent, and 65.7 percent, respectively; and the availability of research funds, 46.3 percent. The study concluded that the meaning of faculty status varies among institutions. Furthermore, state-supported institutions on a whole came closer to meeting the Standards than private institutions (*51*).

In 1973, Anne Carson Cargile conducted a "Study of the Academic Status of Librarians in North Carolina's Colleges and Universities" whose purpose was to determine the status of academic librarians in that state according to the Standards. The population consisted of fifteen public universities, and eleven private senior colleges in North Carolina. The sample was comprised of 65 percent of the academic librarian population. Cargile reported the Standards were adhered to in the following manner: Compensation-equivalent salaries, 31.7 percent; equivalent vacations, 33.3 percent; identical holidays, 76.1 percent; tenure, 35.4 percent; promotion, equivalent rank and title, 49.8 percent; leaves, 31.3 percent; research funds, 75.7 percent; and academic freedom, 100 percent. The author concluded that academic libraries in North Carolina do not adhere to the ACRL Standards, and thus, librarians are not granted the same rights and privileges as teaching faculty (*52*).

The Faculty Status for Academic Librarians: A History and Policy Statements (1975) was a compilation of position statements by the Association of College and Research Libraries University Librarians Section on Academic Status. Basic documents related to faculty status were also included. Furthermore, the following items were also presented: the Model Statement of Criteria and Procedures for Appointment, Promotion in Academic Rank, and Tenure for College and University Librarians; Description of a Model Contract, Procedures for Termination, Dismissal..., and a General Academic Library Grievance Procedure Model (*53*).

An earlier study (1977) by Bonnie Jean Jackson involved academic libraries in Louisiana. The study concluded that librarians have "many of the same privileges and have many of the same responsibilities as the teaching faculty at their institutions." Questionnaires were sent to 32 academic libraries, and 24 (75%) were returned. This study also revealed that many positive activities were occurring in the targeted libraries, but faculty rank is granted only "to librarians in less than half the reporting institutions" (*54*).

In 1978, John N. DePew reported the results of a study of Florida academic librarians entitled "Faculty Status in Florida." The purpose was "to take a quick look at the extent to which faculty status has been achieved in Florida," and the extent to which the Standards were followed. The population consisted of libraries at 36 accredited academic institutions in Florida which offered at least the bachelor's degree. The data were collected from the library directors via telephone from a prepared questionnaire. There were twenty directors queried directly, and the remaining six in the sample were also queried indirectly either through other directors in the system and/or from printed sources.

The reports on compliance with the Standards were enumerated as follows: practice peer review, 27 percent; eligibility to participate on university committees with voting privileges, 92 percent; equivalent salaries, 31 percent; academic year contract 8 percent; tenure availability, 38 percent; faculty rank and titles, 35 percent; eligibility for leaves, 77 percent for sabbatical, and 69 percent for research, and eligibility for research funds, 77 percent (*55*).

C. James Schmidt wrote an exemplary treatise on faculty status during the 1970s that was entitled "Faculty Status in Academic Libraries: Retrospect and Prospects," wherein he introduced the issue of faculty status with an historical overview and documented the beginning dates and locations for faculty status as cited earlier. Schmidt also discussed the implications and problems of faculty status, including collective bargaining, the education of academic librarians, and the special concerns of technical services librarians (*4*).

"Faculty Status: An Heretical View," by Marshall Keys, though written in Mississippi, has generalized application for the universe of academic librarians. This 1979 work asserted that library directors administer libraries and would be better aligned with administrators than with faculty. Full professional acceptance and status, according to Keys, hinges on our ability to deliver information. Thus, we need to become as expert in the tasks we have taken on as the faculty are purported to be in the performance of their tasks. The author further objected to faculty status drawing librarians away from ought to be librarians' real goals (*56*).

The 1980s

The literature on faculty status in the 1980s is challenging. For the first time, there was found widespread criticism of the plight of academic librarians in regard to the issue of faculty status. Many of the relevant studies on the topic discuss the distinctive characteristics of the literature and relate them to the ACRL Standards addressed.

The survey articles by Werrell and Sullivan (*7*) and another by DeBoer and Culotta (*57*) provided an overall perspective of the issue. Additionally, Werrell and Sullivan provided an excellent 121-item annotated bibliography covering the period 1974 through 1985, which is a research report published as an ERIC document. It discussed those studies which were directly pertinent to faculty status and its related subtopics (*58*).

During the 1980s, there seemed to be a widespread departure from the concept of faculty status as the most appropriate model for academic librarians. The librarians of the 1980s might be described as a new generation of professionals who may not want the responsibilities inherent with faculty status. In 1981, Richard Meyer's research revealed five times as many academic librarians held a disfavorable view of faculty status than five years earlier. This, stated Meyer, is due to librarians with faculty status, "trying to juggle all their administrative, supervisory, public service, technical... responsibilities" (*59*).

A study from the Southeast is the one by Jo Ann Stefani and Susan H. Smith entitled "The Status of Academic Librarians in Mississippi." This 1981 research study surveyed 45 academic institutions in Mississippi to discern the current status of academic librarians. The nucleus for this study was the endorsement, in 1973, by the Mississippi Library Association of the 1971 "Standards for Faculty Status for Colleges and University Librarians." In 1980, a questionnaire was distributed to 45 directors of postsecondary institutions in Mississippi based on the Standards. Of the 35 directors replying, 68 percent claimed that faculty status existed at their institutions. Analysis of the results further revealed that no librarian in Mississippi holds full faculty status despite the responses to the contrary. The Standards are ignored in the area of library governance, equal salaries, self-determination and tenure. Although librarians (53%) are offered academic year appointments, the commensurate benefits do not result (e.g., research leaves and funding, academic governance). This survey certainly indicated that Mississippi librarians were not benefitting from the ACRL Standards' implementation, at least not in 1981. In fact, it was reported to have the lowest compliance rate of all studies reported (*60*).

Pharma Sharma, in 1981, conducted a "Survey of Academic Librarians and Their Opinions Related to Nine-Month Contracts and Academic Status Configurations in Alabama, Georgia, and Mississippi." The study revealed that faculty status for librarians in the South was of intense interest to these librarians as in other geographic regions. Sharma acknowledged that the usual elements pertaining to faculty status and ACRL Standards had been explored rather thoroughly. Therefore, this author surveyed the three states of Alabama, Georgia, and Mississippi to "gauge the characteristics and opinions of academic librarians." The study reported the findings from librarians out of a population of 416 and presented the personal, educational, and occupational characteristics. Further items explored were: the demographic and institutional characteristics, opinions of librarians with and without faculty status, publication, research, proposal development activities, opinions on nine-month contracts, and faculty status or a possibly comparable system that recognizes the unique responsibilities of librarians. Of the 267 librarians responding, 82.4 percent had faculty status and 17.6 percent did not. Sharma reported that 47 librarians with faculty status had lost it in the last ten years.

The survey concluded that women dominate in academic libraries in the targeted area and women also provided the main income for their households. Additionally, these librarians were professionally active on the state and regional levels. The author further concluded that the twelve month contract was predominant, but the zealously guarded benefits were tenure and commensurate salaries. Interestingly here, a majority of the respondents (64.4%) indicated a preference for a comparable system of academic status rather than the traditional faculty status (*61*).

Yet another study by Becky Gray and Rosalee McReynolds (Comparison of Academic Librarians With and Without Faculty Status in the Southeast, 1983) explored the subject of academic status primarily in the areas of teaching and research, and the resulting benefits such as professional leaves of librarians with and without faculty status. A questionnaire was distributed to 140 academic libraries in the Southeast. Particularly, 140 private and publicly supported institutions were surveyed in the states of Louisiana, eastern Texas, Mississippi, Alabama, Georgia, and Florida. Seventy-five percent of the respondents reported holding faculty status. The study regretfully concluded that efforts by librarians in these targeted areas toward equity with teaching faculty had had minimal results (*62*).

Another significant investigation of the faculty status issue in the southeast, was provided by Anthony Tassin (Faculty Status for Librarians: Progress and Perplex, 1984). He reported the activities at 10 Louisiana academic libraries and what he termed the "problematic matter of faculty status." Tassin additionally queried 38 selective out-of-state libraries in the Southeast. A dilemma not unique to Louisiana and the other queried libraries was establishment of criteria comparable to those of other faculty promotion and tenure (e.g., research and publications, professional leave). Tassin concurred with other authors that such activities ought not complicate the librarians' unique service to their clientele nor their unique tasks. Significant results included: 80 percent of the respondents indicated that they hold faculty status (higher than the 79% national figure); 5 of the 35 responding did not have tenure; university governance is granted; evaluation on professional competence, research and creative work, service to the university as well as public service are the norms. Tassin concluded that the librarians' role is unique, and thus comparisons with teaching faculty are not useful. He asserted that librarians should soundly "take their stand on librarianship as an integral part of the educational process and not as a competitive field in academe." Results of the survey revealed that faculty status is perceived as myth if librarianship is not given its unique autonomy and distinction within the academic community (*63*).

Other arguments against faculty status related not to the faculty work schedules and working conditions, but to librarianship's lack of an autonomous professional identity of its own. Concomitantly, Query stated, "Until librarians are recognized for what they really do... their role in the mission of the college or university will continue to be misunderstood and inevitably undervalued" (*64*). John DePew expressed similar sentiments in a 1983 article in which he stated, "the ranks and titles of the teaching faculty should not be used because they are the labels of another profession..." (*65*). Another view in opposition to granting academic librarians faculty status was found in a survey of administrators by Thomas English. English found that most academic administrators believe that granting faculty status to librarians does not benefit the institution and furthermore are unsuitable for librarians (*66*). Tassin and other researchers on this topic reported that "large numbers of academic librarians are beginning to doubt its (faculty status) benefits and even assert their conviction that faculty status was not to their advantage (*63*).

There were virtually no dissenters on the virtues of faculty status for academic librarians during the 1960s and the 1970s. However, there now seems to be a shift in the opposite direction. A survey of 130 members of the Center for Research Libraries by W. Bede Mitchell and L. Stanislava Swieszkowski revealed that sixteen institutions in the last ten years have changed their librarians' status to a nontenure track, and twelve have adopted a tenure track system not requiring publication (*67*).

The major characteristic of the research literature on faculty status during the 1980s is that most of the studies use the survey research method. The surveys on faculty status during the 1980s were designed to look at different target audiences, and show varying degrees of faculty status as reported: John DePew surveyed academic librarians on a national level and obtained figures that showed 79 percent with faculty status (*65*). Tassin surveyed 35 state universities in the Southwestern United States and found 80 percent of the librarians had faculty status or some equivalency (*63*).

Benedict and colleagues surveyed 188 college and university libraries in New York State and discovered 72 percent had faculty status (*68*). Fred Hill and Robert Hauptman surveyed 51 librarians using a systematic sampling of librarians listed in the *American Library Directory* and discovered 61 percent had faculty status (*69*). Greg Byerly surveyed libraries in colleges and universities in Ohio, and 25 out of 44 queried reported having faculty status (*70*). The American Status Survey of non-ARL libraries resulted in a 44 percent affirmative response to the question of possessing full faculty status (*71*). Four years later Payne also surveyed 49 non-ARL libraries, and determined 59 percent held faculty status (*72*). W. Bede Mitchell surveyed 138 directors of college and research libraries, and found surprising results. Of the 36 percent having faculty status, a breakdown by type of institution revealed 88 percent of the public institutions and 12 percent of the private institutions grant faculty status to their academic librarians (*73*).

The librarian as a teacher is not a Standard per se. However, it does relate closely to the identification of librarians with faculty. This is a crucial argument in the faculty status dilemma. There are opponents and proponents. Pauline Wilson asserted, "library instruction . . . is not sufficient to award librarians' right to faculty status" (*74*). An opposing view was given by John Budd who asserted, "librarians provide students with information in a systematic and orderly fashion, thus increasing the students store of knowledge" (*75*), and conferring upon the academic librarian the role of professor.

Collective bargaining is another topic discussed frequently in the literature of the 1980s on faculty status. It is predicted that collective bargaining will be the normal pattern for many academic library staff (*76*). David Kreh described incidents in the history of the State University of New York and advocated grassroots participation in unions by librarians (*77*). There is much hope in this area for the future.

"Academic Librarianship: Professional Strivings and Political Realities" presented a unique discussion of faculty status. David Sparks observed that little attention has been given to the relationship of professionalization as an aspect of the sociology of librarianship; the power relationships within the institutions of higher education where academic librarians work, and the phenomenon of academic collective bargaining. The author stated that the most hope for the future lay in collegial relations between the library staff professionals and the library administration in moving the image of the librarians to a more secure plateau (*78*).

The results of a survey research article entitled "Rank, Status, and Contribution of Academic Librarians as Perceived by the Teaching Faculty at Southern Illinois University, Carbondale," appeared in 1981. M. Kathy Cook conducted a questionnaire survey to determine the teaching faculties' perceptions of the academic librarians at Southern Illinois University. Service was perceived as the most important function of the librarians, yet many of those queried expressed a need for librarians to conduct research in order to have rank and status. Fifty-seven percent of the respondents did favor faculty status for their librarians (*79*).

A significant 1982 case study (A New Status Model for Academic Librarians) was written by Dorothy Cieslicki. It related the efforts of the Dickinson College library staff in an evolutionary change from a hierarchically organized professional staff of six with faculty status, to a collegially organized professional staff of seven with the status of librarian, distinct from that of faculty or administrator. The impetus for this change for librarians at this Carlisle, Pennsylvania, academic institution was the denial of tenure to the librarians. This denial was due to librarians being judged by established faculty guidelines which put librarians at a disadvantage. Subsequently, the librarians have developed a well-qualified staff with a high degree of autonomy who exhibit professional attitudes and results (*80*).

Release time, one of the tenets important to the attainment of faculty status was discussed by Nancy J. Emmick in 1984. The article "Release Time for Professional Development: How Much for Research?" was presented at the ACRL Third National Conference. Emmick purported that librarians had sought increased release time for research purposes even prior to the adoption of the ACRL Standards. Yet, it is concluded that despite over two decades of struggles little change has taken place in the amount of release time librarians receive for research-related activities. The predominately quasi-release time activities for librarians include: administrative support such as typing, stationery, duplication, and computation, and possibly some informal release time during student vacation periods (*81*).

"Faculty Status: Some Expected and Some Not-So-Expected Findings" contended that "little has been written about the characteristics of librarians who are currently employed in institutions which grant faculty status." Thus, this study by Hegg addressed some of the perceived benefits of faculty status: demographic characteristics, continuing education activities, and job satisfaction. Only two demographic variables were determined to be related to faculty status: the size of the academic library and salary. It was discovered that individuals in faculty status granting institutions had different characteristics as it related to participation in continuing education than those individuals working in colleges and universities where this status was not available to librarians. Surprisingly, job satisfaction as a single variable was not related to faculty status. Hegg concluded that the subject remains an exceedingly complex one (*82*).

A similar work entitled "Performance Evaluation: The Use of a Single Instrument for University Librarians and Teaching Faculty," (1986) examined the possibility of the successful employment of one instrument at the University of Northern Colorado to evaluate its faculty and other staff. Patricia Wallace stated that the purposes of the document were: (1) to provide individuals with constructive feedback concerning performance; (2) to assist the university in making personnel decisions, program reviews, and evaluations, and (3) to explain the university's expectations with regard to its employees. Intricate aspects of the tenets of faculty status presented difficulties: work schedules; nature of the work, comparing instructional activities and equating intraprofessional activities. These concerns can only be alleviated, it is concluded, if the evaluation system is "developed, used, analyzed, revised, and reused." The evaluation system also needs to be "judged to be more successful than the previous largely subjective system, or discarded because it creates more managerial problems than it solves (*83*).

In her 1986 article, "Beliefs and Realities; Libraries and Librarians from a Non-library Administrator's Point of View," Rebecca Kellogg recommended some helpful alternatives. These alternatives were based on assumptions unique to the status of college and university librarians. The four assumptions were: (1) every one should be taught how to use the library; (2) non-library administrators recognized that librarians work with faculty members and graduate students, as well as undergraduates; (3) nonlibrary administrators increasingly recognized librarians as faculty, and (4) nonlibrary administrators believed the "library is the life-blood of the institution." The author challenged these assumptions and recommended a more aggressive stance from the librarians for the good of the library. The librarians must also actively initiate getting involved in activities beyond the library (*84*).

Faculty status is addressed by Catherine T. Brody in a 1986 article entitled "Faculty Status for Academic Librarians; the Dream and the Reality." Brody acknowledged that a "noticeable shift has occurred from the firm stand of earlier years." In addition to the tangible benefits of faculty status, the intangible benefits which relate to the morale and self-esteem of librarians allow for a sense of equality and first-class citizenship through acceptance as peers by classroom faculty." Subsequently, faculty status encourages research, professionalism, and other activities that denote superior performance by librarians.

Faculty status, according to Brody, might tend to handicap librarians who are more committed to traditional librarianship rather than activities that are germane to faculty status. Furthermore, the technological innovations in libraries have eliminated some of the barriers to faculty status by freeing librarians for other more effective faculty interactions. This author concluded that there is no substitute for the expertise of skilled librarians, despite the trend toward end-user services (*85*).

In 1987, the "Model Statement of Criteria and Procedures for Appointment, Promotion in Academic Rank, and Tenure for College and University Librarians," was revised based on the 1973 statement. The objective of this model statement was to propose criteria and procedures for appointment, promotion in academic rank and tenure for use in academic libraries which will insure that the library faculty and the services provided at institutions utilizing these criteria and procedures will be of the highest quality possible, consistent with the goals and resources of the institution. The revised Model Statement is to be used in conjunction with the ACRL Standards for Faculty Status (*86*).

"A Need for the Professional Development of Academic Librarians," by Susan A. Stussy (1987) provided a provocative study pertinent to faculty status. She addressed the plight of small academic libraries in the areas of professional development. Suggestions to improve the image and thus status of the academic librarian in the small institution included: (1) membership in professional organizations; (2) attendance at library conferences and workshops; (3) reviewing books for professional organizations; and (4) publishing at least one article per year. Stussy affirmed that the needs of the small academic libraries are largely ignored by: (1) library educators; (2) fund-granting foundations; (3) local and regional library organizations; (4) library literature, and (5) career counseling provided from library organizations. The author contended that, by working together, individuals, employers, and library organizations can improve the opportunities for professional development offered at small academic libraries (*87*).

Matthew Simon's "The Library Director's Role in Colleges and Universities Where Librarians Are Faculty," appeared in 1987. The essay indicated that provision of faculty status for librarians "creates a classic middle management dilemma for many library directors." Also, the library director can positively influence the careers of his/her colleagues and thus benefit the academic institution. However, noted Simon, "this is a difficult challenge and may cause the director to try and balance the requirements for a strong library operation with the college or university administration's demands for the expectations and needs of the staff" (*88*).

A unique aspect of the faculty status dilemma was presented in 1988, with a study of "Employment and Status of Part-Time Librarians in U.S. Academic Libraries." The article, co-authored by Mary Jane Brutman and Barbara J. Via, surveyed 203 academic library directors to determine the employment, status, utilization, and compensation of part-time librarians in the academic library workforce. The results indicated that this sizable work force provided satisfactory service, yet they face differential treatment in pay and benefits, as well as fewer opportunities, rights and privileges. Furthermore, this group of part-time workers faces problems in the form of fewer opportunities to become involved in academic governance and other attempts to attain faculty status (*89*).

"The Academic Library of Tomorrow: Who Will Do What" was addressed by Anna Altmann in 1988. She indicated the primary definition of the librarian is by function or task. Also, the primary role of the librarian within the academic structure is to support the teaching and research of the faculty. This latter role is a major component of faculty status. However, noted the author, these traditional divisions of public and technical services in academic libraries and the designations according to function are being challenged by technological change and budget restraints. Thus, new systems of collegial management and subject specialization may be the direction academic librarians move into for the future (*90*).

Rodney Hersberger's 1989 article brings new perspective and insight into the faculty status dilemma. "The Challenges of Leading and Managing Faculty Status Librarians," explored the academic status of librarians and the influence it has on the leadership and management of a library. Hersberger concluded that providing good leadership and management of librarians requires well thought-out approaches and strategies. Accordingly, this author asserted, "the library program and the librarians do not suddenly lose their need for strong, effective leadership and management" when faculty status is granted. Correspondingly, in any setting, "leadership and management are the human elements that can create an organization from a group of people" (*91*).

Summary

Almost since the inception of faculty status in academic libraries, there has been a proliferation of literature which addresses this issue. The impetus for a full scale endorsement began in the late 1950s, and while there has been recognition of librarians as faculty in many institutions, it continues to be an unresolved issue within the library community. A significant thrust was the adoption of the Standards in 1971. Many authors have noted that the major problem in the investigation of faculty status lies in the lack of a precise definition of all that is implicit in the term.

The nine ACRL Standards detailing the rights and responsibilities often are themselves the problem. Too often, librarians have been rightly accused of claiming the rights without accepting the resulting responsibilities. The numerous studies cited revealed that librarians encountered more difficulty in the area of research and publication. This seems to be an inherent problem often for academic librarians. However, having gained faculty status, librarians must meet the same criteria for promotion and tenure as do the teaching faculty. There are credible arguments that can be used to describe this dilemma as revealed in many reported studies.

The image of academic librarians admittedly has improved with the granting of faculty rank and titles. Nevertheless, the responsibilities which this phenomena has imposed on academic librarians in terms of performing dual roles have had varying effects on them.

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LOU HELEN DEVINE SANDERS

HUMAN FACTORS IN COMPUTER SYSTEMS

Introduction

Human factors may be defined as a body of knowledge about human abilities, human limitations, and other human characteristics relevant to design. *Human factors engineering*, or *human engineering*, is the application of human factors knowledge to the design of tools, machines, systems, tasks, jobs, and environments for safe, comfortable, and effective human use.

The literature contains a number of other terms relative to human factors. One that merits special comment is *ergonomics*. The term appears commonly in the United States in advertisements for *ergonomic computer terminals*, *ergonomic work stations*, or *ergonomic furniture*. The implication of these usages is that ergonomics is concerned only with the anthropometric, biomechanical, or physiological aspects of workstation design. That is not strictly correct. Ergonomics is compounded of two Greek words, *ergon* meaning *work*, and *nomos*, meaning *laws of*. The term originated in England at about the same time as the name human factors appeared in the United States. Human factors is now most commonly used on the North American continent and ergonomics is widely used in England and on the European continent. Despite the differences in their origins and areas of usage, professionals regard the two terms as essentially synonymous. Ergonomists in England are just as much concerned with the ergonomics of software and documentation, for example, as human factors specialists are in the United States.

Some other terms used to refer to the human factors in computer systems are *operability*, *usability*, and *software psychology*. It is not worth spending time on the definitions of these terms or on the subtle differences among them. The important point is that they are all concerned with designing for human use. In this article I use the terms human factors, human factors engineering, and human engineering exclusively.

HUMAN FACTORS INVOLVEMENT WITH COMPUTERS

Human factors originated as a discipline during World War II in efforts to resolve the difficulties many servicemen had in using the machines of war that were provided for them. Following the war, human factors began to be applied in industry, then later in the design and use of consumer products. Computers and computer systems are one of its newest areas of concern. Prior to about 1970 there was little interest in the human factors of computer systems. That interest developed rapidly, however, until it has become a major concern of the profession. In 1972 the Human Factors Society formed a technical interest group on computer systems and in 1988 that group had over 1100 members. Other professional groups concerned with the human factors of computers and computing are the Association for Computing Machinery Special Interest Group on Computer and Human Interaction (SIGCHI), the American Society for Information Science (ASIS), the Special Interest Group on User Online Interaction (SIGUOI), and the Internation Federation for Information Processing (IFIP) working group WG 6.3 on human computer interaction. Articles on the human factors of computer systems appear in a dozen or so technical journals and three—*BIT*, *Behaviour and Information Technology*; *Interacting with Computers*; and *The Information Society*—are exclusively, or almost exclusively, dedicated to this subject.

PERVASIVENESS OF COMPUTERS INTO OUR DAILY LIVES

The computer revolution is associated with America's transition from an industrial to an information society (*1*). Until the 1900s the largest single class of workers in the United States was engaged in agriculture. From the early 1900s until about the end of World War II (roughly 1944) it was in industry. Today more working Americans spend their time creating, processing, and distributing information than in any other kind of constructive activity (*2*). Computers are the principal devices serving those activities.

In 1980 there were only four million electronic terminals in the United States and most of them were tied into dedicated applications on mainframe computers. By 1985, the number had grown to 25 million and by 1990 estimates were placed at 75 million computer terminals and intelligent workstations in the United States (*3*).

The ways in which computers are being used are extremely diverse. In fact, they have probably had a more profound effect on society, our lifestyles, and our ways of doing business than any other technological creation of this century. Computers help manage our finances, our checking accounts, and our charge accounts. They help manufacture our goods, sort and distribute our mail, schedule our rail and air travel, book our theater tickets, check out our groceries, diagnose our illnesses, teach our children, and amuse us with sophisticated games.

Computers make it possible to erase time and distance in our telecommunications, thereby giving us the freedom to choose the times and places at which we work. They help guide our planes, direct our missiles, guard our shores, and plan battle strategies. In doing all these things computers have created new industries, and at the same time have spawned new forms of crime. To sum up, computers have become so intricately interwoven into the fabric of our daily lives that without them our civilization would not and could not function as it does.

This rapid growth is also partly the result of another spectacular change. As computer technology has advanced, the cost of computing has dropped precipitously. Since the early 1950s the price of small, general computers of comparable power, in dollars per instruction executed per second, has been dropping at an annual compound rate of about 25 percent per year (*4*). It is hard to think of any other segment of our economy that has shown such a dramatic decrease in the cost of getting work done. Small wonder that all these changes have been heralded as a computer revolution.

CHANGES IN THE NATURE OF HUMAN–COMPUTER INTERACTIONS

As computers have become cheaper and more widespread there has been an equally dramatic change in the way they are used. Years ago, when you had a computing job to do, you took it to a data processing (DP) professional, a person thoroughly familiar with computer programs and programming, and explained the job to him or her. This professional took your job; called up a "canned" program, that is, a program that had already been written, or, as was often the case, wrote a program that would handle your job; input the information you gave him into the computer; had the computer do your work for you; and returned to you the results of those computations.

As computers became cheaper and simpler to use, rather than hand work to a DP professional many, perhaps most, people began to do their own work on a computer. They find a suitable program, or occasionally even write programs of their own, input the data into the computer, and get the results themselves.

So long as computers were used only by DP professionals, complexity was not a serious obstacle to computer usage. Dedicated computer users, fascinated by these machines, were willing to spend months learning how to operate them. Now that they have moved into small businesses, stores, and homes, however, computers are being used by people who are only occasional or casual users for such things as word processing, information retrieval, educational purposes, electronic mail, computer conferencing, household management, and small business management. Users of these systems are typically not willing to spend a lot of time learning how to fathom the intricacies of complex machines. For them, ease of learning, ease of use, low error rates, and subjective satisfaction are important considerations. They merely want to sit down at a computer and get some useful work done (*5*). Moreover, since they are often intermittent users, they don't want to have a remember, or relearn, complicated instructions every time they sit down at a computer.

THE NATURE OF THE USER POPULATION

A point often overlooked relates to the nature of the user population. So long as there were only 4 million or so computers, electronic typewriters, and sophisticated terminals in use, it was theoretically possible to have all these machines operated only by persons of superior intellect with advanced training. But as the numbers reach 50 million or more, it is inevitable that a great many of them will have to be operated by persons with modest or limited education. The statistics force us to that conclusion. Yet at a time when literacy of every kind is indispensable, our educational system is turning out inferior products (see, e.g., *6–8*). It appears inevitable that the people who will be using computers for years to come will include many persons of limited abilities and skills, and it is likely that at best our educational system will be capable of making only modest improvement in that situation within the foreseeable future. This is one of the important considerations behind the drive to make computers easier to use.

COMPUTERS IN CRITICAL APPLICATIONS

Two major areas of application for which computer ease of use is important are (1) life-critical systems such as air traffic control, nuclear power plant operation, medical intensive care and surgery, space flight, police and fire services, and military operations, and (2) industrial and commercial uses such as those in banking, insurance, credit card management, utility billing, airline reservations, hotel and car rental operations, manufacturing control, engineering design, and inventory control. In these applications high reliability, error-free performance, and speed are critical. Yet the full potentialities of many such systems are not realized because of the inability of workers to master and adapt to them (*2*).

SOME DIFFICULTIES WITH COMPUTERS

Human factors efforts have been primarily directed toward three major categories of difficulties associated with computers: their ease of use, physical complaints associated with computer usage, and changes that computers make in the nature of work (*9*).

Ease of Use

Although advertisements claim that computers are easy to use, evidence to refute those claims is not hard to find. For example, in 1984 Willis and Miller (*10*, p. 30) published a book describing and rating 143 personal computers—virtually all models on the market in 1983. The topic of one of the introductory chapters of their book is a dozen of the greatest computer lies; the first lie is that "It's User Friendly!" Among other things they say that

> Virtually every computer on the market today is advertised as a user-friendly computer, and many programs are sold as user-friendly product.... Probably 50 to 80 percent of the

programs and computers that claim to be user friendly are not. Many of them are user surly or user hostile. . . . The main problem is that many computer models and programs are not easy to use, no matter what the ads say.

Similar statements, although perhaps not so sweeping, appear frequently in newspapers, magazines, and journals (e.g., *11*). Some common complaints about computer systems (*9*) are that

- Many languages and systems are too large
- Documentation and terminology are often incomprehensible
- Languages are usually difficult to remember
- Abbreviations are often neither sensible nor consistent
- Messages are often cryptic
- It is too easy to make mistakes
- It is too hard to correct mistakes
- Users have to learn too much irrelevant information
- Help features are too often unhelpful
- Users cannot communicate their difficulties to designers
- Systems often provide no warning of potentially dangerous actions
- Many tasks that could be automated are not
- Many systems are too rigid

Shneiderman (*12*) devised a questionnaire for systematically recording user evaluations of various aspects of interactive computer systems. It is a useful way of uncovering difficulties such as those above that users may have with particular systems.

Difficulties with the Computer Workplace

A second major class of difficulties has to do with complaints about the physical nature of computer work. Some of these complaints are about uncomfortable or annoying workplace features, for example, worktables that are too high, chairs that are not adjustable, chairs that provide no back support, and glare (*13*). Other complaints are more serious. In 1979, for example, a consortium of labor unions in the United States presented a series of complaints to the National Institute of Occupational Safety and Health (NIOSH). The general nature of these complaints was that employees using video display terminals (VDTs) experienced a variety of symptoms including headaches, general malaise, eyestrain, and other visual and musculoskeletal problems. These complaints have since been broadened to include potentially injurious health effects of working with computers.

Job Restructuring Brought About by Automation

A third class of problems is associated with the way jobs are changed by automation in general and computerization in particular. Resistance to change, DP stress, threats to job security, the fear of appearing ignorant or stupid, and job impoverishment are some consequences of computerizing tasks. Computers often pace workers, force workers to concentrate continuously, and permit no rest pauses because many computerized jobs are routine and rigidly structured to meet the demands of the computer or the system, not those of the user. Finally, computers in certain occupations monitor operators for some sort of personal evaluation, a situation that sometimes raises the spector of the computer being seen as Big Brother.

Finding solutions to these three classes of difficulties has provided a full agenda for human factors.

A Model of a User-Computer System

Figure 1 is one way of modeling the user–computer system. The user receives inputs from outside the system (e.g., reservation requests from customers, cancelled checks, emergency calls on a hot line, or simply internally generated questions like "I wonder what my bank balance is") which have to be processed through the computer. This the user does by interacting with the computer through what is commonly called the user-computer interface. The user's outputs (hand actions, head movements, vocal utterances) are inputs to the computer; outputs from the computer (screen displays, printouts, speech) are inputs to the user. The user and externally generated inputs are contained within a job (e.g., making reservations, entering data from cancelled checks into customers' accounts, locating and dispatching emergency equipment, determining one's own bank balance). The work products are things like completed reservations, cancelled check data entered into customers' accounts, emergency equipment dispatched from the closest station, and a printout of one's bank balance.

The computer meanwhile is contained within a workstation comprising the terminal itself, the table on which it rests, adjacent workspace, files for manuals, record holders, the user's seat, and perhaps still other items of furniture associated with the computer. Finally, the entire complex of user and workstation is located in a work environment.

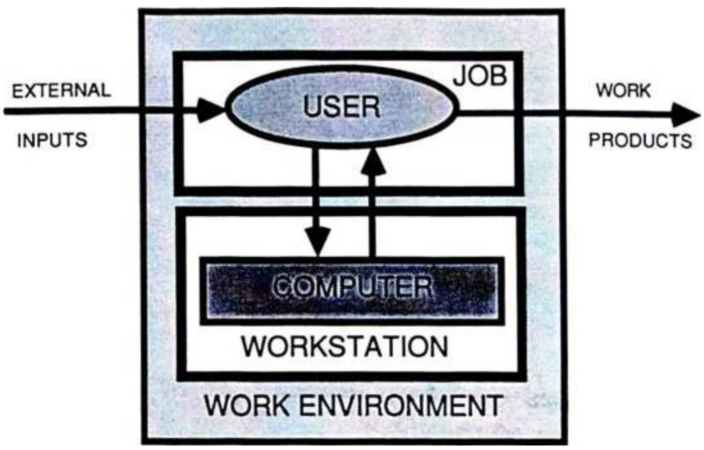

FIGURE 1. *A model of a user-computer system.*

Although the model is simple, it is a convenient way of identifying the various ways in which human factors is involved with computers and computing. The sections that follow provide an overview of human factors work done on each of these components of the model.

Human Factors in the Design of Computers

The difficulties people experience in working with computers have provided the stimulus for human factors research in virtually all aspects of computer design and use. Although the dichotomy is by no means sharp, American efforts have been focused more on ease of use issues while European efforts have been more concerned with the physical design of computer workstations. The sections that follow provide an overview of some of the major activities and findings of research from both arenas.

INPUT DEVICES

Alphanumeric keyboards are by far the most common input devices to computers. They are flexible and versatile, permitting a wide variety of inputs, and are particularly suitable when large quantities of text must be input. Although a variety of alpha and numeric layouts has been tested (e.g., the Dvorak keyboard), the QWERTY arrangement has become the de facto standard. A considerable amount of human factors research has also been done on such keyboard features as the placement of fixed and variable function keys, the slope of the working surface, the operating force required to depress a key, key displacement feedback, keyboard interlock, size and shape of keys, key legends, color and reflection of keys, key repeat, and key spacing.

Although not so common as keyboards, several other kinds of input devices have been studied and guidelines are available for their use and design. Perhaps the most familiar of these alternative devices is the mouse based on research by English et al. (*14*) and Card et al. (*15*). Other input devices used for special applications are joysticks, four arrow cursor controls, light pens, track balls, stylus and grids, touch-sensitive devices and voice activation. The advantages and disadvantages of these various input devices, together with recommendations about their design, are contained in DOD-HDBK-761 (*16*) and NASA-STD-3000 (*17*).

Voice Input

A considerable amount of research on human communication has shown that people can talk faster than they can write or type and that they can solve problems faster when they can talk than when they cannot (*18*). So for a human being the fastest and easiest way to communicate with a computer is to talk to it. Unfortunately, that mode of communication is the most difficult to implement. Nonetheless, there are already a number of successful speech applications in use and the number is steadily increasing. The technology of speech recognition is changing so rapidly that any description of it is almost out of date as soon as it is written.

Current applications, and those likely to be in use for some time in the future, require users to "train" a computer to recognize their utterances, to speak isolated words or short phrases, and to use a limited vocabulary, although that limit is expanding almost daily. McCauley (*19*) describes a number of applications of this technology and provides a detailed review of the human factors considerations associated with speech recognition systems. Some of them are:

1. *Training the user*. Speech-system engineers and marketing representatives are often experienced users of speech technology who have learned through practice the speech discipline necessary to get high recognition. New users seldom achieve comparable recognition scores until they have learned how to use a system properly. A good training program should provide (a) feedback after each trial about whether the system recognized the speech input correctly, (b) training in the acceptable vocabulary, (c) training in a consistent manner of speaking, and (d) training in consistent placement and use of the microphone.
2. *Establishing appropriate speech reference patterns and samples*. Important factors here are the number of repetitions needed to establish templates of vocabulary items spoken by each user, and the amount of variability that should be introduced into the samples to accommodate changes in the way users speak because of fatigue, smoking, illness, or stress.
3. *Developing a discriminable vocabulary*. Important factors are the size of the vocabulary, the appropriateness of the vocabulary for tasks to be performed, and the phonological distinctiveness among individual vocabulary items.
4. *Designing feedback*. Feedback is especially important with novice users, when recognition accuracy is low, and when recognition errors are of critical importance. Important considerations are the form of the feedback, whether visual or auditory, and its timing.

OUTPUT DEVICES

The most commonly used output devices for computers are CRTs and printers.

CRTs

A large number of factors affect the legibility of cathode ray tubes (CRTs): Wavelength, luminescence, contrast, defocusing, refresh rate, drift, jitter, linearity, dot matrix design, and stroke matrix design among them. Human factors research in this area has been concerned with the contribution of these and other variables to the legibility of symbols on CRTs. Shurtleff's book (*20*) provides a good summary of that work.

Studies by a number of investigators over a considerable period of time had shown that people read as much as 30% more slowly from CRTs than from paper. After an extensive series of investigations Gould and his associates (*21*) at the IBM Yorktown Research Center have discovered why. The explanation for the difference, it turns out, lies not in any single variable, but in a combination of them which, taken together, reduce reading speed on most CRTs. Comparable reading speeds are attained on CRTs and on paper if (1) comparable fonts are used, (2) the polarity of the CRT produces dark characters on a light background, (3) characters on the CRT are antialiased, that is, they contain various levels of gray, and (4) characters are produced on a CRT with high resolution, on the order of 91 × 91 picture elements (pels)/in.

(about 40% more than on the IBM 3278 terminal, for example). Personal variables, such as age, experience, or familiarity with reading from CRT displays; and certain other CRT display variables, flicker, alleged subliminal effects, or the self-luminous nature of CRT displays, can be ruled out as contributory factors. Making highly readable CRTs is no longer a human factors problem, but rather one of economics.

Format design is a somewhat different kind of activity concerned with what information is put on a display, how it is organized, and where it is placed. Different format design objectives and rules apply to data entry, inquiry, interactive and menu screens. Ideally, data entry screens should be designed in conjunction with source documents from which data are keyed, since design tradeoffs may affect both documents and screens. Too often forms and documents are prepared with the objective of minimizing composition and printing costs. That, however, is false economy since handling costs are from 20 to 30 times their production costs. The most important design objective should be to make it easy for users to fill out a form and then transfer data from the form to the computer.

Inquiry screen formats are designed to display the results of inquiry requests or the contents of computer files. The primary design objective is helping users locate data or information through scanning. Interactive screens are characterized by short alternating communications between a user and computer. An important design consideration is to make user and computer messages easily distinguishable. The main design objective for menu screens is ease of visual scanning and ease of alternative or choice selection. These and other issues of format design are covered fully in Galitz's book (*22*).

Printers

Despite the ubiquity of CRTs, paper documents have several advantages that militate against their obsolescence. They can be marked up, copied, mailed, and stored. Printers attached to computers are the usual way of providing hardcopy of computer outputs. Indeed, it is rare to find a computer without a printer attached.

Commercially available printers vary from poor to excellent and the features that contribute to their quality are speed, legibility of print, character sets available, fonts and font sizes available, highlighting possibilities, and the kind of paper used. Human factors studies on the legibility and readability of print go back at least to 1916 (*23*) and the findings of that research are applicable to contemporary printers. Recommedations about printers, output-paper qualities, and output-paper content are given in DOD-HDBK-761 (*16*).

Speech Output

Speech output is technically much easier to implement than speech recognition. Two principal methods are (1) to record, digitize, and play back an actual human voice, and (2) to synthesize speech by concatenating a set of machine-generated phonemes or words. The former method requires that a human prerecord desired outputs before messages can be digitized and stored. This generally means anticipating all the words and messages that may be needed for all future uses. Speech synthesis is more flexible in the sense that no human verbal input is required to produce the speech. The principal difficulty with synthesized speech is that it does not simulate complex human speech characteristics such as inflection, emphasis, and stress. For applications in which naturalness is important digitized speech may be preferable. Another consideration is that although synthesized speech may be intelligible, studies show that when listeners are task loaded, accurate recognition of synthesized speech drops off much more rapidly than does the recognition of digitized speech. An analogy is the increased attention required to listen to a person with a pronounced foreign accent deliver a speech on a familiar topic.

INTERACTION DIALOGS

There are several ways of interacting with a computer and human factors work on them has been directed toward clarifying which are appropriate for different classes of users, for different tasks, and for use with various input and output devices. Table 1 summarizes some results of research of these various forms of dialog. Shneiderman (*12*) provides more detailed summaries of a considerable amount of human factors work on these types of dialog and Smith and Mosier (*24*) provide guidelines for their selection and design.

RESPONSE TIME AND DISPLAY RATE

How fast a computer should respond to a user has been the subject of a considerable amount of research, but the number of variables involved and the complex interactions among those variables have prevented researchers from finding a definitive answer to the question. First, however, it is useful to distinguish two times: the response time of the computer and the rate at which the computer displays information.

Response Time

A computer's response time is the time that elapses from the completion of a user's input (pressing an ENTER, RETURN, or mouse button) to the appearance of the first response on a screen or printer. Computer response times are not constant even for identical inputs but may vary considerably depending on, among other things, the load on a central processing unit at any particular time. So, in considering computer response times one should properly specify an average time and a variance around that average. Both have effects on human performance.

Many professionals think that the shorter the response time, the better. That is not always true. In some cases users learn less, comprehend less of what they read, make more faulty decisions, and make more errors as the speed of interactions increases. These consequences may, in turn, result in increased stress and frustration. Overall productivity is a function not only of the speed of interactions but also on the number of errors committed and the rapidity with which a user recovers from those errors. Maximizing productivity, then, depends on balancing carefully the time gained from faster interactions against the time lost in detecting and recovering from errors.

TABLE 1

Characteristics of Some Forms of Computer Dialog

Dialog type	Description	Characteristics
Question and answer	Computer asks a series of questions to which the user responds.	Computer-initiated. For a naive user this is probably the easiest and most error-free kind of dialog. Can require a simple input device. Inappropriate for many kinds of tasks, e.g., word processing, and may become cumbersome as the user acquires experience.
Menu selection	The computer presents a list of alternatives and the user picks one or more.	Computer-initiated. Very natural and easy-to-use form of dialog if response times are short and an appropriate selection device is used. Can be burdensome to sophisticated users but type-ahead, or jump-ahead features make the dialog more acceptable to them. Requires screen space and some tasks may result in an excessive number of menus.
Form filling	The computer presents a form with blanks. The user fills in the blanks	Computer-initiated. Faster than ordinary question-and-answer dialogs because the user supplies several responses in a single transaction. Requires only modest training and shows context for activity. When checks are provided for data in various fields, or blanks, a significant proportion of data entry errors may be detected. Consumes screen space and requires the user to have typing skills.
Command language	User types commands, often using mnemonic abbreviations.	Flexible, potentially rapid for complex tasks, suitable for well-trained users who have a good model of the system function and language syntax, otherwise error-prone and sometimes frustrating. Difficult to learn and retain.
Natural language	Users communicate with the computer in their own natural language.	Requires essentially no training on the part of users and relieves the user of the necessity to learn syntax. Ambiguity of natural language makes programming exceedingly difficult for most tasks and users are not relieved of the necessity for understanding computer concepts and the task domain.
Direct manipu-lation	Computer displays visual representations (e.g., icons) of tasks, objects, and actions. Users perform operations by pointing, zooming, or panning.	Visual representations, rather than words, make tasks easy to learn and retain. Errors are easily avoided. Technique encourages exploration and results in high subjective satisfaction. Requires graphics display, more programming efforts and increased system resources. Some tasks and actions may be difficult to represent

Some general findings that seem to be substantiated by research are that:

- For most situations response times less than 1 s result in higher productivity.
- Novices work better and prefer to work at slower speeds than do sophisticated users.
- Users prefer to work faster as they acquire proficiency.
- Users prefer to work more quickly when there is little penalty for errors.
- Users prefer more rapid action for tasks that are familiar and easily comprehended.
- Users' expectations about response time are shaped by their previous experiences about how long it takes to do things.
- People differ greatly in their expectations about acceptable response times.
- People are highly adaptable and, within limits, change the pace at which they work to accommodate different response times.
- Modest variations in response time ($M \pm 0.5$ M) appear to have little impact on performance. Unusually short response times tend to induce anxiety about erroneous commands and unusually long response times tend to result in decreased performance and frustration.

Although there is undoubtedly an optimum response time for each user and each task, research and practical experience so far do not allow us to specify exactly what that time should be. Table 2 summarizes generally accepted recommendations for some system response times based on currently available information.

TABLE 2

System Response Time Recommendations

	Activity or function	Maximum response time, s	Optimum response time, s
1.	System activation		
	a. Engaging ON button	2.0	0.25
	b. Request to contact the system	5.0	2.00
2.	Response to control activation such as change in control force after moving a key past a detent position, the appearance of a line when a light pen is used as a stylus, or the appearance of a printed character on the screen or page	0.1	0.10
3.	Feedback		
	a. To mechanical insertion of ID card	0.5	0.25
	b. That ID number is correct in length and correct in alphanumeric format	0.5	0.25
	c. That ID is accepted	2.0	0.25
4.	Request for service (from command to beginning of the display)		
	a. Simple (frame already exists)	2.0	0.25
	b. Complex command	5.0	2.00
5.	Error feedback	2.0	0.25
6.	User intervention in an automatic process		
	a. Acknowledgment of command	2.0	0.25
	b. Able to execute command	5.0	2.00

Source: From Ref. *17.*

Display Rate

The display rate is the speed, in characters per second, at which characters appear on a hardcopy or visual display terminal. When large amounts of data or text have to be scanned, fast display rates are advantageous. If, however, text has to be read and comprehended, display rates faster than normal reading rates are disadvantageous. Users feel rushed and comprehend less as they try to keep up with the presentation even though they know they need not do so. Either instantaneous presentations or presentations at about 30 characters per second appear to be best for reading purposes. Variability in display rates should be minimized.

DOCUMENTATION

Although some experts predicted long ago that computers and related technology would usher in a paperless society, the reverse has actually happened (*25*). Year after year we are deluged with increasing amounts of paper and there seems to be no evidence that the flood is being stemmed. Moreover, labels, instructions, and manuals continue to present serious communication problems (*5*). In a survey of reasons why vendors of communication products fall short in meeting user needs, documentation headed the list (*26*). Some companies, for example, IBM, have set up task forces to develop procedures for improving the usability of their publications (*27*). There is ample evidence that the redesign of forms, instructions, and manuals can lead to improved performance on the part of the people who use them (see, e.g., *25*, *28*). There is also a wealth of published advice, guidelines, information and rules on how to write good documentation (see, e.g., *25*, *28–32*). The remaining problem in this area is not in finding out how to write good documentation, but rather in convincing engineers, managers, programmers, and document writers to put into practice what we already know. That is not a human factors problem.

The Computer Workplace

Although the several components discussed above may each be well designed from a human factors standpoint, they may still cause serious problems if they are not well integrated into a workplace. Two important parts of the computer workplace are the workstation itself and the environment in which the workstation is located.

THE COMPUTER WORKSTATION

The computer workstation includes not only input and output devices, but also job aids such as source documents and telephones, and the furniture, tables, chairs, document holders, and files that may be required for the user to work effectively. Some of the most important human parameters to consider in workstation design are anthropometric and postural ones: working levels, desk and seating heights, arm reach, foot rests, placement of document holders and accessories such as telephones.

As in other applications, an important factor in workstation design is the kind of task that will be performed at it.

Data entry workplaces are used primarily by operators who read information from source documents and enter this information into computers. Field studies show that for tasks such as these, even the most difficult types of numerical data are touch-typed into the computer. Head movements occur at intervals of about one to four seconds. In entering alphanumeric material, on the other hand, head and eye movements occur more frequently and the keyboard is the main object of visual attention. Therefore, for data entry tasks, document holders must be placed to minimize awkward head movements and uncomfortable viewing conditions.

Operators who engage in interactive dialogs at workplaces tend to focus more on the screen; therefore its location and readability are the most important design considerations. Since these operators may not have typing skills comparable to those who perform data entry tasks they tend to focus much more on the keyboard. Referring to documents is generally a lesser consideration. Workplaces used for data inquiry may be used for short periods of time and by many different persons (as in library inquiries) and so may be designed for standing operation. Because of the heavy involvement of the keyboard for all types of tasks, its location and accessibility are important design considerations. Perhaps the most difficult requirement to meet for all applications is providing a sufficient range of adjustment in chairs, desks, and other items of furniture to accommodate the wide range of bodily dimensions that may be anticipated among users.

THE WORKING ENVIRONMENT

The working environment has long been a major concern of human factors science, and as it relates to computer workplaces, glare, screen reflections, and lighting are usually the three most important variables to contend with. Investigations have repeatedly demonstrated that inadequate viewing conditions at VDT working areas result in numerous complaints of visual discomfort. The solution to these problems lies in the use of glare shields and the proper placement of luminaires in the room. The principles are well known. Putting them into effect, however, usually must be done on an individual basis, taking into account architectural features and the location of workplaces. The problems are not insurmountable; they merely require an appreciation of their importance and a commitment to their solution.

Since VDTs are much quieter than typewriters, noise at computer workstations is usually due to other equipment in the room and not to the VDT itself. An exception is computers that use either voice input or output. Noise shielding is usually required for voice input applications so that extraneous noise does not interfere with the ability of the computer to recognize spoken words. For applications using voice output it is usually desirable to insulate the workstation so that computer utterances do not distract or interfere with other persons in the vicinity.

Temperature control and air conditioning are usually required in computer workstations because of the appreciable quantities of heat produced by VDTs. These problems have already been well researched for other systems and the general principles resulting from that research apply to computer workstations as well.

HEALTH HAZARDS

The proliferation of computers in business and industry in the 1970s was accompanied by concerns about potentially injurious health effects of working with computers. Initially, these concerns seemed to be centered on visual pathology caused by radiation from computers in general, and VDTs in particular. There followed a flood of complaints about visual disturbances, musculoskeletal pain, and psychological stress from persons working with computers. Perhaps the most serious of these complaints was the claim that pregnant women working with VDTs had more miscarriages and children with minor birth defects than one should expect by chance.

In recent years an increasing number of workers have filed workers' compensation claims for injuries resulting from their work with computers and a substantial number of these claims have been decided in favor of claimants. This situation has fueled hundreds of studies on possible health effects of working with computers* and led to a formal report on the subject from the National Research Council (*34*) by a distinguished group of experts. That and more recent work (see, e.g., *35*) has not yet stilled the debates that have raged about these issues. The following sections summarize the current status of our knowledge about these problems.

Reproductive Issues

Of all the possible injurious health effects that might result from VDT work, birth defects and spontaneous abortions are the most distressing to female workers. The source of these concerns was clusters of birth defects and spontaneous abortions reported in certain groups of female VDT users in the United States and Canada. Although investigation by the U.S. National Institute for Occupational Safety and Health, the Centers for Disease, and the U.S. Army Environmental Hygiene Agency have found no relationship between VDT use and adverse reproductive outcomes, some of them have not been able to exclude VDT use as a potential contributor to such problems. More recent large-scale epidemiological studies in Sweden and Finland have found no specific VDT-related factor associated with adverse pregnancy outcomes. These studies have not satisfied everyone's doubts, and at the time of this article, further epidemiological studies are underway in the United States, Sweden, and Canada.

Radiation Problems

The first health issues raised in connection with VDT use where about the possible injurious effects of x-ray radiation from VDTs. Those quickly spread to include ultraviolet, infrared, radio frequency and low frequency radiation. A number of studies have found that levels of radiation emitted by VDTs are far below current U.S. occupational radiation exposure standards and are generally much lower than the ambient radiation emitted by natural and manmade sources to which people are

*Hedge (*33*), for example, has compiled a bibliography of 187 articles published on this topic between 1980 and 1986 alone.

continuously exposed. Although most experts agree that the biological effects of VDT radiation are inconsequential to health, a few recent studies have suggested the possibility of harmful effects from pulsed magnetic radiation. Further work is currently underway to examine the validity of those findings.

Visual Effects

Concerns about possible injurious effects of VDT use on vision originated from two VDT users at the *New York Times* who subsequently developed cataracts. Additional claims of a relationship between VDT use and cataracts were made by some ophthalmologists who were, however, unable to support their claims with valid clinical or research evidence. One of the conclusions of the NRC report (*34*, p. 3) summarized the situation this way:

> We find no scientifically valid evidence that the occupational use of VDTs is associated with increased risk of ocular diseases or abnormalities, including cataracts. Only if competent pilot studies were to indicate such an association would large-scale epidemiological studies of cataracts among VDT workers be warranted.

Although this issue has since abated, concern about other possible visual effects still remains high.

Numerous studies have repeatedly found more complaints about visual discomfort, dysfunction, and visual fatigue among VDT users than among similar workers not using VDTs. Some field and laboratory studies have also demonstrated changes in some visual functions (accommodation, vergence, dark focus) when working with a VDT. Others have not. Whenever changes have been demonstrated, however, the changes have all been minor and have been followed by a return to normal after a period of rest.

What does seem clear, however, is that using VDTs is visually demanding and that it can produce visual discomfort and fatigue. Although these conditions are not serious and cause no damage to the visual system, they can contribute to decreased worker performance and satisfaction and increased stress. The sources of these difficulties are overuse of the eyes, poor screen images that make it difficult to focus on them, fluctuating screen luminances, screen glare, improper illumination, and high contrast sources in the work environment. All are problems for which human factors can provide solutions.

Musculoskeletal Problems

Although not reported as frequently as visual problems, musculoskeletal symptoms resulting from VDT work are less transient and more pronounced. The difficulties do not appear to be associated with the VDT directly, but are rather caused by the way computers are often used. Many computers induce poor posture because they are placed on any convenient table or desk or in poorly designed workstations. Moreover, the nature of a great deal of computer work requires operators to make repetitive hand and finger movements for long periods of time while seated in static positions.

These static seated postures not only result in stresses on the back, spine, neck, and shoulders but also reduce circulation to the lower legs and feet.

Recognition of the long-term disabling effects of these physical disorders has led to a great deal of human factors work in universities and scientific agencies and by furniture manufacturers to understand their sources and to find solutions. Solutions generally lie in the proper design of workstations, keyboards, and computer tasks to provide more frequent body movement. Despite a considerable amount of recent publicity about these problems and their solutions in scientific articles, trade journals and computer advertisements, these problems are likely to remain with us for some time. Many computers are, unfortunately, still being purchased and installed by persons who do not appreciate the importance of carefully human engineered workstations and tasks.

Computers and the Nature of Work

Computerizing work almost invariably changes work patterns and the qualifications required of employees performing that work. In some cases computerization also changes the nature of supervisory–subordinate relationships. Years ago, for example, store clerks had to get supervisor approval before selling items on credit. New point-of-sales computers provide sales clerks with information about a customer's credit status and so have shifted that decision from supervisors to clerks. Communication links also make it possible for some people to work at home, thus radically altering the usual relationships between supervisors and workers. Computers have also created entirely new positions, such as programmers, that were completely unknown a few decades ago. And, of course, computers have changed the nature of education at all levels, from preschool through graduate level.

One of the major problems associated with computerization has been the electronic monitoring of workers.

ELECTRONIC MONITORING

Ever since the industrial revolution engineers, economists, and psychologists have tried to devise ways of measuring worker performance objectively with the aim of increasing production. Computers have radically changed the nature of that activity. The networking of computers, either through local area networks (LANs) or a telephone system, makes it possible to record instantaneously individual keystrokes made by an operator, the time between keystrokes, the number of keystrokes made per unit time, the time spent on each transaction, the number of letters sorted per unit time, the number of checks processed per unit time; in short, any kind of activity that is performed on or with a computer. Computer programs can also record such things as the time, duration and destination of telephone calls. All these records can be produced for individual workers or can be summarized statistically for groups of them. Perhaps the most revolutionary feature of this kind of recordkeeping is that it is done automatically as part of a computer program and that records can be collected without a worker even knowing that he or she is being monitored.

From a management standpoint electronic monitoring can help to increase productivity by maintaining production standards, identifying bottlenecks, and providing data for personnel scheduling and equipment needs. Likewise monitoring telephone conversations helps management allocate telephone costs, check the correctness of telephone bills, and provide data for traffic studies and scheduling.

Oftentimes, however, electronically generated performance records are used to make some sort of personal evaluation—whether for base pay, incentive pay, promotion, or training. Such uses have led some people to coin the term "electronic sweatshops"—a term connoting boring, repetitive, fast-paced work that requires constant alertness and attention to detail, under the constant supervision of an implacable taskmaster, and a machine at that. A report prepared for the U.S. Congress in 1987 (*36*) estimated that some 4 to 6 million persons working on computer terminals were currently being evaluated for pay, promotion, or discipline on the basis of computer records. That number was projected to increase over the next 5 to 10 years. Word processors, data entry clerks, telephone operators, customer service workers, telemarketing salespersons, insurance claims clerks, mail clerks, and bank proof clerks are some categories of office workers monitored in this way.

For these and other reasons, electronic monitoring raises some serious ethical and practical questions; issues of privacy, fairness, and the quality of life. The last is especially relevant to human factors because of claims that electronic monitoring contributes to employee stress and stress-related illnesses—now a major national health problem. Stress-related symptoms have been estimated to cost American industry from $50 to $75 billion per year in absenteeism, company medical expenses, and lost time. Moreover, claims for worker compensation attributable to accumulated stress have been growing rapidly during the 1980s. In 1985, for example, workers over the age of 40 submitted more claims for stress-related illnesses than for all other occupational diseases (*36*).

The human factors literature, unfortunately, is not very helpful in assessing the severity of the problem. The few studies that have been done on worker stress associated with computer work have not been able to isolate the effects of computer monitoring from those attributable to poorly designed computers, work stations and jobs. For the time being, the issue is an unresolved one awaiting the results of more definitive studies.

Guidelines and Standards

Human factors information about computer design and use has been assembled in a variety of checklists, guidelines, and standards intended to guide and aid designers and practitioners. Several of them (e.g., *12*, *16*, *17*) have already been referred to in earlier sections.

GUIDELINES VERSUS STANDARDS

Design guidelines are unofficial documents containing generally stated recommendations with examples, explanations, and other commentary. They offer flexible guidance and help focus attention on particular design issues. Because of their generality they have to be interpreted and tailored to produce the precise design specifications that are needed for any particular system.

Checklists are a variation of guidelines. They are usually stated in the form of questions that help the user determine whether particular guidelines are, or are not, met by specific systems.

Design standards are official documents containing requirements for design and are imposed in some formal way (e.g., by legislation, contract, or management decree). They typically contain both mandatory statements—identified by the use of the word *shall*—and nonmandatory guidelines and recommendations indicated by words such as *should, is permitted,* or *is preferred.* Standards are often imposed on designers by customers, are usually rigidly enforced, and deviations from them may be made only through some sort of formal exception process.

GUIDELINES

No single set of guidelines covers all the areas of computer design and usage that have been discussed in this article, but several of them collectively blanket the field. Cakir et al. (*37*) have prepared an ergonomic checklist for VDTs and VDT workplaces. It concentrates on screen design, keyboards, and workplace design, but has nothing on input devices other than keyboards or output devices other than screens. The latter are covered by guidelines in DOD-HDBK-761 (*16*) and NASA-STD-3000 (*17*). Cakir et al. have nothing to say about interactive dialog, and the DOD handbook and NASA standard have only scanty information on the topic. Smith and Mosier (*24*), however fill the gap with a monumental set of 944 guidelines grouped into the following major topic areas: data entry (199 guidelines), data display (298 guidelines), sequence control (184 guidelines), user guidance (110 guidelines), data transmission (83 guidelines), and data protection (70 guidelines). Finally, Kirk (*38*) has compiled a list of guidelines relating to the design of computerized jobs.

STANDARDS

In general, Europeans have been the leaders in preparing standards for VDTs and computers. The first German standards on these devices were adopted formally in 1981. The German, or DIN (for Deutsches Institute für Normung), standards most relevant to computers are:

DIN 66 234, Teil 1, Bildschirmarbeitsplätze: Geometrische Gestaltug der Schriftzeichen (Display work stations: Geometric design of characters)

DIN 66 234, Teil 3, Bildschirmarbeitsplätze: Gruppierung und Formatierung von Daten (Display work stations: Grouping and formating of data)

DIN 66 234, Teil 5, Bildschirmarbeitsplätze: Codierung von Information (Display work stations: Coding of Information)

DIN 66 234, Teil 8, Bildschirmarbeitsplätze: Grundsätze ergonomischer Dialoggestaltung (Display work stations: Principles of ergonomic dialog design)

Standards such as these have had a substantial impact on the design of computers and computer products that are targeted for markets overseas.

The first American National Standard on the human factors of visual display workstations was formally adopted in 1988 (*39*). It was prepared by a committee of 19 persons sponsored by the Human Factors Society operating under the rules and procedures of the American National Standards Institute. It contains specifications for the design of visual display terminals, associated furniture, and the office environment in which they are located. The standard is for seated operations involving such VDT applications as text processing, data entry, and data inquiry.

The standard contains nine major sections. The first four are primarily introductory. Section 5 covers the working environment: illuminance, glare, acoustic noise, the thermal environment, external contact surfaces, and heat build-up. Section 6 on visual display covers such things as resolution, luminance, contrast, image contrast polarity, color, flicker, character size, viewing distance, and angle of incidence. Section 7 on the keyboard specifies the layout of keys, cursor control, keyboard size and placement, key dimensions and characteristics, and keyboard profile and stability. Section 8 on furniture deals with the design of display surfaces, seating, footrests, and accessories. Section 9 on measurement techniques contains detailed information on methods of measuring or calculating the various parameters specified in earlier parts of the standard, for example, pixel size, luminance modulation, color discriminability, symbol size, and jitter.

As its title suggests, this standard is heavily oriented toward those considerations involved in the design of computer workstations. It makes no attempt to deal with a great many other human factors requirements for effective computer use, for example, alternative input or output devices, or interaction considerations. Still, it represents a considerable achievement.

ARE STANDARDS WORTHWHILE?

The human factors community is not entirely agreed on the desirability of standards as a way of achieving more usable computer systems (see, e.g., *40*). For one thing, we still do not have sufficient human factors data to cover all the important variables in computer design. As a result, our recommendations, whether in the form of guidelines or standards, frequently involve some element of judgment. Thus, some standards may be based on skimpy data and may actually be incorrect. Additionally some critics say that standards tend to stifle innovation and may be more a restrictive hindrance than a help. The comparative usefulness of guidelines versus standards is one of those issues that can only be clarified through further practical experience.

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ALPHONSE CHAPANIS

INFORMATION BROKERS

An information broker is an individual or organization that researches or provides other information-related services on demand and for profit. Alternative titles for information brokers include independent information specialist, information specialist, information professional, and freelance librarian. Although academic and public libraries provide information services for a fee, information brokering focuses on the entrepreneurial spirit of individuals who pursue this as a career.

The first fee-based information service in the United States, the Engineering Societies Library, was introduced in New York City in 1913 and was designed to fulfill the needs of professional engineers. The next major service was the University of New Mexico's Bureau of Business and Economic Research established in 1945 to provide business, economic, and demographic information to the University and to private organizations. Both of these services were nonprofit and fee-based. *S'il Vous Plait* began in Paris in 1948 as a telephone answering service offering information on any subject for a fee. In 1958, World Wide Information Services, a Commercial news service for journalists, began in New York City (*1*).

Another important development occurred in 1969, when Andrew Garvin founded Information Clearinghouse, Incorporated, which conducts business as FIND/SVP in New York City and is affiliated with the Parisian *S'il Vous Plait*. *S'il Vous Plait* has offices in major cities throughout the world, and FIND/SVP has become the largest information brokerage firm in the United States. These and most subsequent information services, regardless of size, have been organized to generate a profit.

There are several critical factors leading to the emergence of information brokering, the foremost of which is the role of information in today's society. In 1962, economist Fritz Machlup identified over 50 information-oriented activities within five classes which he used to measure the growth of the "knowledge industries." He estimated that in 1958 the knowledge industries comprised approximately 29% of the gross national product (GNP) (*2*). In 1968, Peter Drucker reported that after World War II, the United States shifted from an economy of goods to a "knowledge economy." He suggested that in 1955, one-fourth of the GNP of the United States was based on the knowledge industries and that by 1965 this sector accounted for a third of a larger economy (*3*). Harvard sociologist Daniel Bell coined the term "postindustrial economy" in 1973 to describe the evolution of advanced economies as they progressed from preindustrial to industrial, and ultimately to the postindustrial stages of development. During the final stage, Bell states, the application of knowledge and intellectual technology becomes the critical factor of production (*4*).

In 1977 *The Information Economy* by Marc U. Porat was published by the Department of Commerce. This study set up a six-sector economic model which includes both primary and secondary information products and services. It concluded that in 1967 more than 46% of the GNP and 53% of labor income was derived from knowledge, communication, and information work. The study further examined the work force from 1860 projected to 1980, concluding that in the late 1950s, the American workforce had shifted from an industrial to an information work force. It also supported the theory that the sources of wealth had changed from capital to information and knowledge resources (*5*).

John Naisbitt's *Megatrends* notes that by 1979 more than 60% of the population was employed in an information-related job (*6*).

The information economy is a reality. This economy has been the result of enormously successful adaptations of developing technologies, beginning in the 1940s and early 1950s with the development of digital computers. The new technologies called for a reappraisal of methods used for content analysis of documents and subject headings. As a result, the use of controlled vocabularies was introduced during the 1950s as were thesauruses and other hierarchical vocabularies (*7*).

With the Russian launching of *Sputnik I* in 1957, the scientific and technical communities, including abstracting and indexing services, came under pressure in the rapidly changing environment, to process the massive number of documents produced. Federal funding for Research and Development as well as product and process improvements became readily available. New products and services were developed, creating new markets. Existing services were forced to reevaluate their philosophies and products. The high level of federal involvement ended with the 1960s, but the impetus needed for acquiring additional and more effective services remained (*8*). The most important phenomenon in the information industry has been the emergence and popularity of machine-readable databases (*9*).

Bibliographic databases originated in the mid-1960s, as abstracting and indexing services moved toward computerized photocomposition using magnetic tape. The National Library of Medicine was running on-demand searches by 1964; Chemical Abstracts Services products became available for computer searching on magnetic tape by 1965. Other abstracting and indexing services quickly made themselves available on tape in order to stay competitive.

The years 1970–1975 saw a change from batch searching to online searching; during this time most major abstracting and indexing services began to computerize to decrease production costs and time lags for print products. For-profit companies such as Data Courier and Predicast entered the market, producing databases as well as print products. These databases were sold, leased, and/or offered through information utilities such as Dialog or SDC. Consequently, by the mid-1970s, the information industry recognized the "online revolution" (*9*).

Most studies of the accelerating information economy emphasize the role of computers and technologies in the change from the industrial to the information economy. As the technologies have changed and emerged, the information business has developed more new technologies, products, and new services, one of which is information brokering (*10*).

The early 1970s saw the rise of freelancers belonging to the grass-roots "Alternatives to Librarianship" movement originating on the West Coast (predominantly in the San Francisco Bay Area). But the proliferation of information brokers really began in the mid-1970s (*11*). According to Martin White, this movement was a response to the economic upheaval caused by the Seven Days War in the Middle East, when companies were analyzing their operations to find ways of reducing overhead. The requisite cutbacks precipitated the closing of library and information centers associated with these companies at a time when economics dictated a corporate need to diversify into new markets and products which in turn required information. Simultaneously, online access to bibliographic databases became readily available through Lockheed and System Development Corporation, allowing freelance librarians to do literature searches that were time- and cost-effective without the need of involving major library facilities (*11*). Another explanation for the growth of fee-based information services during this era is offered by Betty Eddison, who stated that "with the election of President Nixon (in 1972), the bottom dropped out of the library market" (*12*). This combination of circumstances made the time right for librarians to develop the innovative career concept of information brokering.

Information brokering firms are a specialized segment of the information industry providing information services on a profit-making basis. These companies offer a wide variety of services: online searching, document delivery, research, consulting, bibliographic compilation, indexing, manual searching, custom information service, current awareness, abstracting, education and training, editing, library development, library services, and cataloging.

Somewhat surprisingly, the market for information brokers is large companies which frequently have a library, rather than small to medium sized companies, as one would expect. Some government agencies use information brokers to staff libraries and/or provide information services.

As attractive as it appears to have one's own business, in order to be successful, information brokers must possess certain characteristics, frequently common to experienced librarians.

According to Maxine Davis, these include (*13*):

1. Understanding the power of information
2. Ability to understand the actual needs of the client, not necessarily those which are stated
3. Skill in interviewing, listening, communicating
4. Adaptability to new situations
5. Ability to organize concepts as well as things
6. Ability to synthesize information
7. Ability to interpret information and repackage it
8. Ability to train and work with nonlibrary-oriented staff
9. Administrative ability and business expertise
10. Research experience
11. Ability to interact with databases
12. Ability to work independently

Due to the nature of information brokering, an individual engaged in the occupation is usually considered to be an entrepreneur. According to Albert King (*14*):

> Independent business is an appealing occupation. Being one's own boss offers independence, personal satisfaction, profit expectations, and social involvement. Entrepreneurship is not for everybody. The individual who desires job stability and security may find owning a business to be unbearable. The decision to go into business for oneself must be made in an objective, deliberate, and comprehensive manner. It is necessary to evaluate the pros and cons of a particular business venture. A well-thought-out decision process coupled with a heightened awareness of one's own personality traits is believed to enhance greatly the probability of entrepreneurial success.

Researchers have found the personality of an entrepreneur to be a primary indicator to success or failure. The following dominant characteristics are most often identified with successful entrepreneurs (*15*):

1. Entrepreneurs are recognized as having a high level of drive and personal energy
2. Successful entrepreneurs have a high level of self-confidence
3. Entrepreneurs view money as a way of keeping score
4. Entrepreneurs have a strong need for positive and definite feedback
5. Effective entrepreneurs use past failures to their benefit
6. The successful entrepreneur has the ability and the commitment to set clear goals
7. Entrepreneurs have an insatiable drive for accomplishment
8. Entrepreneurs believe they can control their own destinies
9. The successful entrepreneur takes initiative and seeks personal responsibility
10. Entrepreneurs prefer to take moderate, calculated risks
11. High-performing entrepreneurs continuously compete against self-imposed standards
12. Entrepreneurs have an intense level of determination and desire to solve problems and complete the job
13. Entrepreneurs who are successful know when, where, and how to seek help

According to John Burch, entrepreneurs like independence, want to be their own bosses, are self-governing, are loners and individualists, and like to make their own decisions. He agrees that entrepreneurs possess common personality traits. His list includes (*16*):

1. A desire to achieve
2. Hard work
3. Nurturing quality (i.e., taking charge of and watching over a venture until it can stand alone)
4. Acceptance of responsibility
5. Reward orientation (receiving monetary incentive, recognition, or respect)
6. Optimism
7. Orientation to excellence
8. Organization
9. Profit orientation (serving as a guage of achievement and performance)

Information brokering has not proved to be a stable occupation over the years. Kelly Warnken's 1978 *Directory of Fee-Based Services,* listed 177 information brokers in the United States (*17*). Helen Burwell's 1987 *Directory* notes 447 entries (*18*). However, only 24 businesses listed in the 1978 edition were extant in 1987, indicating that the life-span of information brokering firms is relatively brief, at least to this point in time.

The future of information brokering is unclear. It appears that on the whole, the business does have growth potential. There is some concern that the increasing availability and promotion of products to possible online end users will decrease the demand for information brokers; however, these target end-users might not have the time or the desire to do their own online searching. Perhaps future information brokers will shift their focus from online searching to interpretation and evaluation of available information (*1*).

However, factors other than the market and the economy may play an even greater role in the future of information brokering. In a study of 125 information brokers who had been in business at least 5 years, Johnson found that the majority carried no liability insurance and only a very small minority expressed any concern over copyright restrictions (*19*). Ultimately, the future of independent information brokers in particular, may be influenced by the legal ramifications involved in providing information to clients.

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ALICE JOHNSON

INFORMATION POLICY

Information policy, a field encompassing both information science and public policy, treats information as both a commodity—adheres to the economic theory of property rights—and a resource to be collected, protected, shared, manipulated, and managed. Although the literature often refers to information policy in the singular, there is no single all encompassing policy. Rather, information *policies* tend to address specific issues and, at times, to be fragmented, overlapping, and contradictory.

Information is "essential to our existence" and assumes a "life of its own" (*1*). Information policy then is a set of interrelated principles, laws, guidelines, rules, regulations, and procedures guiding the oversight and management of the information *life-cycle*: the production, collection, distribution/dissemination, retrieval, and retirement of information. Information policy also embraces access to, and use of, information. Collectively, policies form a framework that "profoundly affects[s] the manner in which an individual in a society, indeed a society itself, makes political, economic, and social choices" (*2*).

Much of the discussion of U.S. information policy in the literature of library and information science revolves around actions taken or planned by government, in particular the federal government. With the national government moving more toward the collection, distribution, and dissemination of information in electronic form, there has been increasing concern about the ability of government to effectively manage this information as well as provide public access to information collected and retained by government. At the same time, information policy must recognize the legitimate role of the private and not-for-profit sectors in the provision of government information.

Information policy embraces developments at all levels of government, as well as international concerns. Moreover, information policy occurs outside of government; it takes place within and among organizations, associations, and other groups. This introductory essay cannot touch upon all aspects of information policy and still provide a semblance of unity. For this reason, the essay does not address censorship, telecommunications, the press, broadcasting, First Amendment issues, propaganda, and archiving. Moreover, the essay focuses on American national government information policy.

Significance of Information Policy to the Library Community

Government policies provide a framework within which libraries and information centers must function. These policies often determine what types of publications will be issued, the availability of government funds, and how funds will be allocated and spent. Obviously, librarians must understand the policy arena and the necessity of influencing the policy-making process.

The importance of information policy to the library community in the United States was underscored in 1988, when President Ronald Reagan signed Public Law 100-382, which provided for the Second White House Conference on Libraries and Information Services. The preamble to that law "constitutes a laundry list of those information access issues that librarians hold dear" (*3*). Such a conference might identify the key policy issues that libraries will encounter for the foreseeable future.

Another reason why librarians should be knowledgeable about information policy is that libraries and information centers are part of a larger organization (e.g., city government, an academic institution, or a corporation). The internal policies set by that organization impact on libraries and information centers and set the constraints under which they operate. Moreover, external policies also have an impact on the ability of libraries and information centers to meet stated goals and objectives.

Perhaps two examples of the importance of information policy might be beneficial. First, the term "national competitiveness" expresses concern that the United States is not well prepared to function in world information and industrial markets. The presumption is that prompt and effective access to information from abroad is important. At the same time, questions such as the following have been extensively debated:

- To what extent do government information policies enhance or injure the competitive edge of the United States in world markets?
- To what extent do current policies encourage the collection and dissemination of scientific and technical information from Europe and Japan to assist U.S. industries?

- What role do libraries and information centers play in making the United States more competitive?
- Will the United States become dependent on foreign-owned publishing houses, vendors, and databases for access to technical and scientific information?

Some policy makers have assumed that *all* libraries should collect everything offered by nations competing with the United States for world markets. The priority of some policy makers and policies themselves is to increase the quantity of information available within the United States. The presumption is that all information is of high quality, has an impact—makes the United States more competitive, and merits collection and retention by U.S. libraries (*4*).

The second example has received extensive coverage in library literature and the national press. As part of its Library Awareness Program, the Federal Bureau of Investigation (FBI) has visited libraries, tried to solicit information about library users, and compiled investigative records on library personnel. A full understanding of the program and the options open to the library community necessitates knowledge of the Department of Justice's counterintelligence activities and the grounds on which the FBI justifies its actions (*5*). Any rebuttal of the FBI's justification for its policies that might result in a change of agency policy and practices must address the legal basis on which the FBI justifies its actions. To effect change, librarians need an extensive knowledge of policy terminology (e.g., the differences among executive orders, circulars, and directives), how policy is formulated, and strategies that might result in policy modification or reversal.

The purpose of this essay is to provide an overview of information policy emanating from the federal government. The essay identifies key policy areas and stakeholders, shows how policy is formulated, and discusses issues central to an understanding of information policy in the 1990s. Moreover, the essay demonstrates that there is no single corpus of statutory or administrative law to coordinate information policies of federal agencies and to eliminate ambiguities in federal information policies. Some policies pertain to an agency and specific activities; others apply to a branch of government, have government wide application, or have international ramifications.

Historical Development of Information Policy

Information policy existed in America long before the establishment of the federal government in 1789. Indeed, it probably can be said that information policy began with the arrival of the first European colonists who brought with them the information policies of their home or sponsoring nation. The common law rights of Englishmen were particularly important in this regard, and were directly influential in the development of the American legal system well into the early nineteenth century (*6*).

The experience of the colonists differed regarding patterns of communication and information dissemination (*7*). Consequently, their expectations about the availability and accessibility of government information varied from one region to the next. Eventually, however, as England became the predominant power in the Atlantic territories, conflicts over information and "the rights of Englishmen" came to be commonly experienced throughout the American colonies. Disputes arose over the secret activities of royal governors and colonial legislatures, the public accessibility of official records, and proper respect for personal privacy (*8*). These and other perceived violations of individual rights by George III kindled the fires of revolt and the rebellion that resulted in American independence.

Within the new nation, information policy was given primary expression in the Articles of Confederation and state constitutions, the latter containing expressions of fundamental rights guaranteeing freedom of the press and personal privacy. These documents would later be important sources for James Madison when drafting the Bill of Rights for the U.S. Constitution. Very little historical research, however, has been conducted on the development of information policy during the American colonial and confederal eras. Some general histories of government institutions and practices of the period provide occasional bits of pertinent knowledge, but much work remains to be done before a better understanding of information policy prior to the establishment of the federal government can be realized (*9*).

The history of federal information policy development begins with the Philadelphia convention of 1787, which itself, owing to the secrecy in which it occurred, was a special information policy event (*10*). The Constitution of the United States created a limited government with some explicit powers and responsibilities. Certain of these concerned information matters. Among the enumerated powers of Congress, for example, are authority to "establish Post Offices and Post Roads," to "promote the Progress of Science and useful Arts, by securing for limited Times to Authors and Inventors the exclusive Right to their Respective Writings and Discoveries," to "make Rules for the Government and Regulation of the land and naval Forces" (Article I, Section 8, clauses 7, 8, and 14), and to "make all needful Rules and Regulations respecting the Territory or other Property belonging to the United States" (Article IV, Section 3, clause 2).

In the Bill of Rights, which was subsequently appended to the Constitution, guarantees are made concerning speed and press freedoms (Amendment I), the security of personal papers against "unreasonable searches and seizures" (Amendment IV), and not being "compelled in any Criminal Case to be a witness against" oneself (Amendment V). Also included are rights to a public trial in criminal prosecutions and "to be informed of the nature and cause of the accusation; to be confronted with the witnesses against [oneself]; [and] to have compulsory process for obtaining witnesses in [one's] favor" (Amendment VI).

The Constitution created a government accountable to the people and itself as well. There was an expectation that government leaders would keep the citizenry informed of developments, or at least maintain a record of their activities. In this regard, the Constitution specifies that each House of Congress "shall keep a Journal of its Proceedings, and from time to time publish the same, excepting such Parts as may in their Judgement require Secrecy" (Article I, Section 5, clause 3). Concerning the duties of electors, the Twelfth Amendment prescribes that "they shall make distinct lists of all persons voted for as President, and of all persons voted for as Vice-President, and the number of votes for each, which lists they shall sign and certify" (Article II, Section 1, clause 3). With regard to the subnational level of government, the Constitution states: "Full Faith and Credit shall be given in each State to the Public Acts, records, and judicial Proceedings of every other State" (Article IV, Section 1, clause 1).

Moreover, with its system of checks and balances, the Constitution anticipated that each branch would be knowledgeable of the activities and interests of the other two. In this regard, the Constitution specifically provides that, when the President vetoes a bill, "he shall return it, with his Objections to that House in which it shall have originated, who shall enter the Objections at large on their Journal; and proceed to reconsider it" (Article I, Section 7, clause 2). Concerning interbranch accountability, provision is made for the President to "require the Opinion, in writing, of the principal Officer in each of the executive Departments, upon any Subject relating to the Duties of their respective Offices" (Article II, Section 2, clause 1). The Constitution also indicates that the President "shall from time to time give to the Congress Information of the State of the Union, and recommend to their Consideration such Measures as he shall judge necessary and expedient" (Article II, Section 3). Finally, as a consequence of the separation of powers doctrine of the Constitution, presidents determined, early in the life of the federal government, that a discretion might be exercised regarding requests for information from the other branches. President Washington contemplated such a discretion in 1792 and exercised it four years later, the first invocation of what would subsequently be called "executive privilege" or the privilege of the Chief Executive to withhold requested information from Congress or the Judiciary for institutional reasons (*11*). Similar powers have been claimed and exercised by Congress (*12*).

In many regards, these constitutional references to information matters indicate some fundamental expectations regarding government accountability and communication, the exercise of certain popular rights regarding information, and subsequent legislation on at least a few particular information subjects. Furthermore, historically, as experience and practice suggested that Congress create and refine additional statutory information policies, these, among other constitutional considerations, have guided the legislative and oversight processes.

An information policy area which quickly commanded the attention of the new federal government, and continued to be refined throughout the nineteenth century, was official publication. The matter had been debated during the Constitutional Convention of 1787. James Wilson of Pennsylvania, addressing a proposal to allow each chamber of the Federal Congress a discretion as to the parts of their journal that would be published, told the delegates: "These people have the right to know what their Agents are doing or have done, and it should not be in the option of the Legislature to conceal their proceedings (*13*). The following year, during the Virginia Convention on the new Constitution, James Madison and George Mason raised a similar consideration when speaking about the importance of publishing all receipts and expenditures of public money under the new government (*14*).

In deference to views such as these, the Federal Congress quickly provided for the printing and distribution of both laws and treaties (*15*), the preservation of state paper (*16*), and the maintenance of official files in the new departments (*17*). The printing and distribution of both the Senate and House journals was authorized in 1813 (*18*).

Congressional floor debate was variously reported in the *Register of Debates*, *Congressional Globe*, and, beginning in 1873, the *Congressional Record* (*19*).

Provision was initially made in 1846 for the routine printing of all congressional reports, special documents (which included Executive Branch materials), and bills (*20*). While these responsibilities were met for many years through the use of contract printers, such arrangements proved to be subject to considerable political abuse. Consequently, in 1860, Congress established the Government Printing Office (GPO) to produce all of its literature and to serve, as well, the printing needs of the Executive Branch (*21*). Additional aspects of government wide printing and publication policy were set with the Printing Act of 1895, which is the source of much of the basic policy still found in the printing chapters of Title 44 of the *United States Code* (*22*).

Congress, in addition to providing for publication of the statutes and a variety of legislative literature (and executive materials produced as Senate or House documents), promoting newspaper reprinting of the laws and treaties (*23*), and circulating printed documents through official sources, also developed a depository library program to further facilitate public knowledge of governmental actions. In 1859, the Secretary of the Interior was statutorily tasked with distributing all books printed or purchased for the use of the federal government, except those for the particular use of Congress or Executive Branch entities (*24*). A decade later, a subordinate officer in the Department—the Superintendent of Public Documents—was mandated to perform this responsibility (*25*). Distributions were made to certain libraries throughout the country which were designated to be depositories for government publications. This arrangement had been begun in 1813 with regard to congressional materials (*26*) and extended in 1857 to include other federal literature (*27*). The Printing Act of 1895 relocated the Superintendent of Public Documents, making the position an integral and important role within the GPO (*28*).

In the relocation process, the Superintendent was also given responsibility for managing the sale of documents and preparing periodic indices of GPO products. Until 1904, the sale stock available to the Superintendent derived entirely from such materials as were provided for this purpose by the departments and agencies or were returned from depository libraries. The situation was altered when the Superintendent was granted authority to reprint any departmental publication, with the consent of the pertinent Secretary, for public sale (*29*). Congress legislated comparable discretion to reproduce its documents in 1922 (*30*).

Shortly after the dawn of the twentieth century, the federal government entered a new phase—the rise of the administrative state. Among the forces contributing to this development was the Progressive Movement, which sought greater government intervention into the regulation of various sectors of American society. With the United States' entry into World War I, regulatory activities further expanded and the number of administrative agencies increased. In the postwar era, government expansion momentarily slowed, but began again with the onset of the Great Depression and the arrival of the New Deal.

As federal regulatory powers and administrative entities dramatically grew during this period, there was a concomitant increase in both the number and variety of controlling directives, regulations, and requirements. Soon, problems of accountability, uniformity in the form and promulgation of agency directives, and public access to agency administrative records arose. To address the first of these issues, an Executive Branch gazette was created—the *Federal Register* in July 1935 (*31*). This cumulation of the authorities appearing in the gazette contained almost all operative agency regulations and was eventually updated annually (*32*). Later, the general statutory authority underlying the *Federal Register* was relied upon for the creations of other series of publications, namely the *United States Government Manual* (1939–), the *Public Papers of the Presidents* (1960–), and the *Weekly Compilation of Presidential Documents* (1965–).

Uniformity in the form and promulgation of agency regulations was addressed by a study committee established by the Attorney General (*33*) and the eventual enactment of the Administrative Procedure Act (*34*). The statute also contained an important public information section which directed the agencies to publish in the *Federal Register* "the established places at which, and methods whereby, the public may secure information or make submittals or requests" (*35*). However, broad discretionary allowances also were made for protecting information, and a changing climate of opinion within the federal bureaucracy soon transformed this public information mandate into a basis for administrative secrecy. Elements of the press community gave particular attention to the unwillingness of federal agencies, as well as some other government entities, to disclose requested information (*36*). In 1955, a special subcommittee on government information was established in the House of Representatives; it inaugurated, with assistance from elements of the press, a major probe of agency information access policy and practice (*37*).

Subsequently, in 1966, after a long congressional examination and a difficult legislative struggle, the public information section of the Administrative Procedure Act was replaced by a new statute and a new concept in information access. The Freedom of Information (FOI) Act established a presumptive right of public access to department and agency records, specified nine categories of information that could be exempted from the rule of disclosure, and provided for court resolution of disputes over the availability of requested materials (*38*). Later amended in 1974, 1976, and, most recently, 1986, with portions subject to considerable judicial interpretation, the statute has remained a very effective tool for enabling public access to topical records of the administrative state. It also came to serve as a model for other information access laws, such as the Privacy Act of 1974 (*39*), and open government statutes, such as the Federal Advisory Committee Act of 1972 (*40*) and the Government in the Sunshine Act of 1976 (*41*).

With the end of World War II and the onset of the Cold War, the federal government entered still another new phase—the rise of the national security state. From the outset of the era until the mid-1960s, it was a time of strong, unilateral leadership by the President in the external affairs of the country and marked by the creation of new agencies and policies to safeguard the nation. Several such innovations were taken regarding information policy (*42*). These developments, however, built upon a few prior policy actions. Since the earliest days of the Republic, for example, government officials had engaged in the practice of assigning a secret status to certain kinds of sensitive information, usually concerning foreign affairs, defense, or intelligence matters. The Executive Branch, including the armed forces, engaged in such information security—secrecy practices for over a half century before they were given direct statutory authorization (*43*). Formal military secrecy directives or regulations appeared only after the Civil War. The initial Army General Order of 1869 concerning security-secrecy pertained to the physical protection of forts and coastal defenses. Such facilities were not to be photographed or otherwise depicted without prior permission from appropriate officials. This limited application underwent a series of evolutionary adjustments and, shortly after United States entry into World War I, resulted in a fully developed information security classification system (*44*). In 1911 and 1917, Congress provided for the criminal punishment of espionage and the acquisition of valuable defense information by spies (*45*). Neither law, however, specifically sanctioned the information secrecy practices of the military departments or the armed forces. Initially, the military departments made no mention of the espionage laws in their information security orders and directives, but soon such regulations began referring to these laws as a possible basis for their enforcement.

Relying upon a 1938 statute concerning the protection of armed forces installations and equipment and "information relative thereto," President Franklin D. Roosevelt assumed responsibility for security classification policy and procedure by issuing an executive order setting such policy. It largely paralleled Army and Navy regulations for marking and handling secret records and gave civilian employees of the military departments authority to classify information. However, the legislative history of the 1938 statute, upon which the President relied to issue his directive, provided no indication that Congress anticipated or expected that such a secrecy classification arrangement would be created (*46*). Nevertheless, it was the begining of presidential leadership in setting security classification policy.

Congress seemingly has evidenced a general reluctance to authorize directly or legislate a government-wide information security classification system. While it has mandated information security arrangements for special areas such as atomic energy (*47*), intelligence (*48*), or patent applications having national security implications (*49*), Congress, through various committees and subcommittees, for 30 years, successfully encouraged and pressured Presidents from Eisenhower to Reagan to narrow classification criteria and limit discretionary authority to classify (*50*). The Reagan administration's sweeping 1982 executive order reversed the prior historical trend by expanding the categories of classifiable information, by mandating that information falling within these categories be classified, by making reclassification authority available, by admonishing classifiers to favor classification in deciding close cases, and by eliminating automatic declassification arrangements (*51*).

Furthermore, with regard to national security restraints on government information, Congress recently indicated its opposition to widespread use of secrecy agreements. In March 1983, a national security decision directive, NSDD 84, entitled "Safeguarding National Security Information," was released by the White House through a press conference at the Department of Justice. Although signed by the President, such directives, unlike executive orders, are not required to be published in the *Federal Register* (*52*). They are a specialized presidential instruction series, usually assigned a security classified status, and maintained in the files of the National Security Council (*53*).

NSDD 84, as issued, required federal employees having access to classified information to sign a nondisclosure agreement as a condition of having access to such information. Moreover, federal employees having access to so-called "sensitive compartmented information" (SCI), a kind of intelligence information, also were required to sign a nondisclosure agreement as a condition of having access to SCI. Unlike the classified information nondisclosure agreement, however, the one concerning SCI was binding upon signatories for the rest of their lives, regardless of whether or not they continued to have any access to SCI. Also, SCI nondisclosure agreement signatories were required to submit their public writing, speech texts, and publication drafts for prior review by security officials to assure deletions of SCI and other classified information. Other provisions of NSDD 84 required federal employees to submit to polygraph examinations, when appropriate, in the course of investigations of unauthorized disclosures of classified information. Agencies were required to develop and adopt policies and procedures to structure contacts between media representatives and Executive Branch employees, so as to reduce the opportunity for negligent or deliberate disclosures of classified information.

Secrecy agreements of the type mandated by NSDD 84 had been in use for at least a decade within the federal intelligence community and a few other agencies possessing particularly sensitive information. In 1980, the Supreme Court found such agreements to be a proper enforcement device to prevent the unauthorized disclosure of classified information (*54*). NSDD 84 extended the use of this particular type of secrecy agreement to all Executive Branch employees, including contractors and grantees, having access to classified information and SCI.

The new directives prompted not only a number of protests against its breadth and accompanying enforcement demands, but also serious questioning of the related use—as well as the reliability and validity—of polygraph testing. Several congressional panels held hearings on the matter, received testimony from Administration representatives and other interested parties, and urged delaying implementation of NSDD 84 until further study of the situation could be made. However, because there appeared to be no willingness to postpone the effectuating of the directive, riders offsetting two of its provisions were attached to two pending bills. Language was added to the Department of Defense (DoD) authorization to prevent increased use of polygraph tests by DoD, which had the largest number of personnel having access to classified information, prior to mid-April 1984 (*55*). Next, an amendment was attached to the Department of State authorization to prohibit the post-employment application of the prepublication review requirement anticipated by NSDD 84 prior to mid-April 1984 (*56*). Both of these temporary limitations on the implementation of portions of NSDD 84 provided a clear indication of congressional displeasure. The following year, legislation was introduced to make these proscriptions permanent.

As the corrective measure began receiving committee consideration in the House, the Reagan administration informed managers of the bill that plans to implement the polygraph testing and postemployment prepublication review provisions of NSDD 84 were being suspended "for the duration of this Congress." No subsequent actions were taken on the pending proposal. What the Administration actually did, however, was discontinue using the secrecy agreement authorized by NSDD 84 and substitute an older form utilized by the intelligence community (*57*). Clearly the policy of more widespread use of secrecy agreements in furtherance of information security has not been abandoned. In response, Congress, in a joint resolution continuing appropriations for fiscal year 1988, set a qualified prohibition on utilizing appropriated funds to implement or enforce employee secrecy agreements (*58*). In May 1988, this restriction came under constitutional challenge, but the Supreme Court subsequently remanded the case, on various technical grounds, to the District Court from which it arose for further consideration (*59*). NSDD 84, however, remains operative policy.

With the arrival of the Reagan administration, the Executive Branch became permeated by a more strident anticommunist attitude, manifesting itself in increased defense spending and preparations, expanded internal security procedures (e.g., NSDD 84), broadened official secrecy arrangements, and more vigorous enforcement of laws restricting the availability and communication of scientific and technological goods or information of possible value to hostile nations, and pursuit of new authority for more strictly controlling the acquisition of American scientific and technological commodities and knowledge by foreign interests.

The new Administration enjoyed considerable success in unilaterally imposing more restrictive national security controls on traditional professional communication by American scientists. The concern was that too much unclassified scientific and technological information of widely varying dual civilian and military application—but all, however, "sensitive"—was readily available to hostile foreign interests through open literature, classroom and conference presentations, and in the case of proprietary knowledge, espionage, and theft. During 1981 to 1984, officials intervened at a number of professional conferences and largely used national security export control authority (*60*) to prevent certain presentations from being given and to restrict the attendance of some foreign nationals (*61*). By the spring of 1984, it became evident that some scientific societies anticipating government intervention, were engaging in self-censorship by closing some conference sessions to foreigners (*62*).

Efforts were made by several university presidents, professional organizations, and two study panels of the National Academy of Science to obtain some relaxation of the stringent national security controls applied to traditional scientific communication (*63*). The situation, however, did not markedly improve until the late years of the Reagan administration, after the departure of Secretary of Defense Caspar W. Weinberger, when proponents of a stronger U.S. trade position and greater competitiveness began to offset national security restraints on technological goods and services. Changing political conditions in Eastern Europe, improved U.S. relations with the Soviet Union, and continued efforts to improve trade with the East Bloc nations will seemingly provide an impetus for lessening national security restraint of traditional scientific communication (*64*).

Finally, apart from national security considerations, information is also lawfully protected to maintain the integrity of persons. In the case of individuals, such protection is understood as privacy. However, in the case of corporate persons, protection extends to proprietary or commercially valuable information.

Individual privacy, the wish not to be intruded upon, probably predates recorded history. Certainly it is one of the presocietal or "natural rights" which the Founding Fathers sought to preserve (*65*). When drafting the Bill of Rights, they gave constitutional recognition to privacy expectations in the First, Third, Fourth, Fifth, and Ninth Amendments, which the Supreme Court characterized as comprising a penumbral right of privacy in a landmark 1965 decision (*66*).

Through the years, for various governmental activities and programs involving the collection and maintenance of personally identifiable information such as the census and income tax returns, prohibitions have been legislated on the disclosure of such data. These statutory restrictions are recognized in the FOI Act (*67*), and the Privacy Act prohibits federal agencies from collecting some kinds of personally identifiable information (*68*). It also allows American citizens to gain access to and make supplemental corrections of a great many agency records on themselves. Indeed, in recent years, several laws have been enacted providing citizens greater control over personal records held by third parties, including, among others, the Fair Credit Reporting Act (*69*), the Privacy Act, the Family Educational Rights and Privacy (or "Buckley") Act (*70*), and the Pupils' Rights Act (*71*).

Further, a century ago, the Supreme Court recognized corporations as being a "person," but has not vested them with the privacy rights reserved for individuals (*72*). Generally, when legal protection has been accorded to the information of corporate entities, it has been done for economic reasons and without explanation in terms of privacy rights. Perhaps the best known statutory prohibition in this regard is the Trade Secrets Act, which makes the disclosure of trade secrets by a federal officer or employee criminally punishable (*73*). A 1977 study prepared by the Department of Justice identified 90 operative statutes "reflecting varied approaches to the regulation of the disclosure by federal agencies of the information they collect from or maintain about business entities (*74*). Moreover, open government laws like the Freedom of Information Act and the Government in the Sunshine Act contain exemptions for the protection of trade secrets and confidential commercial information.

Most recently, policy efforts have concentrated on better standards concerning the collection, maintenance, use, accessibility, and dissemination of information in electronic format. During the past decade, several congressional committees have examined aspects of the electronic phenomenon, but, in 1986, the House Committee on Government Operations produced a comprehensive policy overview (*75*). This perspective was supplemented in October 1988 by an Office of Technology Assessment (OTA) report examining technological developments and implications (*76*). The Office of Management and Budget (OMB) has attempted to set some policy regarding information resources management and electronic formats administration with Circular A-130, issued in December 1985 (*77*). For the moment, settlement of some issues concerning electronic information is being attempted in legislation reauthorizing the Paperwork Reduction Act (*78*). On the horizon, for consideration in the next Congress is the prospect of amending the FOI Act to facilitate better access to agency records in electronic formats.

The Literature

Table 1 identifies selected source material on information policy. A number of recent writings focus on restrictive policies of the Reagan administration, reauthoriza-

TABLE 1

Selected Source Material on Information Policy

INDEXES

Library Literature (1921–)
Resources in Education (ERIC) (1966–)
PAIS Bulletin (1915–)
Social Science Index (1974–)
Monthly Catalog of United States Government Publications (1895–)

PERIODICALS

Government Information Quarterly (1984–)
Government Publications Review (1973–)
Information Hotline (1969–)
Information Management Review (1985–)
Journal of Policy Analysis and Management (1981–)

NEWSPAPERS

The Chronicle of Higher Education (1966–)
Government Computer News (1981–)

NEWSLETTERS

Access Reports/Freedom of Information (1975–)
Privacy Times (1981–)
Privacy Journal (1974–)

SAMPLE WORKS

American Science and Science Policy Issues: Chairman's Report to the Committee on Science and Technology, Congress, House, 99th Cong., 2nd sess., 1986 [Committee Print].

Association of Research Libraries, *Technology & U.S. Government Information Policies: Catalysts for New Partnerships*, Washington, DC, 1987.

Bennett, J. R., *Control of Information in the United States: An Annotated Bibliography*, Meckler Corp., Westport, CT, 1987.

Caudle, S., *Federal Information Resources Management: Bridging Vision and Action*, National Academy of Public Administration, Washington, DC, 1987.

Congress, House, Committee on Government Operations, *Electronic Collection and Dissemination of Information by Federal Agencies: A Policy Overview*, GPO, Washington, DC, 1986.

Congress, Office of Technology Assessment, *Informing the Nation*, GPO, Washington, DC, 1988.

Federal Government Information Technology: Management, Security, and Congressional Oversight, Office of Technology Assessment, Washington, DC, 1986.

Flaherty, D. H., *Protecting Privacy in Surveillance Societies*, University of North Carolina Press, Chapel Hill, NC, 1989.

Hernon, P. and C. R. McClure, *Federal Information Policies in the 1980s*, Ablex, Norwood, NJ, 1987.

Hernon, P. and C. R. McClure, *Public Access to Government Information*, 2nd ed. Ablex, Norwood, NJ, Chap. 2.

(continued)

TABLE 1 *(continued)*

Information Technology R&D: Critical Trends and Issues, Office of Technology Assessment, Washington, DC, 1985.

Lawrence, J. S. and B. Timberg, *Fair Use and Free Inquiry,* Ablex, Norwood, NJ, 1989.

Mann, M. *Information Policy: A Bibliography,* The British Library, London, 1985.

McClure, C. R., P. Hernon, and H. C. Relyea, *United States Government Information Policies,* Ablex, Norwood, NJ, 1989.

McClure, C. R. and P. Hernon, *United States Scientific and Technical Information Policies,* Ablex, Norwood, NJ, 1989.

National Commission on Libraries and Information Science, *Public Sector/Private Sector Interaction in Providing Information Services,* GPO, Washington, DC, 1980.

Newberg, P. (ed.), *New Directions in Telecommunications Policy,* 2 vols., University of North Carolina Press, Durham, NC, 1988.

Rubin, M. R. *Information Economics and Policy in the United States,* Libraries Unlimited, Littleton, CO, 1983.

Shapley, D. and R. Rustum, *Lost at the Frontier: U.S. Science and Technology Policy Adrift,* ISI Press, Philadelphia, 1985.

Scientific and Technical Information Policy and Organization in the Federal Government, Hearings before the Subcommittee on Science, Space and Technology, GPO, Washington, DC, 1987.

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tion of the Paperwork Reduction Act, privacy protection, telecommunications policy, information resources management, scientific and technical information policy, and electronic recordkeeping. OTA has produced a number of introductory studies to specific policy areas (e.g., intellectual property rights).

Novice researchers on information policy will appreciate Mann's bibliography on information policy, which although dated provides international coverage (*79*).

Policy Issues

OVERVIEW

Since publication of the Porat study in 1977 (*80*), little progress has been made in developing detailed typologies of policy issues, using sophisticated methods to organize and relate issues or producing better methods of clarifying issues and their interrelationships. Many policy issues are part of both a larger and smaller issue, and resolution of one issue often depends on resolution of another.

Hernon and McClure, who analyzed a wide range of policy issues, underscore that (*81*):

- The published policy literature is repetitive in the broad themes that it addresses
- Suprisingly little duplication exists among specific policy issues; each issue tends to emphasize specific and unique aspects of the broader themes

- The literature devotes little attention to issues related to (1) the role of libraries in the provision of government information, and (2) the information needs and gathering behaviors of user segments
- The issues become more technologically than user driven with the passing of time
- Policy issues can be isolated in terms of their impact on other policy issues

Table 2 identifies 29 policy issues that have significant impact on the effectiveness with which the federal government provides information. These policy issues are grouped under a typology generated by an extensive review of the social sciences literature. The central components of this typology include:

- *Federal Organization for Information Policies:* the structure of the government regarding the provision of federal information
- *Relationship between the Federal Government and Other Stakeholders in the Information Sector:* responsibilities and roles of agencies and organizations engaged in the production, distribution, and dissemination of government information
- *Information Technology:* applications of information technology and their effect on the government's provision of federal information
- *The Economics of Government Information:* costs and benefits of government provision of federal information
- *Public Access to (and Availability of) Government Information:* the rights of the public and the responsibilities of the government to make federal information accessible and available
- *Freedom of Information and Privacy Protection:* the rights of the public to gain access to government agency records, while at the same time protecting information that should not be released
- *Secrecy and Protection:* the rights of the government to withhold information for the common protection of the public and national security

These categories are not mutually exclusive, but they do offer a means for organizing various policy issues and realizing that some issues have a broader impact than do others.

The categories suggest policy issues related, for example, to: information disclosure, international communications facilities and capacities, privacy protection, freedom of information statutes, the economics of information, information networking, the setting of standards, computer regulation, transborder data flow, intellectual property rights, the role of government and government participation in the marketplace, scientific and technical information (STI), information resources management, national security, national competitiveness, and the public's right to know and gain access to government information.

An enlarged typology of policy issues might address topics related to energy, housing, health care, the environment, transportation, etc. No wonder that from the 95th through the 100th Congress, 1977 through 1988, more than 300 public laws dealing with information policy were enacted (*82*). Added to this, many authorization and appropriations bills contained provisions that directed agency information policy activities. Furthermore, numerous administrative rules and regulations were proposed and implemented during this time period. Consequently, information policy has enormous societal consequences, and the study of such policies appeals to the academic community, consultants, as well as those commissioning the analyses. Policy formulation and execution also interest policy makers and those affected by a policy—interest groups and the public.

TABLE 2

Summary of Significant Policy Issues[a]

Federal Organization for Information Policies

1. Should the federal government have centralized or decentralized information policies?
2. Should formal mechanisms be established that encourage continuing dialogue about federal information policy among the various stakeholders in the information sector?
3. What are the likely impacts on society resulting from the pre-eminence of OMB in information policy formulation?
4. What historical tenets shaped the existing federal information policy system?

Relationship between the federal government and Other Stakeholders in the Information Sector

5. What responsibilities does the federal government have for legislating and regulating access to government information?
6. How can adequate bibliographic control be maintained over government provided federal information?
7. Should federal information activities be administered as a "business" or as a public service?
8. How can the public be better informed and provide greater input into the formulation of information policy?
9. Should the GPO *Monthly Catalog* include electronic formats? If yes, does this impact the role of the private sector?
10. How should the Superintendent of Documents and the depository library program determine the proper balance between public and private sector roles?

Information Technology

11. Should agencies "retail computerized information—make it easily available to the general public" or "limit their role to wholesaling—releasing information only in bulk for possible retailing by private enterprise?" (p. 259)[b]
12. What criteria should the government follow in selecting information technologies for the provision of federal information?
13. To what degree is the federal government responsible for providing training or increasing the competency of user segments and government information intermediaries (such as information brokers and libraries) to access adequately government information available through various information technologies?
14. What trends in agency electronic publishing and dissemination activities are relevant to the future of GPO and NTIS?

The Economics of Government Information

15. To what extent should federally provided government information be considered as property or as a public good?
16. How should the federal government price government information?
17. To what degree can the costs and benefits of federal information programs be measured, and to what degree is it appropriate to assess program effectiveness in terms of cost-benefit?
18. What government information must be paid for, who will determine this cost, and how will the determination be made?

Public Access to (and Availability of) Government Information

19. Do the printing chapters of Title 44 need revision to update the law with respect to the role of the GPO in printing and distributing electronic products?

20. What federal information does the government have a responsibility to make accessible and available to the public?
21. Should Congress reconsider a revision of chapters 1–19, Title 44, *United States Code*, or proceed on a "piecemeal" basis with the development of federal policy governing publication, distribution, and dissemination of government information?
22. What is the role of depository library programs in the government's provision of federal information?
23. Have adequate safety nets been provided to ensure public access to government information?

Freedom of Information and Privacy Protection

24. Do the Privacy and Freedom of Information Acts adequately protect the public's right to know?

Secrecy, Security, and Protection of Federal Information

25. Do laws relating to secrecy and classification specify the only types of protected information?
26. Does a unified policy framework cover protected information?
27. Will restrictions on scientific information enhance the economic competitiveness of the United States?
28. What criteria should be used in restricting public access to government information, and in what situations or circumstances are such criteria appropriate?
29. "Do electronic communications links between agency databases and members of the public intended for acquisition or release of information increase the likelihood of unathorized access to information possessed by the agency? Second, does keeping information in electronic form make it more likely that agencies will make errors in screening information in response to FOIA requests, thereby failing to afford the protections contemplated by the exemptions to the Freedom on Information Act or by the Privacy Act? Third, do such systems increase the possibility that information could be lost, because of transmission errors, accidental erasure, or deterioration of electronic media?" (p. 263)[b]

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[a]Adapted from P. Hernon and C. R. McClure, *Public Access to Government Information*, Ablex, Norwood, NJ, 1988, p. 31.

[b]H. H. Perritt, "Electronic Acquisition and Release of Federal Agency Information: An Analysis of Recommendations Adopted by the Administrative Conference of the United States," *Admin. Law Rev.* **41**, 253–314 (Summer 1989).

ECONOMICS OF GOVERNMENT INFORMATION

It might be useful to expand briefly on two issues identified in Table 2. The first, the economics of government information, questions "to what extent should federally provided government information be considered as property or as a public good?"

A key philosophical issue is the degree to which government information is one or the other. "There can often be sound economic reasoning on both sides of any dispute over property rights, and property rights in information [policy] are no exception" (*83*). For-profit organizations regard government information as a commodity to be bought and sold in the marketplace. As such, the marketplace determines the value and cost information. Furthermore, the cost of providing value-added enhancements should be passed along to the users (*84*).

The view that government information is a public good holds that because the public supported the collection and organization of the information either through direct participation or the payment of taxes, the public, as a whole, should have access to and use of the information. This view assumes that any restriction on the public's ability to identify, access, and use this information reduces overall societal "progress" and productivity.

Both positions make assumptions about the importance of government information for national progress, the potential for selling the information, profitability of the information, rights of the public regarding the information, and responsibility of the government to encourage the maintenance of an informed electorate. Clearly, the production, organization, and delivery practices that result from each position differ. However, the notion that information is a "capital resource," that is, provides future investment for the market and is a public good, offers common ground between the two divergent positions.

Intellectual property law in the United States generally applies to patent, copyright, and trademark protection. Rooted in the Constitution, that law permits the federal government to grant intellectual property rights as inducements for authors and inventors to create and offer intellectual works. Although technology is changing a number of roles that people perform, "attitudes about intellectual property protection may vary accordingly" (*85*). Compounding the problem, the legal framework must now apply to *all* types of intellectual works, from printed publications to computer software and electronically distributed data and information.

Decisions regarding intellectual property rights have economic, political, social, and personal implications. The decisions may also shape lifestyles and patterns of information use. Clearly, the law must recognize information as both a commodity and a public good.

One issue involving copyright relates to works that federal contractors produced for compensation. Some argue that contractors should not profit from the commercial publication of their works. Others maintain that, under certain conditions, agencies commissioning works can return the report to the contractor, once they have received whatever information they needed. The advantage of commercial publication is that the work might reach a larger audience than a government publication would. The commercial publication might enter the mainstream of the literature of a discipline, profession, or field. Accessibility and availability are enhanced. In brief, intellectual property rights, like most information policy issues, are complex and not easily resolved, especially when different stakeholders cannot reach a common ground as the basis for a new policy.

PUBLIC ACCESS TO (AND AVAILABILITY OF) GOVERNMENT INFORMATION

A central question is "What federal information does the government have a responsibility to make accessible and available to the public?" Hernon and McClure note that "government information is a broad term that emcompasses both published and unpublished information that...government either does or does not intend to make public" (*86*). Public information encompasses that which a government agency chooses to make available on its own or the courts force it to release. In contrast, private information is intended solely for internal use within government. There is a gray area between public (released) and private (protected) information. The availability of information in the gray area would be determined through the FOI Act, the Privacy Act, judicial review, etc. Clearly, the definition of key terms should be an important component of information policy. Where terms are not well defined, agencies have broad latitude in their execution of a policy.

There are numerous instances where certain types of information are available from one federal agency but not another, and perhaps at a different cost. Numerous writings underscore that no segment of the government should unilaterally determine what information to make publicly accessible, how that information will be made available, and who will receive it. If government alone controls these determinations, more information will become privileged and available selectively, if at all (*87*).

Another question is "What is the role of depository library programs in the government's provision of federal information?" The federal government currently operates a number of depository programs including, among others, those of the GPO, the Bureau of the Census, the Patent Office, Geological Survey, National Oceanic and Atmospheric Administration, and the Department of Energy. There is minimal coordination among these programs, in terms of the types of source material distributed and the specific missions, goals, and objectives guiding the provision of this material.

Many federal agencies consciously and unconsciously ignore the GPO's depository program and do not make their publications available through it. Various waiver provisions in sections 501 and 504, Title 44 of the *United States Code*, provide a means historically whereby agencies have bypassed the printing and distribution of copies for depository libraries.

A current issue relates to the extent to which agencies should and will provide electronic information to depository libraries. According to a recent ruling by GPO's legal counsel, agencies must deposit electronic information issued in the form of a publication (*88*). A key issue focuses on how this ruling will be written into public law and the extent by which agencies will comply.

Policy Framework

At the federal level of government, information policy may be made in a variety of ways and prescribed in a number of different forms. The prescribed way for Congress to establish information policy is largely through the constitutionally specified legislative process. A member of Congress formally introduces a proposal in the form of a bill or a joint resolution. Usually the measure is one endorsed by the member, but legislation can be offered "on request" on behalf of the President. Ideally, the proposal is referred to the appropriate committee of jurisdiction; given a hearing, where public comment is received; marked-up in accordance with committee wishes;

reported to the floor; and voted upon by the chamber membership. After the other House of Congress completes similar action on the measure or on one nearly like it, a conference committee may be necessary to resolve differences in the two adopted versions. After both Houses have agreed to the single compromise bill, the proposal is presented to the President for signature. When signed into law, the measure attains the status of being a statute and, usually, is position within the *United States Code*. If it is vetoed by the President, the Congress has an opportunity to override and, if successful, the measure becomes a statute.

There are, however, other techniques and procedures available to Congress for setting policy. Within its own domain, the two Houses of Congress adopt rules and standards which constitute policy. In 1980, for example, the Senate adopted a simple resolution which changed the rules of that body so as to increase public access to its archived records (*89*). A similar reform was instituted in the House of Representatives in 1989 with the adoption of a simple resolution amending the rules of the House for the 101st Congress (*90*). Committees of the House and Senate set rules for themselves which constitute information policy. For example, many committees have a rule on how security classified or other sensitive information is to be handled and maintained.

Congress also appropriates funds for the departments and agencies. This fiscal authority can be directly and indirectly used to set policy. A generous appropriation for an information program may be accompanied by a verbal understanding or committee report language concerning the operation and/or expansion of the program in question. Similarly, funds may be denied or withheld for a program. Moreover, a permanent prohibition may be instituted through the appropriation process (*91*).

Finally, policy may be set through informal but, nonetheless, documented agreements. A powerful committee chairman may ask an agency head to conduct some information operation in a particular way; the verbal agreement, extracted at a hearing, is captured in the transcript of the proceeding. In the same regard, an exchange of letters may be used to set policy. For example, shortly after President Kennedy assumed office, the chairman of the House Subcommittee on Government Information wrote to him asking for an explanation of how "executive privilege" would be invoked by his administration. By return letter, Kennedy pledged he would exclusively exercise this power and would assume personal responsibility for its use. A similar exchange of letters and response occurred with Presidents Johnson and President Nixon's occupancy of the Oval Office. Sometimes, of course, a record documenting an informal agreement setting policy may be difficult, if not impossible, to locate. Furthermore, sometimes no such record exists.

The federal courts also make information policy. When a judicial decision is rendered on a dispute, it may uphold the status quo or modify an existing policy at issue. Moreover, in writing an opinion on a decision, a judge or judges may offer views or prescribe a procedure which assume a policy character. For example, law professor Robert Vaughn's FOI Act lawsuit to gain access to Civil Service Commission evaluations of certain agencies' personnel management programs and other similar reports prepared by the Bureau of Personnel Management resulted not only in a ruling in his favor, but also inaugurated agency creation of an index that would enable courts to facilitate reference to particular portions of documents and to know the exact exemption being relied upon by the government for each controverted section of a document at issue. Such an index allows a requester to better prepare arguments for the disclosure of sought records. An agency must identify specific portions of disputed documents that are being exempted from disclosure and must justify in detail the reasons for protecting particular information under certain exemptions (*92*). The FOI Act, in particular, has been subject to a considerable amount of such judicial gloss.

Courts and individual judges also enjoy a considerable amount of authority for setting information policy for their domains. Federal court rules, practice, and procedure, not inconsistent with legislative enactments, have the force and effect of statutes, but any such rule inconsistent with a statute is inoperative. The Supreme Court promulgates rules for itself and the separate lower federal courts (*93*). These are for the general guidance of the courts. However, since the individual Courts of Appeals in their circuits and Federal District Courts throughout the country encounter special local conditions and circumstances, they are empowered to make their own special rules, not inconsistent with the rules of general application set down for them by the Supreme Court (*94*). Furthermore, within all of these rules, presiding trial judges have some latitude to control information (e.g., issue a protective order, seal documents, or perhaps close a portion of a proceeding). Such actions may be viewed as policymaking; their significance will vary depending on their public effect.

Judical opinions, once filed, are publicly available at least in typescript at the court house of the authoring judge(s). Some judges, however, may be slow to file their prepared views. Commercial publishing firms obtain these opinions and produce various compilations, including the well-known *Federal Reporter* and *Federal Supplement* series. Supreme Court opinions, while also available in commercially published form, are produced by the GPO in the *United States Reports* series.

Within the Executive Branch, information policy may be prescribed through a wide variety of forms emanating from the Oval Office, an agency fulfilling a government wide responsibility, or an agency serving only its own personnel. In the first category, the President may set policy through the issuance of a directive, such as an executive order or a national security decision directive, a letter, a memorandum, or simply an announcement. In almost all cases, such policymaking cannot conflict with statutory expressions and is of an administrative nature and internal to the government. Occasionally, however, the President may exercise some constitutional authority (e.g., Commander in Chief powers) resulting in policy expression in conflict with congressionally legislated policy. Some speculate, for example, that one of the reasons why Congress has not directly legislated information security classification policy, except in very specific program areas, is that the President has the prerogative in this field by virtue of being constitutionally Chief Executive and Commander in Chief. Conflicts between a congressional and a presidential policy expression are sometimes settled by the courts, but are oftentimes left to political settlement.

Government-wide policy on a matter may be set by a particular agency. For many years, OMB, and the Bureau of the Budget before it, has issued circulars, announcements, and guidelines on a variety of fiscal and administrative matters. The Privacy Act of 1974 authorized OMB to issue government wide guidance and regulations for implementing the statute (*95*). Similarly, the 1986 amendments to the Freedom of Information Act mandated OMB issuance of a uniform schedule of fees for all agencies (*96*). The FOI Act does not, however, require the Department of Justice to issue any guidance on the statute. Nonetheless, an interpretive memorandum on the original law was issued in 1967, followed by supplemental memoranda on FOI Act amendments in 1975 and 1987. Moreover, in the aftermath of the 1986 amendments, the Department also produced new fee waiver policy guidance. These interpretive materials have been somewhat controversial not only because Congress did not legislatively mandate them, but also because of the questionable views they have offered. Indeed, it is expected that any such guidance will not conflict with the statues being interpreted and will otherwise be a faithful explanation of legislative intent. As the legal arm of the Executive Branch, the Department of Justice may also express policy through formal legal opinions of the Attorney General or the Office of Legal Counsel/Office of Legal Policy, which may be consulted in periodically published collections of each series.

The prevailing executive order on security classification policy and practice establishes a government-wide coordinating and monitoring entity—the Information Security Oversight Office—for these matters (*97*). This agency has issued a government wide directive implementing the executive order (*98*).

Finally, each individual agency produces forms of policy. Again, the expectation is that these agency expressions of policy will not conflict with statutes or other superior policy forms, such as a presidential directive or government wide guidance. Agencies issue regulations implementing and interpreting statutes and presidential policy instruments, internal administrative orders and directives governing their organization and operation, and staff manuals, such as security classification guidebooks, all of which contain expressions of policy. Most agency regulations can be found in the *Code of Federal Regulations*. New regulations and some other agency orders and directives are published, when first issued, in the *Federal Register*. Nonetheless, some of this material is unpublished and fugitive. For example, agency general counsel opinions and interpretations, which can set policy, are not readily available to the public in a reference series.

Stakeholders Affecting Information Policy

Given the impact of information policies on many facets of one's work and nonwork situations, a listing of stakeholders involved in policy formulation and review would be endless and unproductive. For issues of concern to library and information science, stakeholders tend to include professional associations, government agencies, and the private sector. This section highlights two different associations and shows a difference in approach to information policy issues.

AMERICAN LIBRARY ASSOCIATION AND INFORMATION INDUSTRY ASSOCIATION: A STUDY IN CONTRASTS

The American Library Association (ALA) has produced a policy guide expounding principles and aspirations (*99*). The ALA also has a strategic, long-range planning document that briefly highlights goals and strategies for their accomplishment (*100*).

In contrast, the Information Industry Association (IIA), established in 1968 and representing approximately 760 companies (ranging from traditional electronic publishers to telephone and computer companies), has also articulated general principles, including some relating to public and private sector competition (*101*). In addition, the IIA has a summary list of major policy issues on which the Association has taken a position (*102*). A "Friday Memo" provides the membership with access to current reports, letters, announcements, and memoranda on issues deemed vital to the Association.

The different approaches of these two interest groups in articulating policy issues became evident most recently during negotiations over reauthorization of the Paperwork Reduction Act. The IIA identified its position, as did other interest groups, and negotiated over provisions in both the House and Senate bills. In contrast, the ALA preferred to espouse general principles, condemn the "information dissemination" section of the House bill, and not to regard itself as a stakeholder with a position to advance and protect. Only through the efforts of different groups serving as an honest broker did the library community start to formulate a position. Clearly, the library community found it difficult to participate in the political "give and take" and to back away from wanting an ideal bill.

This example underscores that information policy is subject to the political process. All of those involved in influencing policy formulation must be willing to compromise and to court policymakers.

Government Information Safety Nets

OVERVIEW

In the mid-1980s, OMB, the congressional Joint Committee on Printing (JCP), and various writers associated the concept of a safety net with government information policy. For example, OMB's Circular A-130 referred to the depository library program administered by the GPO's as "a kind of information safety net" (*103*).

A safety net refers to a kind of insurance, a device to cushion the impact of a fall by a person walking a high wire or performing on a trapeze. In a political context, the concept of a safety net protecting the public probably dates from the New Deal and the desire of the Roosevelt administration and Congress to guarantee a minimum standard of living, to reform financial practices, and to protect the public through old-age pensions, unemployment insurance, etc. The Johnson administration, with its vision of a Great Society, expanded the role that government played in managing the economy and improving the overall condition of (and opportunities for) the American people.

National discussion of a safety net has focused on both economic issues and social welfare. The policy literature suggests that there are various safety nets for separate segments of society that could "fall" (e.g., for child welfare, education, low-income and poverty, pensions and old-age assistance, and health care).

The concept of a safety net underscores a fundamental question: "What is the *basic* responsibility of government and society to assist the 'truly needy,' those experiencing difficulty in caring for themselves?" A safety net maintains power balances among the branches of government, helps people, and ensures that governmental policies and practices are equitable. Fiscal retrenchment, record federal deficits, and a political philosophy advocating less federal intrusion into state and local activities have had an undeniable impact on society's willingness to support certain safety nets. It seems that both government and society are now questioning their ability to support a number of safety nets at the same level of commitment provided in the past.

EXAMPLES

The FOI Act and GPO's depository library program are the most frequently mentioned government information safety nets protecting the public's right to know. OMB, the JCP, and various authors have referred to the depository library program as an information safety net guaranteeing that the public has a minimal level of access to government publications/information. The adjective *minimal* is the key qualifier. A recent paper substituted a different qualifier—adequacy (*104*). Clearly, the policy literature does not regard safety nets as comprehensive channels for the provision of government information.

If the depository library program comprises one safety net serving in minimal capacity, what are the complementary ones that, together, ensure the public has access to *all* publications and information products labeled as public information or as falling within the gray area?

Toward National Information Policy

ORIGIN OF THE TERM

In July 1976, the U.S. Domestic Council submitted a report, *National Information Policy*, to President Gerald Ford. The principal recommendation was that "the United States set as a goal the development of a coordinated National Information Policy . . . that is comprehensive, sufficiently sensitive to new technology, and responsive to the implications of the Information Age" (*105*). The report advocated a unified approach to information policy coordinated in the Office of the President. That approach never materialized.

THE CONCEPT

Discussions of information policy have encouraged the development of a "requisite arterial system" for "the free and equitable flow of all nonproprietary, nonconfidential information to each individual, regardless of location, level of comprehension, economic status, or other circumstances" (*106*). Such discussions focus on national information policy, but for either government or nongovernment information. Rarely, has such policy been viewed as a marriage of all information resources, be they government or nongovernment.

Many writers have considered the terms national, federal, United States, congressional, and Executive Branch information policy as synonymous (*107*). Of course, U.S. government policies have national and international ramifications. The Paperwork Reduction Act of 1980 (P.L. 96-511) created a climate whereby the three branches of government profess a common goal; reduction of the federal paperwork burden and the effective and efficient management of government information resources. Various policies therefore may have government-wide implications (or create the impression that they do).

Brinberg recognizes a hierarchy in information policy and has a vision of a national information policy articulated by the President and his advisors. His vision, however, is largely technologically oriented; there should be both a national communications network and standard protocols. National policy, he maintains, is shaped largely by the administration and congressional leadership (*108*).

FOUNDATION OF NATIONAL INFORMATION POLICY

The Glenerin Declaration is a trinational statement emanating from the U.S. National Commission on Libraries and Information Science, the British Library, and the Canadian Institute for Research on Policy (*109*). The Declaration, in effect, might be a preamble for national, or international, information policy that recognizes the impact of information on national economies and societies. The policy might also articulate an agenda of issues, initiatives, and strategies for achieving the marriage of all information resources.

Briefly, national information policy conveys a sense of national purpose and represents guiding principles leading to the integration of all publicly available government information in the United States, regardless of the level of government producing that information. Moreover, that integration combines government and nongovernment information, extends bibliographic control over that information, and produces mechanisms (i.e., safety nets) for gaining effective and efficient access to that information. In contrast, federal information policy has the force of law and variously binds the federal government to prescribed courses of action.

One purpose of national information policy is to improve coordination among safety nets and to bring pertinent government information resources produced in the United States to the resolution of various information needs. Of course, national information policy might have another component: the identification of significant foreign source material that, for example, will lead to a U.S.-based patent or scientific breakthrough. National information policy should encourage differentiation between quantity and quality of information and discourage the generation of information that merely adds to *information overload*.

Looking Toward the Next Century

If there is a single dramatic and profound factor of change in information policy at present and for the future, it is that information has both a civic and economic value.

For a long time, information policy has been viewed and formulated in a context of civil liberties and citizen rights in a democracy. This value will continue to be important, but is being joined by the somewhat competing factor of information having economic worth, particularly when government information is increasingly available in electronic formats which are attractive to information industry marketers.

The amount of data and information produced annually within and outside the United States is large and ever-increasing. While the quantity of data and information dramatically increases, so too does the usefulness of these data and information to diverse segments of the population. Information policy is crucial to national economic well-being and scientific discovery. This two applications receive extensive coverage in government literature.

The availability of information is no longer restricted by national barriers. Furthermore the free market is expanding and geopolitical structures are undergoing radical changes. As a result, many policies have broad implications. Local libraries and information centers operate within this broad framework. That framework shapes what information is available, in what forms, at what price, etc. Clearly, libraries can play a part in revitalizing U.S. competitiveness in world markets. However, they have other charges as well. The result is that a host of current and potential policy issues have direct and indirect implications for library and information science. It is important that these issues be identified and that that the discipline and profession of library and information science work out strategies to protect the role of libraries and information centers as safety nets providing their publics with more than minimal access to information products and services of a local organization and community.

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JAPANESE TECHNICAL INFORMATION: ITS INFRASTRUCTURE

Introduction

The flow of technical information in a modern industrial country is anything but simple; this is especially true in Japan, a country where technology is highly advanced, where the number of items published annually is the second highest in the world, and where social and cultural influences vary substantially from those of other advanced nations. Describing the flow of information in Japan (i.e., analyzing the infrastructure of information) , is therefore a very complicated task.

A relatively small country in area, Japan has emphasized more than many other advanced nations the development of nationwide information networks to handle both primary (textual) and secondary (bibliographic) information. These information networks function as the backbone of the infrastructure of Japan's technical information flow and are central to understanding that flow. However, it should be noted that, in Japan, there is also an enormous amount of information produced which is not necessarily to be found in these sources or in regular commercial or other established channels (i.e., proprietary information). Much of this information is, in fact, of a secret nature. However, a considerable amount of this information is not restricted, but still one must look for it. This category of Japanese information is usually referred to as gray literature, or nonconventional literature. Some early observations on the current state of this gray literature are vital, for gray literature plays a significant role in Japan, especially in the fields of science and technology.

It is also essential to understand that the pattern of technical information flow in Japan differs in significant ways from patterns found in other advanced countries because of Japanese society's unique structure and norms of behavior. It is therefore essential to have a basic understanding of some of the national characteristics which influence Japanese behavior and thought, and thus, information flow.

Some National Characteristics

Japan has for centuries been a national and government centered society, which facts are strongly manifested in its technological advancements. Not only in financial and political matters, but in many other aspects of academic, industrial, and commercial life the national government and the nominally private sector are very much interconnected. Indeed, without the approval and support of some agency of the government, it is very difficult for any individual or body to succeed in any major venture, including information research and development. The following also explains another aspect of a close relationship between governments and private industry (*1*):

> Private companies also employ various retired upper-echelon officials of government ministries and public corporations. These sometime officials, generally have enjoyed close contacts with the companies prior to retirement, and continue to play important roles in fostering and coordinating Government–industry relations.

Second among relevant national characteristics is Japan's traditional vertical social structure. Government institutions are relatively isolated from each other and from the private sector, except in narrow channels. Among government agencies, offices within one ministry are isolated from offices within other ministries. The same holds true in the private sector. A powerful company extends its umbrella over all its subsidiaries, benefitting each, but at the same time greatly limiting those subsidiaries' associations with the subsidiaries of rival companies. This social characteristic extends itself to the information sector. Information, especially technical information, tends to flow vertically. Information produced by a government agency is likely to stay within the agency and its parent offices of the particular ministry. Information produced by a university department typically will be available only to the faculty and researchers of that university or, perhaps, only to those at work in the department. Sometimes information may be made available to universities with the same standing; for example, to other national universities, to other formerly "imperial" universities, or to individuals in universities with which the information producer (i.e., a faculty member or a researcher) has special ties. Information produced by a private company, especially sensitive information, is very likely to stay within the company, but it is possible for other companies which are under the umbrella of that company to obtain the information. There existed in the past so-called Zaibatsu ("mega-organizations" or "clans"), the history of which can explain such a development of a group of relatively close companies which share profit and have mutual dependancy (*2*).

A third national characteristic is that much in Japanese society is exclusive, even rigid. A heavily populated country with poor resources, Japan has tried over the centuries to perpetuate societal values (and the independence of the country) by adopting this attitude. However, in recent decades Japan has become much more open to communication with other countries, in many respects more open to these external entities than to rival clans within Japan.

A fourth factor in understanding Japanese information flow is not related to Japanese social structure; the rapid development in the 1980s of Japanese character computers. When only Roman alphabet computer processing was readily available, machine-readable information (databases) tended to be produced only in English or in Romanized Japanese. Today, processing information in Japanese characters is no longer inefficient, and the Japanese are able easily to create databases *in Japanese*, which tends to limit access to the Japanese. This is obviously a factor influencing the flow of technical information to potential users in western countries, where advanced skill in or even knowledge about the Japanese language are still very limited.

Finally, another important characteristic affecting the flow of information in Japan is its copyright law. Unlike many other advanced nations, there is no requirement in Japan to submit copies of a publication to the national library (National Diet Library) to obtain copyright. Many publications therefore never reach the National Diet Library, and thus are not included in the various segments of the Japanese "national bibliography" compiled by the Library (*3*).

Primary Sources of Technical Information

In Japan, as elsewhere, technical information is produced in every sector, in government, both at national and local levels; in the academic community, both in national universities and in private colleges and universities; in semigovernmental/public entities; and in private industry. Many research projects, even if nominally nongovernmental, often are subsidized by various government agencies, if not contracted for by them. The generation and subsequent acquisition of the results of research projects is therefore often especially complex because of the Japanese government's vertical structure, as well as more regulations and controls than one finds in other nations.

NATIONAL GOVERNMENT RESEARCH AGENCIES

There are many national institutes and national laboratories in Japan which devote themselves to a wide variety of research projects related to the functions of their parent government bodies. The offices and ministries that produce the most technical information are the Prime Minister's Office; the Ministry of Education, Science and Culture; the Ministries of Health and Welfare; Forestry and Fisheries; International Trade and Industry; Transport; Posts and Telecommunications; Labor; Construction; and Home Affairs (*4*). Under the Prime Minister's Office, there are several agencies, such as the Defense Agency, which administer the National Institute for Defense Studies, and the Technical Research and Development Institute. Also under the Prime Minister's Office is the Science and Technology Agency, to which the National Aerospace Laboratory, the National Research Institute for Metals, and others report. Under the auspices of the above-mentioned ministries, are also numerous national institutes and national laboratories located all over Japan that are engaged in various scientific and technical research projects that produce technical information in enormous quantities (*5*). More information is produced in this sector than in any other.

A report of the results of each project undertaken by government agencies is created. These technical reports represent a category of gray literature, as they are not for sale and there is neither systematic bibliographic control of them nor systematic deposit in any library or archive of the reports themselves. A typical example of the way this information is managed can be found in the Agency of Industrial Science and Technology of the Ministry of International Trade and Industries. The Agency has many laboratories which produce numerous research project reports, including the National Aerospace Laboratory, National Research Institute for Metals, National Institute of Radiological Sciences, and National Institute for Research in Inorganic Materials (*6*). These entities do report the completion of research project results to the Agency's International Research and Development Cooperation Division, which, in turn, compiles an annual bibliography of the reports. However, very few of the reports themselves are retained in the Agency, reportedly for want of space. Since the division's bibliography is issued only annually, the timeliness of the information it contains is often questionable. However, when requested, the agencies will distribute copies of reports, while supplies last. Regrettably, many of these government reports are not submitted to the National Diet Library. Some Japanese researchers and librarians do consider this a serious problem and urge individual researchers and agencies to submit copies to the National Diet Library, though so far without much success (*7*).

In addition to project reports, each institute issues at least one and sometimes two serial publications, explaining current progress. Often these publications describe progress being made in such internal issues as automating a laboratory or review the highlights of current research projects. These serial publications are clearly an important source of information. In most instances, one can arrange to receive these serial titles on a regular basis, though "subscriptions" often are not formally taken.

LOCAL GOVERNMENTS: PREFECTURAL AND MUNICIPAL LEVELS

Local governments, mainly prefectural governments, perform research and related investigations in order to establish new policies (e.g., to change policies related to school-supplied lunches) or to prepare for a certain project, such as constructing a dam.

In many cases, local government projects are funded by appropriate national bodies, which require that the local governments report research results to them. Normally lists of the titles of the reports are compiled annually by the funding agencies, but the reports themselves very seldom are retained by the funding agencies. Some, of course, are submitted to the National Diet Library.

Most local governments have no means of bibliographic control of their reports and many reports are not systematically retained even in local government offices once a project has been completed. It may be that even when local government reports are expected to be retained, they are easily lost or become impossible to retrieve from masses of paper, for want of bibliographic control. The frequent reorganization of government offices and promotion of government officers do not help the situation, since knowledge of the disposition of a particular report frequently rests with the official who handled it at the time of its receipt.

At times, local governments commission private research institutes, which specialize in various types of investigations, actually to perform research. In these cases, the reports are prepared by the private research institutes and submitted to the local governments, but are usually retained as company property and often are maintained there under excellent (internal to the company) bibliographic control. However, it is very difficult to gain access to such documents or even to the bibliographic apparatus within which they are described. The institutes almost always maintain the attitude that it is not within their authority to distribute freely or make available such information without the contracting agencies' permission.

SEMIGOVERNMENTAL/NONPROFIT ORGANIZATIONS

The most active semigovernmental or, officially, nonprofit public organization in technical research is Nippon Telephone and Telegraph (NTT), whose research in the areas of telecommunications and general communication is more advanced than that of any other organization. NTT has its own laboratories, which are counterparts, in effect, of the Bell Laboratories in the United States. The NTT laboratories produce many research reports, about which little information is routinely provided: It is not easy to gain access to them. One *can* obtain a considerable amount of information on NTT's activities by attending NTT's annual exhibition, where it is possible to obtain brochures, study sample equipments, and even operate models of related equipments. However, attendance is usually very limited, indeed it is by invitation only.

RESEARCH PROJECTS ASSISTED BY NATIONAL GRANTS

Various ministries administer research grants in various formats. The best known are the Science and Research Grants-in-Aid administered by the Ministry of Education, Science and Culture. The grants-in-aid program supplements university research allocations for individual faculty members, as well as supporting research project teams in academic and research institutions (*8*). Grantees must file a report annually—when the project funded spans more than one year. Though the reports are physically retained in the Science Information Division of the Ministry, the general public does not have access to the Ministry's collection. All of these reports are submitted to the National Diet Library, where they are available to the general public.

Other grants are given by the Ministry of Health and Welfare to aid scientific research promoting medical science and technology or by the Ministry of International Trade and Industry which aid research and development of important industrial technological concepts (*9*).

DOCTORAL DISSERTATIONS

Though most doctoral degrees conferred in Japan are in the field of medicine, Japan has recently seen an increase in the number of doctoral degrees in the fields of science and technology.

Many theses are not found in university libraries, contrary to the typical practice in the United States, where the library of the degree-conferring university generally holds one or more copies of theses accepted. In Japan, some, but by no means all, copies are submitted to the National Diet Library. At least one copy of each thesis is retained in the so-called Kyoshitsu (literally 'class-room" the designated study room and, therefore, also the designated unit for a group of researchers within a particular discipline) of the degree-conferring department of a university.

PROCEEDINGS, PREPRINTS, AND YOKŌSHŪ OF PAPERS PRESENTED AT ACADEMIC CONFERENCES

Normally, when papers are presented at a national or international conference, proceedings are issued. But in the case of many other academic conferences and study group meetings in Japan, proceedings often are not issued, and even when issued, the papers included are only a selection and are often in an abstract form. Thus preprints and "yokōshū" play a very important role. A yokōshū is an advance abstract of a paper to be presented at a conference. It is customary to prepare yokōshū approximately three weeks in advance of a conference. A yokōshū was typically two to three pages in length, but it is now usually only half a page long, because of the proliferation of papers presented (in recent years there were more than 3,000 science and technology papers presented during the fall conference season), such that the quantity of yokōshū had become unmanageable. It should be noted that yokōshū are written *before* conferences are held, and their contents at times may be quite different from what is actually presented at meetings. Yokōshū often include a presenter's expectations or plans, and the actual research may not reach completion by the time of the conference. When obtaining yokōshū at conferences, it is important to check their contents against actual presentations.

Normally, preprints and yokōshū are distributed only to conference participants and at study group meetings. Few copies beyond the number needed by the expected attendees are printed, and if one misses this opportunity to acquire copies, they are difficult to obtain later. Some associations will distribute copies of preprints to some universities and institutions by prearrangement. Indeed, one of the best ways to learn about the progress of a particular academic discipline in Japan is to serve as a secretary to the association in that discipline, thus taking responsibility for coordinating conferences and so giving oneself an opportunity to read all papers submitted, including those not selected for presentation. It is also possible, of course, actually to send a representative to conferences to obtain copies of distributed materials.

Since researchers and scholars are evaluated by the quality of the papers presented at conferences, the information presented is presumably up to the minute and of potentially great value to others at work in the field.

BOOKS AND JOURNALS IN SCIENCE AND TECHNOLOGY

The number of Japanese researchers and scholars in science and technology who publish their research results in international or foreign academic and research journals is increasing, especially when the research has notable international interest or application. In Japan, publishing research results in established journals in a particular field is considered less notable than presenting papers at academic conferences. There are 9569 journals in science and technology in Japan listed in *Nihon Kagaku Gijutsu Kankei Chikuji Kankōbutsu Mokuroku*, 1984 (*10*). Many are published by academic societies, and articles usually appear within a much shorter time than they do in the United States. However, the journals of some academic societies are published in limited numbers and it is difficult to obtain subscriptions to them unless one is a member of the society.

As elsewhere in the advanced world, information found in books is often more substantial, but takes longer to appear in print.

TECHNICAL REPORTS

In Japanese academic society, scholars and researchers are evaluated with more attention on papers presented at academic conferences, as mentioned above, than on publication in established journals. Even less attention is paid to the publication of research results in technical reports, which helps to explain why technical reports are fewer, and why their content is less substantial than is the case in the United States.

A comprehensive study by Yuiko Teramura of the National Diet Library describes the status of technical reports in Japan as of 1974 (*11*). According to Teramura, the fields which produced the greatest number of technical reports then were as follows, in order of the number of reports produced: Nuclear engineering (9 institutions), 15 reports; physics (5 institutions), 10 reports; electrical engineering (6 institutions), 9 reports; and aerospace engineering (4 institutions), 6 reports (*12*). Teramura also points out that the reason for the scarcity of technical reports in Japan is partly because much of the available government research funds are given to supplement academic research and less money is allocated for other research contracts.

All technical reports fall within the category of gray literature, in other words, none of them is for sale. Their distribution is very limited, typically to government offices, academic and research institutions, academic associations, and private research institutions that are engaged in related areas of research. A limited number of reports are distributed to individuals or to institutions in other countries. Most are usually distributed to individuals only on request, and while the supply lasts. Some reports are distributed solely by their authors. The most serious obstacle to obtaining technical reports is their poor bibliographic control. There is no comprehensive listing or bibliography of technical reports, and the percentage of technical reports included in the following three major compilations is fairly low: *Nihon Kagaku Gijutsu Kankei Chikuji Kankōbutsu Mokuroku (Catalog of Japanese Serial Titles in Science and Engineering)*, 68%; *Nihon Shizen Kagaku Zasshi Sōran (Comprehensive Bibliography of Japanese Serial Titles in Natural Science)*, 52%; and *Nihon Kagaku Gijutsu Jōhō Sentā Chickuji Kankōbutsu Shozō Mokuroku (Catalog of Serial Titles in Japan's Information Center of Science and Technology)*, 43% (*13*).

PRIVATE RESEARCH INSTITUTES

Since the 1960s, Japan has experienced the birth of many private research institutes. Approximately 100 private research institutes exist as of the late 1980s, and the most progressive are those in the field of finance and marketing. Almost as progressive are those which engage in research in science and technology. Most private research institutes were originally established to perform investigations, to search out existing information, or to engage in research projects for groups of companies under the umbrellas of large parent companies from which the institutes originated. Most of the institutes developed only later as independent research institutes. Among these institutes are Mitsubishi Sōgō Kenkyūjo and the Asahi Research Center, relating to the Mitsubishi group and Asahi Chemical Industry, respectively. In the case of Mitsubishi Sōgō Kenkyūjo, the research it performs is in the following proportions: approximately a third is for the companies in the Mitsubishi group, a third is for government agencies, and a third in response to requests from others in the private sector.

Research project reports are in general submitted only to the requesting organizations with no further distribution. Some institutes do make their research results available for sale; but usually charge a very high fee, sometimes as high as 50,000 yen per item.

Some institute-sponsored journals specialize in the areas in which the parent organizations concentrate, and their information should be regarded as valuable. For example, *Nikkei High Tech Report: The Journal of Japanese High Technology for Marketing, Research and Planning*, an English language biweekly journal published by the Nikkei Industry Research Institute, publishes news about developments in Japanese technology, especially in industrial settings.

PRIVATE INDUSTRY

Research results originating in private industry usually are classified, and access to reports resulting is difficult, even for Japanese government officials. There can be no reliable estimate of the number of documents in this category. Other materials, such as manuals, specifications, gihō, etc., are available from individual companies upon request. There are two contrasting opinions about this: Many Japanese think that any reports that are freely distributed cannot be very useful technically, whether because of the age of the data, because of the accuracy of detail, or because of the general quality of the contents. Researchers in other nations, especially the United States, usually think that documents of this kind contain useful information. And, in truth, gihō, translated literally as "technical reports," do give information that is sometimes important for certain purposes, but not usually, as Japanese correctly judge, vital or relevant to core research. The common feeling among Japanese is that gihō, which are usually beautifully printed, are of public relations value only. In effect, they report what is being done but not *how* it is being done.

Secondary Sources of Technical Information

NATIONAL BIBLIOGRAPHIES/JAPAN MARC

Nihon Zenkoku Shoshi, Japanese National Bibliograpy Weekly List (Tokyo: National Diet Library)

Nihon Zenkoku Shoshi Furoku—Shōsasshi no Bu, Japanese National Bibliography Supplement—Pamphlets and others (Tokyo: National Diet Library)

Nihon Zenkoku Shoshi Furoku B—Chikuji Kankōbutsu no Bu, Japanese National Bibliography Supplement B—New Serial Titles (Tokyo: National Diet Library)

The titles included in these three bibliographies are those submitted to the National Diet Library and therefore, as mentioned earlier, do not represent an exhaustive list of Japanese publications, because many publications are not submitted to the National Diet Library. Nonetheless, taken as a whole, these bibliographies comprise the most comprehensive listing of Japanese publications covering all areas of knowledge. The National Diet Library does make an effort to include citations to gray literature, especially to technical reports, in these bibliographies. There is a chapter called "Kankōchō Nōnyū no Bu" (Section for Items Submitted by Government Agencies), and many listings of unpublished governmental materials can be found here.

Japan MARC is a database analog to the first bibliography mentioned above, and is distributed internationally by the National Diet Library. It is counterpart to LC MARC or UKMARC.

Nihon Kagaku Gijutsu Kankei Chikuji Kankōbutsu Mokuroku (Catalog of Japanese Serial Titles in Science and Technology) (Tokyo: National Diet Library). Serial titles will appear in *New Serial Titles* before appearing here. Information is also input into a machine-readable file, which is not available for public use.

There are many other important bibliographies of which the following two must be mentioned.

Kagaku Gijutsu Bunken Sābisu (Science and Engineering Literature Service (Tokyo: National Diet Library). This quarterly journal introduces materials acquired by the National Diet Library, and describes information activities, both national and international, and activities in the National Diet Library relating to science and engineering.

Kagaku Shōhō: Abstracts of Japanese Chemistry (Tokyo: JAICI Japan Association for International Chemical Information). A biweekly journal of abstracts from approximatley 118 periodicals in the fields of chemistry and chemical engineering, the journal covers 90% of the important Japanese literature in these fields. Abstracts are published approximately seven weeks after the release of original journals, and most of the abstracts are also issued in English.

NATIONAL BIBLIOGRAPHIC INFORMATION NETWORKS

Two major national bibliographic information networks make up the core of Japanese technical information activities: the Japan Information Center of Science and Technology, commonly referred to as JICST, and the National Center for Science Information System, abbreviated as NACSIS. Each plays a different role in the distribution of technical information without much overlapping.

Japan Information Center of Science and Technology (JICST)

JICST is an agency of the Science and Technology Agency (STA), located in Tokyo (*14*). It collects science and technology journals published in Japan, and produces indexes and abstracts, both in print and online. The printed formats include SDI services and news bulletins such as *Kagaku Gijutsu Bunken Sokuhō*, which are also available in microform. However, online services are quickly becoming JICST's major functions. JICST online services provide ready access to its databases: JOIS (the JICST online information retrieval system), e.g., JOIS-II and JOIS-III, which cover JICST's own databases, three Japanese industries' files, and files from foreign countries, including files MEDLINE, BIOSIS, and INSPEC. The important files concerning Japanese technical information are the JICST Kagaku Gijutsu Kenkyū Johō Fairu (Science Technology Research Information File), and the Kōkyō Shiryō Fairu (Public Resources File), which consists mainly of listings of known technical gray literature titles produced in Japan.

Other JICST services are the JOIS-F fact databases, which include the JICST chemical dictionary database, JICST thermophysical and thermochemical property database, and the JICST mass spectral databases.

JICST was one of the first agencies successfully to use Japanese character computers, and therefore, JICST's major files of journal indexes and abstracts (e.g., the above-mentioned JOIS) are in Japanese, with some files in English. The files are made available through JICST's own computer network throughout Japan. Eight branches located throughout Japan function as nodes, with clusters of computers in smaller cities providing access to files. Private companies can obtain dial-access to JICST files directly, as well as through local nodes. JICST makes its online files available to other, mainly Asian, countries.

Additionally, JICST publishes journals such as *Kaigai Gijutsu Hairaito*, which highlights foreign technology developments, and *Jōhō Kanri (Information management)*. JICST provides a copying service for requested articles and a service which translates foreign language articles into Japanese. JICST functions, in fact, cover all aspects of information activities. JICST recently added a new facility, Tsukuba Shiryō Sentā (Tsukuba Resource Center) in Tsukuba Research City, to provide storage space for the rapidly increasing number of journals and to process numerous requests for photocopies of articles.

JICST recently became the third member of STN International, the Scientific and Technical Information Network, the first and second members being the Chemical Abstracts Service (CAS), Columbus, Ohio and Fachinformationszentrum Energie, Physik, Mathematik GmbH (FIZ Karlsruhe), Germany. JICST's participation in STN International is significant for the world of information activities because it will speed the flow of Japanese scientific and technical information to European countries and the United States. It is important to mention that in the mid 1980s the Japanese government began to request that many semigovernmental institutions be privatized, as a consequence of which the privatization of JICST is being considered, as is making JICST a self-supporting institution.

JICST is often compared with Chemical Abstracts Service in the United States. The role JICST plays in the technical information flow of Japan is similar to that played by Chemical Abstracts Service in the field of chemical information, but obviously covers a wider range of literature. JICST is the most concentrated and largest technical information supplier in Japan.

The National Center for Science Information System (NACSIS)

NACSIS is an agency of the Ministry of Education, Science and Culture, also located in Tokyo. NACSIS's ultimate purposes are: providing an online cataloging system; database construction; providing an information retrieval service; performing research and development in information activities; and providing communication utilities (*15*). NACSIS's primary function of providing an online cataloging system is very similar to that of broad-based bibliographic networks found in other countries, such as the OCLC Online Computer Library Center in the United States. It is truly a national bibliographic service, of which the core of its bibliographic database is Japan MARC, LC MARC, and U.K. MARC. In contrast to JICST, which collects and retains source information such as journals and reports, and which is a database producer and distributor, NACSIS's main databases are catalog records of Japanese, U.S., and British national libraries' holdings, thus giving access only to secondary information. Member institutions catalog their own books using available bibliographic information or input their originally cataloged records into NACSIS's database, thus instantly making the records available to other member institutions, and at the same time, contributing to what is, in effect, a national union catalog.

In addition to providing an online cataloging system, NACSIS creates its databases for online information retrieval, though the major databases it serves at present are science and engineering databases created in the United States. NACSIS created in the late 1980s three databases of its own which will play an important role in the future systematic distribution of information about the gray literature of Japanese science and technology. The databases are the Gakui Ronbun Sakuin Dēta Bēsu (the dissertation abstracts database), the Kagaku Kenkyūhi Hojokin Kenkyū Seika Gaiyō Dēta Bēsu (abstracts of reports of science research grants-in-aid database), and the Gakkai Happyō Dēta Bēsu: Dai Ikkei (conference papers database: the first group) (*16*).

The Japanese dissertation abstracts database contains abstracts of theses for doctoral degrees conferred in Japan. The dissertations listed in the abstracts are those which are reported to NACSIS, which accounts for 134 out of approximately 160 doctoral degree-conferring universities. Being the first of its kind in Japan, this database plays a significant role, especially because the number of degrees conferred in science and technology is increasing. As of April 1988, the database contained 21,350 entries, with an annual increase of about 8,000 titles expected. NACSIS does not actually collect the dissertations themselves, but depends on the lists each institution supplies to it. Copies of the dissertations are submitted to the National Diet Library.

Equally important is the database of abstracts of the reports on the results of research funded by the Science Research Grants-in-Aid, administered by the Ministry of Education, Science and Culture since 1985.

The database potentially of the most significance to understanding the flow of science and technology information in Japan is the Gakkai Happyō Dēta Bēsu: Dai Ikkei, a database of preprints and yokōshū of papers presented at conferences held by six associations in electric and electronic engineering. These three databases are sources of information not otherwise easily obtainable. As these databases grow, they should smooth the flow of technical information within Japan.

At first, NACSIS's services were rendered mostly to national institutions of higher education because of administrative difficulties in establishing accounts for private institutions. Of late, NACSIS has extended its services to include private institutions, as was originally intended. This development is contrary to Japan's former practice of favoring subsidies to national universities and research institutions, thus introducing the potential for great change in existing patterns of information flow. NACSIS is still young (officially it took its current identity in April 1986) and the amount of information in any of its databases is not yet large. However, the increase in the number of participants and in the size of each database has been impressively rapid. Together, the NACSIS and JICST databases consolidate and make retrievable a large body of highly specialized technical information.

DATABASES: ACADEMIC AND COMMERCIAL

With the recent spectacular progress of technology for computers and data communications in Japan, noticeable growth has occurred in the number of databases and online services operated by government and nongovernment agencies. These databases include numerical, full text, and bibliographical or index-type information. Some are primary sources of information. All are discussed below.

In 1987, NACSIS investigated the current status of databases on science information created in academic and research institutions, in order to compile a comprehensive directory of databases on science information. NACSIS surveyed 492 academic and research institutions in Japan and received 758 responses (*17*). NACSIS plans to make the resulting directory available by creating an online file called the Data Base Directory (*18*). NACSIS found that the creators of these databases are mainly organizations, and a few are individuals and study groups. Most of the databases concentrate on physical science, with agriculture and multiscience disciplines occupying 62.7% of the total databases included. Of these there are 397 numerical databases (52.4%), 190 bibliography databases (25.1%), and 106 full text databases (14.0%) (*19*). Many are not openly distributed, and if they are, their distribution is limited to within a group or institution. Science and multiscience disciplines are more open than the areas of medicine and engineering. According to the survey, approximately half of the databases are open for external use. One reason for the exclusivity of medical databases is that they consist chiefly of individual clinical data and the privacy of patients is being protected. Some information is distributed in printed format.

Another important database directory which lists Japanese and other commercial databases is *Dēta bēsu daichō sōran (The Database Register), 1982–1985*, published by the Ministry of International Trade and Industry. It includes natural science and engineering databases, with these numbering 635, or 37.3% of the total (*20*). The directory lists 78.2% foreign databases. Of these, 427 are bibliographies (35.6%), which is a larger percentage than that of academic database collections; 378 full-text databases (31.5%); and 335 numerical databases (27.9%). The Ministry of International Trade and Industry supports a nonprofit organization called the Database Promotion Center which was established in 1984 to promote the development of domestic database services in Japan. The Center is expected to function as a clearing house of databases in Japan (*21*).

PATENT INFORMATION

Along with research publications, another essential source of technical information, especially important for the development of new technology and the expansion of product shares, is patent information.

Patent practice in Japan is quite different from that common in other advanced nations. Upon application for patent, the application is given an *application* number; some 18 months later, the *application* is published for public disclosure (*22*) and given an *unexamined patent application* number. (The information in this stage is most used by industries.) The applicant must request the examination of the patent application within seven years, and when the application is examined and no reason is found to reject it, the application is published for public inspection and given an *examined patent application* number. Finally, two months after the patent is issued and registered, it is given a *patent registration* number, making the patent effective for as long as 20 years, providing an annual fee is paid.

Patent information and information on patent applications in various stages are managed by the Japan Patent Information Organization (JAPIO) in Tokyo (*23*). Patent information here includes patent, utility model, design and trademark. JAPIO's two major services are printed gazettes, the Patent Agency Official Gazettes service and the Patent Online Information System (PATOLIS). The gazettes service includes the *Patent and Utility Model Gazette*, which lists patent applications and utility model applications published for public disclosure as unexamined patent applications, as well as examined applications. Another publication is *Patent Abstracts of Japan*, the English language version of Japanese patent abstracts, produced under commission from the Patent Office of the Japanese Government.

The most important of these services is PATOLIS, whose database includes approximately 28,000,000 entries, the earliest being examined applications of 1955 (*24*). The annual increase in entries in Japan has been 760,000 in recent years. PATOLIS is open for anyone to subscribe to, though the text is in Japanese. The above-mentioned English language translations of Japanese patent abstracts are issued thus far in printed form only. Patolis is distributed over Japan through leased line having seven nodes. JAPIO offers its services to European countries over the VENUS-P Line. English language abstracts on Japanese unexamined patents since 1976 are available through the ORBIT online service of Pergamon ORBIT InfoLine, Inc. throughout the world. This is the only comprehensive online source of Japanese patent information searchable in English.

English language versions of Japanese patent abstracts concerning atomic energy are provided under commission from the Japan Atomic Energy Research Institute, which contributes the information to the INIS ATOMINDEX published by the International Atomic Energy Agency (IAEA). Another source of Japanese patents is The World Patent Index by Derwin. This does not cover older Japanese patents.

NEWS INFORMATION DATABASES AND ONLINE RETRIEVAL SYSTEMS

A representative of this category is the Nikkei (Japan Economic Newspaper) NEEDS (Nikkei Economic Electronic Databank System) data base service. The focus is on Japan's economy in a very broad sense; other countries are covered from the point of view of Japan's economy. Technical information in substantial amounts is included, again from the point of view of Japan's economy, with most information relating to new technical developments and financial prospects. Nikkei NEEDS can be accessed by anyone and represents the easiest and fastest access to Japanese information in any field related to the economy. In Japan, the information is disseminated through NEEDS-NET, Nikkei's exclusive communications network, as well as through Japan's domestic telephone network. This information is also available internationally through the Packet Switching Data Network, and extends to Telenet, Tymnet, IPSS and other international and value-added networks. Nikkei also distributes NEEDS information by a computer-to-computer transmission service and on magnetic tape (*25*). NIKKEI TELECOM, Nikkei's online information service, is now available in an English version (*26*). Also of note is the Asahi Newspapers' HIASK (*27*).

The usefulness of professional or trade newspapers should not be underestimated. Termed "Semmon" or "Gyōkai" shi, they contain a tremendous amount of news, especially of new products. Their coverage includes reports of various agreements and contracts, both domestic and international, research being planned and in progress, new developments and results. Professional or trade papers also contain critiques, which are important aids in the evaluation of research, new products, and processes, and which alert readers to new theories, potentials, trends, forecasts, government interventions or supports, etc. While much of the information in Japan is available only within the vertical boundaries of a clan or clique, these newspapers are among the few major organs which make information available horizontally.

Conclusion

Since Japan is a homogeneous, geographically compact country, functions and organizations have traditionally been centrally controlled or directed. The Japanese national government exercises its power in every sphere, including the area of communication, and can strongly influence the way information flows. However, the national government does not "control" the flow of information, in that Japan's vertical administrative and financial structure acts as a barrier to the general horizontal distribution of information among institutions with similar interests. Each institution typically retains information within its sphere or clique. Also, information flow is sometimes hindered by practical problems, such as the simple difficulty in managing accounting across organizational barriers.

It is axiomatic that in the private sector most research vital to a company's progress must be kept secret from others, especially competitors or potential competitors. This is no less true in Japan, but when one is within the clique of a major company, it is entirely possible to obtain even top secret research results from groups within the clique. One need only know the right route and the right person.

Recent activities of information vendors in the United States, such as University Microfilms International (UMI) of Ann Arbor, Michigan, which publishes *Japanese Technical Periodical Index*, and *Japanese Technical Bibliography*, and in Europe, such as Euroconsortium, which distributes abstracts and translations of Japanese gray literature (*28*), may lead to at least one interesting development. They may have the effect of cutting through vertical barriers *inside Japan*, as well as making all kinds of Japanese technical information available abroad.

It cannot be stressed too strongly that success in locating and acquiring Japanese technical information depends heavily on a knowledge of Japanese national social structure and characteristics and their manifestations in information production, retention, bibliographic control, and distribution.

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LEGAL TEXT RETRIEVAL AND INFORMATION SERVICES

Legal Decisions and Legal Sources

The business of lawyers is to make decisions. Decisions which may take the form of simple advice to a client, or an elaborate judgement in a court of law. The decisions relate to problems or conflicts emerging out of our complex society and the endless variety of human activities.

These decisions may call upon the experience and wisdom of a lawyer. Essentially, however, they are based on the application of valid legal rules, part of the legal system of a certain jurisdiction. These legal rules all have a structure which is a variation of an *if. . .then.* structure: *If* [a certain factual situation] *then* [certain consequences follow].

Finding the solution may then be described as the problem of identifying which rules as part of their *if* segment (their antecedent) embrace the facts or circumstances of the problem at hand. If there is a match, the antecedent is identical to or includes the facts and circumstances of the problem at hand. The consequent is triggered, and a decision may be reached.

This obviously is an oversimplified description of legal decision making, but it characterizes an essential property: the matching of the antecedents of rules with a case or problem before the lawyer. The problem confronting the lawyer may be seen as one in which the applicable rules are to be identified.

A lawyer may through education and experience have achieved a broad background knowledge of law in general. When a problem is presented, the lawyer may have sufficient insight into the possible applicable rules for this type of problem to suggest an immediate decision, on the basis of his or her background knowledge alone. But this is not typical.

In the typical situation the lawyer is *ignorant* of the detailed applicable rules. These rules have to be dug out in some way. According to legal methods (details of which may vary between jurisdictions) the rules are, so to say, embedded in *legal sources*. A typical legal source is a statute, which is a text passed according to certain procedures by the parliament or other legislative body. Statutory texts may be interpreted according to the acknowledged legal methods, and the lawyer eventually will arrive at an understanding of the legal rules embedded in these texts. Other examples of legal sources are regulations, case law, and legal literature; and the categories of legal sources may again vary between jurisdictions.

One will notice that an elementary distinction is made between the legal sources and the rules embedded in these sources. This distinction is similar to that between text and contents, data and information, syntax and semantics. The interpretation of a statutory provision may yield one or more rules, and one rule is typically based on more than one legal source. The rules are *legal knowledge*, and they are what our ignorant lawyer is looking for.

In order to arrive at the applicable rules, the lawyer has therefore to identify the relevant legal sources, which, when interpreted, yield the applicable rules.

The major legal sources have the common property of being *texts*, they are written down, often published. The obvious problem is that there is rather a lot of them, literally filling libraries. The ignorant lawyer cannot cope with them by sequentially reading all possible texts, the lawyer has to find some sort of shortcut; tools for retrieving possibly relevant documents.

Such tools have been developed, and there are traditionally several different types. Though our concern is with computerized information systems, we might mention three of the major types of traditional retrieval tools. These all take the form of *indexes*, the simplest (1) being an *alphabetical index*. The documents are intellectually assigned indexing terms. These terms are sorted into alphabetical order, each term with a reference (an address) to the documents described by that term. Such indexes are usually found as back-of-the-book indexes. (2) A second type of index is the *systematic index*. This presumes that some sort of systematic structure for a legal domain has been constructed. Each document is then described by one or more systematic codes, indicating for which part of the domain the contents of the document is relevant. An example of such a scheme is the West Key Number Indexes. (3) A last example may be the *citation indexes* of different forms, from the case tables in the back of a book, to the elaborate and sophisticated citation indexes of, for instance, Shepard.

With this brief sketch of the available tools, we return to our ignorant lawyer. The lawyer has two broad strategies available for identifying possible relevant documents. (1) The lawyer may make a tentative legal classification of the problem in terms of a certain classification scheme, using a systematic or citation index to retrieve documents relevant to the identified area of the legal domain. Or (2) the lawyer may use essential features with the problem at hand, and match these with an alphabetical index.

To take a simple example. The advice of a lawyer is sought by an elderly lady, who—while taking a stroll in the countryside—was attacked by a bull and suffered an injury. She had expenses for medical treatment and replacing torn garments. She would like to have these expenses reimbursed by the owner of the bull.

The lawyer knows little about this area of law, and will have to consult his legal sources. He may make a tentative classification of the problem as concerning liability, and look up the corresponding code in a systematic index. Or he may consult the alphabetical index directly, using the term 'bull' or the more general term 'domestic animal.'

This simple example may be sufficient to illustrate the principle of using an information system. The lawyer looks up the indexes, gets the relevant references, and looks up the statutory provisions, cases, etc. Probably, the lawyer will find that the documents retrieved are not sufficient to solve the problem. But a *learning cycle* has been initiated; the lawyer will keep chasing possible relevant sources through the use of information systems until (1) satisfied that he has arrived at a sufficient understanding of the applicable rules, or (2) the resources available for this activity have run out. The latter of these two alternatives is the more frequent cause for terminating legal research.

We mentioned that the initial search request was based on the problem itself. However, when possibly relevant documents have been retrieved, a type of *secondary*

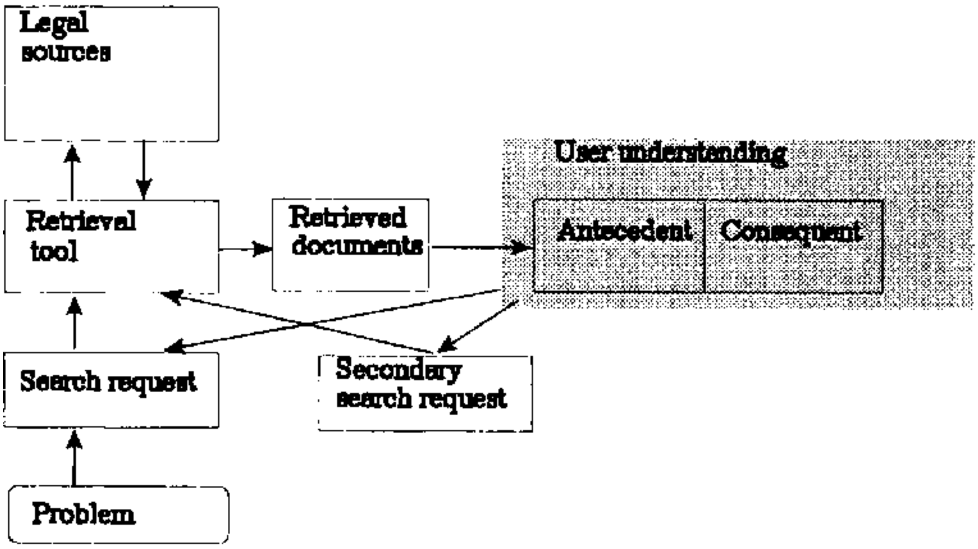

FIGURE 1. *The retrieval process.*

search request begins. A statutory provision uses the term 'domestic animal,' which animals are embraced by the term. Our bull may be an obvious example, but what about a reindeer, a tame fox, or a parrot? The answer may be in the case law material, and secondary research is carried out to seek decisions elaborating the interpretation of the term.

We have now outlined the process of legal research. A problem initiates a search request, which is formulated to fit the research tools at hand. A first set of possible relevant documents is retrieved. Armed with a better understanding of the problem derived from this, the lawyer may make further requests, or secondary requests to better understand the documents already retrieved. This activity goes on until a satisfactory understanding of the law has been achieved, or resources (such as time) give out.

At that point, the real legal argument begins. We have indicated that the consequent of the applicable rules imply the result; although this is correct in principle, in practice the arguments may be many and complex. Compared with the whole decision process, the legal research often is only a trivial part, or a small part measured in time or resources. It is, however, the part which we will discuss in further detail.

To sum up this introduction, we may show the legal retrieval process as part of the decision process in a simple diagram (Fig. 1):

The Emergence of Computerized Legal Information Systems

In the late 1960s, a state legislature in Pennsylvania passed a bill to change the phrase 'retarded child' in the health law to the somewhat less stigmatic phrase 'exceptional child.' This gave rise to a need for identifying all passages in the body of health statutes and regulations where this phrase (or a version of it) occurred.

To solve this problem, the legislators contacted Professor John F. Horty of the Health Law Center at the University of Pittsburgh. He set out to solve the problem in the time-honored way of professors: He subcontracted a group of students to read sequentially through the statutes and indicate all the relevant passages. However, as many professors before him, he was disappointed with the quality of their work. He therefore contracted a second group of students to do the job all over; again with an unsatisfactory outcome.

He then adopted a more radical method. He approached the Data Processing and Computing Center (which had been established in 1955), which, at this time, was running an IBM 7070 supplemented by an IBM 1401. The text of the body of law was recorded by double punch, a program was devised to organize the text in such a way that it was possible to have a response to the request: "In which passages does the word 'retarded' (or a version of that) co-occur with the word "child" (or a version of that)?" (*1*).

The program made it possible to identify all the passages with the infamous phrase. But, it also made it possible to identify all the passages in which any other word or combination of words occurred. Horty had indeed designed the first legal information retrieval system based on text retrieval methods. His system was successfully demonstrated at an American Bar Association conference in 1960, and his methods were applied to the establishment of the first operational legal information service—contracted by the Air Force Accounting and Finance Center at Denver, Colorado, and given the name Legal Information Thru Electronics. It was launched by the Staff Judge Advocate at the end of 1963 under the irresistible slogan *Let there be LITE!* (*2*)* It remains the oldest computerized legal information system still operational, and is testimony of the durability of the principles developed by Horty. Actually, one of the more fascinating characteristics of text retrieval systems is the endurance of their basic design. In the next section, we will look briefly at the basic design, and in a later section, we will return to the issue of improving current system design.

BASIC DESIGN OF A TEXT RETRIEVAL SYSTEM

A text retrieval system is designed to retrieve texts (i.e., documents in natural language). In its most simple form, a text retrieval system is designed to describe these documents only by their vocabulary, the words used by the author, the authentic text. The documents may be brief or long, and the system will handle documents of variable length.

> One will occasionally see the term *full text* retrieval systems used. This is a term which is ambiguous. It may be used to indicate that the system is based on text retrieval techniques described in this section. It may, however, also be used to indicate that the documents of the system has an authentic form, rather than being abstracts or other descriptions of the authentic form of the document. The retrieval techniques should not be confused with document design, and in this article "text retrieval" is used for the technique, while the nature of the documents is described by explicit terms like "authentic form," "abstract" i.e. Obviously, text retrieval techniques may be used for retrieval of abstracts, at it indeed is used in many bibliographic systems.

*The system was later renamed FLITE to emphasize its federal responsibilities.

As an example, one may take a case which is to be documented by a text retrieval system. This case has first to be made into machine-readable form. At Horty's time, this presumed punching of the text. Today, most texts are available in machine-readable form as a byproduct of word processing or publishing systems. The text retrieval system will process this text, establishing two files, the text file and the search file.

The *text file* is a copy of the inputted text, exactly as it is read into the program. The program will, however, process the text for at least two purposes.

First, it will strip the text of codes which may be a residue of a word processing or publishing system, and which govern layout and similar properties of the text.

Second, and more important, it will make the structure of the text explicit. It will identify the beginning of a document, a word, a sentence, and a paragraph. Any word—and for the purpose of the system, any string of characters is defined as a word—in the text file will be associated with such an exact address (though the number of levels of the address may vary—the four exemplified being most common). The file will also be indexed in such a way that the program easily may retrieve a document or part of a document by its address, and display this text on a screen.

The *search file* is established in two steps.

First, the program will discard a small number of frequently occurring words; typically conjunctions, pronouns, adverbs, words like "and," "well," "it," and so on. A rather large fraction of the total number of words in any text is made up of these commonly used words, the fraction will vary with the language, but typically be between 40 and 50 percent.

The original reason for discarding these "stop words" was to save storage capacity. For modern computers, storage capacity is not a problem, but neither is retrieval performance improved by the inclusion of such words. It is rather easy to demonstrate that the stop words themselves do not in any way describe the subject matter of a certain passage, and one is not able to distinguish between possibly relevant and nonrelevant documents by including the stop words in a search request.

The remaining words—content words—are sorted alphabetically, each different word occurring once. To each occurrence is associated the address or addresses of the word in the text file. The addresses provide the link between the two files, when a word is identified in the search file, it is trivial to look up the word as part of a document in the text file.

The search file is also known as a concordance or an inverted file. The latter is rather apt, as the text of the documents may be reconstructed and sorted according to the associated addresses by using the words of the search file. The result would be a copy of the text file—with the exception of the stop words, which would appear as gaps in the text. The search file may therefore be viewed as an inverted version of the text file.

These two files constitute the basic text retrieval system.

The system offers the user possibilities for specifying a search request. The simplest request is a one word request. The system will use certain methods to identify the segment of the search file in which the word occurs. This method may take the form of an additional index to the search file ("if the word starts with characters 'la,' the segment is number '*n*'"), it may hash on the first two characters of the search word, or may use one of various other methods.

Once the relevant segment of the search file is retrieved, the program will conduct a binary search through that segment until it has found a match to the search word, or determined that the search word does not occur. This combination of an initial index search combined with a subsequent binary search has given rise to the term "index sequential" to describe the system.

If a match is found, the system may report back to the user, giving the number of different documents to which addresses are specified in the search file. If the user wants to read any of the documents, the system employs the same addresses to access the text file, retrieve the desired documents (or parts of them), and display these to the user.

This is the basic structure of text retrieval systems, retained from the time of Horty.

There is an inherent problem in the described data structure. Legal information systems are dynamic, new documents are added to the database. This will also imply that new addresses will have to be added to the search file, and that new word forms will be identified, which have to find their place in the sequential structure. The structure sketched above is efficient for retrieval, but not efficient for updating—as the search file would have to be reorganized at each update.

If the search file were structured as a tree, updating would be facilitated. A simple tree structure would, however, impair the efficiency of retrieval, as more accesses to the search file would be necessary before a match to the search words could be determined. There are, however, solutions which give a better mix between optimizing updating and retrieval, the favored data structure currently is known as B-trees.

In summary, the basic structure of a text retrieval system may be sketched as in Figure 2. It should be made explicit that most modern text retrieval systems have a more complex design than this sketch may indicate. Especially important is the inclusion of *fixed fields* associated with each document. The fixed fields are defined as records in a conventional database system, and there may be fields for date, author,

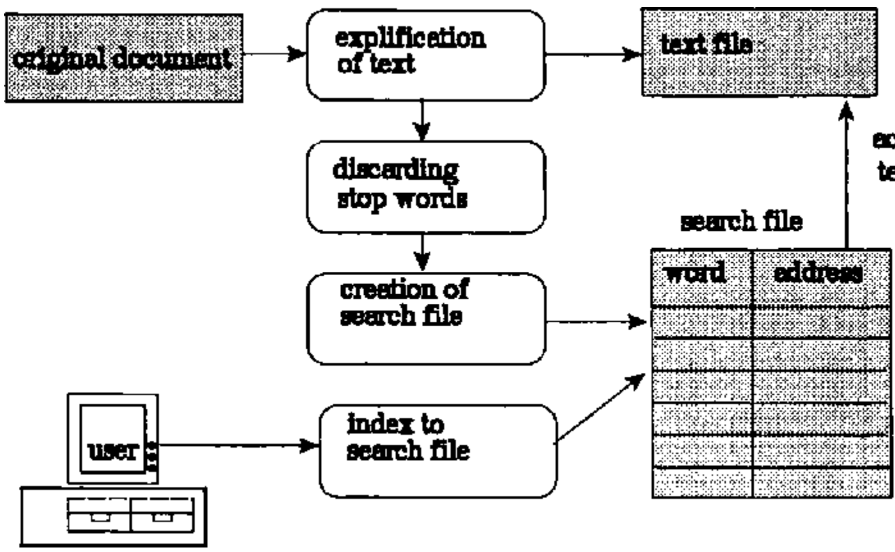

FIGURE 2. *Basic structure of a text retrieval system.*

citation, and so on. Some legal information systems emphasize these features, the system of the European Communities, CELEX, has approximately 30 fields for some types of documents. More sophisticated systems allow the user to combine retrieval on the defined, fixed fields with text retrieval requests.

Text retrieval systems may be designed along other lines than those sketched above, though such alternatives currently are not part of any operative legal information service.

One method is based on word frequency ranking, using different algorithms for calculating "nearness" between documents and search requests. There is a historic example of such a system in the original Canadian QUIC/LAW project, but currently word frequency ranking is only used in auxiliary mode.

A related method is based on *vectors*. For each document a vector is established, the number of elements in the vector equals the total number of different words in the database, and the values of each element denote the frequency of which that word occurs in the document using '0' for nonoccurrence. The search request is represented by a vector constructed in the same way, and nearness is calculated according to different schemes, the most common using a cosine function of measuring the distance between query and document vectors. The method performs not too different from word frequency ranking, and inferior to systems based on boolean queries. Tapper has demonstrated how a case law system with document vectors based on *case citations* rather than words has interesting properties (*3*).

The most recent method is using *connectivism* for representing documents. This method is briefly mentioned below. Test results are not yet available.

Performance of Text Retrieval Systems

INTEREST AND FACT RETRIEVAL

An important distinction for legal information retrieval is the distinction between interest and fact retrieval.

Fact retrieval may be exemplified by the initial problem given to Professor Horty: He was to identify certain passages of text containing a specific phrase. He was, as legislators often are, mainly interested in the occurrences of certain word forms, more or less like a linguist. Lawyers are in the habit of using retrieval tools for fact retrieval. Three main examples may be mentioned. (1) Lawyers often need to find *dates*, either within documents or as part of the identification of a document. (2) Lawyers often need to lookup *document identifications*, names of cases, citations of statutes, *etc.* (3) Lawyers also often look for proper names, the names of judges, parties, or companies.

These examples emphasize importance and high practical value of fact retrieval. Text retrieval systems permit fact retrieval, a date is treated as any other word, and may be looked up through the system, as may a proper name. However, fact retrieval, allows conventional database system to be used as an alternative. In text retrieval systems, the fixed fields associated with documents will be designed especially to cater for fact retrieval.

The characteristic property of fact retrieval is that the user may assess the relevance* of a retrieved document prior to the retrieval. If the document is looking for cases citing another, specified case, the relevance assessment is trivial: If a citation is included, the retrieved document is relevant. Also failure to retrieve documents may be interpreted as valuable information—provided that there are no errors in the material, failure denotes that there are no citations to the case in question.

Interest retrieval is characterized by a difference in relevance assessment. No prior judgement on possible relevance can be made, it is not feasible to indicate which formal properties a relevant document may contain. Returning to our small example of the bull harassing the old lady: A relevant case may include the word 'bull.' But a case concerning a 'cow' may be as relevant, as may be cases concerning any number of other domestic animals. Even a case on liability for damage caused by a circus elephant may be relevant. The legal methods of interpretation and analogous reasoning make it necessary to *understand* the document before a relevance assessment is made.

Actually, a case may be made for the nature of legal reasoning requiring a tool similar to text retrieval. Text retrieval permits the user to formulate search requests as hypotheses of relevance, using the words occurring in the authentic texts as clues to relevance. The problem is the basis of the search request, and the user is in a position to guess at which words are used in the database to describe the essential features of such a problem. Any intermediary between the user and the text may make it more difficult to use properties of the authentic, relevant document for retrieval.

AUTOMATIC OR INTELLECTUAL INDEXING?

As mentioned above, a case can be made for text retrieval as especially suited for legal research. But initially, when computerized methods were introduced, there was a heated debate on what was more efficient, automatic, or intellectual indexing.

It is perhaps prudent to observe that there is a close relation between a conventional back-of-the-book index and a text retrieval system. Both are based on alphabetical indexes with addresses to the documents associated with the index. There are two striking differences. One is the way in which indexing terms is selected: In the conventional index, they are selected intellectually. They may be words occurring in the text itself, but they may also be words taken from a predefined vocabulary, a thesaurus, where the indexer observes a number of rules for the selection, and where the interrelationship between terms is set out. The second difference is the *indexing depth*, measured as the relation between content words in the document, and the indexing terms associated with this document. In conventional indexes, this fraction will be small (perhaps less than 1%), while the indexing depth in a text retrieval system will be 1.

The U.S. and Northern European systems have from the outset favored (perhaps for different reasons) automatic indexing over intellectual indexing. Initially, France

**Relevance* is one of the more difficult concepts in information retrieval. Herein, it will be used as a binary value assigned to a document, denoting that the document is worthy for examination with respect to a certain problem. A fuller and more formal discussion is given in Ref. *1* (pp. 197–203).

and Roman countries, favored solutions based on intellectual indexing. It has been suggested that this partly was due to the fact that the French system of legal education makes rather a great number of well-qualified lawyers available at university institutions, while the university computer installations tended to be of a rather modest size. Initially, it was easier to have material indexed than to have available a computer adequate for the processing of the rather large volumes of data required by a solution based on authentic text (*4*).

Empirical tests are available which indicate the relative merits of the two solutions. These tests were mainly designed to disclose the efficiency of different indexing languages and methods, using automatic indexing of the authentic text of documents as a control. Cleverdon (*5*) suggested that such indexing was sufficiently efficient, and for many purposes might be the better, cost-effective solution. Salton and Lesk (*6*) state:

> . . . one is tempted to say that the efforts of trained indexers may well have been superfluous for the collection at hand, since equally effective results could be obtained by simple word matching techniques. Such results appear even more probable in the case of larger or less homogenous collections, where the manual indexing tends to be less effective because of the variabilities among indexers, and the difficulties ensuring a uniform application of a given set of indexing rules to all documents.

Most clearly, this result may have been expressed by Saracevic (*7*), who concludes that the "human factor" seems to be the most important for the retrieval performance. On the choice between indexing languages or systems, he states:

> The length of the indexes (i.e. variation in number of indexing terms per index as produced from titles, abstracts, or full texts) seems to affect the performance considerably more than do the indexing languages; given the same length (often termed "depth") various indexing languages tend to perform at an equivalent level.

These are notes from a conflict long laid to rest. The choice of indexing method is mainly dictated by the practical necessities of costs, and few legal information services are able to meet the costs of intellectual indexing for the sake of the computerized service alone. If, however, documents are edited by addition of abstracts, indexing terms etc. a legal information service will welcome their inclusion; it clearly enhances the retrieval performance (and adds to the indexing depth). Also the relevance function (discussed in the next section) is enhanced by the inclusion of abstracts, and may be sufficient reason to do so.

One may mention the case of the U.S. LEXIS system operated by Mead Data Central. In the U.S., this system offers the documents without editorial enhancement, like for instance headnotes of cases. This is a major difference between LEXIS and their competitor WESTLAW of the West Publishing Company, which uses the editorial material produced with respect to their National Reporter system in addition to the authentic text of the cases, marketed under the slogan of *Full Text Plus*. The LEXIS system operates also in the United Kingdom in cooperation with the major legal publisher Butterworths. These cases include abstracts and other material derived from the published reports of Butterworths. Actually, LEXIS in the U.K. has a role parallel to that of WESTLAW in the U.S.

It can be demonstrated both by theory, and by empirical tests, that retrieval performance increases by the inclusion of indexing terms and abstracts to the authentic text, but that of the three alternatives assessed separately, authentic text performs best. A result from the series of controlled experiments of text retrieval carried out at the Norwegian Research Center for Computers and Law may illustrate this.

Retrieval performance is here measured in the traditional terms of recall and precision. Recall is defined as the relation between all relevant documents in the database, and the retrieved relevant documents. Precision is defined as the relation between all the retrieved documents, and the relevant retrieved documents. Both recall and precision are fractions, and maximum performance is reached if both recall and precision equal 1.

Performance results may be set out in a recall-precision graph, in which precision is set out along the horizontal, and recall along the vertical axis. The maximum performance result is the upper right hand corner, and will in practice not be achieved. Empirical results distribute themselves along a diagonal from right to left, from high precision to high recall.

The controlled experiments are based on *relative* results, and do *not* indicate anything of the absolute performance of the system or method tested. This is due to the slippery concept of relevance, which is inherent in the definitions of recall and precision; many experiments have demonstrated the failure of lawyers to agree upon relevance, an infamous example is the Joint American Bar Association and IBM Project (cf, Ref. *1*, pp. 226–227).

The controlled experiments are based on a set of questions, approximately 20–30. These are matched against a test database of a few hundred documents. The same lawyer who has formulated the questions, does also identify the documents he or she deems as relevant. This is known as the target set. Obviously, another lawyer may disagree on the target set, but as the experiments only measure the relative performance of different strategies, it is thought unlikely that such differences of opinions should have a systematic relationship to the performance of the strategies. This may be argued according to theory, and has been confirmed by tests.

Search requests are formulated, and identical requests are processed varying different elements. If different requests have to be formulated, the method is not valid. In the experiment below, the same requests were processed against decisions represented as abstracts alone, authentic text alone, and abstracts combined with authentic texts (cf, Ref. *8*, pp. 168–171).

The discussion of controlled experiments above illustrates that it is possible to have empiric results on the performance of different retrieval strategies and other aspects of text retrieval systems. It must be permissible to note that information systems often are developed without attempts of measuring system performance and without basic knowledge of the theory of text retrieval. One should try to make such experiments in order to have indications of the cost–benefit effectiveness of features which are candidates for inclusion in operational systems (Fig. 3).

As emphasized, empirical tests do not indicate the total performance of a system. One may, however, analyze the identified instances of performance failure. It has been suggested that text retrieval based on authentic text only, or authentic text only

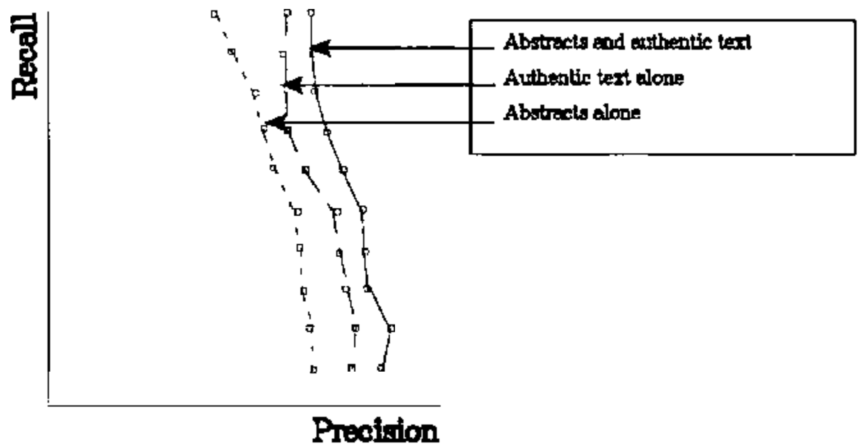

FIGURE 3. *Retrieval performance and indexing depth.*

supplemented by an editorial abstract, will fail due to *the implicity* of the text (i.e. that a reader will understand from the text that it is about a certain subject, but that an appropriate term representing this subject is missing: It is written 'between the lines,' so to say). The major example may be legal concepts developed subsequent to the date at which the legal source was created, for instance, the emergence of the notion of product liability in liability law.

Detailed analysis at the Norwegian Research Center for Computers and Law would seem to indicate that recall failure due to implicity is a marginal cause. Theoretically, recall might reach 96–98%, the residue being caused by implicity in the text. In practice, implicity is not a problem—the major problem in practice is the problem of synonymy, discussed below: The problem to specify all appropriate search terms for a certain idea. Implicity is also a problem in systems based on intellectual indexing, and though empirical results hardly may be directly compared, there is no indication of it being less of a problem in such systems (cf. Ref. *8*, pp. 161–162).

FUNCTIONAL EFFICIENCY OF INFORMATION SYSTEMS

In the preceding two sections, we have discussed retrieval performance. This is important, but some may maintain that the importance of computerized systems as a retrieval tool may have been exaggerated. There are other important properties of a system which determine its *functional efficiency*.

For a legal information system, it may be appropriate to discuss three functions which all have to be satisfied for the system to be perceived as efficient from the user's point of view.*

The first of these functions is the *retrieval function*. Its performance may be measured as suggested above, using recall and precision; other methods are also available.

*This is, however, only part of efficiency of the system, we will return to a wider perspective later.

The retrieval function is supported by *indexes*. We have discussed how such indexes should be established, and suggested that there is evidence for the performance best being supported by indexes based on the authentic text of the sources, enhanced by indexing terms and abstracts. But in any system, manual or computerized, the retrieval system is best supported by a form of index, though methods for the establishment of indexes may vary.

However, once a document is retrieved, one has to determine its possible relevance. A system also has to support a *relevance function*. A final relevance assessment may only be based on the authentic text of a source, but there should be possibilities rapidly upon which to base tentative decisions.

For this, abstracts are very useful. It has been demonstrated that relevance assessment based on abstracts is efficient measurement in the time necessary for the user to make a judgement (*9*), and that the results compare well to a relevance assessment based on the authentic text (cf, Ref. *7*, p. 571).

Computerized text retrieval systems usually offer another method for fast relevance assessment known as *highlighting* or *focusing*. The system will display long documents not from the beginning, but extracting those passages in which words from the search request occur. These passages will most likely be those which are decisive for a relevance assessment.

Experience would seem to indicate that this is very important to legal information retrieval, and presumes that the authentic text is available. An example may be the initial version of the U.S. system WESTLAW, which represented cases as headnotes and indexing terms. It was thought that this was sufficient for efficient retrieval. As we have suggested above, retrieval performance would be enhanced by the addition of authentic text. But also this limitation made relevance assessment employing focusing on passages of authentic text impossible. WESTLAW abandoned this approach in 1978, and today offers also the authentic text of the cases (cf, Ref. *1*, p. 500).

When a document has been retrieved and deemed relevant, the lawyer would want to use the information in a legal argument. There are rules regarding the form a certain source may have before it can serve as the basis of an argument, and the system has to support this *source function*. One easily appreciates that an interpretation of a statute cannot be based on an abstract of the statutory provisions in a text book, the lawyer has to base his or her argument on the original and authentic text of the statute. Likewise, in many jurisdictions an argument based on a case requires that the authentic text of the case be available, while in other jurisdictions, it is permitted to base the argument on an authorative abstract of the case. The latter would appear to be the case in Italy, where the Corte Suprema di Cassazione in Rome has a special office which develops abstracts of its decisions, and it is these abstracts—*massime*—which are documented through their national information service, ITALGIURE.

The importance of the source function cannot be overstated. It is of little comfort for a user to know through a bibliographic system that there is a thesis of probable importance to his or her legal argument, but that this book is only available in a library outside his or her access. In traditional library systems, the source function is solved by a system auxiliary to the retrieval system; the library will lend the user an identified book, and assist the user to have a copy of the book communicated in physical form from another library.

	Functional efficiency		
	Retrieval performance	Relevance assessment	Source access
Index			
Abstract			
Authentic			

FIGURE 4. *Document design and functional efficiency.*

In computerized legal information systems, where the authentic text of the sources is available, the source function is very efficient. One major explanation for the success of legal information services is probably the use of the system as a 'reading glass,' facilitating rapid access to authentic texts.

As a summing up, one may illustrate the relation between document design (authentic text, abstract, and indexing terms) and functional efficiency in a small table (Fig. 4). It is easy to appreciate that computerized systems have increased the functional efficiency of legal information systems—with respect to all three functions: retrieval, relevance assessment, and access to sources. In the discussion of such systems, the retrieval function has been emphasized, but it is believed that the two other functions are important for the overall utility of such systems.

Search Strategies

CONSTRUCTING A SEARCH REQUEST

As mentioned above, a lawyer may conduct both fact and interest retrieval searches. Of these, interest retrieval is the more difficult, and also the type of research characteristic for legal work.

In interest retrieval, the user is searching for a certain document which 'is about' a certain issue. The user is *not* looking for a document which contains certain words. Much of the difficulty in interest retrieval is related to a proper understanding of this distinction. A search request is constructed of words, but these are only used as indications of what formal properties (which words) a possible relevant document, which discusses the issue of interest, may have.

Therefore, it may be of interest to indicate a method for constructing search requests.

To illustrate the method, we may return to our initial example of the elderly lady who suffered damage from a bull. When the lawyer constructs the search request, the first step will be to partition the problem, as he or she understands it, into *ideas*. The problem may be perceived as an intersection of the idea of a "domestic animal" inflicting some "injury" on a "person."

This is a very simple structure indeed. The problem is analyzed in ideas more or less intuitively by the user. The only requirement is that the intersection (in Fig. 5

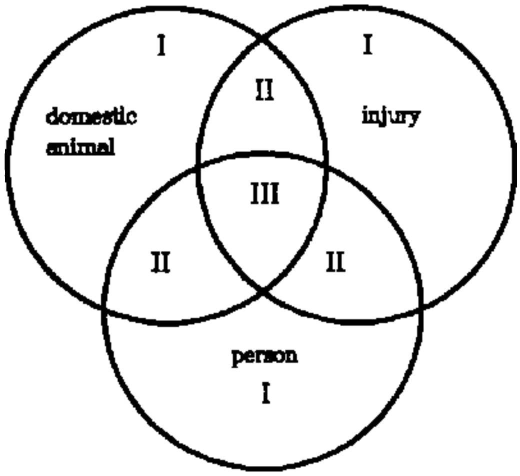

FIGURE 5. *Analysis of the problem as an intersection of ideas.*

indicated by 'III') contain the issue in such a way that the user cannot think of any relevant document outside this intersection: All relevant documents must contain the notion of a "domestic animal," an "injury," and a "person."

This obviously is not a *necessary* condition for relevance, but only a *minimum* condition for relevance. It is easy to exemplify cases which contain all three ideas, but which are not relevant for the issue at hand: For instance a person inflicting injury on a domestic animal, where the owner claims damages from that person. This illustrates one of the defects of text retrieval: One may search on ideas using the words occurring in the document, but are not able to control the *relation* between the ideas, as this outside the scope of traditional text retrieval.

The task of the user is then to describe all the ideas by sets of synonyms (in the context of the problem). There is high probability that a relevant document will contain at least one word representing the idea, but the richness of natural language offers innumerable possibilities to represent the idea. The user may specify each idea, and for instance for the idea of "domestic animals" give the specification:

"domestic animal": domestic animal*, bull*, cow*, horse*, goat*.

In this example, comma (,) is used to denote *or*, and the asterisk (*) is used to denote truncation, both will be further explained below.

The result will be three lists of synonyms. Such a list of synonyms related to an idea of the problem, is often called a "conceptors."

Using these three concepts, the user will be able to retrieve the documents which have all three ideas represented by words in the text. This will be a subset of the documents which have all the three ideas present, as experience has taught us that it is difficult to make a conceptor sufficiently comprehensive. But the probability of the documents in the intersection of all three conceptors to be relevant, will be higher than, for instance, the probability of documents in the intersection of two of the conceptors (in the figure above marked by 'II') to be relevant. It may be a good first search, to be further refined in further steps.

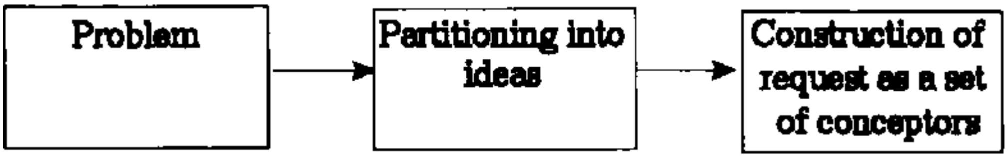

FIGURE 6. *Construction of search requests.*

The method suggested, may be summed up as in Figure 6. The relation between a problem and the search request is essential, and training is needed to construct a request which is appropriate for the request. The simple method above emphasizes that search requests are based on problems, and should reflect the features of that problem. It also emphasizes that a search request for most problems consists of more than one idea, and that an adequate request often is rather complex or composite. Regrettably, most legal information retrieval systems are not designed to make the construction of such requests easy for the user.

THE CURSE OF BOOLE

The logic developed by the British mathematician George Boole, presented in his *An Investigation of the Laws of Thought* (1854) is used for constructing search requests in most legal information retrieval systems, as it is in text retrieval more generally.

Boolean logic is quite simple. Using our example above, the two main operators or connectors may be exemplified. The operator OR denotes that a document may be retrieved if either of the words combined by the operator occur in the document. The operator AND denotes that a document may only be retrieved if the two words combined by the operator co-occur in the document.

These are the basic operators. Some additional operators are common. One is NOT, which denotes that a document should not be retrieved if containing the word following the operator. Another is EXCLUSIVE OR (XOR), which denotes that a document should be retrieved only if one of the two words combined with the operator occurs, and not if both of them occur.

Boolean logic is popular. If we take our example above in its most simple version, using the word "bull" for the idea of "domestic animal," the boolean search request might be:

bull AND injury AND person

This request would retrieve all and only documents in which all the three specified words occur. It would not retrieve a word only containing the word form 'injuries,' as synonyms have not been specified.

Boolean logic is popular and necessary. But it is difficult to appreciate that it has not been enhanced in the systems available, like the large U.S. systems. It has been maintained that boolean logic is simple. This may be true in the intellectual sense that it is simple to understand, but it is *not* true in the sense that users find it easy for constructing search requests.

Two problems may be indicated.

One is the problem of priority between the operators. This is quite an interesting detail, as natural language does not have priorities between 'and' and 'or,' this is governed by our understanding of the expression. An example* may illustrate the point. The expression

a AND b OR c

is ambiguous. It does not by itself tell us which of the two alternative interpretations below is the correct interpretation:

(a AND b) OR c

a AND (b OR c)

But changing the context-free letters into words, will tell us which of the two alternatives is valid in a certain context:

whisky AND water OR soda

whisky AND water OR beer

The problem is a minor one, and once aware of it, the user will either learn the priorities for the system he or she commonly uses, or will routinely insert parentheses to govern the priorities.

More severe is the practical problem that boolean requests are difficult to specify if of any complexity. The systems have often poor tools for editing requests. As we have indicated above, an appropriate request may be rather complex, and should emphasize the use of synonyms. This would promote requests of a number of search words, for instance a rather more appropriate boolean request based on our problem might be:

(bull OR ox OR cow OR goat) AND (injury OR harm OR damage) AND (person OR individual OR man OR woman)

Not surprisingly,users are reluctant to specify such requests in a cumbersome way. They tend to use rather brief requests, with only a few and especially characteristic words, perhaps similar to our first example, or even briefer.

This may lead to the situation which often is called *output overload* or *overrecall*: The user retrieves too many documents to cope with. The boolean request actually bisects the data base in two: One part which is retrieved, another part which is not retrieved. The retrieved documents all have the same probability of being relevant.*

Obviously, a user will for practical reasons want to cut down the number of retrieved documents to manageable size. It is often suggested that the proper way of doing this is

*The example is used in an educational video from Mead Data Central, explaining the problem of priorities.

*The order in which they are presented to the user is not, however, incidental. They may for instance be sorted chronologically, the user finding the most recent document on the top of the stack.

to AND on further search words. This is efficient for reducing the number of retrieved documents, it is indeed surprising to see word statistics and learn how small the probability really is for two random words to co-occur in a document.

It is, however, not an appropriate way of coping with the problem. Overrecall may have one of two causes.

Either the user has constructed the search request of too general words. Referring to our figure above of the problem as an intersection of ideas, this implies that the user has specified too general ideas, and that the documents are covering a broader area than the intersection. In this situation, a further constriction of the area is proper, and ANDing a term may be appropriate.

Or, the user has specified the search argument in an appropriate way, but there are a large number of candidates for relevant documents. In this situation, a further ANDing is a type of boolean lottery, which may increase the probability of drawing a relevant document, but which also increases the probability of discarding other and as relevant documents.

This may easily be demonstrated using our example. The user may have constructed the rather simple request:

bull AND injury AND person

This request retrieves a large number of documents. The user decides to solve the problem by ANDing, and adds a further search word to the request:

bull AND injury AND person AND goat

We see that the probability of the remaining documents being relevant may be somewhat higher than for the first request: The remaining documents are obviously somewhat more concerned with domestic animals, and mention two categories. But it likewise is obvious that the remaining documents do not have a higher probability of relevance than a document containing the words "bull" and "ox," or a document containing the word "bull" several times.

The user is, however, by most legal information retrieval systems left with few tools to solve this problem, and ANDing may indeed be the only way out.

One may be surprised why users do not complain about this property of legal information retrieval services. The explanation is probably that they do not perceive the defect. They only see the relevant documents retrieved, not the relevant documents missed. User research (*10*) has demonstrated that lawyers as users have an exaggerated view of the performance of the systems in terms of recall.

However, there are simple solutions to the problem.

One possibility would be *ranking*. Using our conceptors, we see that they easily allow for retrieved documents to be divided into three rank sets, in our example, the top rank set would be documents containing words from all three concepts, the next from two of the conceptors, and the lowest, from only one conceptor. Initially this would seem only to aggrevate the overrecall, as there generally would be a very large number of documents retrieved.

But each rank set might be further ranked, using a secondary criterion. Theory and empirical tests have shown that the best criterion is the *total number of search words*

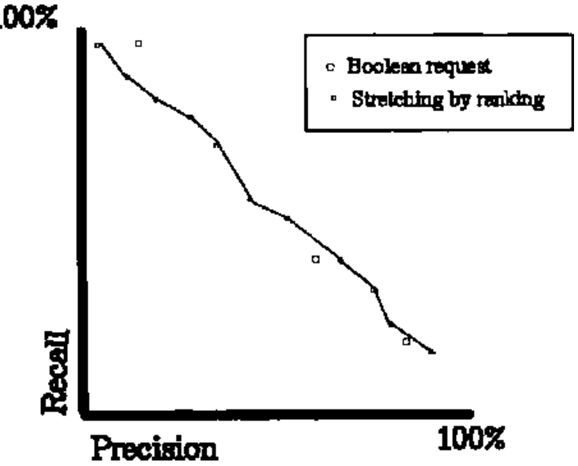

FIGURE 7. *Boolean and conceptor-based strategies con*

from the request occurring in the document. In this way, the first document to be presented to the user would be the document in which all (or most) conceptors were present, and which had the highest frequency of search words. This is also the document which, according to the criteria of the search request, has the highest probability of being relevant. In this way, the user may work his or her way down the list of ranked documents until interest is exhausted.

Comparing the pure boolean strategy with the modified conceptor based strategy, the performance in terms of recall and precision is illustrated in Figure 7. There are other methods available which also would remedy the problem (cf, Ref. *11*). The example is mentioned for two reasons. First, it closely parallels the recommendation of Professor Horty for construction of research requests using his first generation systems; perhaps the cumbersome batch processing of requests made users more concerned with the construction of requests. Second, it has been introduced in the legal information service Lawdata (Norway) with positive user response, and is also reflected in the design of the Australian STATUS-IQ program, which is an enhancement of the program currently used in the national Australian system CLIRS (*12*).

One may mention that simple word frequency ranking also has been used in legal retrieval systems. The original program used in the Canadian QUIC/LAW project—which today has graduated as QL Systems—used a number of word frequency ranking algorithms, but (as one might expect) they did not perform satisfactorily. The system has switched to a conventional boolean scheme.*

It might be fascinating to dwell on the subject of different ranking methods, use of modified boolean logic, weighting of search terms for ranking etc. but we will not be tempted. This section has only had the limited objective of introducing boolean logic, and indicating some of the problems associated with this most common type of operators for text retrieval systems.

*The program of the QUIC/LAW project was also the basis for the initial system launched by West Publishing Company, but is today developed to a rather different product.

DISTANCE OPERATORS

Brief mention should also be made of another class of commonly available operators, the *distance operators*.

These operators may be considered as a 'stronger' version of the boolean AND. Rather than requiring that two words only should co-occur in the same document, the distance operators make it possible to qualify this.

The most common is the *phrase* operator. This requires that two words combined with the operator should follow each other in the text. We have already introduced one example, (i.e., "domestic animals"). It is easy to see that a document containing both the word 'domestic' and the word 'animals' may not be concerned with domestic animals.

The phrase operator is essential for such languages and English or French, where phrases are constructed with a meaning different from its composite parts (e.g., "Ministry of Justice" or "chemin de fer"). It is of interest that this problem largely is absent in Germanic languages, which uses compounded terms in these cases, like 'Bundesjustizministerium' (German) or 'jernbane' (Norwegian). In these languages the problem is however, reflected in the problem of splitting compounded words for matching search terms against parts of words.

Similar operators may combine words with a requirement that they occur within the same sentence or paragraph. Also, some general versions of the operator specify the permitted 'distance' between the words combined measured in the number of words in between.

THE PROBLEM OF SYNONYMS

Experience with text retrieval will teach the user surprising things about language. One major lesson has been mentioned above; the wealth of synonyms for a single idea. An example often cited is the very different words which may denote the idea of a "dangerous weapon," an idea encountered in the context of criminal law, where provisions in several jurisdictions have increased penalties if a criminal act is carried out using a "dangerous weapon."

In the context of the problem, the idea may be expressed by obvious examples (e.g., gun or knife) or by more inventive use of other objects (e.g., bottle, spade, or candlestick). In few other contexts one will find 'gun' a synonym for 'spade.'

Synonyms come in several categories. A common distinction is between context-independent and context-sensitive synonyms.

Examples of context-independent synonyms are important in text retrieval, where different word forms are treated as different words. Grammatical variations (plurals, tenses) are to be seen as synonymous. Also different spelling of the same word (i.e., between American and British English), or archaic word forms surviving in the legal sources—some jurisdictions have different "generations" of the same language (the Greek *Demotic* and *Katharevousa*) coexisting. Dialect is another example, and one should bear in mind that a surprisingly large number of jurisdictions are indeed bi- or multilingual (Belgium, Canada, Finland, Ireland, Switzerland).

Examples of context-sensitive synonyms are, of course, even more numerous. One may mention at least two dimensions of context-sensitive synonyms. One is the dimension from the general to the more specific—from 'Ferdinand' through 'bull,' 'domestic animal,' 'vertebrae,' and so on. Another is the dimension from the center to the periphery, from 'bull' to 'dog,' 'fox,' 'reindeer,' 'parrot.'

In practice, it may be an overwhelming task to try to specify all the possible synonyms which an idea may take in, for instance, a case law material. Luckily, part of the problem is solved by the documents themselves: If the documents contain the authentic form of the source, this will tend to use several words for the same idea. The very property of authentic language documents which create problems also offers some solution.

Another simple strategy is that of *right-hand truncation*. This implies specifying the first few letters of a word, but not the ending. Truncation is surprisingly efficient. Tests would seem to indicate that as much as 75% of the context-independent synonyms—which includes the grammatical variations—are handled by truncation (*13, 14*).

One should appreciate that truncation is also very efficient in terms of text retrieval; all the truncated terms occur in the same segment of the search file, and may be retrieved at the same time. The cost effectiveness of any other solution of the synonym problem will have to be compared against this very simple strategy.

A solution often suggested is a *synonym thesaurus*. Several examples of such solutions are known from legal information systems, and two may be mentioned.

One is the impressive thesaurus developed as part of the ITALGIURE system. The thesaurus is based on the concept that any word may be expressed as a boolean combination of other and more basic words. A small vocabulary of such basic words was selected, and all other words were defined in terms of these basic words. When a user engaged the thesaurus, the search terms would be translated into the combination of basic words, and this expanded expression would then be matched against the total number of definitions, and documents not containing the original word might be retrieved. For instance, the word 'arson' might be defined as 'fire' AND 'murder,' and would retrieve documents which satisfied this expanded request.

Another example is the interesting bilingual thesaurus developed as part of the DATUM system in Quebec, Canada. The thesaurus gave synonyms in both English and French, and between the two languages. It was established by translating words in context, and then running a statistical analysis of which word pairs co-occurred in a significant way.

It may, however, be indicative that none of the two examples has survived. The ITALGIURE thesaurus still exists, but is not recommended for use, the DATUM project was discontinued in 1979.

The drawbacks of thesauri are several. First, they have difficulties coping with context-sensitive synonyms, as they are established for a database as such, and cannot take into consideration the very special context created by a problem. Second, and perhaps more important, they require large resources not only to establish, but to maintain.

A thesaurus will be an important feature of many legal information systems, but the cost effectiveness will have to be measured against the impressive performance of simple right hand truncation. Some systems have introduced semiautomatic methods for establishing synonym groups, for instance on the basis of synonyms frequently occurring in search requests. Others have introduced special solutions for grammatical variations; for instance, in the Mead Data Central's system LEXIS, singular forms are expanded into plurals. But any final solution to the synonym problem has not been offered.

There are, however, interesting possibilities in a number of techniques. One might mention the work on *relevance feedback* (*15*). This method presumes that an initial request is made. The documents satisfying the request are retrieved, and the user indicates a number of these documents which are deemed relevant. The system then analyzes the textual environment of the search words as they occur in the documents, and does a statistical evaluation. If others co-occur with the search words in a significant degree, these are added to the search request, which then is processed once more. This method of *metrical relevance feedback* has been tested with interesting results on the unique Israeli legal information system, the Responsa project, at Bar-Ilan University.

Efficiency and Availability

LEVELS OF EFFICIENCY

It is generally agreed that information systems should be *efficient*, but not always made clear what this term may imply. For some, efficiency mainly is related to the retrieval function, for instances measured by recall and precision. For the user, this clearly is not sufficient. Not only should the other aspects of functional efficiency be taken into account, but other elements. An obvious example is *coverage* (i.e., the fraction of the sources of interest to the user available through the information system). It is self-evident that a functionally very efficient information system only covering last year's case law will have very little 'efficiency' from the user's point of view.

It may be useful to indicate three different levels of efficiency.

The bottom level has already been indicated—the technical efficiency of the system. This generally is limited to measures of the retrieval performance, measures for the other functions are not generally agreed upon.

The top level is related to the relation between the legal information system and the legal decision process. An efficient information system is not an end in itself, it is only 'efficient' to the extent that the legal decision process is improved in quality. Fast access to legal sources would obviously not be a good thing if it could be demonstrated that this would reduce the quality of the legal decision process.* In many jurisdictions this is expressed as the need for strengthening the 'Rechtssicherheit' (German), a term which translates into English as a strengthing of due process and the rule of law. As will be mentioned below, this argument was very important in the introduction of computerized system in European jurisdictions.

*Such arguments have been voiced with respect to the use of unpublished precedents, cf for instance in United Kingdom, Lord Diplock, supported by Lord Brightman, in *Robert Petroleum Ltd v Kenny Ltd* (1983) 2 AC 192.

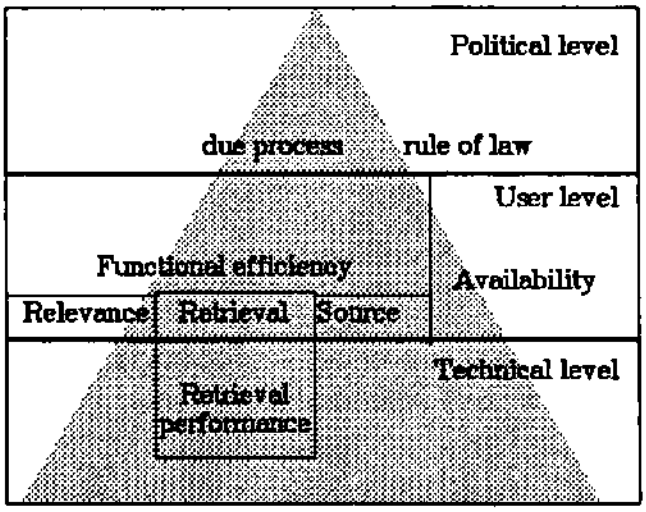

FIGURE 8. *Different levels of efficiency.*

Between these two levels, the technical and the political levels, we find the practical level of the users. They are concerned with functional efficiency, but also with what may be called *availability*, the costs by which information is made available to them through a certain system. This will be discussed in some more detail in the following section. Figure 8 is offered as a summing up of the different levels of efficiency.

AVAILABILITY

Discussing information systems, one often takes as self-evident that a system is defined as having one provider and several users. From the perspective of the user, this is not so: One user has several information systems available. These may be quite different, an in-house library, a computerized information service, and outside libraries. The user's situation may be described in terms of how information, or rather documents, from these systems are available, measured in costs (*16*).

The user will not construct his or her own information system by chance. It will be constructed to meet the probable information needs the user will have in solving legal problems. The user will to a certain degree perceive an *area of interest*, and will try to cover this area of interest with information systems with matching *documentation areas*. Without elaborating this argument, it is perhaps sufficient to say that the user-constructed information system will have a "database" comprised of the different information systems made available, and that this database is established to make information necessary to solve probable future problems easily available.

Using this sketchy argument, we may further suggest that costs for using information systems should be distributed on the different problems or cases the user handles. There will be two cost components.

First, are fixed costs, that which is necessary to maintain the user-constructed information system; for instance, subscriptions to journals or information services, assistance for maintaining an in-house library; etc. These costs are distributed with an

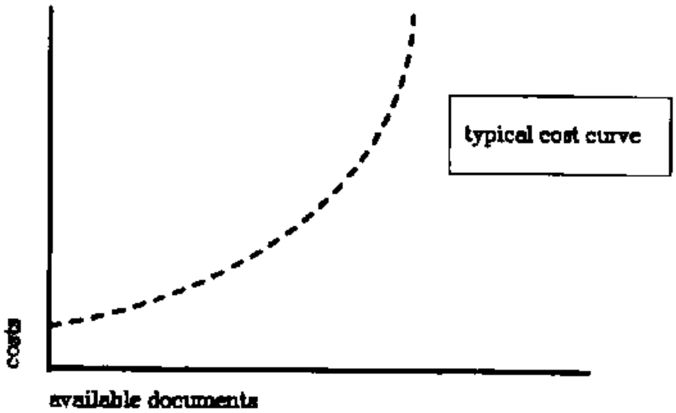

FIGURE 9. *Typical cost curve.*

equal part on all cases—even when a lawyer does not avail himself or herself of an information system, costs have been incurred.

Second, are variable costs, that which is incurred in using the system. A typical availability factor incurring cost is the expenditure of time in doing legal research, another may be the fee to be paid a computerized service while on-line.

Typically, the user-constructed system will make documents for problems within the user's area of interest available at low costs. But if an uncommon problem is encountered, the user will have to look outside his or her own system, perhaps look up a central library. It seems probable that when the user extends his or her legal research outside the boundaries of his or her rather ill-defined local database, costs will steeply increase. According to the arguments sketched here, a typical cost curve will be as indicated in Figure 9.

This curve is not based on empirical studies, but on arguments like the ones sketched above. If we accept that the curve represents a typical user situation, it may, however, be useful when discussing the user's situation. For instance, one may consider the effect of introducing new technology for retrieval of legal information.

It was thought, at the end of the 1970s that computer technology would imply a somewhat higher fixed cost per case. On the other hand, it was thought that the 'flat' segment of the curve would be longer, making a larger database available to the user. If the user was generally drawing on more than a modest volume of documents, the new technology would improve availability. This hypothesis is indicated in Figure 10.

In the mid 1980s the European Community was considering policies with respect to community and national legal information services. A study was conducted (*17*), with rather depressing results: Legal information services were generally characterized as *user hostile*.* Rather than realizing the optimistic hypothesis, it seemed that the study indicated that computerized services made the sources less available (see Fig. 10).

*Not all European systems were part of the survey, only a selection of the systems within the member countries of the European Community. It should be mentioned that the only system which satisfied users in the survey, turned out to be the users served by LEXIS through national providers in France and the United Kingdom.

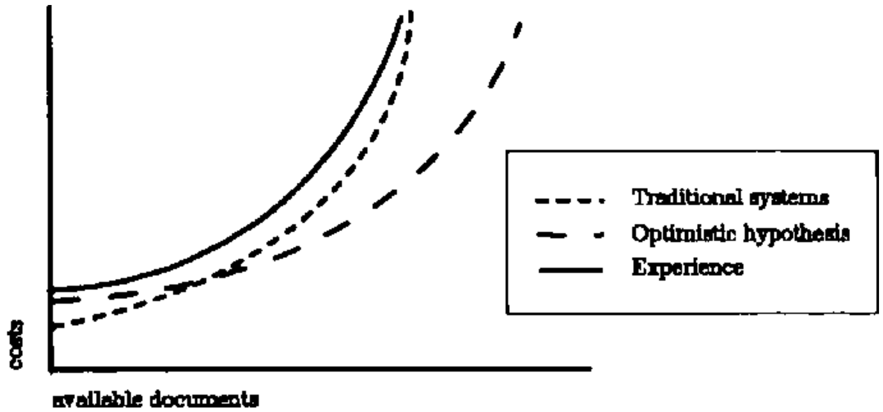

FIGURE 10. *Impact of technology on availability.*

This is somewhat discouraging, but it is an occasion for reflection on the state of the art in the mid 1980s. Some causes for lack of user acceptance are mentioned briefly below.

1. *Coverage*. Too many systems, perhaps especially European systems, have had an unsatisfactory coverage. Building databases requires relatively large funds, and until the database has a sufficient coverage, users will not accept the system. The period of investment is therefore a period where small revenues flow from the system, making it tempting to launch the system as early as possible. If the system is launched too early, and coverage is not satisfactory, it may be rejected in the market place. This is, however, largely a thing of the past; today the major European national systems also have a satisfactory coverage.
2. *Telecommunication*. Users had problems with telecommunication, and also with the associated protocols. This would vary according to the state of national telecommunication services, and it may be hoped that packet-switched networks have reduced this problem.
3. *Costs*. It is often maintained that the costs for using computerized services, inhibit users from employing such services. This does not, however, according to user research, emerge as a critical factor.
4. *Physical availability*. This may be the single most important factor for a user not employing a service. User research has demonstrated a dramatic impact of the distance (measured in meters) from the desk of the user to the point at which the service may be accessed. Terminals to computerized services are often located some distance away at common terminal rooms, or even worse, word processors used by secretaries are configured to act as terminals. In both cases, the user has to make an effort to get to a terminal. It is believed that this factor currently is being eliminated, as personal computers are moved onto the desks of the lawyers, and these may function as terminals to access a legal information retrieval service.*
5. *User interface*. It is relatively difficult to use a text retrieval system. The reason is rather simple. When text retrieval was introduced, it emerged as a simple system compared with other terminal-oriented systems of the day, often embarrassed by obscure codes and strict syntaxes. Today, text retrieval systems are compared with modern office systems, using on-line help functions, pull-down menus, icons, full screen editing, and so on. The communication protocols still restrict the design of the user interface for legal information services.

*This development has a major impact on services such as LEXIS, which mainly have been accessed from customized terminals. LEXIS now permits access from personal computers, and it is understood that in 1989 the use originating from such terminals exceeded the use originating from the customized terminals.

But there are interesting developments.* The user interface is made more 'intelligent,' supervising dialogue and helping the user along the way. And there is the emergence of PC bridges or PC ports, which are local software running on the user's own equipment and assisting the user in dial-up, construction of search requests, and other functions. WESTLAW has introduced such PC ports, and third-party PC port developed for MacIntosh has been adapted for both the German JURIS system and the SWISSLEX system.

We have also seen examples of local information retrieval solutions based on high-capacity local storage media like CD-ROM, combined with on-line services, achieving a very interesting and user-friendly mix. An early example is the system offered by West Publishing Company for case law based on CD-ROMs, which also draws on the central WESTLAW facilities.

It may have been apparent from our discussion of boolean search requests above, that it is suggested that much can be done to improve the user interface. In the next section, we will briefly look at some of the efforts of marrying techniques from the research on knowledge-based or artificial intelligence systems, with text retrieval.

Conceptual Text Retrieval

To overcome some of the shortcomings of the current legal information services, there has, over the last decade, been an increasing interest in applying some of the techniques developed for knowledge-based or artificial intelligence systems to information retrieval. (*19*). One main thrust of such efforts has been to enable the user to employ 'concepts' as part of the search request, and also to specify relationships between concepts (see, e.g., Constructing a Search Request, where it was indicated that conventional text retrieval is not able to distinguish between cases in which a person injures a domestic animal, and cases in which a domestic animal is injured by a person).

One of the earliest attempts is the experimental Legal Information Retrieval System (LIRS) developed by Carole Hafner (*20*). The system was designed for the domain of negotiable documents law (Uniform Commercial Code art 3 and 4). The legal knowledge of this domain was modeled as a semantic network, containing approximately 300 nodes.

In this way, the concepts, relations, and events of the domain were described on a general level, independent of the different documents in the database (which contained 186 cases, 110 sections of the UCC, and 188 official comments). Each document was described using the same formalism. When retrieving documents, the search request was constructed using the rather rich possibilities of the formalism, and the system matched the request with the formal description of the documents, retrieving possibly relevant cases. Very simplified, the approach is illustrated in Figure 11.

The LIRS formalism allowed the user to specify relationships between actors, to specify a general concept, and retrieve cases in which only special instances of the concept occurred. The experiment was both stimulating and innovative. The approach

*A fuller discussion is given in Ref. *18*.

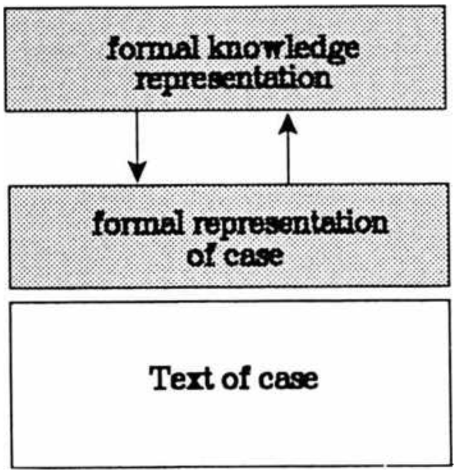

FIGURE 11. *The LIRS approach to conceptual retrieval.*

is, however, associated with some drawbacks, a major one being that all documents have to be described in the formalism of the system. This process requires large resources, similar to the resources necessary for intellectual indexing. This may be a practical obstacle to realizing an operational system using this approach.

A somewhat different approach is adopted by the RUBRIC system, developed over the last few years by the U.S. based Advanced Decision Systems (*21*, *22*). This system is reported in operational use, but not for legal applications, though tests have been made using legal documents.

RUBRIC also is based on a formal description of the legal domain, similar to the description in LIRS. However, the documents are not described in the formalism. Rather, the formalism is supplemented by *evidence rules*, which define the probability of a concept being present in the text by textual evidence. In an example, the concept "friendly" was defined with respect to takeover offers. The evidence rule for "friendly" is shown in Figure 12.

This is to be interpreted similarly to a traditional text retrieval request: If the words 'board' AND 'offer' AND 'recommend' co-occur in the same sentence, the concept "friendly" is present with a probability of 0.9.

RUBRIC has been tested with rather impressive results. In RUBRIC, however, relations between concept are limited by evidence rules, which have the same limitation as in conventional text retrieval systems. Also, the incorporation of a small text retrieval system as part of the knowledge representation may prove to be less flexible than desirable.

The RUBRIC approach is illustrated in Figure 13.

(EVIDENCE friendly

((SENTENCE "BOARD" "OFFER" "RECOMMEND") 0.9))

FIGURE 12. *Evidence rule in RUBRIC.*

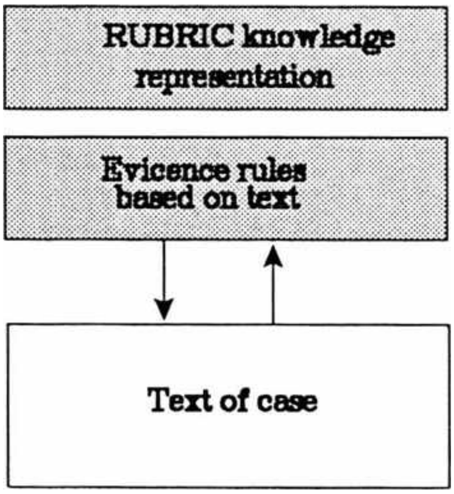

FIGURE 13. *The RUBRIC approach to conceptual text retrieval.*

An approach related to that of RUBRIC has been adopted by the Norwegian Research Center for Computers and Law in their ARCTIS* prototype. In this system also, a formal representation of the domain is specified, in this case using arrow diagrams to represent the rule structure as a graphic user interface. The user specifies the search requests by identifying which nodes in this rule structure are appropriate to his or her problem. Each node is associated with a predefined list of search terms. The system uses these lists, combining them with logical operators according to the relations between the nodes as defined by the rule structure. The result is a complex, conceptor-based request, which is processed in a conventional way by a text retrieval system.

*Automatic retrieval of concepts from textual information systems.

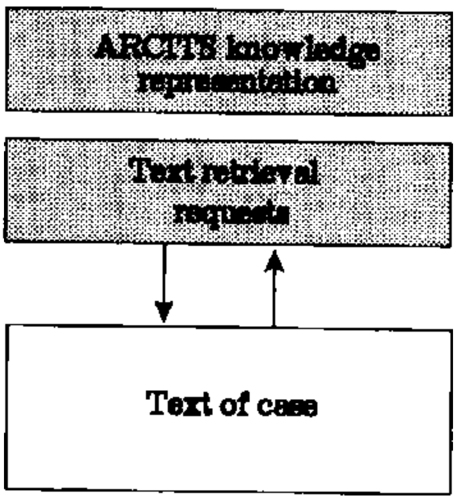

FIGURE 14. *The ARCTIS approach to conceptual text retrieval.*

This approach has replaced the 'evidence rules' of RUBRIC by a text retrieval interface. The approach has the drawbacks associated with thesauri, as the node lists have to be maintained. There are, however, suggestions for semiautomatic maintenance, which may somewhat diminish this drawback.

The ARCTIS approach is illustrated in Figure 14.

These three examples are somewhat related. A very different approach is *connectivism*, in which documents are represented as weighted graphs. Two experimental systems have been reported, both by the same team (*23*, *24*).

In these systems, documents are represented as 'document nodes,' Types of attributes of the documents are qualified; these are in the example below content words and authors, but may be other types (e.g., citations). Each different attribute within a type is represented as a node, and connections link the document node to the attributes of that document, for instance to all word nodes representing content words occurring in that document. Also, all word nodes are linked to the document nodes containing that word. This establishes a symmetrical link structure. Each link is given a weight, for instance, the link from document to word nodes may be based on the distribution of the word: The more documents in which the word occurs, the weaker the link.

A simple example of a document node is given in Figure 15. One will appreciate that this is only a representation of one document with very few attributes. When the number of documents represented is large, the network will be complex.

A search request may specify any attribute. The corresponding nodes are identified, and a certain weight is given the initial nodes. These weights are then carried from the nodes along the links connecting them to documents, the initial weight being modified with the weight associated with the link. This first cycle will transfer weight to the document nodes, and the weights of the documents will vary according to how many words of the request are linked to a document, and the weight associated with the links. In the next cycle, the weights of the document nodes are transferred along linkages to nodes of attributes, and so on. When the process is stopped after a number of cycles, the weight of document nodes can be measured, the node with the highest weight having the highest probability of being relevant.

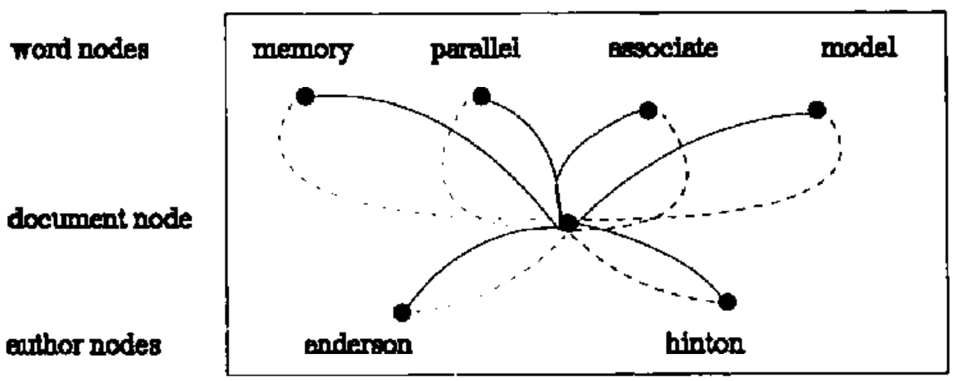

FIGURE 15. *Connectivism representation of one document.*

Notice that this solution has some similarities with vector retrieval. However, in principle, documents having no words in common with the search request may be retrieved, presuming that such a document has collected weight from other links.

The method has been demonstrated in the experimental system AIR, and is further developed for SCALIR, which is working within the domain of copyright law. It is an exciting method; the performance has still to be proven, but it is intriguing and innovative.

National Developments, Some Major Systems

In this last section, some of the developments of legal information services will be discussed. Only a selection of systems and countries will be mentioned, but it is hoped that this selection nevertheless will disclose the major experiences and trends. A more comprehensive discussion will be found in Ref. *1*, which, however, is current only to the end of 1983.

NORTH AMERICA

As mentioned earlier, developments began in the United States, and a profusion of projects have paved the way for the current systems. We will limit our description to the two major commercial systems: LEXIS and WESTLAW, though this excludes a discussion of such important systems as the JURIS system of the Ministry of Justice.

The oldest of these systems is LEXIS. It started as an initiative by the Ohio Bar Association as far back as 1964, which created a nonprofit organization, OBAR (an acronym for Ohio Bar Automated Research Corporation). OBAR contracted the Data Corporation of Dayton, Ohio to develop a retrieval systems (this organization had considerable expertise and designed an innovating system).

In the summer of 1968, Data Corporation was acquired by Mead Corporation, and made into Mead Data Central. The next year (1969) a prototype system became operational. In 1971, Mead Data Central announced that its objective was to create a national legal information service. The OBAR system was completely redesigned, and the new service was launched in the beginning of 1973 under the name LEXIS.

Apart from the computerized system, LEXIS had also to establish its own system for collecting cases from all over the United States, and organize a massive recording of older cases. This part of the operation is in itself impressive. Actually, LEXIS emerged as the first challenge to West Publishing Company's National Reporter system.

LEXIS emphasized case law material, which was not edited with headnotes, etc. It also emphasized a reliable and robust retrieval system, operating out of a central site at Dayton, Ohio. Liaisons with bar associations and law schools were also established, helping to spread the system throughout the country.

A characteristic of LEXIS was the choice of a dedicated terminal. This was an important and controversial strategic choice. Most other systems based services on standard terminals. With the advantage of hindsight, it should be admitted that the choice was sound. The keyboard had engraved legends corresponding to the commands a lawyer would use during a terminal session. In some sense, the menu had been lifted down from the screen to be pasted onto the keyboard. This made the system considerably more user friendly that many others, and is partly an explanation of its success.

Obviously, this choice had to be reviewed when computers climbed onto the desks of lawyers as part of office automation system. A lawyer would prefer to have only one work station on the desk, and would prefer to access also the legal information retrieval service through that general facility. In 1983, Mead Data Central authorized the use of IBM personal computers.

The retrieval system is based on boolean requests, incorporating a number of browse options, and offering different citation indexes for cross-reference between documents. The current system is not too different from the initial 1973 version, though it has been revised several times. Most of the revision happened 'behind the scene' so to say, in order to maintain the impressive performance of the system with rapidly growing databases. Nevertheless, one may perhaps expect enhancements of the retrieval system in the near future.

Its competitor is the largest U.S. legal publisher, West Publishing Company located in St. Paul, Minnesota. West announced its Computer Law Retrieval Service in 1975 under the name WESTLAW. The initial retrieval software was purchased from the Canadian QL Systems, though major amendments (e.g., inclusion of distance operators) were made before the service was launched. Today, the program is quite independent from this origin; both West and QL Systems have developed the programs further.

Originally, West limited the documents to headnotes of cases, as reported in the West publications, and was, to some extent a byproduct of the publishing business. This was changed in 1978, and documents now include the authentic text. Also, West documents decisions which are not published in any of its reporter series, and it may be maintained that West has emphasized statutes and regulations to a higher degree than LEXIS, perhaps due to its contacts with the Ministry of Justice for the publication of the U.S. Code.

The system is accessed through standard terminals, though West also makes available a terminal especially designed for the service. The terminal is intelligent, and is configured for using the WESTLAW service by downloading information from the West system. The retrieval system is based on boolean requests, but is rather flexible; though perhaps the user interface was initially not as friendly as the LEXIS customized terminal. West also emphasizes citation indexes and other auxiliary systems.

A comparison of WESTLAW and LEXIS will not be attempted in this brief space: One would have to compare coverage, document design, user interface, retrieval performance, reliability, training, service, and costs. There is no tendency for any of the systems to win the market place; one expects both of them to coexist for the foreseeable future, expanding and developing in different ways. One should appreciate that the companies have very different backgrounds. West is a traditional legal publisher with no ambitions to branch out into other areas of documentation or markets outside the United States. Mead Data Central also offers a retrieval service based on editorial material from newspapers (NEXIS), and has expanded their legal operation into other jurisdictions, especially the United Kingdom and France (cf, below).

The Canadian development is somewhat linked with the United States through the initial use of the QL System software for WESTLAW. QL System originated as QUIC/LAW.* initiated in 1968 by Professor Hugh Lawford at Queen's University, Kingston. A commercial system was established in 1972. Their software was initially rather unique, retrieval being mainly based on word frequency ranking algorithms. In 1974, the project was reorganized as QL Systems Ltd, and the retrieval program was amended, emphasizing boolean requests, and distance operators, and reducing the original ranking algorithms to options.

QL Systems based its operations on hosting different databases. Legal publishers, the Federal Department of Justice, and others maintained databases on the system, which the QL Systems offered to end users, costs and profits being shared between the host and the database owners. One major database owner was Canada Law Books Ltd. They tried for a while to make their own service more visible through QL Systems, using the name CAN/LA for their databases. In the mid 1980s they terminated their cooperation with QL Systems, and went into business of their own.

QL System had the unique capability of documenting one case in more than one base, corresponding to case reporters published by different database owners. This was less than satisfactory; in the mid 1980s, QL Systems decided that they would collect the authentic text of the case themselves, and then link the authentic text to headnotes or other editorial material in the different databases. The separation between Canada Law Books, and the initiative to collect cases, would seem to herald a new phase in the development in Canada.

Before leaving Canada, one might mention that the Canadian Legal Information Council (CLIC) was established in 1973, and has played a major role in forging a national policy with respect to legal information services.

EUROPE

The oldest European system is the CREDOC, created by the notaries of Belgium. It is an interesting system, both because it is early, and because it copes with the bilingual jurisdiction of Belgium. However, its preference for intellectual indexing over authentic text, places it outside the main thrust of development.

At the end of the 1960s, there was concern in many European jurisdictions over the increasing volume of legal source material. It was perhaps most clearly voiced by Spiros Simitis (Germany), who coined the phrase 'information crisis of the law' (*24*). It was perceived that the quality of legal decisions were challenged: Precedents† were not taken into account to secure certainty and equality in law, two important elements in the ideal of the rule of law *(Rechtssicherheit)*. It is striking to see how initiatives are taken in several European countries, pivoting on administrative courts or similar institutions. These were institutions giving the rule of law a very high priority, where the decisions by the institution itself were an important legal source, where case load rose steeply at this time, overloading the conventional information systems. Finding justifications for maintaining the quality of legal decisions, governments funded

*QUIC/LAW is an acronym for Queen's University Institute for Computing and Law.

†Though continental Europen jurisdictions do not subscribe to the *stare decisis*, precedents are important legal sources.

experimental information systems, mainly concentrating on court decisions (*25*). Examples are the initiative in 1963–1964 of Corte Suprema di Cassazione (Italy), the current Centre Nationale d'Informatique Juridique (CNIJ) in France, which grew from the initiative taken by Lucien Mehl of the Conceil d'Etat in 1967; the German JURIS system, initiated in 1967, and emphasizing the decisions of two administrative supreme courts: the Bundessozialgericht (for social law) and the Finazhof (for fiscal and tax law). This also was characteristic of the Nordic countries, where the decisions of the Swedish administrative courts (Regeringsträtten and Kammarrätterna) were the first court decisions to be included into the RI system; where the decisions of the Finnish supreme administrative court (Högsta Förvaltningsdomstolen) served as a pilot project for FINLEX; and where experiments in Norway was carried out in 1975 based on the decisions of the Social Security Court (Trygderetten).

Thus it may be maintained that European systems started out as specialized systems for a small group of users in the early 1970s. Over time, these systems have grown more general and become available to all users as national legal information services.

Three examples of this development may be mentioned.

In Italy, the initiative of the Corte Suprema di Cassazione grew into a nationwide system, using a software system FIND developed by the court and emphasizing abstracts of the court's decisions. The system had an original design, and a unique thesaurus (*26*). The system was supported by the Centro elettronico di documentazione of the court, which successfully promoted the system on both the legal and political levels. Statute law was included in the system in cooperation with one of the chambers of the parliament, Camera dei deputati, and bibliographical databases were established in cooperation with a national research institution, the Istituto per la documentazione giuridca, Florence (both these latter institutions had also their own information systems). In this way, ITALGIURE emerged as a national legal information service, supported by a large number of interested users, with high political priorities. The latter does not fail to impress foreign participants to the congresses organized every fourth year by the CED in Rome, lending ITALGIURE some of the traditional Italian grandeur.

A second example is Germany, where in 1967 the Bundesministerium für Justiz started exploring the possibility of launching an information system, reporting on such possibilities in 1972 in a report of traditional German quality (*27*). On this basis, a 'development system' was created. Tests for the selection of computer software were carried out, resulting in the choice of the Siemen's system GOLEM. The pilot system was operated in the period 1973–1982, establishing databases within the domains of social and tax law, developing tools to tackle some of the problems related to German language, especially compounded words, and having end-user evaluations. At the end of the period, another major cost-benefit study was conducted (*23*), which reached a positive conclusion. The extended JURIS system started to operate in 1983. At the same time, reorganization of the system was considered. Today, the system is a limited company organized outside the Ministry, but with the Federal State as the only shareholder. Provisions are made, however, later to include the individual German states, and private institutions (like the DATEV, an organization of tax lawyers and accountants, operating its own information service, DATEV LEXinform).

Germany offers an example of perhaps an overly cautions development of a national system. But the objective has from the very start been to create a comprehensive cost-effective, national legal information service, and this objective is being realized.

A third example is France. The initiative there was, as mentioned above, related to the Conceil d'Etat, and the system resulting from the initiative also emphasized decisions made by that institution. There was a great deal of experimenting in France, which has vigorously promoted the information technology industry and related services as part of their national and overall policy. This led to a profusion of systems, most of them rather specialized. Also, the U.S. company Mead Data Central teamed up with the company Tele Consulte (affiliated with the major publisher Hachette), to offer a French legal information service based on the LEXIS system, operated out of Dayton, Ohio.

The profusion of initiatives and systems were coordinated through a plan devised in the mid 1980s, in which the CNIJ was given responsibility of statutes, regulation, and supreme court material; a private publisher, Editions techniques, is given responsibility for appeals court material through its service JURIS-DATA; and the system of the notaries, SYDONI, is supposed to provide coverage of legal literature. Though there still are different systems, they are all reached through the same host organization, and the coordination has created a French national service.

In the Nordic countries, the development has been rather similar in Sweden. In 1966, the Ministry of Justice started planning a legal information system. An interdepartmental committee secured a coordinated development, but the different databases were in principle the responsibility of the different cooperating institutions. When the system was made available to the public in 1983 under the name RÄTTSDATA, it emerged as a somewhat fragmented system. Since then, efforts have been underway to forge a comprehensive, national legal system, the computer service bureau operating the public service (DAFA) takes an active part in improving software (a Swedish system, IMDOC, is used for text retrieval) and database coverage. Still this system has not found its final organizational framework.

A similar development has taken place in Finland, though the Ministry of Justice has here been careful to plan for the growth of the system into a comprehensive, national service.

In Norway, a national system was established by a foundation, Lawdata (*29*), in 1983, and this has grown into a national legal information service for statutes, regulations, case law, and literature—using the rather powerful Norwegian text retrieval system SIFT enhanced by in-house development of an intelligent user interface. Lawdata is also charged with other tasks, it does, for instance, produce the official legal gazette on contract with the Office of the Prime Minister, the biannual, consolidated statutes in force, and the consolidated compilation of regulations. It is believed that Lawdata is a major example of a national service integrating several functions of the national system.

In Denmark, developments have parallelled those in Norway. Private companies initiated systems in 1981, but these were absorbed in the RETSINFORMATION when the Ministry of Justice started a systematic creation of a national legal information facility. All statutes are now part of the system, and funds have been made available to start on case law. The main difference to Norway is the organization; in Denmark the system is still operated by the Ministry of Justice, while in Norway, it is operated by an independent foundation working on contract with the government and other institutions.

This brief outline of European developments is believed to demonstrate many similarities in the emergence of national legal information services. Obviously, there are jurisdictions with a different story, the major example is the United Kingdom.

The very earliest experiments in legal information retrieval in the United Kingdom were conducted by Colin Tapper at Oxford as early as 1963. Also, in 1968–1969, the U.K. Atomic Energy Authority at Harwell developed a text retrieval systems for legal information retrieval, STATUS, designed by Bryan Niblett and Norman Nunn-Price.* Despite these early efforts, it was some time before a commercial service was launched. In 1978, Butterworths announced that they had reached agreement with Mead Data Central, and would offer a legal information service through LEXIS, operating out of Dayton, Ohio. It may be maintained that it was resented by some that a British service in this way became part of a U.S. system. The following year, the European Law Center announced a competing service (Eurolex), based on the STATUS software. For some years, the systems competed, until June 3, 1985, when Mead Data Central and Butterworths bought the EUROLEX system outright from Thompson International, which owned the European Law Center. More or less overnight, EUROLEX discontinued its services, and the Butterworths LEXIS system prevailed alone.

This has been the situation since, though an interesting company, CONTEXT, has set up a specialized service, JUSTIS, which is based on a Gould minicomputer and a hardware device which are able to search large databases very fast sequentially, and which is an alternative to the conventional file structure of text retrieval systems. It is also known that the Lord Chancellor's office is considering the establishment of an official database of consolidated statutes.

AUSTRALIA AND ELSEWHERE

Computerized legal information services have proliferated in North America and Western Europe. In Eastern Europe, there have been activities in, for instance, Hungary, Poland, and Yugoslavia, but no major system has emerged. Also, in Latin and South America there are interesting activities, like the PRODASEN system of Brazil, UNAM-JURE in Mexico, based on French technology, or the Argentine reception of the ITALGIURE system. One might also mention that there is at least one Islamic legal information system based at the University of Lebanon in Beirut.

But these systems are not easily summarized. And our last note on the international development will therefore be some words on the Australian situation (*12*). In 1973, the Commonwealth Attorney General established a Committee on the Computerization of Legal Data, which recommended to establish a federal system to be expanded to include state material. An interim system, SCALE (Statutes and Cases Automated

*The more recent versions of this program are used for legal information services in Holland and Australia.

Legal Enquiry) was established. In 1981, the Standing Committee of Attorney Generals announced that all Attorneys throughout the respective States of Australia, had agreed that they would only permit statutes and cases from their jurisdictions to be included in systems which conformed with the database design and user interface of the STATUS standard.

This is a unique example of invoking Crown Copyright to establish some sort of monopoly for legal information services, at the same time ensuring compatibility. As a result, Butterworths, which also is an important legal publisher in Australia, was not able to copy the U.K. scheme of introducing a national system integrated with the LEXIS service.*

A new company was formed, CLIRS (Computerized Legal Information Retrieval System), owned by Computer Power Pty Ltd. CLIRS has a contract with SCALE, which switches subscribers from the CLIRS facility to the SCALE system, where Commonwealth material and material for Australian Capital Territory is held. CLIRS also made initial contracts with New South Wales and Victoria, and has since 1983 obtained contracts also with the other States, though there has by no means been a straightforward development. For instance, the Queensland contract is the result of acquiring the company which originally was awarded the contract. Today, CLIRS has emerged as a platform for a national and unified legal information service.

An interesting appendix to the LEXIS-EUROLEX struggle in the United Kingdom may be found in Australia. English law is relevant also to Australian lawyers, and CLIRS had made a contract in 1984 with EUROLEX to have exclusive license for its English material to Australian subscribers. CRIS tried by court order to stop the termination of EUROLEX services, and sued the successors for breach of contract. An agreement was reached out of court, which enabled CLIRS to continue for a time offering English material to its subscribers, supported by the LEXIS system.

This small anecdote may be an appropriate end to this article, as it hints to future development. National systems will certainly be developed into international services, but the organization of such a worldwide network of legal information still has to find its appropriate form.

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JON BING

LIBRARY ABSENTEEISM

In a period of rising personnel costs and strained library budgets, library managers must seek methods to maintain, if not expand, library services without budget increases. The productivity of current employees can be a key to the achievement of such a task. The reduction of employee absenteeism is one way to increase employee productivity. Throughout the workplace, the leading causes of absenteeism are (in order of frequency):

1. Illness
2. Unexplained (often dissatisfaction with job and working conditions)
3. Personal
   death in family
   medical appointments
   personal or family matters

Libraries should maintain accurate records which indicate causes of absenteeism among employees. With accurate records, the library can recognize and respond to attendance problems.

To ensure fair employment practices, every library should develop a written attendance policy and every library employee should be aware of that policy. The components of an attendance policy may include: a statement concerning the importance of satisfactory attendance; library standards for attendance; classes of employees affected by the policy; procedures for recording attendance, reporting absences, and extended illnesses; and definitions of such terms as attendance, categories of absence, absenteeism, and excessive absenteeism.

Accurate records and written policies alone will not reduce absenteeism. Library administrators and first-line supervisors must fairly and consistently apply policies. Additionally, they must counsel that it is the responsibility of the employee to attend work as scheduled. If library administrators and supervisors unconsciously communicate to library staff that occasional absenteeism is normal; then, that attitude will become a self-fulfilling prophecy.

Absenteeism is always defined and usually categorized by the employer. Common categories are voluntary/avoidable versus involuntary/unavoidable and unscheduled/unauthorized versus scheduled/authorized. Employers generally seek to limit any absences, no matter what the cause, that are voluntary/avoidable or unscheduled/unauthorized. Traditionally, these categories of absenteeism are controlled through a system of punishments (progressive discipline that may lead to termination of employment) and rewards (certificates and awards, incentive bonuses ["well pay"], or pay for unused sick leave).

Continued dependence on such traditional methods of controlling absenteeism has met with only limited success in many of today's workplaces. Before social science researchers began to study the problem, much absenteeism was dismissed as laziness on the part of the worker—"He/She doesn't *want* to work." However, changes in the workforce such as the increased number of women workers and single parent families have revealed the problem to be more complex.

Recent studies have shown that problems with childcare, eldercare, and other family matters may be significant causes of absenteeism. One survey revealed that more than 70% of employees have used work time to attend to children. Additionally, 41% of parents report the loss of at least one day of work in a 90-day period to deal with family matters of various kinds. Libraries have recognized the role that work and family conflicts play in absenteeism. A study of 60 libraries (28 public libraries and 32 academic libraries) identified absenteeism as the number one problem resulting from work and family conflicts.

Increasing recognition of the role that family responsibilities and the changing nature of the workforce play in absenteeism has caused employers to reconsider their policies of punishments and rewards which are designed to promote attendance. Concepts such as flextime work schedules, job enrichment activities, wellness programs, employer-assisted child and eldercare, and employee assistance programs to provide help in dealing with personal and family crises are all finding their way into the library workplace.

Many of these policies were first implemented in the private sector but more public agencies, such as libraries, are recognizing their value in reducing absenteeism. As Table 1 shows, a majority of libraries have policies that assist employees to meet family responsibilities.

TABLE 1

Policies and Benefits Supportive of Family Life

Policy	*Academic* (N-32)	%	*Public* (N-28)	%	*All* (N-60)	%
Use of sick leave when family member is ill	27	84	22	79	49	82
Option to include dependent health with employer paying all or part of cost	22	69	18	64	40	67
"Flex" time	24	75	15	53	39	65
Short-term disability with pregnancy and childbirth included	23	72	12	43	35	58
Unpaid parental or elder care leave	19	59	9	32	28	47
Information and referral service for elder care options	8	25	13	46	21	35
Information and referral service for child care options	12	38	8	29	20	33
Access to on-site child care center	12	38	2	7	14	23
Job sharing	5	16	7	25	12	20
Financial assistance with child care	2	6	1	4	3	5
Financial assistance with elder care	2	6	0	0	2	3

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LARRY J. WYGANT

LIBRARY SERVICES TO MULTICULTURAL POPULATIONS

Introduction

In discussing the provision of library services to multicultural populations, these populations are variously addressed as "disadvantaged," "culturally deprived," "minorities," "ethnic," "linguistic," "underprivileged," "immigrants," "foreigners," etc. Such terms are considered one way of dissociating this cultural group from the mainstream of the majority population. Therefore in this article, the term "multicultural populations" is used to identify and discuss the dynamics of this group as a special clientele with special service needs of library and information science.

In writing about library services provided to multicultural populations, it is essential to define the meaning and the philosophy of multiculturalism. To understand culture, one must attempt to identify, analyze, and interpret the basic values and norms of the multicultural population.

Culture is defined in Webster's *New Collegiate Dictionary* as the integrated pattern of human behavior that includes thought, speech, action, and artifacts and depends on man's capacity for learning and transmitting knowledge to succeeding generations (*1*). Culture, in a sociological anthropological sense, is defined generally as a way of living, working, and thinking, more particularly as food, dress, art, customs, family morals, ethics, religion, and philosophy. Dobbert and Dobbert define culture as "a complete way of life which includes all the patterns of behavior necessary to maintain the existence of a community, a language, a family system, an education system, a set of values and beliefs"(*2*).

What is multiculturalism? According to the Toronto Libraries Special Task Group Number 10..."Multiculturalism is based on the belief that cultural diversity is beneficial to the well being of a society." The chief aim of this philosophy is to create the kind of environment in which cultures are respected, valued and supported (*3*). Therefore multicultural library service is a service which values cultural pluralism. Multicultural library service affirms that libraries should be oriented toward the cultural enrichment of all cultural groups through provision of equal services to all cultural groups through the preservation and exchange of literature, experiences, values, attributes, and beliefs.

This article concerns itself with the library services designed specifically for multicultural populations; we will analyze the different situations that necessitate these services, and identify library associations and educational institutions which provide leadership in this direction.

Services to Multicultural Populations

In past years three sources have provided comprehensive suggestions to this area. (1) The Report of the Task Force on Library and Information Services to Cultural Minorities of the National Commission on Libraries and Information Science, 1983 (*4*). (2) The Report of Multicultural Library Services: A Partnership in Responsibility (*5*) by the Ontario Public Libraries Programme Review, Special Task Group Number 10, 1981 (*5*). (3) IFLA's Guidelines for Library Service for Multicultural Communities (*6*) prepared by Section on Library Services to Multicultural Populations, 1987.

In its report, the National Commission on Libraries and Information Science (NCLIS) acknowledges that the sobering reality is that a rapidly growing portion of our population needs and will continue to need more library and information services than have been available in the past. The report went on to say that, in some cases, services that have been available are inappropriate; in some cases, members of these groups have not known how to use the services available to them. They suggested that "it is in our national interest to make appropriate library and information services available to all our citizens, and to help those who need our assistance to derive personal and professional benefits from these services" (*7*). The Commission endorsed the following 34 recommendations:

1. Community needs assessment studies should be conducted from the library user's point of view as well as from that of the library service provider. Particular emphasis should be given to assessing the needs of cultural minorities.
2. Library and information service providers must set new goals and establish new priorities for meeting the library and information needs of cultural minorities. Further, such goals and priorities should be constantly measured and modified to satisfy the needs which they were intended to address.
3. Library and information service providers should devote some of their funding and efforts to actively promoting specific services for cultural minorities within the community and to making sure that the library's resources and services are known to them.
4. Libraries must improve, both qualitatively and quantitatively, the services that they provide to cultural minorities and initiate services to such groups where none exist.

5. As noted in the WHCLIS report, libraries must increase the public's awareness of their resources and services, and prepare library and information services professionals to market techniques to increase public use of the library.
6. Urge library schools and the profession to accelerate the recruitment of minorities. Such action carries out the intent of the WHCLIS resolution in addressing the needs of minorities in the profession.
7. Urge ALA-accredited library schools to prepare, publish, and distribute widely policies and procedures for recruiting cultural minorities into their programs.
8. Urge libraries to provide an opportunity for promotion and upward mobility for minorities who are already in the profession, or who will be recruited for the profession.
9. To carry out the WHCLIS resolution further, encourage the Association of American Library Schools to direct its members to examine curricula in their individual schools and reevaluate their programs for evidence of courses on services and materials provided to cultural minorities. Where it is shown that such courses do not exist, they should be added. If needed, existing courses should be expanded.
10. Urge the National Council for Accredition of Teacher Education to include in its standards for accreditation a requirement that students have a basic understanding of multicultural, multiethnic society.
11. Urge libraries to adopt a continuing eduction policy and to provide opportunities for minorities to participate. Eliminate barriers to participation in such programs, such as lack of release time and affirmative action programs. A program of continuing education for trustees should be established.
12. Encourage libraries to ensure growth through staff development programs for professionals and for support staff.
13. Urge libraries and library schools to provide opportunities for minority librarians to obtain specialized skills to serve in specialist positions in libraries.
14. Seek funding from private sources and from state and federal agencies as a means of removing financial barriers for cultural minorities who wish to enter the profession. Priority funding should be for
    (a) continuing and expanding funding for professionals in ALA-accredited library schools
    (b) training of staff at differentiated levels for which credit can be earned (the emphasis here is to categorize levels of funding according to career ladders and to give highest priority to the highest level of education)
    (c) providing scholarships and fellowships which are not less than the current economic level (e.g., in 1982, $12,000 each for professionals and $6,000 each for support staff levels)
15. Urge political jurisdictions and public libraries to include minority representation on library boards of trustees and other policymaking or advisory boards to guide libraries in developing programs that address the needs of cultural minorities in the community.
16. Urge library administrators to base decisions for planning library services on the ethnic, linguistic, and cultural representation of the population(s) within the community.
17. Urge library policymakers to provide relevant library programs and services, such as basic literacy, learners' advisory programs, and community information and referral services based on the educational, cultural, social, and linguistic needs of the community.
18. Urge libraries to recruit cultural minority people as trustees, librarians and as support service employees who are representative of the population within the community.
19. Urge libraries to disseminate information on their resources that service the needs of cultural minorities.
20. Urge the Library of Congress to develop a national, comprehensive system of bibliographical control of cultural minorities' resources.
21. Urge state library agencies to establish networks and to implement other programs of resource sharing to strengthen collections of materials on cultural minorities.
22. Urge libraries to strengthen the collections of print and nonprint materials and to acquire in generous supply information on the four cultural minority groups discussed in this report.

23. Urge libraries to review their materials selection policies and to assess their appropriateness for building collections that include information on the four cultural minority groups.
24. Urge libraries to develop an effective program of acquisition and preservation of minority archival collections. It follows also that such programs require facilities with space for archival storage, appropriate environmental control, and adequate staff with professional training in archival processing and preservation.
25. Urge libraries to provide for the preservation of the oral tradition among cultural minorities, and ensure that projects involve audio and videotaping.
26. Urge local, federal, and state governments to provide support specifically for minority colleges to build and to strengthen their library collections.
27. All types of libraries should include the funding of such programs and services as part of their regular budgets rather than rely solely on support from outside ancillary sources.
28. Public funding should be tripartite: from local, state, and federal sources.
29. Additional funding for library and information services for cultural minorities should be energetically solicited from other than governmental sources, such as from business and industry, trusts and foundations, and endowments.
30. Funding for libraries serving minority communties should provide for adequate personnel, materials, supplies, services, facilities, and equipment.
31. Libraries should also explore funding sources from the private sector for cultural minority library services, and actively seek the use of such funds.
32. Library schools, ALA, and state library associations should seek from state and federal levels priority funding for scholarships and fellowships to be granted at the 1982 economic level: $12,000 for professional and $6,000 for support staff.
33. Library schools, ALA, AASL, and school media specialist training institutions should explore scholarship funds from the private sector to provide minority teachers with a professional librarianship training program.
34. ALA, Chief Officers of state library agencies, and other national library and professional associations are urged to continue to work with the Congress to extend and strengthen LSCA including the new proposed title, Library Services for American Indians, and work toward other provisions that will ensure quality library service for the other three cultural minority groups. In addition, vigorous efforts should be made to include libraries and the information infrastructure in any legislation designed to rebuild the economic and educational infrastructure of the nation. (*8*).

The Ontario Special Task Group Number 10 on Multicultural Services has developed three objectives. They are (*9*):

1. To analyze the current situation, develop alternative strategies and make recommendations to achieve a well defined, comprehensive structure for multicultural service and collection delivery in Ontario
2. a. To ensure, where appropriated, that multicultural services are embraced by new legislation and regulations resulting from the program review
   b. To ensure that the delivery of multicultural services is an integral part of the final implementation plan of the executive director of the program review
3. To forward a philosophy of multiculturalism in the public library context for discussion in the community at large for amplification, modification and, finally, adoption in practice

It also devised three concepts directly applicable to their government's multicultural policies on the specific library environment. These are (*10*):

Provision of material and services in heritage languages.
Provision of community and government information.
Provision of materials on, and promotion of, the concept of multiculturalism or cultured pluralism in Canada

IFLA's Guidelines for Multicultural Communities Library Services maintained the belief that library service should be provided to all ethnic, linguistic, and cultural groups at the same level, and according to the same standards. The guideline strongly urges that all ethnic, linguistic, and cultural minorities be provided with library materials in their preferred languages and reflecting their own cultures, on an equitable basis (*11*).

The early 1980s saw a growing awareness of the need to improve library services to multicultural groups in North America, Europe, and Australia. Various committees were set up by the Library Association and governments to look at the needs of special services for this group.

In the United Kingdom, in 1981, the Library Association set up a special community service subcommittee, and in 1982, established a community services group. These two committees have designed an overall direction of professional developments in the area of multicultural librarianship and issued its publication, "Library and Information Services for our Multicultural Society" (*12*).

In Canada, in the metropolitan Toronto area, a cooperative network was organized for the delivery of multilanguage materials and for the exchange of information on library services to multicultural communities in Canada and abroad. The formal mechanism through which cooperation is achieved is the Metro Multi Language Services Committee (MMSC). This committee is composed of representatives from each metro public library system manager, from the regional multilanguage department, and from the Metro Toronto Library Board. The committee was given responsibility for putting into effect the multicultural policy established by them. Its main task was to initiate projects of a cooperative nature, and work toward regional cooperation and coordination of a cooperative network.

The New York Queens Borough Public Library (QBPL), initiated the New American Project (NAP) in 1977. The project's primary objectives were (a) to extend library services to residents whose primary language is not English, and (b) to facilitate the immigrants adjustment to their new surroundings through the acquisition of appropriate materials and the creation of special programs (*13*).

In Australia, the 1978 Gabbally report "Migrant Services and Programs" was presented to the Australian Government which adopted its recommendations and undertook to sponsor special programs particularly for those migrant groups with little understanding of English, who, as a consequence of this, have the most difficulty in settling into the community. Two other prior reports were issued in Australia. In 1973, the first report of Des Pickering and Helen Modra, Library Services to the Disadvantaged covered the need for appropriate library services for migrants and aborigines. It also included requests from Aborigines to librarians to reassess many of Australia's history books which contain bias against the Aborigines; they also wanted greater representation of works by Aboriginal authors and a larger number of Aboriginal librarians employed. The second report of Thurles Thomas, Library Services to Migrants in New South Wales, identified four categories of library needs for migrants. (*14*).

1. Material to assist them to learn English as a second language, including graded readers, special dictionaries, tapes, discs and films, as well as specially selected books and magazines.

2. Information about Australia and Australian life, customs, flora and fauna, rules and regulations, community and government services, etc.
3. Material to allow them to maintain contact with their own culture and country, particularly books and magazines in their own language but also books about their country in English.
4. Material in English of only a moderate degree of difficulty to assist migrant students of all ages in their studies where the language of the normal textbook may be too complex for ready assimilation.

In Sweden, two important government reports appeared in 1974. The Report of the Commission of Immigration (*15*) and The Book: Main Report of the Literature Commission (*16*). As a result of these two reports, the government of Sweden appointed a special committee on Library Services to the Multicultural groups. This committee drew up the guidelines for facilitating this project. Among the committee's recommendations is the suggestion that the collection of immigrant literature should contain books which could enable immigrants to retain their own literacy traditions, to understand their jobs, and to cope with problems relating to home and family.

In Denmark, three reports were published in support of library service to multicultural populations. The 1973 report entitled Foreign Workers and the Public Libraries (*17*) was published by a committee set up by the Danish State Inspectorate of Public Libraries. The committee recommended that the immigrant portion of the Danish populations be provided with information on the practical social and cultural aspects of life in Denmark (their new country) and at the same time be enabled to keep in touch with their native society and culture. Additionally, the report stated that it was vitally important for children and young people to become familiar with their native language and culture in order to avoid a generation gap within the family based on a cultural and linguistic schism.

The committee favored the establishment of a central collection which should:

1. Act in a central advisory capacity to public libraries in municipalities with foreign workers in the selection, purchasing, cataloging, and classification of titles
2. Act as a central purchasing agency at national and international levels
3. Act as a central circulation department for the loan of books on an individual and interlibrary (national and later international) loan basis
4. Act as reference library (with reading room facilities and, if possible, with interpretation services)

A 1980 report entitled Library Service to Immigrant Children (*18*), was prepared by a working group set up by the same authority, the Danish State Inspectorate of Public Libraries. This second report concentrated on library service to children of multicultural minorities in Denmark. The report included proposals on: (1) cooperation between public libraries and school libraries, (2) cooperation among Nordic public libraries, (3) cooperation among librarians working in the children's section.

In 1981 The Immigrant Council of Denmark published its report on Library Service to Ethnocultural Minorities in Denmark. The report criticized the Danish libraries for providing discriminatory and inferior library service to ethnocultural minorities. It urged upon Danish library authorities the importance of developing services to ethnocultural minorities on the basis of cooperation with these minorities (*19*).

Another country that started to look toward the improvement of library service to multicultural populations is Germany. According to Hans G. Shulte-Albert, German libraries were hesitant to address the library needs of the "foreign workers," as they are called in Germany. Most of their efforts were concentrated on library services for children and youth. The International Youth Library in Munich was given responsibility to select and compile basic buying lists in foreign languages. This library has produced, among other publications, various kinds of multicultural book lists for public or school librarians, preschool educators, and social workers who deal with the children of guest workers, immigrants, or other minorities. Based on these lists, the library published two editions of selective bibliography of childrens' books: *The Best of the Best*, from 110 countries in the native languages (*20*).

Materials and Resources

Any discussion of multicultural collections in libraries requires a careful understanding and examination of the different kind of cultures, background, and ethnicity and delivery of services. These are interdependent and it is impossible to talk about one without the others. At the same time, the nature of the community and its needs are essential elements which contribute to the success and provide the framework of collection development in any multicultural library services effort. Selection of materials is one of the most challenging and imaginative functions that faces every library serving multicultural groups.

In many libraries, special collections for multicultural groups are shelved separately; more often they are dispersed throughout the general collections. Which system is best suited to this kind of service is a matter of debate among librarians. As many writers of multicultural library services have noted, the latter is more difficult, especially when coupled with the users' unfamiliarity with the arrangement of library materials and how to find them.

Once the need and the importance of library service has been identified by the community and the library, the next step is the formulation of a selection policy and procedures for acquisitions of multicultural materials. The selection and organization of materials for multicultural populations very often do present problems, especially if there is a lack of good booksellers with strong holdings of books by and about multicultural populations. This will lead to a heavy reliance on publisher's lists and ordering of books from abroad. Materials imported from abroad, especially from native countries differ in terms of physical condition, quality of paper, design, and illustrations, from the books published in the industrial countries of the west. Once these materials are imported there are other important things to be considered. The need for an international staff with a knowledge of the language in which the books are written and with a sufficient cultural background to do the job well. This person will assist the library in the selection, acquisition, and publishing of the lists of materials acquired by the library.

In recognizing the importance of multicultural collections in libraries, the IFLA Section of Library Services to Multicultural Populations outlined the following points for library acquiring materials and resources:

1. Library materials should be provided for all users, in their preferred languages and relating to their own cultures.
2. An effective, balanced, and substantial collection should be maintained for each ethnic, linguistic, and cultural minority group.
3. The provision of library materials for members of minority groups should be proportional to the size of the group.
4. Such provision should be at the same per capita level as for the population in general. However, it should be recognized that for small groups, a higher per capita provision than is generally applied may be necessary in order to provide an effective and equitable service.
5. Library materials provided for ethnic, linguistic, and cultural minorities should include both materials published within the country of residence and elsewhere.
6. Library materials reflecting the experiences and interests of the minority group, and intended for use by them, should include materials published in the majority or official language where it is used or understood by members of the minority group.
7. Library materials should include material in languages widely used as second languages.
8. Periodicals and newspapers provided for ethnic, linguistic, and cultural minorities should be provided at least at the same per capita level as for the general population.
9. Books provided for ethnic, linguistic, and cultural minorities should be provided at least at the same per capita level as for the general population.
10. Sound recordings are an integral part of library service to minority groups, and should be provided at least at the same per capita level as for the general population.
11. It is appropriate and desirable for libraries to provide other materials than those specified above. Such other materials include video recordings, maps, pictures, and projected media. Where such provision is made, the materials provided should cater for all ethnic, linguistic, and cultural groups within the community.
12. It may be necessary to provide library materials for some groups at above the general per capita level.
13. For small or widely scattered groups, provision of materials should be at a higher per capita level.
14. Where there is a lack of any one type of library material, the increased provision of other appropriate materials or services should be considered as an alternative.
15. Where there is a lack of print material or a low reading level in a minority community, or a significant level of illiteracy, nonprint materials, in particular sound and video recordings, should be emphasized if they are available.
16. Libraries should aim, in acquiring materials, to reflect the ethnic, linguistic, and cultural composition of society and to foster racial harmony and equality.
17. Library materials acquired should enable access to other cultures in the minority user's own language.
18. Library materials should include material in the majority language relating to linguistic minorities and their countries of origin.
19. Libraries should encourage and cater for language-learning, with particular emphasis on students not attached to any educational agency, but libraries should work closely with local educational agencies so that the best possible provision is made.
20. Libraries should provide materials which will facilitate learning of the national language(s) and other languages.
21. Such material should be in minority languages as well as in the national language(s) and should include all appropriate media.
22. It may be an appropriate function for libraries to conduct or sponsor classes for students of the national language(s) and other languages.
23. Libraries should participate in the life of the community by involvement and initiative in local events such as cultural activities, festivals, and the commemorative ceremonies of the various ethnic, linguistic, and cultural groups in the area (*21*).

The U.S. Task Force on Library and Information Services to Cultural Minorities has also expressed concern in the development of library collections for this group by suggesting that materials and resources for cultural minorities need to be collected, disseminated, utilized, and preserved much more effectively and efficiently if the libraries that house them are to attract each group to the center of information. Resources should be collected in print and nonprint form and should include an adequate supply of information on the four cultural minority groups discussed; Blacks, Asians, Hispanics, and Native Americans (*22*).

Collection development for multicultural populations is a complex process involving several factors such as community analysis, policies, selection, and acquisitions. For the library, the starting point is the examination of its own multicultural community. This will help the library to understand the way in which their needs can be best ascertained. Policies regarding the multicultural group in areas such as selection and collection development provide librarians with guidelines for choosing items for inclusion in the collections. The selection part of this policy will include a form of decision making. It will include which and what type of items are to be purchased. Here input from the community is required if the collection is desired to be highly utilized. Acquisitions work also requires the librarian to take account of all aspects of the community's cultural background; starting with the preparation of an order form vendor selection, the recording of the material (cataloging), and through preparation of the lists of materials required by the library, the community can impact on every decision.

Finally service to multicultural populations requires special attention, significant funding, stronger library collections, and stronger cultural and linguistic background among librarians. Therefore, the following two statements are recommended as a form of philosophical foundation. (a) In order for the collection to be effective, it must reflect a responsiveness to the total needs of the community; (b) collection development should be carried out with the knowledge and cooperation of the community.

Library Education

The role of library schools has always been to develop programs, offer courses, and recruit and train students to receive professional degrees. In the United States, several concerned writers have recommended and urged library schools to take on the responsibility of offering programs about services to and recruitment of students from among multicultural populations.

In the United States, the issue of minority recruitment to librarianship has been addressed several times by the American Library Association at various conferences, committees, and Task Forces. In 1971 a preconference on recruitment of minorities was organized by the Office for Library Personnel Resources Advisory Committee. Again, in 1988 a similar conference on recruitment of minorities was organized by the same office. The report by ALA's Office for Library Personnel Resources stresses that "while there has been growing awareness of the urgency of the issue since 1971 and some successful programs of recruitment implemented, the percentages of minority students selecting librarianship as a career are insufficient" (*23*).

A 1985, report, Equity at Issue—Library Services to the Nation's Major Minority Groups 1985, recommended that the committee on accreditation request minority policies and procedures from ALA accredited schools (*24*). Also, in 1988, William E.

Moen and Kathleen M. Heim reported the ethnic breakdown of library school students to be 93.7% white, 3.7% black, 1.1% Asian/Pacific Islander, .8% Hispanic, and .6% American Indian/Alaskan Native (*25*).

The 1986 survey by the Library Education Task Force of the Ethnic Materials Information Exchange Round Table (EMIERT) indicated that ethnicity was treated at core course level, that is, in elective courses, such as advanced reference, government documents, and services to children, young adults, or adults; 35% of the schools surveyed answered that ethnicity was not included in those courses designed specifically to prepare specialists to work with various ethnic groups in their curricula. These were usually taught on a once a year schedule or every two years. Courses in this catagory included library services to special population groups, services to ethnic minorities, multicultural librarianship, and information resources in languages other than English. Of the respondents, 64% responded that such courses were not included in their curriculum (*26*).

The roundtable further made the following recommendations for effective change:

Curricular

1. Inclusion of materials and services to ethnic and minority groups as an integral part of the core library school curriculum
2. Preparation of guidelines concerning specific ethnic and minority topics related to each area of the curriculum
3. Use of consultants and adjunct faculty to teach specific courses in ethnic librarianship or to provide input or guidance in the integration of ethnic and minority resources and services throughout the curriculum. Practicing librarians, particularly those working with ethnic communities, should establish working relations with library schools in their area
4. Course offerings in interpretation and assessment of community information needs and interests
5. Encouragement of a knowledge of languages relevant to the patrons served
6. Encouragement of internships working with ethnic and minority communities
7. Petition the ALA Commitee on Accreditation to require that library schools demonstrate that their curricula include materials and services to ethnically and culturally diverse groups

Recruitment

1. Recruitment of ethnic and minority students and faculty should be a continuing priority for library schools
2. Establish connections with ethnic studies departments and other relevant undergraduate, graduate, and professional level programs
3. Develop and support summer work programs in libraries for ethnic and minority students
4. Encourage library associations to offer scholarships to library school students who are specializing in minority and ethnic materials and services

Continuing education

1. Supporting research in areas relating to ethnic librarianship
2. Educating and sensitizing library school faculty and administration, as well as students, to ethnic and minority needs and issues through practica, colloquia, and other continuing education activities

3. Evaluating faculty teaching for intercultural sensitivity and awareness, as well as for the inclusion of ethnic and minority materials, services, and issues (*27*)

Recently the President of the Association of Library and Information Science Educators (ALISE), Miles M. Jackson, appointed a special committee led by E.J. Josey to look at the state of affairs in ethnic, multicultural, and humanistic concerns—the library and information educators curricula. The president has charged the committee to prepare a report for ALISE covering the following areas:

1. The extent of inclusion of ethnic and multicultural concerns in the library and information science curricula in ALISE schools.
2. Respond to these questions: What is being done to recruit minorities to the profession? What library association committees exist for recruiting racial minorities?
3. Explore the possibility of establishing a Special Interest Group (SIG) for ethnic and multicultural concern in Library and Information Science education.

A preliminary report from the committee was made at the Board of Directors meeting at the ALISE annual conference in January 1990 in Chicago.

In Europe, Canada, and Australia, the problems of education of librarians from among multicultural populations has received scant attention by library educators. As far as the library literature in this area is concerned, services to multicultural populations is mentioned only in the syllabus relating to "outreach activities." If there is any direct treatment of this area, it is the progress of a few continuing education seminars organized by the library associations. Among the difficulties of why library schools give such a low priority to recruitment of multicultural populations and course offerings on multicultural library services, one is the very well known problem of securing feedback from library practitioners. Another is the difficulty in making the "establishment" at the library school adjust its resource allocations and teaching emphases to take account of new specialties and trends in the library profession as a whole.

Continuing library education programs is another way to enable librarians to remain abreast of ongoing changes and developments in the library profession. The MCLIS report indicated that when cultural minority library personnel suggest to supervisers that they are interested in participation in continuing education, they are usually told that they cannot be spared, there are no available funds, or in some instances they simply are not encouraged. The report also mentions that librarians from the majority population seem to encounter fewer impediments to their participation in continuing education programs. The report further indicates that, after having attended advanced certificate programs and obtaining additional credentials such as certificates and degrees, minority librarians are given no chance for upward mobility, while librarians for the majority populations are promoted without receiving continuing education (*28*).

Another way of sensitizing staff to the needs of multicultural populations is by the arrangement of staff development programs. This kind of program will help make staff more aware of the multicultural population the library should be serving. Here staff development workshops and other training programs can be arranged to encourage fulfillment of their needs and promote cultural awareness. As Virginia Lacy Jones pointed out, "the lifeblood of all professions is dependent upon the successful efforts of all professional associations, schools and practitioners in recruiting in sufficient quantity a variety of types of people to serve at various levels in a broad scope of diversified positions" (*29*).

Conclusions

It must be recognized that all people need and want accurate and quality library and information services. As the studies and literature of librarianship show, multicultural populations often lack a body of literature about their own cultural heritage. There is a need for multicultural population participation in library program planning and greater involvement in setting of policy and program direction.

Library services to multicultural populations requires special attention, significant funding, stronger library collections, and a greater representation of the multicultural community.

Library educators are regarded as the most important part of development of services to multicultural populations. Courses on multicultural materials are lacking in many library schools. Continuing library education and staff development programs are also very important for librarians in keeping abreast of developments in the profession. The overall responsibility for recruitment and the design of curricula falls to library and information science schools. If the services to multicultural populations need improvement, library schools should take the lead in the recruitment and training of librarians from among the multicultural population.

Recommendations

1. Libraries should set new goals and establish equal services for meeting the information needs of multicultural populations
2. Libraries must improve their services to multicultural populations qualitatively and quantitatively, and where much a service is nonexistent, a new initiative should be undertaken.
3. Library schools and library associations should cooperate in recruitment, and in addressing the needs of multicultural populations in their programs
4. Library schools should examine their curriculum and where courses on services to multicultural population do not exist, new courses should be initiated and where such courses exist if needed, expanded if needed
5. Continuing education and staff development programs should be established
6. Public libraries should ensure that members of multicultural populations are fairly represented on library boards of trustees and on advisory boards to guide the programs and address their needs
7. Libraries should strengthen the collections of printed and nonprint materials as well as provide for the preservation of the oral tradition among multicultural populations
8. Libraries should ensure public funding from local, state, and federal sources to provide adequate personnel, materials, supplies, facilities, and services

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ISMAIL ABDULLAHI

MANAGEMENT CONCERNS FOR THE DATABASE FOR AN INTEGRATED LIBRARY SYSTEM

Introduction

As online public access catalogs (OPACs) became generally available in the 1980s, it became apparent that librarians were not content to offer patrons merely card catalogs in machine-readable form. Another, "age," perhaps to be known simply as the "Age of the Integrated Library System Database," may be added to the chronology of catalogs described in the article "Catalogs and Cataloging" in Volume 4 of this *Encyclopedia* (*1*).

With the introduction of online systems, librarians insisted, as Horny stated, "any system must be at least *as good* as the card catalog it replaces" (*2*).

Since the integrated systems include the Online Public Access Catalogs, OPACs must serve the purposes outlined by Cutter (*3*):

1. To enable a person to find a book of which either is known: author, title, or subject
2. To show what the library has by a given author, subject, or in a given kind of literature
3. To assist in the choice of a book: as to its edition (bibliographically) or as to its character (literary or topical)

The Cutter principles were restated in IFLA's *International Conference on Cataloguing Principles* (*4*):

> The catalog should be an efficient instrument for ascertaining:
> 2.1 whether the library contains a particular book specified by
> (a) its author and title, or
> (b) if the author is not named in the book, its title alone, or
> (c) if author and title are inappropriate or insufficient for identification, a suitable substitute for the title; and
> 2.2 (a) which works by a particular author and
> (b) which editions of a particular work are in a library

Integrated Library Systems

Malinconico explained the nature of an integrated system (*5*):

> A collection of programs which operate on data maintained in a common data base must by any reasonable definition be considered an integrated system. Such a system permits the product of actions taken in the course of different processing activities to be recorded in a single information store. Thus, anyone performing any of the functions supported by the data base has knowledge of the consequences of any related activities also supported by the system. Such a system eliminates the need for special processing routines to synchronize or coordinate related information.

To summarize, an integrated library system allows the major functions of a library, acquisitions, cataloging, circulation, serials control, and public access, to function from one bibliographic database.

Hudson stated (*6*):

> There are five components of the maintenance of bibliographic records in a catalog: addition of bibliographic records to the catalog, identification and correction of errors, application of authority control, addition of information to the records, and withdrawal of records from the catalog.

For an integrated system the first of those five components will almost certainly be done during the acquisitions process. It is possible that the second, third, fourth, and fifth components may be carried out whether or not the library ever receives the items. Decisions that will be reflected in the public catalog must be made at the time of ordering. The lines between acquisitions and cataloging blur.

Traditionally, a library catalog includes records for items that have been received and cataloged. The database for an integrated system, on the other hand, includes not only records for items already in the library's collection, but bibliographic records for items on order or in process. It may include, also, holdings records for serials. Because circulation and serials control may operate from the single bibliographic database, it is apparent immediately that the database for an integrated system is a new entity.

The integrated system may have to be experienced before librarians in both public and technical services are aware of the differences between such a system and the mere replication, in machine-readable form, of the card catalog. For example, the

Acquisitions Department may order materials for the vertical file. The library must decide whether patrons are served well or misled if such records remain accessible in the online system when *all* vertical file materials are not represented in the database; libraries often have subscriptions to "binding copies" of periodicals and must decide whether holdings information for such subscriptions should be available to the public or should be suppressed in order to avoid defeating the purpose of having such subscriptions. Staff who create or update records for an integrated system must be aware, constantly, of the impact of their work on all aspects of the system.

SOURCES OF THE ONLINE DATABASE

The divergence of the database for an integrated system from a traditional library catalog begins with the sources of the records that form the bibliographic database. Traditionally, catalog records have been prepared by the library's staff or have been purchased from a vendor of catalog card sets. Generally, libraries have made an effort to bring all occurrences of access points into conformity with the latest revisions of cataloging policies and cataloging codes.

In planning for an online system, the library must plan for converting its catalog records to machine-readable form. Such machine-readable databases usually will be derived from several sources: (a) machine-readable records from a cataloging support system; (b) retrospective conversion products; and (c) current cataloging.

Cataloging Support Systems

Examples of major vendors of cataloging support in the 1980s were bibliographic "utilities," OCLC, RLIN, WLN, and UTLAS. Through such vendors, many libraries had machine-readable records of cataloging created during the period of affiliation with the utility. Criteria for selecting a cataloging support system were discussed in *Library Systems Newsletter* (*7*):

> Concurrent with making an online catalog available, a library should have a reliable automated cataloging support system to provide an ongoing source of machine-readable records. . . . The editors recommend consideration of the following criteria before choosing a cataloging support system:
>
> 1. The system should operate online in real-time. . . .
> 2. The cataloging support system should have an online interface to the library's local system. . . .
> 3. A library should be able to treat its local data base as its primary data base, maintaining it on a current basis. The library should not have to maintain two data bases, one on the cataloging support system and another on its local library system. . . .
> 4. The cataloging support system data base should contain a minimum of 10 million records, including Library of Congress created records and contributed records from other libraries. . . .
> 5. The data base should include all types of materials: monographs, serials, microforms, audiovisual, maps, manuscripts, etc. . . .
> 6. The system should provide support for the original cataloging of all types of materials. . . .
> 7. The cataloging support system should be cost competitive with the other options meeting the same criteria. . . .

8. The vendor of the cataloging support system should provide onsite training and field support....
9. The online system should be available at least 95 percent of the time between the hours of 7:AM [sic] and 7:00 PM from Monday through Friday.

Retrospective Conversion

For very large libraries, total retrospective conversion of catalog records to machine-readable form may be an elusive goal, but the advantage of total conversion, permitting patrons to consult only one source for determining the library's holdings, was summarized by Dwyer: "The best scenario I can imagine is a single online catalog representing the library's entire collection" (*8*).

To achieve the goal of a single online catalog, many libraries turned to commercial vendors for automated retrospective conversion projects. Others relied on "manual" conversion or a combination of automated and manual conversion projects using records available in the database of a cataloging support system. In manual conversion projects, records were keyed into the database. Inevitably, the various methods of automated conversion left some records to be added manually to the database. Inevitably, also, conversion projects resulted in a database of catalog records prepared under various cataloging policies and various editions of cataloging codes.

Current Cataloging

Hudson explained (*9*):

> After implementation, there are two stages in the life of an online catalog. The first is a period when the library must load cataloging records into the system and resolve conflicts and inconsistencies in bibliographic description and syndetic structure caused by variations in cataloging and classification policies and procedures over the years. The second period is one when cataloging records are integrated routinely into a system that is internally consistent.

During the first stage, libraries may establish special "clean up" teams, perhaps using, when appropriate, "crash projects" to dispose of problems that may interfere with patron access to records. During the second stage, a library will use its interface with its cataloging support system as well as manual keying to create its new catalog records. It may establish a catalog management unit to assume the quality control responsibilities as well as the authority work, allowing ordering, cataloging, and serials check-in to be done without the delays that can accompany error correction and authority work. Since records for titles on order or received but not cataloged will be easily apparent to library patrons, it is important that patron tolerance not be tested by allowing library routines to keep titles unavailable for long periods.

Quality control of the database continued as a significant aspect of library cataloging responsibilities with its need obvious in the online environment. In a card catalog some errors could be overlooked—perhaps never discovered. For example, a typographical error in an author's name could be overlooked by filer and filing revisor so that the card was filed with the other cards representing the same name. The literal response of a computer to a search key will not forgive such an error.

Authority Control

In general, OPACs introduced in the 1970s and 1980s provided initially for access by author, title, or subject and were perceived as needing authority control of headings. Tillett stated (*10*):

> There is still much to be done to develop the 'perfect' computerized authority control system and file design for online catalogs. . . .
>
> . . . For the library patron, authority control collocates related names, titles, and subjects and helps the user match his or her own search terms with those controlled access points used in the catalog. For the cataloger, authority control provides unique, consistent headings (i.e., access points) with appropriate references for variations in form and links to related headings in accordance with a given set of cataloging rules and rule interpretations. . . .
>
> . . . In order to accomplish the finding and gathering functions, the catalog must have authority control and without it, a file cannot be considered a catalog.

Integrated systems may provide for authority files yet lack authority control. Tillett explained (*11*):

> The *authority file* then is a set of authority records. Headings within an authority file are usually consistent and unique within that file.
>
> *Authority control* is the overall term for the concept encompassing the operations of authority work and emphasizing the control over variant forms of access points. . . .
>
> Perhaps the term 'access point control' is less confusing than authority control to describe the control of headings.

Only when authority control becomes part of an online catalog can it be said to be "as good as the card catalog it replaces."

BEYOND THE CARD CATALOG

Tyckoson speculated that the library catalog, originally projected as "the key to finding anything and everything contained within the intellectual walls of a given library," evolved, ultimately, as an index to only two percent of the collection: the books and periodical titles. He concluded, "Electronic databases have brought us full circle from the cataloging practices of the nineteenth century to the potential for a fully integrated Catalog for the twenty-first century" (*12*).

Serials Holdings

A logical step following the conversion of card catalog records to the online system is the conversion of serial holdings records. Prior to automation, library patrons could usually find retrospective holdings for serials in one special file, a "Serials Catalog" or

"Periodicals Catalog." Usually, in an effort to accommodate patrons, that special catalog was located near the main card catalog. Normally, however, it was necessary for the patron to visit a third station, the check-in file for current periodicals, to learn whether the library had received the recent issue he sought.

Circulation Status

The circulation subsystem of the integrated system enables the patron to know whether the item he seeks has been checked out. With the implementation of the online catalog, the serials control system, the acquisitions system, and the circulation system, the patron may find, at any public access terminal, information he formerly had to seek in at least three different locations within the library.

Keyword Searching

Usually, the first feature added that provides a kind of access not possible in a card catalog is keyword/Boolean searching. Such access provides evidence of the value of the work catalogers have traditionally done in keeping up notes fields, contents, etc. as, usually, keyword/Boolean permits searching any field in a catalog record.

Unique Files

As libraries adjust to the online database and the ease of updating and correcting records in contrast to the labor-intensive work with manual records, they may consider the possibility of adding to the integrated system records for other kinds of library materials: government documents, vertical files, picture files, maps, etc. Such collections traditionally have been accessed by files or bibliographies unique to them. Automation provides the opportunity to unite the various channels for access to the information in the library's collections.

Other Bibliographic Databases

By 1987, an exciting trend was developing for integrating bibliographic databases into a library's system. Buckland proposed a redefinition of the library catalog as automation provides for the combining of bibliography and the library catalog. Whereas the library catalog shows what the library has, Buckland defined bibliography as (*13*):

> . . . perhaps the best available term for the whole apparatus of access to records of all kinds: textual, numerical, visual, musical, etc., in all kinds of storage media: books, journals, microforms, computer disks, etc. Examples of the sorts of bibliography under discussion include *Chemical Abstracts, Annual Review of Information Science and Technology, Books in Print, Readers' Guide to Periodical Literature,* and *Arts and Humanities Citation Index.*

Buckland continued:

> The next logical development would be to provide links from the reference in the bibliographies to libraries' holdings records. If one were to find an interesting reference to an article while searching *Chemical Abstracts*, for example, it would be an obvious amenity if one could move automically from the reference to a statement of local libraries' holdings of the periodical concerned—and, ideally, could know whether that particular volume is out on loan and/or whether to send a request for a copy of it.

Buckland suggested, further, that full texts of documents could become a part of the redefined library catalog:

> The following approach is suggested:
> 1. Since bibliographies constitute the principal means of identification, there should be extensive, convenient access to bibliographies regardless of technology.
> 2. Because it is necessary not only to identify but also to locate material, it should be possible when searching bibliographies to ascertain how to get to the texts, whether by knowing call numbers and availability of local library holdings or by access to online databases.
> 3. It would be convenient to have an option whereby searches in bibliographies could be limited to the holdings of one or more particular libraries.
> 4. In order to achieve the central mission of libraries, providing access to information, references in bibliographies should also link directly and permit immediate reference to machine-readable full text or, otherwise, to request that copies be sent in the original, in photocopy, or by telefacsimile.

Potter wrote in his introduction to a special issue of *Information Technology and Libraries* (*14*):

> There is a wealth of material in all libraries that is more difficult to find than the books that are usually reflected in catalogs—journal articles, technical reports, essays in collections, songs in collections, government publications, etc. Somewhere in most libraries there are specialized indexes that provide access to this other material, but barriers of cost and effort stand between them and most readers. Online systems now in place in many libraries offer the possibility of providing more unified access to collections.

Full-Text

Potter reported, also, that libraries are expanding their online catalogs to include ready reference works such as encyclopedias and dictionaries (*15*):

> These full-text services mark a radical departure for online library systems. All the other services provided as part of these systems merely point the reader to where information can be located. The full text of reference works and of journal articles, however, actually delivers the information. The services in place today should serve as an important first step to the eventual provision of a wide range of full texts of reference works, journal articles, and possibly complete books. . . .
>
> . . . The next steps for expanding online library systems lie along three complementary paths. The first is simply more of the same—more indexes to more sets of collections and

> more reference works. The second is the inclusion of the full text of more articles and, possibly, books. . . . The third path involves providing greater connectivity from online library systems to other systems, including other library systems, commercial services, bibliographic utilities, local networks, CD-ROM servers, and other information providers in the community.

Collections Not Owned by the Library

Possibilities may arise, also, for adding bibliographic records for collections not owned by the library, but existing on the campus or in the community served by the library. While such records may provide useful information for patrons, significant questions must be considered: (a) Will information need to be updated frequently? (b) Will the library have a voice in assuring the quality of a collection represented in its system? (c) What is the nature of the collection? Does it consist of incomplete runs of journals, textbooks, or duplicates of items in the library's collection? (d) Does the collection include serials? If so, what procedures are necessary for updating holdings? (e) Will the collection circulate or will it be a reference collection? If it circulates, will the library's circulation system be used? (f) Will the owners of the collection take responsibility for notifying the Library of withdrawals, additions, title changes, etc.? (g) Will the owners of the collection provide financial support for the library to add the bibliographic records to its system?

Nonbibliographic Databases

Libraries recognized the opportunity to make available on library systems nonbibliographic as well as bibliographic databases. Clemson University, for example, loaded the Faculty Senate minutes and Classified Staff Commission minutes (*16*).

Wall suggested that a "bibliographic database that represents physical library holdings will eventually be dwarfed by other text, numeric, statistical, graphic, and algorithmic databases."

Wall suggested further (*17*):

> In addition to mounting materials acquired from external sources—federal, state, and local governments; networks; commercial publishers; associations; other libraries; etc.—increasingly libraries will mount locally-produced resources. These may be dissertations produced at a university, perhaps captured by scanners and optical character recognition (OCR) programs.
>
> These local resources may consist of articles and papers prepared by faculty members and researchers, . . . the library will become a file server to a very large community.
>
> The library should assume custodial responsibilities for the unique, local resources on its computers. . . . And it will perform quality control and archival functions that individuals are unlikely to perform themselves.
>
> These will be additional, new challenges for the library, but challenges, if successfully met, that will ensure a pivotal, future role for them. Libraries should take the lead in defining and developing the library's role as *the* institutional file server.

Impact of Systems on Library Organization

Librarians voiced concerns that technology and integrated systems required new organizational patterns. Various organizational patterns emerged, many involving the combining of acquisitions and cataloging tasks. Martin summarized, however (*18*):

> The library of the future will have a different organizational structure only if the introduction of technology matches the administration's desire to make a particular change: technological activities will not in themselves require reorganization in the immediate future. After all, thus far, only those applications are being discussed which are direct translations of functions which take place in a traditional structure.

The Future

Malinconico summarized the optimistic view of the future of the online catalog (*19*):

> There is little doubt that we are standing on the threshold of changes that will alter the catalog and library service in ways that we can only dimly perceive. The library catalog will very likely change into something that bears little resemblance to the instrument we currently know.

Predictions that appeared in the library literature of the late 1980s indicated that maintenance and management responsibilities for the databases of integrated library systems will not only change, but will increase during the final decade of the twentieth century.

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BETTY BARTLETT DAVIS

MARGINALIA

While reading the manuscript texts of classical authors, the Bible or early Christian and profane writers, students and teachers, on meeting with any obscure or out-of-the-way words which they considered difficult to remember or to require elucidation, wrote above them, or in the margins, interpretations or explanations in more easy or better-known words. The interpretations written above the line are called "interlinear," those written in the margins of the MSS. "marginal glosses" (*1*).

Marginalia represent hard evidence of a book having been read. Someone handled the volume, read its author's words, reacted to them, and responded by writing in those reactions. Annotations deserve attention both as evidence of study and scholarship, and as evidence in the history of reading.

Many books printed in the fifteenth or sixteenth centuries have marginalia throughout them. These follow medieval conventions and take the form of glosses. These marginal notes were so little valued in succeeding centuries that they were often cut through when trimming a book for rebinding, regardless of their contents.

Books have been annotated for several reasons: marking changes from errata sheets; corrections of unnoticed typos; corrections of errors of fact in the eyes of the reader; comments from readers; glosses; problems worked in textbooks by students; addenda to charts by researchers; notes by authors in their copies for new editions; and children's scribblings. For some reason, glosses seem to occur more often in the incunabula than annotations in later printed books; perhaps from the scholarly habits of medieval writers making notes on manuscripts. Annotations often cluster in the first half of a book, as if the reader grew tired of penning responses or guidelines as reading progressed.

Biblical and literary scholars have paid much attention to marginalia, both to better understand the text so annotated and as indicators of contemporary or later readers' responses. The study of marginalia per se and the appreciation of them may have begun with an essay in 1895 by Lang, who although deploring careless writing in books, treasured those of the past with autographs or notes by famous people as relics (*2*). In 1896, Gilbert Redgrave spoke on inscriptions in books and included sections in the talk on "...intelligent notes of the former owner," and on marginal notes (*3*). Redgrave deplored the practice of trimming the often wide margins when rebinding early books with the subsequent loss of marginalia. He didn't like the medieval habit of putting in marks or arrows or little pointing hands to highlight"...double entendres and improper stories": "All writing of this kind appears to me to be an abuse of books..." (*4*).

Soon after, Alfred Pollard (1907) stated that in fact margins in printed books had two purposes: "(1) to give room for manuscript notes, (2) to lend dignity to their appearance. The practice of writing manuscript notes is dying out... not many readers feel the need of an abundance of blank paper round the text of their books as a means of recording their valuable observations" (*5*). Pollard was interested in determining, if possible, whether some early printers produced books with a "golden mean" relating the width of margins from top margin to side to bottom, and inner to outer, as espoused by William Morris. He suggested (1933) that the generous lower and outer margins were developed in medieval times for the convenience of readers who held books, and that some manuscripts (and perhaps early printed books) were designed deliberately for illumination and annotation (*6*). He gave as an example of a special case some Elizabethan legal manuals printed with wide margins for notes (*7*).

Curt Bühler (1946) followed Pollard's studies with more examinations of page proportion and type size (*8*). No one seems to have investigated the possibility of estimating the margin widths by the study of trimmed marginalia, i.e., recreating the words for the remaining chopped notes and estimating the space needed for the original notes.

Recognition of the value of annotations beyond the 'relic' interest has characterized the twentieth century attitude. In the worldwide explosion of Ph.D. dissertations in literature, the annotated text has often served as a vehicle for a thesis. Detailed analysis of the annotator (often as well-known as the writer of the book) has produced illuminating and interesting information as well as providing insight into the annotator's responses to the text "in hand." Antiquarian book dealers also have recognized the value of some annotated books and carefully describe them in their catalogs. Roger Stoddard produced a very interesting exhibit and catalog at Harvard University in 1985, particularly useful for its examples of annotations in the process of writing, editing, and printed books (*9*).

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MICROCOMPUTER SOFTWARE FOR LIBRARY AND INFORMATION WORK

Microcomputers have become an established item of office equipment, no less in libraries than in any other working environment. Library applications were first developed in the United States in the early 1980s; they have been growing in Europe over the last five years, and many other countries are now investigating their potential.

Installing any type of automated system, whatever its size, necessitates a considerable amount of planning and dedication. Rarely does it save money. However, as hardware capable of running a library size system is decreasing in cost, an ever-growing number of library and information staff are recognizing the advantages, namely that a computerized system will make more efficient use of two valuable resources: staff time and the library stock, thus providing opportunities for an expanded range of services.

Despite the availability of powerful programming tools for developing customized systems, commissioning or even writing programs from scratch is a costly exercise in terms of personnel, money, and time. The advantages of looking at off-the-shelf packages are that they are cheaper, tried and tested, documented, and supported. Also, the well-established packages are likely to have existing user groups for the exchange of information and to encourage suppliers for developments deemed by users to be needed or useful.

The market for library and information systems software is both volatile and subject to rapid expansion, and it contains a growing diversity of microcomputer products. The author's main experience is of packages available and supported in the United Kingdom, where software is firmly based in the DOS environment despite a growing interest in the use of UNIX. Apple machines have not yet had a large impact in libraries in the United Kingdom, but their growing use in the business world and the ability to link them into DOS-based systems may provide a stimulus to library software development. Although the particular systems mentioned in this article represent the U.K. market place, the basic options discussed apply worldwide. Two main categories of software can be identified: general purpose business software and software particularly suited to library and information applications. This article concentrates on the latter type.

General Purpose Business Software

Most libraries can benefit from using a microcomputer as a general office tool. A few examples are: word processing for general correspondence and standard letters; spreadsheets for budgetary control and planning; desk top publishing for publicity materials; communications software for electronic mail, data transfer, and telex access. Integrated business packages such as Framework, Symphony, and Smart, which offer combined database management, word processing, spreadsheet, and communications, are useful tools for general office automation.

One particular type of business software that has been widely used in libraries before library-specific packages were developed is the database management system (DBMS). These systems are ideal for highly structured data such as mailing lists, sales records, directories, inventories, and client lists. As they are general purpose in design, the system has to be tailored for each application and as a result the learning curve in developing a new system can be quite long.

The main disadvantages of DBMS for many library applications are:

1. Fixed length fields and rigid record structures
2. Field-directed searching
3. Poor ad hoc retrieval: for example searching for a word within a field is done by searching through the entire database for a match to the character string, a very slow process on a large database

Other features of DBMS are:

1. Calculations on numeric data
2. Real-time global updating (useful where data changes rapidly)

3. Relational DBMS allow links to be established between separate databases which contain common elements so that they can be searched simultaneously and data can be called up from one to another

DBMS may be suitable for particular library tasks such as maintaining borrower lists and subscription data. Many libraries have developed more adventurous applications using standard DBMS such as dBase, Dataease, and Reflex, as until recently few library-specific packages were available. However, the general purpose DBMS no longer represents the state-of-the-art approach to library automation. Tailoring a system requires considerable knowledge, time, and patience, and the inherent constraints mean that such systems will never be suitable for the textual retrieval most libraries need. There are some exceptions, notably those offering variable field lengths and indexes for searching, though these are not the usual inverted file systems associated with true information retrieval packages.

Many of the new microcomputer-based library housekeeping systems are based on relational DBMS but in these cases the supplier has developed the applications routines, set up the database links, and improved the retrieval capabilities. These systems will be discussed at greater length later.

Software Particularly Suited to Library Applications

There are three main categories of software which have been specifically targeted at the library sector: (1) information retrieval systems, (2) library management or housekeeping systems, and (3) communications software for online searching.

INFORMATION RETRIEVAL SYSTEMS

At their simplest, information retrieval (also called text retrieval) packages consist of programs to create, search, and maintain the records in text databases. A text database may contain the full text of reports, newspapers, or legal documentation, or more structured information with a consistent format suitable for library catalogs, product files, inventories, etc. Some systems can handle structured records with field tags, others can handle large files of unstructured text (e.g., contents of newspapers, magazines, legal documents, etc.), some packages cater for both types of text. Additional facilities such as linked thesaurus files, synonym control, and user-defined print report formats, determine the flexibility and price of the package. A recent development is the appearance of packages which index and search 'free text' files, such as word processed documents or downloaded data. They can find any occurrence of words or phrases located across multiple files. More sophisticated searching features such as 'wild card' searches and combined searches are also accommodated. These packages are becoming widely adopted as part of general office automation strategies.

Information retrieval packages tend to be the library solution adopted by special libraries where the emphasis of the service is on fast and detailed information provision rather than circulation and other transaction-based activities.

BASIC FEATURES OF INFORMATION RETRIEVAL SYSTEMS

Record Structure

Data in a computerized database are held in records, where each record is structured in a similar way. Data are normally divided between fields in which particular types of information are stored, such as title, author, publisher, publication date, citation details, abstract, or keywords. Each field is usually identified by a field label or tag, for example, AU for author, TI for title. Users define their own record structure which involves specifying how many fields are required, assigning field labels, and specifying how the fields are to be indexed. Text records can be unpredictable in terms of size of fields and size of records. For instance, bibliographic records may have short or long title entries, with or without authors, with or without abstracts. Information retrieval systems cater for this by allowing for variable length fields and records, within the overall data structure.

The Database Index

The ability to search for a word or phrase anywhere in a record is the prime reason for using an information retrieval package. To achieve this flexibility of searching, the majority of packages use inverted index files, that is, alphabetically sorted index terms which have pointers to where they occur in records. The advantage of this type of indexing is that it provides quick searching regardless of database size. The disadvantage is that the index must be created before searching can take place and the index itself may take up considerable disk space. Also, index creation and updating can be very time consuming.

Indexing Options

Part of the task of setting up the system involves deciding what parts of the record are to be added to the index and in what form. Most software packages offer some flexibility in type of indexing and all automatically strip "common" words, such as "and," "of," "the," and "but," to avoid unnecessary use of disk space. Some packages allow this list to be user defined. It usually is possible to decide for each field how the contents will be treated. The exact choice of indexing method varies between packages, but the common options are: full field indexing, where the whole content of the field is entered into the index; free text indexing, where each individual word becomes an index entry; tagged indexing, where on input, selected words or phrases can be marked so they are indexed; and manual indexing, where the index terms are entered in a separate field at the end of the record. Some packages allow a combination of two or more types of indexing on any one field. As with manual systems, the choices made dictate the flexibility of retrieval and some compromise has to be reached between providing too few and too many paths to a record.

Data Input and Editing

Flexibility of input and editing is important, as entering data, especially initially, is very time consuming. Different packages offer different types of solutions: some use a field-prompting method whereby the next field label appears when the previous one has been completed, others offer 'formatted screen input' where all the field labels are displayed with cursor-controlled input and editing available on the full screen. Many of the packages can import files prepared by word processing software or other text-editing systems, provided the records have the appropriate field tags and that the files are in an ASCII text format. A number of data preparation packages are available which can be set up to automatically assign field labels when records are entered from the keyboard.

Searching

The range of search facilities and their sophistication usually are related to the price of the package. Typical features include word or phrase searching either globally across all fields or restricted to one field; truncation and wild card searching; Boolean logic; set creation; and search refinement. Additional features include range searching, proximity searching (necessary if the package is to cope with full text), and soundex searching for retrieving words that sound similar to one another. Searching is usually command driven, although some packages provide a menu-driven interface or the ability to set one up. The latest developments in information retrieval are concentrating on ease of use. Findings from research into online public access catalogs (OPACs) are also beginning to be applied in general text retrieval systems and the continued interest in intelligent interfaces to provide natural language search facilities can be expected to change the traditional command-driven approach to text retrieval in the next few years.

Data Output

The results of a search can usually be viewed in one of three ways: displayed on the screen, printed on an attached printer, or copied to a file on the disk for further processing or manipulation by another software package. Screen displays vary in their flexibility: in some systems it is possible to scroll through a search set in either direction and specify the format and record numbers to be displayed. A few information retrieval packages offer arithmetic calculations on numeric fields. With some packages, a special program called a 'report generator' is used to create various formats with additional options including page width, page length, print enhancements such as indenting, underlining and emboldening, and the ability to incorporate stored text and headings.

Language Control

Many information units develop their own thesaurus or authority list to exert some control on the number and range of subject terms and names used in the database.

Some of the more expensive packages offer linked online thesaurus programs to assist in both index creation and searching. A few of the systems assist at the data entry stage, by allowing the user to browse through the authority file/thesaurus, select a term, and mark that term to be lifted into the new record. The systems which offer full document storage and retrieval often provide synonym control. The information manager defines the synonyms for a particular term, and the system automatically searches on all terms, which saves the user specifying alternative terms at the search stage.

THE MARKET PLACE

Information retrieval packages were first developed in the 1970s for mini and mainframe computers. As the power of the micro has increased, a number of the larger systems have been reworked for the microcomputer and a number of packages available for micros only have appeared. The speed of development has been such that micro packages are now as sophisticated in terms of their functionality as the original mini and mainframe systems.

Micro packages can cost anywhere from under £100 to several thousands. As in most software, the range of features provided is usually related to cost. However, there are systems at the lower end of the market which have certain features normally expected in the more expensive packages, and vice versa. Often the range of features tends to reflect the underlying intended use of the package. For example, Assassin-PC provides for searches globally across the record only as it was designed to deal with the full text of documents, and not highly structured records.

Two areas are currently the subject of much research and development interest: the user interface and integrating text and nontext data. The former has two aspects, namely screen presentation, with menus, windows and screen prompting increasingly being adopted, and the sophistication of the search interface itself, with features such as a natural language search facility and relevance ranking of the search results beginning to appear in systems on the market. Integrating text and nontext has become a realistic option now that storage capacities are greatly increased through optical media.

EXAMPLES OF INFORMATION RETRIEVAL PACKAGES

Assassin-PC

Assassin is designed particularly for storing and searching long sections of text. It is relatively friendly to use, being searchable on two levels: one for the new or infrequent user, which displays prompts and explanations of commands on the screen; and one for the "expert" user, in which it is possible to short-circuit some of the commands and which has less screen prompting. Up to nine different databases can be set up within the system and these may be searched individually or in combination. Single words or phrases are searchable, but field searching is not supported. Search terms can be controlled by creating synonyms for similar terms (e.g., abbreviations, foreign equivalents, as well as true synonyms), these are then automatically included when one term of a synonym group is searched. Sorting only operates on a whole database and reporting is limited to four user-defined formats supplied with the system. Data can be input from the keyboard but Assassin-PC also supports batch uploading from a number of different word processing packages. Assassin 6 runs on mini or mainframe computers.

Cardbox-Plus

Cardbox-Plus is a general purpose data management package with better text retrieval than many database management systems. It runs on a wide range of micros and there is a multiuser networked version. There are some constraints on record structure: there are a maximum of 52 fields per record, and the fields are fixed in length. The package has a single search and maintain facility which allows users to search for records, display them on the screen, and make the necessary changes quickly and easily, the amendments being incorporated in real time. Global updating of multiple sets of data is possible. Searching is done on single words, numbers, or dates using a simple command system—a list of available commands is on the screen at all times. There is no Boolean searching, but users can refine searches hierarchically. Different output formats can be defined and a template facility can copy details of records into standard letters and text.

Headfast

This is one of the newest systems on the market. It has been developed specifically with ease of use in mind. In the search module there are three methods of searching: Quick Search, to retrieve words or phrases within a single field; Form Search, to retrieve from different fields; and, Menu Search, which allows a search strategy to be built up in stages. Boolean logic and truncation can be used in all the search methods. After the search is completed, records are automatically displayed in a summary list: two other report formats can be user defined. The system is menu driven and function key controlled throughout.

Inmagic-Micro

A micro derivative of a large software system running on minicomputers, Inmagic-Micro runs on a wide range of machines and there is a multiuser networked version. It offers variable field length, repeatable fields. The software is command driven although there is help and a tutorial contained within the program to explain the commands and how to use them. Searching requires fields to be specified and can be done on either single words or whole fields depending how the user has set up the indexing options. The latest version offers full-screen editing and good report generation facilities, whereby report formats can be stored and called up to format data for output. Simple calculations are available on numeric fields within the report formatting program. Sorting is possible on up to five fields at a time and an "exploded" sort will allow a record to be included as many times as necessary in the output if the sort field contains more than one entry. Inmagic-Biblio provides data structures for a library housekeeping system based on Inmagic.

Micro-Cairs

Also a micro descendant of a larger system, Micro-Cairs runs on a wide range of micros and can be networked. A multiuser version runs on the Micro-Vax. The package is available in three versions catering for simple single database users through to multiple databases with full thesaurus controlled searching, stored searches, and current awareness facilities. The thesaurus file creates a list of "go" words and establishes relationships between words. When searching, the user is prompted if they use a nonpreferred term and up to three levels of terms in the thesaurus hierarchy can be incorporated automatically in the search. The latest release contains menus to assist the inexperienced user: the full command language still is available for expert users. All menu screens and help screens are user definable. Up to 26 report formats can be stored within the program. Sorting is also done by creating profiles which can be called up and included in the output command.

Micro-Status

Status is designed as a free-text information storage and retrieval package. The micro version runs on IBM and compatible machines, as well as some Unix micros. Micro systems can be easily upgraded to larger systems. Records (called "articles") are made up of keyed fields which contain numeric or value information, and named sections for textual information. Articles are grouped into "chapters" which may be searched singly or in combination. The many search facilities include general browsing and proximity searching. Unlike many packages, searches are not assigned set numbers but the subquery command does allow the previous search statement to be refined. Display options are also varied and user defined formats can be easily created as part of the display command. Menu-driven searching, help functions, and small, often-used routines can be set up in the system using "macros": a number of these are supplied as standard with the system. The system supports synonym control and there is an optional thesaurus module which acts as an online aid for controlled term searching.

LIBRARY HOUSEKEEPING SYSTEMS

Library housekeeping or management systems embrace the following functions or application areas: cataloging, including catalog creation, and catalog access, in hard-copy or online form; acquisitions, mainly relating to the purchase of monographs; circulation control; and serials control, including subscription management, check-in, and distribution or routing to users. A few packages are currently developing inter-library loans as an additional module.

Information retrieval systems can be used for such tasks but traditionally they have had a number of drawbacks if applied to library housekeeping, though these are disappearing as packages are enhanced. Many have allowed only batch updating of records and of indexes; even if available as a real-time option: index updating, usually by reinverting the whole record, offers poor performance in a dynamic system where data is constantly changing. As noted above, they have tended to be command driven and hence not suited to casual user access. They are self-evidently most suited to cataloging and catalog-related activities, especially if there is a requirement to handle documents or reports with abstracts. They are weakest in the areas of serials check-in and routing, and circulation control in cases where a high volume of loans transactions is involved. Some packages do, however, incorporate features which make them more amenable to use in a housekeeping context and a number of IR-based housekeeping systems are now on the market, including Cairs-LMS and LibraryPac.

The alternative is to purchase one of the dedicated housekeeping packages, which have been increasing dramatically in range and in diversity over the past few years. There are essentially two kinds of systems: those developed solely for microcomputers; and those which, by virtue of their operating systems (e.g., UNIX, PICK) run on a range of machines from microcomputers up to large minis and mainframes. In the former category, there are single-user systems, normally running on IBM or compatible micros, which are often also available in multiuser versions running on a local area network such as Novell. As well as the recent upsurge in the number of packages available, there has also been considerable development in the application areas supported by such systems. Many now support the complete range of applications, and integrated multifunctional systems now outnumber those for single applications. This distinction is, on occasion, rather arbitrary: having developed one application, very often the supplier will add another interfaced to it.

FUNCTIONS AND FACILITIES PROVIDED

The functions described are based firmly on facilities of the packages in the present market place. However, most packages will not provide all the facilities/functions in all the areas.

Cataloging

For bibliographic record handling, all packages allow online data entry, to formatted screens or to prompts, with full-screen editing facilities such as cursor control, insertion, overtyping, etc. Files and indexes are updated online, often in real time. Record structures vary in their flexibility: they may permit the user to change field labels on screen and print output; some allow libraries to define for themselves fields and indexes, indicating which fields are to be indexed and which type of indexing is to be applied. Output is normally on card or print in a variety of sequences and levels of sort, and some systems will also provide COM.

Catalog Inquiry

For access to the catalog file, inquiry is, naturally, online with access by at least Author, Title, and Classmark, in addition to some form of Control Number. The more basic systems employ phrase indexing up to a maximum number of characters, with, therefore, implicit right-hand truncation. The more sophisticated systems have keyword indexes, with words taken from title field(s), subject, abstract, as specified by the library; often there are additional retrieval facilities such as Boolean logic (usually

AND and OR), wild card characters, and truncation. Most systems are menu driven; some have an OPAC for casual or novice users.

Acquisitions

Systems use the same bibliographic file and/or allow bibliographic details to be copied to the order file. Other standard facilities are: support for a suppliers' file, so booksellers' data are easily input and retrieved by a simple code; ability to handle item costs and totals; production and printing of orders, usually in supplier order batches; production of chasers and claims notices, possibly as exception reports; handling fund allocation and budgets for monies committed and spend; fast recording of receipts with use of defaults to reduce keying; and a couple of packages have also introduced automatic currency conversion.

Circulation Control

Circulation modules maintain borrowers' files with at least one address for mailing and with status information on the borrower. They provide speedy entering of book and borrower, either by keyboarding but increasingly by light pens and barcodes. Online checks are carried out on entitlement, and on book and borrower status; these may simply warn or may inhibit the transaction. Once a transaction has been accepted, all files should be updated immediately. Overdue notices are printed and some form of reservations control is provided.

Serials Control

This is an extremely complex area requiring handling of many titles, copies, routing lists, and the idiosyncracies of serial publishing patterns. Systems currently available allow the library: to record titles with multiple locations; to control subscriptions, both costs and renewals, for these copies; to check in copies and issues of a title (probably with some element of prediction included in the system); to produce claims for missing and overdue issues; to control distribution or routing round borrowers; and in some cases, there are even routines for binding control.

THE MARKET PLACE

The market place can be divided into two broad categories: the 'integrated' library package; and the application-specific package. This distinction is, as noted above, on occasion rather arbitrary, given that, having developed one application, very often the supplier will add another application interfaced to it, so it is a quasi-integrated system. The description 'integrated' should itself be treated with caution—though the classic definition is of a system of several applications or modules each served or supported by a common bibliographic file: design constraints and development histories have often given rise to apparently integrated systems which do in fact maintain more than one version of the bibliographic file. In addition to the integrated library package and the application-specific package, it is sometimes possible to buy an individual module of an integrated system for one particular application. Costs vary considerably ranging from under £1000 to several thousands, depending on many factors such as the modules taken, hardware base, and number of users. Some suppliers can provide hardware as well as software.

Integrated Library Systems

Integrated library systems have come from two backgrounds, the special library and the small academic library, and the features of each are correspondingly different. Those with special library origins (e.g., BookshelF, Calm, and Sydney) tend to have a stronger emphasis on retrieval and in particular on use of keywords, of Boolean searching, and of thesaurus control to subject terms. They also have serials control and routing, though not necessarily binding control. On the debit side, circulation control is often limited, with perhaps one single overridable loan period, and with severe restrictions on the options to control borrower entitlement and to implement differing borrower categories and privileges. However, recently some packages of this type have introduced 'high level' circulation modules expressly to cater for the needs of the college market. The integrated systems which have evolved from academic library needs (usually small college) offer more generalized retrieval, often via simple menus, and frequently targeted at known-item searches. On the other hand, circulation control is more parameterized with varying loan periods, with provision for borrower categories to influence loans policies, and with fines control. Examples are Lending Library, Libra, and Datatrek Integrated Library System. As prices of hardware fall and the emphasis on project style learning has become popular in schools, the demand for school library systems has been met by a number of new products. They tend to concentrate on catalog provision and circulation activities and are priced at the lower end of the price spectrum. Systems such as Micro-Librarian, Micro-Library-System, and Dolphin are only for schools; a few of the other small system suppliers have developed stripped down versions for the school library market or offer systems at considerable discounts to schools.

Application-Specific Software

The application-specific software is predominantly for serials control, although there are some packages available for circulation control, acquisitions, and interlibrary loan. Serials control is most commonly seen as suitable for a specific application package; these may be developed either solely as a serials product (e.g., by the subscription agents) or offered by the supplier of an integrated package on a standalone basis. Suppliers of integrated systems all have different policies regarding the supply of standalone modules, but most offer a range of options.

EXAMPLES OF LIBRARY HOUSEKEEPING SYSTEMS

BookshelF

The system runs under PICK on a range of hardware, and under PRIMOS on Prime, and is marketed to large libraries, as well as to the small libraries for which it was originally developed. For the smaller library, the system will run on an IBM-PC

AT or compatibles. BookshelF has the following modules: acquisitions; cataloging and inquiry; circulation; and serials control. The inquiry module is command driven, although a menu interface is due for release. Users include various college and special libraries, including several medical libraries. BookshelF pc is a single-user version of the software covering cataloging, acquisitions, and circulation control, running under the Revelation database system.

Cairs-LMS

Cairs-LMS is a Library Management System developed on the Cairs-IMS information retrieval software. LMS incorporates a series of predefined Cairs databases, with links between these, typically by accession number. Cairs-LMS can run independently, supported by its own bibliographic database or be interfaced to Cairs-IMS. Cairs-LMS runs on a range of hardware from mainframes downward: at the microcomputer end it runs on IBM PCs and compatibles. It is available in three functional modules which can be purchased separately: catalog and acquisitions; loans; and periodicals. Though the loans module offers features such as control of loans period and entitlement by a range of borrower and material categories, Cairs-LMS is targeted at the needs of the special library with less demand for dynamic updating. Most of the records and files are updated in batch.

CALM

CALM was developed in Israel and first marketed in the United Kingdom in 1984. It includes the following modules: acquisitions; cataloging and inquiry (with thesaurus control, subject indexing, and free text indexing); circulation control; and serials control. The system was initially geared toward the special library, but with college libraries taking an interest, an upgraded circulation control module was developed, with loan matrices by reader and material categories, to determine loan policies. The system runs under MS-DOS, and on various networks, including Novell. CALM has more than 50 users in the United Kingdom, including college and special libraries.

Data Trek Integrated Library Management System

Dawson's originally marketed a serials management system, SMS, and Data Trek Inc., their Card Datalog system developed in the United States for corporate libraries. The two companies came to an understanding at the end of 1987, resulting in a new company, and a new system incorporating Card Datalog and SMS: the Data Trek Integrated Library Management System. The system runs on IBM PCs or compatibles and is multiuser, running on any network which supports DOS 3.1. or above. A VAX version is also available. Modules are: acquisitions; cataloging; online catalog; circulation control; serials control; and AIM (the interlibrary lending module, developed in conjunction with Leicester Polytechnic). The cataloging module includes authority control, and the online catalog provides for index browsing and full Boolean searching. It is possible to take individual modules: the system is designed so that separate files are maintained for each function. A recent enhancement is the addition of a

Reserve collection function for the control of loans and reservations from a short-loan (hourly based) collection. The system is marketed for college, corporate, and school libraries.

Lending Library

G & G is a partnership which developed the CARS/CLASS system for Plymouth College of Education, a system which was taken up by several other college libraries. The new system, Lending Library, supercedes CARS/CLASS, and runs under UNIX. Modules are: book ordering and order printing; book cataloging and searching; abstract cataloging and searching; circulation control; and periodical control. There are several users of the system, all college libraries.

LIBRA

Emtek Computers are specialists in microcomputer system maintenance and became involved with library systems in this role. The LIBRA system incorporates acquisitions, cataloging and retrieval, issues, reader search, and various utilities such as word processing and spreadsheets. It is a low-cost system developed initially for college libraries. It runs on a variety of machines, under MS-DOS, Concurrent DOS, and Xenix.

Librarian

Eurotec Consultants partnership, formed in 1979, provides various packages including the library system, Librarian. As a single-user package, the software runs under both MS/PC-DOS and on Concurrent DOS systems; multiuser versions are available on MS-DOS-based networks and on multiuser concurrent-based micros. The system in developed around a proprietary database management system, and customizing to suit each library's requirements is a basic feature of the system. The original system, developed in 1982, was for cataloging and inquiry; the range of advertised modules now includes current awareness and OPAC as submodules of inquiry, circulation control plus stock control, and interlibrary loans, acquisitions, and serials management. Management statistics, word processing, and a bulletin board are also supported, as is access to external databases. Librarian has more than 48 users, spread fairly evenly across educational, commercial/industrial, and medical libraries with sites also in government libraries and in the libraries of professional bodies.

LibraryPac

LibraryPac is the name given to an evolving series of packages offering various levels of integration between a text retrieval package and a full circulation control system. LibraryPac1 is a flexible text retrieval package and is suitable for libraries starting with storage and retrieval functions, but who may wish to extend to circulation control at a later date. LibraryPac2 combines the features of LibraryPac1 and circulation control in a single user package suitable for smaller libraries. It provides for barcode indexing to create entries in a barcode number file for later use. LibraryPac3 also combines storage and retrieval with circulation, but with Epson HX-20 microcomputers interfaced as intelligent issue desk terminals. All packages run under MS-DOS, and are available in networked versions. Systems are in use in various schools, colleges, and hospitals.

Sydney Library System

Sydney is an international corporation marketing various kinds of bespoke systems and packages, as well as the library system. The Sydney Library System (formerly Micro Library and renamed because it now runs on VAX, and so is not technically just a micro system) was developed from a mini-based library system for special libraries, originally marketed in North America. The system has three base modules: cataloging (including authority control); inquiry; and inventory control. Optional modules are: MARC record interface; acquisitions; circulation control; and serials control. The serials control module is also marketed as a standalone product. Circulation control was initially geared toward the needs of the special library, but a module to suit the needs of the college library is being developed. There are around 60 users in the United Kingdom, primarily in the special library field.

TINlib

Based on the proprietary relational database management system TINman, TINlib runs under MS-DOS, DOS networks and UNIX, with a VAX version planned. TINlib has been in use for cataloging and retrieval for some time; circulation, and more recently acquisitions and serials control, have been added so it is now sold as a fully integrated system. Also available are communications software, import/export options, and an interlibrary loans module. Some of the modules are also sold as standalone products, namely TINlend, TINbuy, and TINper for interlibrary loans, acquisitions, and serials control, respectively. There is also a standalone thesaurus management tool, TINterm.

TINlib is, in general, aimed at the special library, but its circulation module can be set up to provide for college library type requirements. It has some powerful retrieval capabilities, including a browse and navigate facility: this allows the user to search any index, using an arrow to select the required heading; when a record is displayed, keywords, authors, and other index terms are included in the display, and any one of these may be selected by positioning the arrow for the next search—the navigational aspect. Another feature is the ability to window specific portions of files (e.g., authority files) and to conduct searches and amend data within the windows. There are around 30 users of the system in the United Kingdom, primarily using the cataloging and retrieval modules.

Communications Software

In addition to using microcomputers to improve the productivity and efficiency of many in-house library routines, micros are increasingly being used to communicate with other computers. Terminal emulation online with a micro makes it possible to access online services, electronic mail, or bulletin boards', to transfer files to and from another computer, or to act as a terminal to an in-house mini or mainframe computer.

There are a number of benefits to using a micro rather than a dumb terminal to go online. These include: easier connection to a remote computer service; downloading information to disk; and uploading pre-prepared files. Of these perhaps downloading is the most useful feature as it allows data to be reused in a number of ways. This may mean simply loading it into a word processing package to tidy up the search or electronic mail message before sending it on. More extensive reworking of the data into different formats is another option, and special reformatting packages are available to do this. Running downloaded data through such packages can convert data for a number of purposes. For example, a search can be stripped down to a format more appropriate to a current awareness bulletin, or the same record could be changed to match an existing in-house database so that the downloaded records could be incorporated into it. Reusing records in this way will, of course, depend on the attitude of the database producer.

FEATURES OF COMMUNICATIONS SOFTWARE

Software for communications, and particularly going online, should be able to do the following:

1. Make the micro behave like a terminal (i.e., to transmit and receive data under certain specifications).
2. Deal with the idiosyncracies of different telecommunications networks and different hosts when transferring data. The telecommunication line variables such as baud rate, parity, and duplex, etc. are stored within the program for each host to be accessed.
3. Store within the program the logon procedures required for the remote computer (e.g., network addresses, user identifiers, passwords). Most packages now allow completely automatic logon. Some provide additional programmable function keys or 'user-defined' keys which are useful for storing frequently used commands, search sequences, or logoff commands.
4. Transmit the stored logon and logoff parameters by at least one of three different methods: line by line, each being triggered from the keyboard; en bloc by inserting time delay characters between the stored parameters to allow time for the network or remote computer to respond; en bloc by inserting the prompt sequences expected from the network or remote computer to act as a trigger for the software to send the next stored parameter.
5. While online, permit local control over the printer, upload and download files, and provide a break key facility.
6. Allow the option to transmit a prestored search strategy either en bloc or line by line, thereby enabling the user to adjust the strategy if necessary.
7. Capture data displayed on the screen and at the same time record it on disk for later display or printing after disconnecting from the online service. The printing could be done though word processing software to repackage the results into a format more appropriate for the end user.

Some packages offer additional features. A number can be used to access viewdata services with the full range of graphics, double height characters, and flashing characters, although use of these facilities will also depend on the micro. The facility to redial or cycle telephone numbers is useful to save time should the preferred route fail, if more than one telecommunications route is available for a particular service. Several packages have an editor within the package so that files can be prepared without the need for separate text editor or word processing software. Improved screen handling when online is another recently developed feature: a number of packages now store incoming data automatically, even if it is not being downloaded to disk. This gives the user a chance to redisplay previous screens of a search and take a screen dump if necessary. For a manager of an online search service, the ability to log all calls made to online services is another useful extra feature. In some circumstances you may want to have your computer do a search in the middle of the night or at a specific time in your absence. Some packages offer this by providing a programming facility. The newest developments in communications software include the ability to search systems containing graphics: examples to date include trademarks and chemical structure searching.

THE MARKET PLACE

The packages currently on the market can be divided into four different groups:

1. General purpose communications software (e.g., Crosstalk, Datatalk, ProComm Plus and ChitChat). These packages are intended for general business use rather than being specifically geared to online searching and they are usually supplied by high street computer dealers. They can often be used for a wide range of communications activities including file transfer. There are a number of public domain and shareware products in this category.
2. Packages intended for use with a wide range of hosts and aimed primarily at online search intermediaries (e.g., Headline). As few online services offer all the databases needed by any one organization, many librarians and information workers require a package that will work well for a range of services.
3. Packages aimed at users of particular online services (e.g., Dialoglink, Blaise Recorder, Mikrotel, STN Express). As these packages are designed for a particular service, they incorporate features specifically suited to that service. They vary in their ability to access services other than the one for which they are principally intended. Some also incorporate features designed to help the novice or casual searcher.
4. Packages aimed only at the novice online searcher, designed to mask the logging on and the different online search command systems (e.g., Information Transfer, Tome Searcher, and Pro-Search). Packages in this group provide a considerable amount of help in designing an online search and choosing a database. They will also logon to the chosen online service, translate the search query into the appropriate command language, download the results, and logoff, without any user intervention. They operate only on the few services for which they have been designed and so are not suitable for those who need access to a wide range of services.

Costs of software varies from free public domain software to several hundreds of pounds for friendly front-end packages.

EXAMPLES OF COMMUNICATIONS SOFTWARE IN USE FOR ONLINE SEARCHING

Blaise Recorder

The British Library's software is primarily intended for users of the Blaise Records service, but it can also be set up for automatic access to eight other services. One set of communications settings is stored within the system. If the different services used require different settings, these must be altered each time. Some settings can be changed while online. Different logon files can be created using the text editor within the software, and called up for automatic logon. The text editor is also used to prepare uploading files and for searches based on matching ISBNs (a validation function is available to check the ISBN digits entered). A recycling program can be used online to automatically edit stored searches, removing requests which have been satisfied, and allowing only the remainder to be matched against other databases. The software stores previous screens of a search in the micro's memory and a scrolling facility allows the user to review the last 18 screens of a search while online. Data can also be downloaded very easily; a single keystroke opens a temporary file which can then be renamed when the search is complete.

Chit-Chat

This general purpose software is designed for ease of use. It comes already configured for 24 of the most popular electronic mail and bulletin board services, as well as for Prestel. Additional services can be added. Purchasers can obtain a free subscription to Telecom Gold and there is also an option to buy the package together with the Thorn-EMI autodial/autoanswer modem. The required service is selected from a main menu of all services for which profiles are set up; a single key stroke then sets the connection procedure in motion. The stored profiles are divided into three sections containing basic connection details, advanced and nonstandard connection details, and the auto logon parameters with search details. Most operations are function key controlled; definitions of the function key uses appear at the base of each screen. Command files can be set up for automatic online sessions at predetermined times and there is also a host option to allow file transfer micro to micro.

Datatalk

Datatalk is a communications package with an internal text editor for preparing text files and editing before uploading. The package works by calling up a series of windows using cursor-controlled keys to make a selection at each stage. In the set-up window, the options are to choose values for speed, data bits, parity, or to enter the service window for setting up or amending host profiles. The auto logon sequence is stored on one line (a maximum of 73 characters) which means that for a long logon procedure, such as going through PSS can entail, space is rather limited and the sequence has to be carefully planned. There are three options for automatic logging on: timed delays; stored matching prompt sequences from the host and network; or the use of function keys. With a system clock, a command file can trigger a search at a preprogrammed time, automatically upload and download, and logoff from the system. The package has a wide range of emulation facilities, including dumb terminal for online searching and electronic mail services, viewdata emulation, X and modem for file transfer. Purchasers of the software can obtain a free subscription to Telecom Gold.

DialogLink

DialogLink is available as two separate products. The Communications Manager comes set up ready for access to Dialog: users have only to enter their own passwords and telephone numbers to go online. The package can also be used to access up to 20 other online services automatically once a profile has been set up using the menus and macros to store logon procedures. Once in terminal mode, DialogLink uses function keys to call up windows to activate logon procedures and control operations such as uploading, selective downloading, selective printing etc. It is possible to type ahead on many of the remote systems which can save connect time. The type ahead buffer can also be used offline to prepare searches in advance. In the latest version, DialogLink supports image searching. Search results are automatically saved in a retrieve buffer which can be reviewed on the screen and tagged for selective downloading or printing either online or offline. Context-specific help is available. The Communications Manager can be used to track an online search session on Dialog services. This information can be used to generate an invoice that itemizes costs and connect times for individual search sessions. Using the Account Manager, it is possible to compile summaries of search activity and costs and to prepare estimates of Dialog costs. A DialogLink evaluation disk restricted to two hours of online search time is available for potential users to assess the software.

Headline

Headline was developed specifically for online searching and can be used for all the major online services and electronic mail services which require dumb terminal emulation. It cannot be used to access viewdata services. Host profiles are stored in a single screen standard format: 10 user-defined lines are available for logon passwords and the logoff command, and a series of letter-coded lines store the line configuration details. Each stored line is transmitted to the network or host as required by a dual key command. Files for uploading can be prepared in HL-Entry, the text editor included within the package. Once online, printing, uploading, and downloading are controlled by toggle keys. Transmission of files can be done line by line, with the option to skip lines or hold them for later transmission, or the file can be sent en bloc. The same company also markets Headform which can be used to reformat downloaded data.

ProComm Plus

ProComm Plus is the latest version of ProComm, a general purpose communications shareware package which has been very popular in the United States. For a very modest sum, the package provides a wide range of communications protocols and emulations and provides a number of useful features for online work, such as scrolling displays, screen dumps to disk or printer, or the option to view a file before uploading. The new version includes masking to provide password security, context-specific help, telephone call history, and an audit facility to keep track of the number of calls made and their duration. The software is controlled by a range of different mnemonic 'Alt' key combinations (e.g., Alt-D for the dialing directory listing the services for which auto-logon has been set up, Alt-B to send a break to the host, Alt-H to hang up the phone). As supplied, invoking these different commands often produces an interesting sound effect from the keyboard. Luckily this feature can be disabled when the novelty wears off! Logon can be done line by line using the keyboard macro facility, or completely automatically by writing a script file. A useful feature is ProComm Plus' ability to record a series of prompts and responses while online to form the basis of a script file to automate that procedure. There is no text editor for preparing searches, but there is a hot key facility to allow access to a separate program from within ProComm Plus; another hot key allows access to the operating system. The manual is very comprehensive and includes a useful chapter introducing the idea of communications with a micro. However, the examples given relate to procedures typical of e-mail and bulletin board access rather than those familiar to online searchers.

STN Express

One of the newest communications packages, STN Express is a friendly front-end package designed for those using the scientific and chemical information available through STN International. Using a series of prompts, the package allows searchers to construct and check chemical structures and to download graphics. If this feature is to be used, the micro must have 512K RAM, graphics capabilities, be running DOS version 3.0 or higher, and have a mouse system installed. STN Express also uses prompts in the guided search feature to assist the novice user in constructing a search strategy. However, unlike some front-end packages, users who are familiar with the command language can make full use of it in STN Express. A series of predefined search strategies is supplied with the software for commonly asked inquiries. Logging on is completely automatic and is activated by selecting the appropriate option from pull down menus at the top of the screen. STN Express can also be used for searching on BRS, ESA, and Dialog. Full downloading and printing features are supported and help is available at all times. An STN Express sampler is available from the suppliers.

Tome Searcher

The Tome Searcher expert system aims to remove completely the need for any knowledge of search construction. Configured for a particular subject area, the Tome Searcher allows a user to describe their query in natural language and then formulates it in the language of the host. By asking questions, the system knows whether a broad or narrow search is needed and any limitations which should be applied. The system will then logon, do the search, download the results, and disconnect, without the need of any further input from the user. At present Tome Searcher is available only for electronics and computer science databases on ESA or Dialog, but more are planned, with pharamceuticals and aerospace products already well developed.

Useful Directories of Software

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CAROLINE MOORE

REPRODUCTION RIGHTS ORGANIZATIONS, IFRRO, AND THE COPYRIGHT CLEARANCE CENTER

The pervasiveness of the photocopy machine and subsequent advances in copying technology have generated a critical need for the establishment of systems that enable users to copy lawfully from copyrighted works, and ensure that rightsholders receive appropriate monetary compensation for such access to their intellectual property.

The mechanism that has emerged to address this need has been the Reproduction Rights Organization (RRO). RROs were originally called collecting societies and are patterned in many ways after performance rights organizations, which have existed throughout the world for decades. RROs issue licenses to photocopy where and when it is impractical for rightsholders to act individually. In addition to the multiplicity of rightsholders, from whom millions of authorizations would have to be secured by hundreds of thousands of users, there are the complexities of differing languages and laws, unknown legal risks, lack of understanding of the market in order to set fees, and the difficulties associated with any enforcement activities. RROs are able to act where individual rightsholders simply cannot.

Sixteen countries, including the United States, currently have functioning RROs. In order to convey authorizations en masse from their respective national rightsholders, RROs enter into bilateral agreements with each other. These agreements are generally based upon the convention doctrine of "National Treatment," that is, each RRO seeks to act on behalf of foreign rightsholders in approximately the same way that it acts on behalf of its domestic rightsholders. The international mechanism that facilitates these bilateral agreements is the International Federation of Reproduction Rights Organisations (IFRRO).

IFRRO began in 1980 as an ad hoc working group of the Copyright Committee of the International Publishers Association/Scientific, Technical, Medical Publishers Group. Since that time, it has evolved into a formal nongovernmental federation eligible to speak on behalf of RRO interests before various international bodies such as WIPO and UNESCO. As of this writing, IFRRO has some 50 members that include both RROs and Associate Members, which are both national and international associations of publishers and authors. IFRRO's purposes are to foster the creation and development of RROs worldwide; to facilitate rights/royalty conveyance agreements among its members; and to educate and assist in information flow among its members.

The Copyright Clearance Center, headquartered in Salem, Massachusetts, is the RRO for the United States. It began operation in 1978 as a result of the efforts of various groups, associations, and individuals from the author, publisher, and user communities. These efforts were catalyzed by the recommendation of the Congress that a practical clearance and licensing organization be developed by the particularly affected interest groups to facilitate compliance with the revised U.S. copyright law that became effective in 1978.

The CCC's first efforts were the creation of a transactionally based system, whereby users would record and periodically report photocopying from all works registered with CCC. After two or three years of operation, it became clear that the administrative burdens of such a system were simply unacceptable to the vast majority of users within the United States. With the assistance of user corporations, CCC responded by developing an annual licensing system for corporations that relied upon 60-day surveys from which statistical estimates were developed and annual predictions photocopying were generated.

This licensing program, called the Annual Authorizations Service, was developed with the help of consulting econometricians at MIT and Harvard University. Photocopy machine and employee demographics are used in combination with the results of photocopy surveys at corporate sites in order to calculate license costs. The licenses are based either upon a particular company's photocopying behavior exclusively or, in a less intrusive version, upon the photocopying behavior of all corporations surveyed within a given industry.

These processes not only provide accurate estimates of the quantities of photocopies generated by a corporation, but also provide information on titles from which the copying occurred, thereby allowing effective distribution of royalties. CCC's distributions to rightsholders were (U.S.) $2.5 million in 1989 and $5.2 million in 1990. More than 120 major corporations in the energy, pharmaceutical, electrical, chemical, and electronics industries now hold CCC licenses.

To date, more than 8,000 publishers have registered 1.5 million titles with CCC. A substantial number of these titles are part of CCC's repertoire as a result of bilateral arrangements with foreign RROs. Through these agreements, CCC is authorized to collect royalties in the United States on behalf of participating foreign rightsholders. CCC has such agreements with the Copyright Licensing Agency (United Kingdom), Centre Français du Copyright (France), VG Wort (Germany). Copyright Agency Limited (Australia), and Kopinor (Norway). Pro Litteris (Switzerland), CEDRO (Spain), Copyright Licensing Limited (New Zealand), and VAAP (USSR).

Reciprocal agreements also have been executed between CCC and several RROs through which these RROs are authorized to collect royalties for copying from U.S. works in their respective countries. In July 1988, CCC received its first-ever payment from a foreign RRO, Kopinor which to date has sent to the United States (U.S.) $3.1 million for copying from U.S. works by the Norwegian government, schools, and universities from 1985 through 1989.

Although national RROs have already made a significant contribution to the effective administration of reprographic rights, numerous groups of users throughout the world continue to reproduce copyrighted material without securing the necessary authorizations from rightsholders. In an effort to broaden its licensing scope in the United States, CCC has begun a pilot licensing study involving several universities. The purpose of the program is to generate data that will allow the development of a licensing system appropriate to academe.

In addition to these developing licensing efforts, CCC is also exploring, on a pilot basis, the possibility of creating a collective licensing program for electronic database access to print works. This is a complex area that will require exceptionally careful planning and development in order to effectively safeguard the interests of everyone involved.

Appropriate copyright laws are the first step in the effective protection of literary works. But, operational RROs are the critical second steps that are the *sine qua non* for reasonable implementation of the world's copyright laws.

JOSEPH S. ALEN

SELF-DIRECTED INFORMATION PROCESSING

Self-directed information processing (SD-IP) by individuals is reviewed in relation to the information environment within which American society is now rapidly expanding. Scholars have cited various sources as evidence of the initiation of the information revolution and numerous "celebrations" (*1*) have occurred which extol the very real benefits to be obtained. But for the masses, any real life evidence of personal and individual lifestyle applicability does not seem very prevalent.

Unfortunately, such a gap between the aroused expectations of benefit among large segments of the population and deliverable consumer products "that work" all too often fosters a luddite backlash. In the current entrepreneurial environment, it is hoped that some popularly viable deliverable would soon "make good" and remedy the limitations of such "volkswagen" efforts at a people's computer as those of Apple, Leading Edge, and other products.

For the purpose of this article, two documents have often been recognized as instrumental in focusing attention on the many phenomena which have been associated with information consumer advocacy. The market, institutional, and professional (to some extent) aspects of the new commercial enterprise surrounding information processing were initially considered to be delineated by Machlup (*2*) in the *Production and Distribution of Knowledge in the United States*. This work provided extensive documentation for the new social environment that has arisen since mid-century even though Machlup (*3*) was later to question the validity of the many cults surrounding the new information society.

The human information processing aspects of the information phenomenon were carefully analyzed by Havelock (*4*) in *Planning for Innovation.* Taking a sociological and social psychological perspective, Havelock developed the macro model of knowledge production, dissemination, and utilization (KPDU). To some extent, Havelock realized the "vision" expressed by Weaver (*5*) for an explication of the social and psychological implications of information theory. But more significantly, Havelock articulated the need for a consumer advocacy approach to information deliverables (*4*, Chap. 11).

This preliminary departure was advanced in the work, *Putting Knowledge to Use* (*6*), which analyzed and synthesized the literature about knowledge dissemination and social change. More recently work in this area continues to be reported in the quarterly journal *Knowledge* (*7*) a publication of the Howard R. Davis Society for knowledge utilization and planned change. Thus, some professional interests are beginning to coalesce into socially responsible movements formed to promote the democratization of knowledge in both its sociological as well as, hopefully, in its psychological dimensions (*8*).

In helping to articulate this socioentrepreneurial movement—following Hall's model (*9*) of dissemination—some entity could be created to serve as: (i) a catalyst for melding theory and practice, (ii) producing knowledge utilization, and (iii) exploiting knowledge in the process of bringing about planned change. These outputs may be embedded in each of the following themes (*10*):

Creating a national learning community for improving human services.
Knowledge utilization strategies in managing the changing human services milieu.
Planning survival strategies for human services programs and agencies.
Training human services administrators for knowledge utilization and planned change.
Defining public and private roles in bringing about planned change.

The multifaceted advances being made by researchers, policy makers, administrators, educators, consultants, and other service providers are being applied to knowledge production and dissemination. But little attention is focused on that kind of responsible knowledge utilization which seeks to reduce human loneliness and the anguish of being uninformed as well as foster individual personal development. Indeed, the dichotomy between the celebrated benefits of the information society (*1*) and the actual realization of these expectations is approaching a mental dislocation among the mass population.

Self-informative behavior has long been considered to be at the base of the essential transfer competency in society and constitutes that set of skills which underlie all areas of ability development. Before the emergence the modern world, the otherwise educated person was either a churchman or a politician. In the Renaissance, such a person may have been called a scholar printer, or a universal thinker. During the subsequent age of specialization, responsibility for this person's development was either transferred to the institutions or went underground.

Since 1928 (*11*) which it first became evident that adults could continue learning throughout the lifespan, light has increasingly been shed on the fact that there are few if any adults who do not process information constantly in everyday life (*12*). In addition, more and more scholars have become independent of institutionalized specialization (*13*), but yet on their own, have developed a measure of specific and generalized ability to carry out fundamental information processing (IP). In this regard, the independent scholar has profited from self-referral to the various expert systems whether manual or machine based (*14*).

The composure of modern people can no longer be unprotected from an overexposure to the cult of information (*15*). Many people are so frantic over the appearance of events passing them by that the national character is being infected with an excess of impatience (*16*). Reacting to "blipped" spots of information, they scurry around in a patch of newsletters for elusive "tid-bits" that will give them an edge on others. But the titillation is like a runaway infectious disease transmitted from individual to individual as they try to outdo each other in cornering that ultimate "newsletter."

Psychological Systems

During the 1950–1960 era, an information processing approach to psychology was being developed as one "window of opportunity" for explaining human behavior (*17*). This focus on information processing led many scholars to reexamine the older schools of psychology from a systems perspective. Instead of the hoped-for grand synthesis of learning psychology, two streams have developed in parallel fashion and, at times, have overlapped: cognitive psychology and social learning theory (*18*, *19*).

In the language of information analysis, these parallel developments are analogous to the two approaches of top-down and a bottom-up analyses (*20*). In the first, cognitive psychology, knowledge is considered in relation to a screen of human attributes (K_A). In the second, social learning theory, human attributes are considered within a screen of knowledge aspects (A_k). From the perspective of the actual human being involved in the affairs of a personal lifestyle, circumstance may on occasion dictate both top-down (K_A) or bottom-up (A_K) approaches.

No humanly significant approach to information processing can be taken by either K_A or A_K to the exclusion of the other. Humans may at one time face circumstances that force them into a top-down analysis of a problem. In other circumstances they may be heavily involved in a bottom-up approach to situation resolution. Indeed, one may question whether there are two psychologies at variance with one another or a systematic continuence of information processing behavior encompassing various psychologies within which any particular individual may range (*12*, *21*).

In fact, from the syntheses of research about cognitive style, learning style, and the transfer of skills acquisition (*22*), it appears that individuals map themselves onto appropriate behavior sets depending upon the circumstances surrounding their information processing. Over the years since midcentury, when Witkin et al. (*23*) first conducted experimental studies in perception, at least nineteen separate polar dimensions of information processing have been identified (*24*). Thus the complexity of human information processing is evident and the range of possible combinations is enormous (*25*).

Facilitating providers may have to enter the behavior manifestations of any individual whether bottom-up or top-down and move as rapidly to any level therein as quickly and nimbly as does the information user (*26, 27*). Citizen expectations which seem to be rising exponentially come at a time when the information professionals are slowly moving from resource use studies to investigations directed at information processing in the human mind (*28*). In addition, the experts in artificial intelligence have not been able to deliver the kind of proactive services and products based on natural language processing which their press agents seem to have so glibly promised.

From an analysis of some psychological positions one could get the impression that the processes of information utilization were largely subconscious phenomena in the makeup of any individual. More than likely some are and require the facilitation of a helping information consultant for articulation and development. But for the most part, information processing is a highly deliberative affair whose patterns are guided by the imperatives emerging from the organizing circumstances in everday life (*29*). Much of the current emphasis on self-directedness and individual responsibility has developed from the empirical foundation laid down by Tough (*30*) and from the top-down advances of Knowles (*31*).

In these instances, the focus has been on adult populations among whom there has been a sharp increase in the number of self-directed learning projects. The rise in information processing for decisioning, learning, and communicating has been fairly uniform across the population as a whole. This emphasis on the adult as learner takes on a considerable social urgency when the recommendations of the Commission on Higher Education and the Adult Learner (*10*) are taken into consideration:

Developing or renewing employability for the unemployed
Maintaining and enhancing occupational skills in the face of technological change
Eliminating adult illiteracy (both literature and computer based)
Providing equal access to education for all adults (whether self-directed or teacher based)
Developing knowledgeable citizens in an information technology society

These high hopes for human development depend in great measure on an informatively relevant response system that rests on a "volkswagen" approach to a personal computer and natural language software. Work in artificial intelligence is helping to advance the art, but the ventures taken whether top-down or bottom-up have yet to fully explicate the interconnections with real-life interface. Empirical studies are called for which verify and validate a naive psychology and a naive physics and develop a frame of reference out of the actual ways people are involved in everyday life (*32, 33*).

In other words, an explication is needed of the questions surrounding how a self-directed (SD) information processor (IP) does use everyday language to think about and express decisioning, learning, and communicating behaviors, both verbal and nonverbal, whether alone (intrapersonal) or with others (interpersonal) (*34*). Personal information processing probably varies as widely as the unique situational constraints and opportunities of individual humans. However, the transcript analysis of verbal self-reports show several patterns recognizable to most, if not all people. Pattern recognition and use is a function of their membership in the human race, a particular culture, ethnicity, or country and its language.

Social learning theory (*35*) together with Lewin's (*36*) formulation of the concept of life space presents the psychological, social, and physical elements as forces in a dynamic framework. Social learning theory would appear to be the consensus theoretical framework within which much of learning research (especially that on humans) will evolve in the next decade. Study of the life space focuses on action or change or locomotion and works to join neobehaviorism with social learning psychology, thus adding learning-by-modeling to the learning-by-doing of self-directed learning (*37*).

SD-IP occurs when a person encounters some task or problem and the environment provides information concerning the nature of the problem or task, necessary knowledge or skills for its solution, and relevant performance criteria (*38*). A moment of SD-IP thought such as this might occur during a brief lull in a bewildering array of interruptions. Or the individual may not know what SD-IP task is needed far enough ahead of time. Information stored and indexed for one purpose today may be useful in a completely different way next time. Technically speaking, the SD-IP user needs flexible databases with front-end natural language processing (NLP) systems that allows for different record length, associations between records, and the contents of records.

The development of such NLP software systems integrated for self-directed learning (SDL) purposes will be facilitated to the extent that SDL researchers identify the functions that are to be accommodated and communicate them to the knowledge engineers in developing expert systems. Of all the unique combinations of behaviors manifested in SDL situations, research findings continue to support a definable group of transferable skills that are significant across various situations (*22, 39, 40*).

Software "understanding" cannot be developed unless it is embedded with extensive knowledge of the particular world with which it must deal. It is relatively easy to develop mechanistic approaches based on tight logical systems. But these are inadequate when extended to real-world tasks. The everyday world of information processing is often messy and illogical. Therefore, experts in artificial intelligence (AI) have had to leave specialized subject approaches behind and become much more psychological (*41–43*). But the problem remains of not having a real-world contextual psychology within which cognitive psychology can be embedded.

Any prospective SDL software must be able to operate swiftly and efficiently in this human environment of organizing circumstances (*29*) if a microcomputer system is to be a personal SDL tool based on front-end natural language processing (NLP). In the practical world of SDL, the individual must be able to store, maintain, and process all relevant information in integrated databases. The wave of the future is to have a personal database system upon which "all" functions can be performed. Such a system would have to be able to manipulate both structured and unstructured data while at the same time capturing information at the time of thought.

Unfortunately, people are often dismayed that the possibility of the computer taking over cognitive processes is very real because of the great deal of research and data syntheses that have been done. On the other hand, the knowledge about perception and attending (sustained awareness) is more diffuse, susceptible of personal variation (e.g., cognitive and learning styles), and patterned in systems of facing the world (*44*). It is assumed, and some evidence exists for such a conclusion, that these patterns and styles are reflected in natural language which also can be embodied in software programming.

Few people seem to realize, however, how exceedingly complex and often evanescent these patterns of perception and attending really are. They have been the substance of the literatures of the civilizations and feed the diversity of human cultures. It is rare to find either a crosscultural approach to information processing or an examination of the cultural variations in cognitive behavior. Computer software systems seem to have been more oriented to machine architecture than they have to cultural variation. One way of doing this is through the controlled analyses of guided introspective accounts of SD-IP.

The presence and thrust of cognitive psychology is a case of the mind studying the mind. It presumes to replace all of the previous psychologies by studying the foundation on which all other social sciences exist (*45*, p. 6):

> Understanding how humans think is important to understanding why certain thought malfunctions occur (clinical psychology), how people behave with other individuals or in groups (social psychology), how persuasion works (political science), how economic decisions are made (economics), why certain ways of organizing groups are more effective and stable than others (sociology), or why natural languages have certain constraints (linguistics). Cognitive psychology studies the foundation on which all other social sciences stand.

While cognitive psychology is empirical, it eschews the limitations of behaviorism and aims to replace the humanists and the gestaltists. Its principal methodology, protocol analysis, introspection, stems from the work of Wilhelm Wundt in the last quarter of the last century (*45*, p. 7):

> In this method, highly trained observers, reported the contents of their consciousness under carefully controlled conditions. The basic belief was that the workings of the mind should be open to self-observation. Thus, to develop a theory of cognition, one need only to develop a theory that accounted for the contents of introspective reports.

The use of such a methodology has raised a number of confusing issues such as imageless thought, the duality of perception and imagery, and the question of whether memory is dual, multiple, or neither. The confusion has compounded the problem of the representation of knowledge in memory, but especially in external devices such as software analogs. In addition, to compound the matter, there appears to be evidence for an abstract, nonsensory code as well as how this abstract information might be represented (*46*).

The rise and prevalence of behaviorism has been taken as evidence of the limitations of introspection: its irrelevance and its apparent contradictions. Fundamental to the problems was the lack of theories explanatory of internal cognitive processes. After midcentury, various influences were tapped for heuristic models:

> Information processing advances which grew out of information theory and human factors research on human skills and performance.

Computer science efforts to get computers to behave in a manner resembling human intelligence. Numerous computer science concepts have been indirectly applied to psychological behavior.

Linguistic structural analyses showed that language behavior was based on higher mental processes more complex than could be accounted for by the prevailing behavioristic formulations.

Neural network simulation research employing software designed around the random association of infants learning natural language behavior.

Work in these fields has led to improvements in methodology over introspection as the only source of empirical evidence. Measures today are commonly taken on frequency of success in a task and on performance speed which are aimed at improving human cognitive behavior. Task success is usually expressed in percentage correctness to make comparisons less arbitrary; and speed is referred to as reaction time. Statistical significance is coupled by a reliability measure (i.e., reproducibility); and the importance of the difference is determined on criteria applied to both reaction times and performance differences.

There appears to be a tendency to employ artificially intelligent software as the source of data for measures of performance and reaction time. Obviously, cognitive psychology is directed toward those theories which hold explanatory power for cognitive skills and behaviors. The major model of human cognition appears to emphasize information processing defined within such systems boundaries as:

Representation of knowledge, neutral imagery, stored information, schemas and prototypes

Memory and learning, elaboration, and reconstruction, cognitive skills, declarative, and procedural knowledge

Problemsolving and reasoning, induction and deduction, language comprehension and generation

This emerging shift toward abilities other than cognitive ones draws new attention to the complexity and pervasiveness of both perception and attention. Arguments associated with these matters advance the notion of multiple simultaneous thought processes within which serial problemsolving is a special case (*47*). Whether obtained from introspection or laboratory experiments, information processing becomes more persuasive if one steps back from the cognitive domain and observes the broader perspectives of human behavior (*48*). In fact, thinking as executive cognition may not only be parallel, but so distributed in processing as to exist only as a theoretical model and explanatory only of the currently popular computer software approach to intelligence (*49*).

The computer metaphor of cognition may continue as a mainline approach to research methodology, but the reemergence of verbal reports and introspection can help to enrich the totality of research findings (*50*). Protocol analysis of observations has proved valid for recall of the contents of human behavior in incubative and intrusive thought, for example, contents of focal attention, current sensations, plans, and so on. But to bring introspection to these contents would be to deny the ability of people to be involved with metacognition (*51*), that is thinking about the processes of thinking (*52*).

Focusing on computer information processing as the model of cognitive problem-solving has tended to block an understanding of the way in which perception and attention may have contributed to successful outcomes. Performance has traditionally been evaluated on such factors as the time taken to solve a task, and on the correctness and elegance of a solution. But such approaches have obvious limitations when the aim is to nurture the underlying lifestyle performance of an individual or to promote the transfer of problem-solving ability (*53*).

A critical attribute of a theory of perceptual independence is that it have a separate structure devoted to both perceptual and decisional processes. Perceptual independence is, by definition, a perceptual phenomenon, and is defined as an attribute of the perceptual system. Extra assumptions are needed (e.g., whether processing is serial or parallel, self-terminating or exhaustive, etc.), and these make the theory more controversial (*54*). A fundamentally important problem is to determine how these dimensions are combined in perceptual processing (*55*).

Unfortunately, perceptions are not usually directly observable; instead they first pass through some decision process that uses the perceptions to select a response appropriate to the general experimental milieu. Decision or judgment processes therefore fundamentally alter direct perceptions (i.e., the early stages of perception). The theory of perceptual behavior is a substantial generalization of signal detection theory, which can account for experiments with stimuli composed of two or more components and with any of a wide variety of response instructions (*56*).

A decision problem is defined by the acts or options among which one must choose, the possible outcomes or consequences of these acts, and the contingencies or conditional probabilities that relate outcomes to acts. The term "decision frame" is used to refer to the decisionmaker's conception of the acts, outcomes, and contingencies associated with a particular choice. The frame that a decisionmaker adopts is controlled partly by the formulation of the problem and partly by the norms, habits, and personal characteristics of the decisionmaker (*57*).

It is often possible to frame a given decision problem in more than one way (*58*). Alternative frames for a decision problem may be compared to alternative perspectives on a visual scene. Rational choice requires that the preference between options should not reverse itself with changes of frame. Because of imperfections of human perception and decisioning, however, changes of perspective often reverse the relative apparent size of objects and the relative desirability of options.

When faced with a choice, the "rational" decisionmaker will prefer the prospect (theory) that offers the highest expected utility. A predictive approach encourages the decisionmaker to focus on future experience and to ask, "What will I feel then?" rather than "What do I want now?". The former question, when considered and answered carefully, can be the more useful guide in difficult decisions. In particular, predictive considerations may be applied to select the decision frame that best represents the hedonic experience of outcomes (*59*).

The common conception of rationality also requires, in addition to consistency criteria, that preferences or utilities for particular outcomes should be predictive of the experiences of satisfaction or displeasure associated with their occurrence. Thus, a person could be judged irrational either because his or her preferences are contradictory or because his or her desires and aversions do not reflect the individual's pleasures and pains. The predictive criterion of rationality can be applied to resolve inconsistent preferences and to improve the quality of decisions (*60*).

Cognitive styles represent an integrated component of an individual's mode of functioning and are evident in the ways that individuals respond to situations and circumstances. Cognitive styles are broad stylistic characteristics which individuals employ to process information within their cognitive structures. An individual's cognitive style determines the method used to apprehend, store, and use information and refers to the individual's different approaches to understanding, remembering, and thinking (*61*).

Research is beginning to reveal extreme cognitive style polarity in the skill acquisition of many information providers (*62*). Question negotiation involving direct interpersonal interaction seems to be characteristic of field-dependent practitioners. On the other hand, field-independent providers appear to excel in search strategy retrieval, particularly for the more complex knowledge inquiries. Such bicognitive differences in staff behavior also include:

	Field Dependent	Field Independent
Peer relations	Seeks work with others for common goals	Task oriented, not attentive to social groups
	Likes to assist others	Prefers individual work
	Sensitive to feelings and others opinions	Like to compete for individual recognition
Personal relations	Expresses positive feelings openly	Restricts interactions to tasks at hand
	Needs mentor guidance	Eschews physical contact
Supervisory relations	Seeks guidance and personal contact	Prefers new tasks without others help
	Seeks supervisor rewards	Seeks nonsocial rewards
	Only motivated by one-on-one contact	Impatient to begin and finish tasks alone
Information seeking	Seeks global knowledge	Seeks concept details
	Humanized or fictional. Concept presentations	Cognitive (math, science) Presentations
	Proactive deliverables	Reactive deliverables

At least 19 cognitive styles have been identified (*24*) which describe the various dimensions within which individuals structure different perceptual and problem-solving functions. Various assessment techniques have been developed; and while these numerous techniques are correlated with one another, the relationships are far from perfect. Different dimensions of cognitive style which seem to be measured by each may be a function of the item variance which occurs in test proliferation than in the basic measures of rod-and-frame and embedded figures tests (*25*, *63*).

In his research, Witkin (*23*) noted that certain individuals relied heavily on the outside environment for perceptual cues even as these conflicted with internal ones. Others were able to separate easily essential information from a surrounding visual field. The two orientations, titled field dependence and independence, respectively, exist on a continuum, with individuals found at all points. Field-dependent individuals tend not to add structure to visuals and accept visual as presented. Because they do tend to fuse all segments of a visual field (e.g., a picture) they do not view the visual's components discretely.

Field-dependent and independent individuals approach learning in different ways (*64*). First, field-independent individuals, being more analytic in approach, tend to act upon a stimulus complex, analyzing it when it is organized, structuring it when it lacks organization. In many instructional situations, metacognition, or the ability to analyze and structure aids in learning is lacking. The field-dependent learner, however, takes a more passive approach, accepting the field as given, experiencing it in a more global, diffuse manner.

This passive approach means that field-dependent individuals tend to notice those cues in a stimulus field which stand out or are more salient. When the stimulus is arranged so that the salient cues are also relevant, then the field-dependent person may experience little difficulty. In fact, if a learning task is clear, well-structured, and low in complexity, then there may be no significant differences in learning by the two orientations. In situations where cue relevance and saliency are in conflict, the performance of field-dependent individuals seems to suffer.

A visual with a background containing certain relevant (contextual) cues would be of value to field-dependent individuals in recalling information about figures appearing in the picture or visual. Compared to field-independent persons, field-dependent individuals have a greater need for, and are more dependent on external sources of structure (background) and organization. Information recall from visuals for field-dependent individuals is facilitated if major visual cues are made relevant. It is hindered if important appearing cues are irrelevant or not noticeable.

The field-independent person samples more fully from cues, both salient and nonsalient, and performs more successfully. Increasing salience by manipulating instructional material should tend to make the field-dependent learner sample more fully from all cues, thus modifying the visual strategy employed. Field-independent persons tend to be able to glean information from both relevant and irrelevant cues. If field-dependent individuals are shown a procedure (modeling) in which they view figures within a background containing important and useful cues in terms of number, shape, and location, then they will be able to transfer the context to these types of pictures on subsequent viewing of pictures or visuals without these relevant contextual cues.

Because of the ability of field-independent persons to create structure and not to be dependent upon external cues, they should not be affected by either treatment (presentation or order). Field-independent individuals should score higher than field-dependent individuals on any visual recall test. If information can be identified which supports the concept of certain types of cognitive styles, then certain visual formats become more effective. Field-independent individuals tend to give structure to unstructured visual material and to separate an individual item or component from its overall context. Field-dependent individuals, on the other hand, tend to respond holistically to stimuli.

The complexity of cognitive style derives from the many dimensions (*19*) identified by Messick (*24*) out of the many dimensions which constitute the polarities of field dependence–independence. Thus the characteristics of cognitive style cannot be limited to a single dichotomous continuum, but constitute an environment of several polar dimensions. However, for initial discussion purposes, it is helpful to view behavior from the dichotomy of the one seminal and macro polar dimension as measured by the group embedded figure test.

SD-IP Theory and Research

Much has been written about self-directed learning (SDL) research and theory generation; and it is instructive about a phenomenon that has captured the interest and involvement of the general population (*65*). The most useful of the numerous reviews and syntheses of SDL are those which place it in a continuum of lifelong human development (*66–68*). The lifelong impact of SDL stems from the various networks within which individuals process information in the community (*69*).

Much of what the adult does in SDL is in reaction to, or as a result of sequential conditioning, lifestyle growth, and successful achievement. This "learning stance" is comprised of a number of dimensions (*70*):

Learner choice, responsibility and ownership: the learning agency.
Enabling settings and enablers: a community of self-directed learners.
Participating conditions: information processing for decisioning, learning, and communicating.
Ownership of learning processes and products: proprietary versus shared values in community.

Personal existence encompassed within a lifestyle includes all the facts within the life space at any given time that have existence *within the perception of the individual* and excludes those that do not (*36*). These elements not only constitute the field of life space of the individual but also the boundary zones. Other facts, events, or people in the social and physical world beyond those boundaries do not affect the individual involved in real-life circumstances at that time (*29*).

The changed circumstance tends to provide a single or, at best, very few resources or opportunities for learning that are reasonable or attractive for the learner to pursue.
The structure, methods, resources and conditions for intrapersonal information processing are provided or dictated most frequently by the circumstances.
Learning sequences progress, not necessarily in linear fashion, but rather as the circumstances created during one episode become the circumstances for the next necessary and logical step in the process.

Individuals bring to each episode or project their own motivation, aptitude, creativity, energy, and tenacity. The essential elements for understanding the process appeared to be (i) the expectations of the individual, (ii) that person's inventory of skills and knowledge, and (iii) the particular resources present within the environment. Contrary to the evidence of numerous correlation studies, the demographic characteristics of the learners appear to be less important than the uniqueness of the individual's circumstances (*21*).

The following is less of a model of learning than it is a guide that has proved useful for the study of SD-IP projects rather than precise steps or directions for a particular investigation:

> The study of SD-IP projects profits from a naturalistic or qualitative approach based on interviews with individuals. Such projects are inherently individualistic and can be understood primarily in terms significant to the individual.
>
> A detailed account of the project is required and is most likely to be described in the chronological order in which events took place even though they are not functionally related. Probing questions are almost always necessary. At the end of the interview the individual should be asked which events had influence in reaching a final goal.
>
> Individual clusters of elements tend to emerge through the labeling process since clusters either reach a deadend, produce a singular product, or lead directly to the origin of another cluster. With a transcript of the interview in hand, clusters may be identified as separate entities or as parts of a series of related clusters.
>
> Once identified, each individual cluster can be analyzed and understood according to how the elements interact and affect one another.

These analyses give insight into the degree of significance that respective elements contribute to any SD-IP project. For instance, residual knowledge has been found to have a part in project development. The analyses may demonstrate that this prior knowledge was a major factor in only a few instances for determining the final product. However, cluster analysis has identified several cases in which fortuitous environmental factors occurred, and in a majority of these instances they became the base for launching the SD-IP project. At the same time, the amount of exploratory action initiated by the individuals may vary from a great deal to very little with no readily discernible explanation.

The data obtained through interview and protocol analysis may be better understood in application to selected activities drawn from SD-IP project descriptions. Any real-life SD-IP project is composed of clusters of elements and it is necessary to study these clusters individually as well as in relation to the project as a whole. A cluster is a defined set of elements within the organizing circumstances of real life that have interactive relationships. These elements include: (i) knowledge (residual or acquired); (ii) actions (directed, exploratory or fortuitous); (iii) environment (consistent or fortuitous) (*71*).

One may dismiss the significance of these processes in real life as serendipitous. But the sustained attention of a human being as information processor, based on values and purposes, may be considered as analogous to the preplanning of an instructional developer. However, SD information seekers and processors, rather than preplanning their projects as do teachers and librarians, tend to select a course of action from limited alternatives that occur within the environment. Their behavior is guided by interpersonal discourse and the nonverbal (sight, sound, movement) manifestations of sociodrama and leads to significant inferences.

Thus, the behavior of the individual as identified and investigated by Tough (*30*) and others (*72*) reveals such intangibles as information processing, imagery, problem-solving, vicarious modeling, and motivation. In a learning-by-modeling process, Bandura (*35*) identified the behaviors of observation, attention, retention, motor reproduction, and motivation in learning by modeling. However, Bandura did not give attention to the structuring of what was (or is) processed. As a result, Spear and Mocker in a series of studies (*29*, *71*, *73*) have drawn out the implications for self-directed information processing (SD-IP).

SD-IP project descriptions which have been protocol analyzed to identify the suggested elements of environment, behavior, and personal attributes and to search for other factors suggest the following organizing circumstances (*29*):

Anticipated single event which the individual enters expecting that IP and possibly learning will be required but has little or no idea of what must be processed nor, specifically, how it can be learned

Unanticipated single event where tasks are performed by people repeatedly but where the individual does not anticipate being engaged in a learning project

Series of related events that are not anticipated but where each episode in a fixed sequence provides the organizing circumstance for the one that follows

Series of unrelated events in which individuals assemble random bits of information, observations, or perceptions whose purpose for retention emerges over time

The impetus or triggering event for information processing or episodic learning stems from changes in life circumstances. Such change may be positive or negative; may happen to the individual or someone else who impacts that person's life; or it may be an event which simply occurs and is observed within the life space of the individual. Following Lewin (*36*), life space is defined as the physical, social, and psychological environment in which the individual lives and functions.

In application, a SD-IP project whether based on a "shopping-list" or not, is more the process of searching for and acquiring the materials than the building of "the house." Materials are seldom acquired in the order of their use and their relationship may not be apparent until the project or "house" is finally built. The activities in a SD-IP project are clusters of elements which usually result in acquiring resources that are stored, at least for a time, until they fit into, or are used in relation to other acquired resources. Each cluster of elements has its own determinants and effects, and must be first studied as a discrete entity.

The social dimensions of these impediments should be a part of the sociology of the information professional and of learning in general and serve as matrices for the questions of policy development (*74*). The implications of SDL are as revolutionary as the results of the information and communications revolutions (*16*) which have ushered in the TELCOM (telecommunication) society. Long (*75*) goes on to assemble evidence that cognitive development continues across the lifespan. Both Kirby (*22*) and Knapp (*75a*) document the support for the lifewide occurrences of transferable skills.

Various syntheses of empirical findings derived from self-directed learning research exist (*76-80*). While these deepen and extend the pioneering work of Tough (*30*, *72*), the problem of SDL "instructional" applications remains as underdeveloped as

Hilgard and Bower (*17*, Chap. 16) have pointed out for other-directed educational systems. Brookfield (*81*) assembled a group of scholars to address this issue of a disparity between SDL theory and its relation to field practice.

Social learning theory as developed by Bandura (*35*) and others is assumed (*17*, pp. 599–605) to provide the best integration of modern learning theory to the solution of practical problems. Hilgard and Bower (*17*, p. 21–23) propose a series of questions which, if answered, could serve to help integrate learning theory into a cohesive system. Others (*82*) maintain that the theory has overextended its empirical base:

> It would appear that we have done serious work in conceptualizing the nature of the method—especially as evidenced in the work of Tough (1971, 1978), Knowles (1975, 1980) and Spear and Mocker (1984)—but have not gone far enough in our empirical work (p. 5).

The models of self-directed learning (as individually determined) can be functionally related to, if not built on a foundation of theories of information processing. This is seldom done, almost as if self-directed learning had such special problems as would make it unique. Other researchers have noted this lack of consideration in the literature; for example Mocker and Spear (*73*) have developed a four-part differentiation based on their investigations of organizing circumstances within which various types of learning are embedded.

These organizing circumstances are determined by, and embedded in the constraints of the environment. Organizational circumstances seem to account for as much decisioning, learning, and communicating competencies as do the personality dimensions of cognitive style (*25*). These dimensions yield procedural patterns that are closely aligned with steps that have to be taken to offset the "missing link" (*83*) faced by all too many adults in real life and for the elimination of which, supposedly, the professions had a social responsibility (*10*).

The verbal report of each respondent's efforts to resolve a situation or solve a problem should be carefully collected and analyzed for patterns (*50, 51*). In examining the transcript or in critically listening to the audio record, the researcher gains awareness of strategies selected, thought patterns employed, memory capacity, and solution monitoring ability. The parameters of the exploration are determined by the interview schedule, or instrument used, the task demanded of the respondent, and the processes to be explored and categorized.

Behavioral areas can be explored individually or in combination as each respondent struggles to resolve a situation or achieve some task requirement. There is scarcely any limit to the type of question or tasks that can be explored. However, only the concomitant use of experimental and ex post factor research designs will offset the major criticisms that cling to the method since Wundt (*84*) first used it:

Behaviorist skeptism about the use of retrospection, introspection, and protocol analyses unless coupled with more objective measurement

Wide methodological variations have resulted from loosely applied criteria which fail to differentiate between legitimate and illegitimate techniques

Tape recorded transcripts yield hard "objective" data of the respondent's original statements which can be analyzed by a number of researchers to achieve interrater reliability

> Cognitive processing models have strengthened the theoretical structure of the analyses and the logical development of interpretative hypotheses
> Preprocessed data segments removed from extraneous elements can be encoded into the language of the theoretical model for category selection and assignment.

Present trends in SD learning research leave out many areas that have been claimed to demand attention (*81*) and which could be of advantage to information professionals in developing a client-centered psychology. Librarian research seems to be influenced, sometimes heavily, by fashion which may help to explain the neglect of such important and significant studies as Peters (*51*) and ABE lifestyle research (*85a*). In fact, Peters (*51*, p. 2) specifically drew attention to this relationship:

> We are especially interested in the dynamics of learning in "natural" or non-formal settings, and in the role that literacy plays in learning. All of this is couched in a problem-solving framework, consistent with our belief that learning is the result of a problem-solving process.

Integrating SDL research findings into cognitive psychology conceptualizations and information process (IP) theory across the lifespan is directed at answering and addressing the issues raised by Huey Long and his colleagues at the University of Georgia (*75*, pp. 11–12):

> Educators of adults generally appear to be of the opinion that cognitive development continues into and across adulthood. Individuals interested in the education of adults, however, continue to search for a cognitive theory that addresses life-span development.

This issue must be addressed squarely and a stand has to be taken based on the evidence of research. Such a position could accept the following assumptions to advantage. The transferable competencies, described by various reviewers, do not occur by happenstance but are deliberately applied to meet SDL objectives (*85*, p. 15):

> Learning is a problem-solving process in which a new idea comes into the perception of an adult. The adult interacts with that idea mentally trying or deciding not to try to give the new idea a chance at entry into the memory. The adult makes a conscious decision to accept or reject each perceptual input. Learning is not ever all that new because there must be some way to relate new ideas to prior ideas. A whole new idea still needs to get a foothold in the mind based upon an old or prior idea.

Few information professionals would question the validity of this process when directed by a teacher where external observation and verification are supposedly applied. But those same critics who place confidence in the reliability of a teacher-controlled classroom behavior vociferously question the objectivity of the processes when applied by individual "street persons" in real life. In other words, the validity of the learning process is somehow abrogated when it is applied by adults in everyday SDL contexts which occur without benefit of teacher intervention.

Such a contention is not only challenged, but refuted by the findings of SDL research. From Tough (*30*) through Reisser (*86a*), Knowles (*31*), Ziegler (*70*) and beyond to Gibbons (*86b*), Peters (*51*), Cross (*76*), Spear and Mocker (*29*), SDL processes exhibit individual purpose, planning, integration, and are deliberately aimed at the objectives of the learner. With the Peters' (*51*) study as with Tough's approach, the significance cannot be overestimated. Despite the fact that these investigations are almost totally ignored by librarians, it is likely that any future information processing research will have to take them into account when the validity and relevance of other research findings are considered.

In retrieving and subdividing a set of data for an individual to use, it is necessary to attend to the psychological nature of that data. Humans prefer to specify and be told about subdivisions and relations that they already understand. Approriate and meaningful access paths depend on the human user's knowledge structure, which is not necessarily the most convenient for systems design.

Structure is the relation between different elements of knowledge and the constraints on the ways people can think about them. At all times, it is necessary that particular attention be given to bridging the gap between the world of the laboratory and our experience in everyday living. The only way to effectively organize empirical results is by theory. But all too often the advances taken are aimed college students and those with higher levels of education or in upper socioeconomic strata.

An approach to cognitive psychology from orientation of the average person on the street is rare, granted that a study of cognitive psychology will help the student to improve the capacity of their intellects and maximize the consequences for intellectual performance (*87*). If it is so important for people to improve the way they think by understanding the basic mechanisms of human thought, then why not create the software to help those who do not have the time for such discovery exercises?

Professional Imperatives

Suffused with exaggerated claims of an artificial intelligence and the software control of human beings, people need to know the limits of the computer takeover and the opportunities offered by machine-assisted human development. The computer analog of software information processing may account for many automatic and deliberative cognitive processes, but these behaviors are but the workhorse of a rich and varidimensional lifestyle permeated with many awareness and attentional manifestations. So many are these that one can only identify their massive dimensions appropriately as cultural and intercultural environments.

How will this gap be bridged and the "missing link" be filled between the people's concerns and the information entrepreneurs (*88*)? Obviously any breakthrough will not be a single dimensional advance but a combined effort of many interests including the knowledge industries, information technocrats, and the information welfare systems as well as the associated professinal organizations. In addition, although no single information service or product will predominate, research and development centered around a "volkswagen" standardization of people's access is both a marketing and socially responsible necessity.

Research and development, of course, continues to be advanced on various fronts by any number of vested interests. Ostensibly, these efforts take the consumer's needs for information services and products into account. Unfortunately, however, proprietary matters all too often crowd out that research and development upon which the standardization and simplification required by the masses can be based (*89*).

Such hopes, it appears have been the marketing promise of the information industry—that it can make computers see, talk, listen, and think like humans in everyday life (*1*). While the artificial intelligence community may scoff at these statements, professionals have done little to take into account the real-life information processing of the vast numbers of people in the general population. The cognitive model of computer software processing represents only a part of people's lifestyle information behavior.

Each person constantly produces knowledge; it is a function of continual information processing whether applied to decisioning, learning, or communicating. The output behavior of any individual is a state of equilibrium among the processes which satisfy the decisioning, learning, or communicating constraints. Thus, information processing functions to liquify knowledge (whether retrieved or recalled) in order that it be reconstituted or "solidified" around a new equilibrium.

Each equilibrium represents a resource (whether stored in concepts or in manual and machine-readable form) which can be referenced when future knowledge "liquefactions" are needed. Any interactive and intelligent front-end access system would seem to have to be built on principles at variance with those which stem from rigorously defined cognitive problemsolving. Research in self-directed information processing appears to hold promise in extending application to these developments.

In traditional information and library science, the taxonomy of the cognitive domain (*90*) has been fairly widely employed for indexing schema and database development. Today, the affective and psychomotor domains, although behaviorally taxonomized (*91*, *92*), are being brought into professional consideration through the "back door," so to speak, by the recent emergence of cognitive psychology. Cognitive psychology could be described as a system approach to rational problemsolving—combining aspects of various older psychologies such as the behavioral, humanistic, and gestalt. The prevailing metaphor in cognitive psychology for studies of learning and memory emphasizes the acquisition, storage, and retrieval of "information."

On the other hand, mind can more realistically be described in terms of skill in manipulating processes; the notion of skills provides a useful framework for accounting for the significant aspects of intelligent and interactive information. Evidence supporting the procedural view includes studies that show: (i) that the means for the acquisition of information form part of its representation in mind, (ii) that recognition varies with the similarity of procedures in acquisition and test, and (iii) that transfer between tasks varies with the degree of correspondence of underlying procedures.

To factor one's total approach to an information processing psychology into encoding procedures, retrieval processes and their interaction based on a computer metaphor of problemsolving (*54*) is a somewhat limited approach to an intelligence that is artificial (*15*). The fact that space and structure are a large part of both the traditional library's and the computer's operations is not a sufficient reason to suppose that such a dimension alone adequately describes human thinking (*93*). Observations such as these should not be construed as a luddite protest, but only to serve as a reminder that: "A long tradition has held that 'contents' of the mind in some sense exist independently of the 'processes' that create the contents, change them, and make use of them" (*94*, p. 265).

Focusing on computer information processing as the model for cognitive problem-solving has tended to block an understanding of the way in which the culture of perception and attention may have contributed to successful outcomes. Performance has traditionally been evaluated on such factors as the time taken to solve a task, or the correctness and elegance of a solution. But such approaches have obvious limitations when the aim is to both nurture the underlying lifestyle performance of an individual and promote the transfer of problem-solving ability (*53*).

On the other hand, the knowledge about perception and attending (sustained awareness) is less well documented, more susceptible of personal variation (e.g., cognitive and learning styles), and patterned in systems of situation-facing involvement. Few professionals seem to realize how exceedingly complex and often evanescent these patterns of perception and attending really are. Such deep abiding impressions have been the substance of the literatures of the civilizations and continue to feed the diversity of human cultures.

It may be an oversimplification to say that once perception and attention are accounted for (controlled by some input coding device), then cognitive psychology explains the bottom line of those cognitive processes which operate in all human beings. However, cognitive processes appear to be a common core of intellectual support behavior that can be programmed in software embodying declarative and procedural knowledge operations. This common set of cognitive skills, which need to be learned by all persons retrieving informative data regardless of perceptual style and attending patterns, can now be delegated to machine learning.

The intellectual structures built upon such foundations as cognitive psychology are impressive as are the artificially intelligent applications in computer programs and software systems. But suspicions about this magnificent superstructure become evident upon examination of the actual empirical base of facts (variables) and relationships which have been obtained largely from observations limited to white mice, pavlovian dogs, and college students. Seldom has a fresh look been taken at the behavior of adults involved in the curriculum of everyday life.

While no one common definition of intelligence exists, contemporary research in the field concentrates primarily on the metaphor of information processing, even though cultural contexts and their interrelationships (*52*) are presumed to be included. On the other hand, considerable progress has been made in conceptualizing intelligence at least in the cognitive domain and to the point where aspects of it can be programmed in computer software (*38*). On the other hand, an interest has emerged concerning "real-life" intelligence, particularly among adults immersed as they are in lifespan lifestyles and in the affairs of everyday life (*12*, *30*).

Part of that theory can be derived from self-directed learning research (*29*, *30*, *51*, *95*) and part is supported by research in cognitive psychology and problemsolving (*45*, *53*, *96*, *97*). But the findings of investigations of precognitive behavior remain either dispersed in the literature or selectively codified by various schools of thought and for particular professional interests (*89*). In addition, even the traditional information scientist feels more comfortable with the computer-coded output manifestation of cognitive problemsolving than with the input behavior of attention and sustained awareness.

In any event, from Binet (*98*), through Duncker (*99*) and Ericsson and Simon (*50*), to the most recent investigations of self-directed information processing, "thinking aloud" protocol analysis obtains actual precognitive behavior data rather than subjective inferencing based on apriori specifications of software-coded problemsolving. Within the professions themselves the client-professional relationship could have a more humanly relevant explanatory power.

Of what value would be such a revolution in the information professional's psychological thinking? Today, despite industry claims to the contrary, the recent report of the Center for Libraries and Education Improvement (*8*) found that little attention was being given to the study of information use as distinct from library use. The realignment of priorities noted earlier by Cuadra (*100*) is an aspect of cognitive psychology which has to be developed before client-centered facilitations are generally available to the American public.

Information advocacy and resource validity would then become more generally accepted characteristics of intelligent consumer reports. Rather than the "laissez-faire" and largely amoral proliferation of deliverable characteristic of a bookstore, information clients could expect more responsible guidance and even wisdom applicable to knowledge transformation and utilization. With a more humanly significant psychology of lifestyle knowledge utilization, the unfortunate gap between the expectations aroused by the information revolution (*1*) and the reality of consumer information advocacy (*4*) could be more readily narrowed.

Concluding Perspective

Obviously, another revolution is in the making, perhaps of even more radical implications for social change than the previous information upheaval. If managed in a sociopsychologically significant manner, this marriage of knowledge and action holds enormous significance for the person "on the streets" of everyday life. But unfortunately the implications are still more sociological than psychological, supporting a top-down movement to be developed and administered by technocrats.

Self-directed information processing (SD-IP) has had a long history in human affairs. This capacity for self-development may be as old as the human species. Before the establishment of institutions in society it was the major form of education and the learning of how to process information most effectively for decisioning, learning, and communicating. As such it could remain the principal legacy of the human animal struggling to realize the full potential of its unique capacity to think and integrate knowledge.

In the mind of the self-directed learner (SDL), each piece of information relates to other lists of data in various ways. Each individual remembers and organizes data for a variety of purposes and functions which can be identified and meaningfully organized in conjunction with appropriate software developers. Working together, this team can turn the SDL content and processes into the software representations and constraints required for natural language processing (NLP)—front-end software packages that facilitate computer access and use.

That the ordinary citizen in everyday life has not been able to do so is because natural language front-end services are as yet not generally available. However, further penetration of the population by personal computers is only a matter of time.

Even though the most revolutionary impact has been technological, the low-cost personal computer has made it possible for the average citizen to become the scholar communicator whenever and wherever located. Like McLuhan's proto image of the irridescent light source, all information is available from any direction for processing and can be accessed at any other point in return.

The problem, of course, is the extraordinary complexity of the individual human being, who in a simple day may range across all the known dimensions of information processing in response to an opportunity or a confrontation. In the past, human behavior has all too often been compartmentalized in order for the information specialist and instructional psychologist to more easily respond. Self-directed individuals involved in modern lifestyle development expect to have their behavior tracked and responded to wherever they are in the behavioral cycle of decisioning, learning, or communicating.

The SD-IP practitioner working to develop the materials and methods of knowledge systems wants to know how percepts are structured in the human mind, how such concepts develop, and how they are used in understanding and behavior. The software expert works to program the computer (software development) in a situation-producing manner that evokes an understanding and interaction with the outside world. The major problem in developing intelligent and interactive systems is to emulate the human conceptual mechanisms that deal with perception, image making, and language.

Within this framework, the mind is often treated as if it were a physical object and information, perhaps subconsciously, is assumed to have concrete properties. Mental processes are often described as objects or events in an actual physical space, as when we speak of storing and organizing memories, of searching through them, or of holding or grasping ideas in our minds: like objects, memories may be lost or hard to find, etc. All such descriptions are little more than fanciful nominalizations, (e.g., administrative organizational charts, clients), irrespective of the detail embodied in the accompanying propositions.

On the other hand, mind can more realistically be described in terms of skill in manipulating symbols. The notion of skills has been shown to provide a useful framework in accounting for significant aspects of cognitive processes. Evidence supporting the procedural view includes studies that show that: (i) the means of acquisition of information form parts of its representation in mind, (ii) recognition varies with the similarity of procedures in acquisition and test, and (iii) transfer between tasks varies with the degree of correspondence among underlying procedures.

Equally important, the everyday affairs of most SDL individuals are marked by frequent interruptions, both from external sources and by internal prompts such as the pressure of a lifestyle task that has to be addressed. A person must be able to respond to an interruption and then return to the SDL behaviors at hand, as well as move easily from one task to another. Otherwise many SDL neophytes, whether because of prior inhibiting experiences or lack of ability to follow through, may all too easily stop trying to perceive or hold interest in some new idea.

Information professionals could, if motivated, redirect toward broader populations the principal methodology of research in cognitive psychology—protocol analysis and possibly introspection—which stems from the work of Wilhelm Wundt in the last quarter of the last century. In this method, randomly selected and trained observers could report the contents of their consciousness under carefully controlled experimental conditions. The basic belief is that the workings of the mind can be open to self-observation. Thus, to develop a theory of cognition out of the interpersonal events of everyday life, one needs to develop a theory that accounts for the contents of introspective and protocol analysis reports.

The frequency of recommendations are increasing that the group-embedded figures test (*23*) be employed for observing field dependence-independence along with protocol analysis rather than the numerous verbally based tests that have appeared in recent years. The group-embedded figures test (GEFT) provides a more valid and reliable measuring standard than the many microdimensional variants which may be used for indepth probes of those particular aspects of the 19 or more polar dimensions. The findings will thus enrich with examples the numerous characteristics of the complex and multidimensional construct of field dependence-independence.

Work in the field could lead to improvements in methodology over simple introspection as the only source of empirical evidence. Employing experimentation measures of success on task behavior and performance speeds would indicate real-life information processing competencies. Task success as expressed in percentage correctness and speed as reaction time make comparisons less arbitrary. Such participatory research in everyday human environments would offset the tendency to employ artificially intelligent software as the only source of data about performance and reaction time.

Without such advances in methodology, it is difficult to give much credence to self-directed learning as a theoretical construct. Of all the issues and topics discussed in self-directed learning (SDL), there is one which occurs over and over again: SDL processes occur by happenstance and not under the carefully contrived administration of a teacher. This issue stems either from an ignorance of what happens during SDL processing in real life or from a lack of integration of research findings on the part of the practitioners involved.

Unfortunately, all too many people are dismayed with the possibility of the computer taking over cognitive processes even though a great deal of research and data syntheses have been done. Suffused with seemingly exaggerated claims of an artificial intelligence and the software control of human beings, people need to know both the limits of the computer takeover as well as the very real opportunities offered by machine-assisted human development.

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PATRICK R. PENLAND

TECHNOLOGICAL CHANGE IN LIBRARIES

Introduction

Libraries are in the midst of a period of radical change, precipitated in large part by rapid and penetrating advances in automation. As libraries are moving beyond their traditional role as custodians of printed materials and integrating new methods of information storage, retrieval, and transmission into existing collections and services, they are, at the same time, incorporating the extensive changes that new technologies bring to organizational structures and staff responsibilities.

Cline and Sinnott describe the consequences of these technological changes in their book *The Electronic Library*. They state that libraries "are being pummelled by profound and undoubtedly permanent changes. For example, the distinction between public and technical services appears to be eroding; communications within the library and outside organizations are taking on a new dimension; and new demands are being placed on professional staff. These shifts and turns, moreover, are not one-time modifications to which libraries subsequently adjust, quickly rebounding to status quo. Rather automation apparently introduces continuous change" (*1*).

Libraries currently are experiencing technological changes in how services are provided and in what these services are. These changes can be attributed to three major phenomena: the information explosion, escalating library costs, and the technology "revolution." The latter is of particular interest to us here.

The information explosion describes the consequences of an exponential growth in information. One researcher reports that the knowledge base doubled between 1980 and 1988 and, within fifteen years, will be doubling every eleven hours (*2*). The amount of materials published is now increasing at 2.5 percent each year and libraries are losing ground in the proportion of new information they are able to purchase. Studies indicate that the size of research library collections now tends to double every 16 to 20 years (*3*). It is becoming clear both that individual libraries will be unable to continue to acquire materials as exhaustively as in the past and that traditional printed media will be unable to keep pace with the information being generated. Libraries are turning to new technologies as a mechanism for responding to these concerns.

A second significant factor affecting libraries is escalating costs. While library collections have expanded, library costs have also risen. Between 1976 and 1986, U.S. periodical prices quadrupled and prices of hardcover books tripled. From 1968/69 to 1978/79, member libraries in the Association of Research Libraries spent 91 percent more for library materials, yet added 22.5 percent fewer books to their collections. Personnel costs increased 106 percent in the same period, yet essentially no new positions were added in academic libraries. In addition to rising costs, libraries of all types also have had to contend with diminishing levels of federal, state, and local support, thus attempting to maintain excellence in a climate of economic austerity (*4*). The bottom line is leading libraries to consider and, in many cases, implement alternatives to traditional library services and practices. Battin has written, "We are not replacing traditional services because we prefer the new gadgetry but because we no longer have the resources necessary to make the old ways effective in the current environment" (*5*).

New technological developments have already profoundly affected libraries. Almost every function carried out in a library has been altered to some extent by advances in electronics, computerization, and telecommunications. The manner in which libraries process, store, and retrieve information is changing, as is the information medium itself. The technological revolution in libraries has been called a "quiet revolution." According to Becker, it is quiet because the signs of change are subtle and not always evident; it is a revolution because the new technology will most surely affect all libraries (*6*). Today's libraries are in transition from manual to electronic systems. Databases are replacing card catalogs and printed indexes and abstracts. Information is being produced and stored in new forms. The merger of computers and printing is leading to a new method of information transfer. Libraries are no longer self-sufficient but are linked through electronic networks of various types. New technologies offer viable alternatives for dealing with the information explosion and escalating costs.

The changes brought about by advances in technology have been so extensive that it is difficult to assess their total effect, but it is clear that libraries are in a state of fundamental transformation. In the words of Pat Battin, libraries are being "reinvented in the electronic environment" (*7*).

Changing Processes and Services

Computers are so omnipresent, from banks to grocery stores, that one tends to forget what a recent phenomenon they are. The first computers, large, slow, and used primarily for numerical calculation, were built just before World War II. General purpose computers were not widely available until some twenty years later, only two decades ago. Interest in the possible applications of computers to library science began early. Computers seemed ideally suited for dealing with a particular feature of library operations, that of handling large amounts of information. Cline and Sinnott state that libraries are driven by data—"its creation and storage, retrieval and review, modification and manipulation. Indeed, librarians spend considerably more time processing information about books and serials than they devote to handling the objects themselves" (*8*).

Computers were seen as a practical alternative for managing proliferating library collections and increasing service demands. The paper-based systems in use at the time had reached and often exceeded the limits of their effectiveness. Certain libraries began automating some of their more routine functions during the early 1960s. The National Library of Medicine, the Library of Congress, the University of California at San Diego, and Southern Illinois University were early leaders in library automation. The MARC (Machine-Readable Cataloging) system began in 1965 at the Library of Congress. MARC was developed to define a standard format for machine-readable catalog records that could be used interchangeably on different types of computers across the country (*9*).

By today's standards, early automation efforts were cumbersome and limited. Hardware was extremely costly. Few library personnel were trained in systems analysis and automation in general. Interactive systems were rare until the late 1960s and most of the early local systems were batch oriented, requiring the storage of information on punched cards or magnetic tapes. All of these systems required the use of a large mainframe computer. Most were designed to automate the recordkeeping functions of librarianship, those tasks which were fairly routine. Though computer-based, most of these systems continued to produce paper products such as catalog cards, purchase orders, and circulation cards.

Initially, libraries designed their own local automated systems. These carried high costs in software development and hardware adaptation. In a relatively short period, it became clear that most library activities were done in a similar rather than in a unique manner in the majority of libraries. Libraries collectively turned to shared automation efforts to manage routine functions and to the purchase of "turnkey" or complete package automated systems.

Establishment of national shared computerized library networks, such as OCLC (originally Ohio College Library Center), RLIN (Research Libraries Information Network), WLN (Washington Library Network, later Western Library Network), and UTLAS (University of Toronto Library Automation Systems) have permitted libraries to use machine-readable cataloging done by other libraries, as well as to submit their own cataloging to the networks. In 1971, the first on-line shared cataloging system or bibliographic utility was established. By 1984, the two major bibliographic networks, OCLC and RLIN, provided information on a combined total of 18 million unique records for books, maps, manuscripts, periodicals, audiovisual materials, sound recordings, and music scores (*10*). By now most cataloging in academic libraries and in many public libraries is produced through some form of interaction with the shared cataloging database of one of these utilities.

As the benefits of library automation became more widely recognized, interest continued to grow. A variety of commercial vendors entered the library automation market during the 1970s. Commercial firms had sold individual libraries computer hardware and automation expertise during the 1960s, but during the 1970s vendors began to market self-contained systems that libraries could install and use immediately. These automation packages included hardware, software, system installation, training, and continuing support for the system. In 1974, one vendor marketed such systems; in 1979, there were nine (*11*). By now, such system names as GEAC, NOTIS, and Data Phase are widely recognized. An Association of Research Libraries (ARL) 1986 automation inventory reported a 22 percent increase in number of ARL libraries operating integrated on-line systems between 1985 and 1986 (*12*). This expansion in library automation is mirrored in the public library sector, as well.

In addition to technical changes in the way libraries managed their internal operations, automation offered new ways to provide information to patrons. Commercial vendors such as Lockheed Information Systems, SDC (Systems Development Corporation), and BRS (Bibliographic Retrieval Services) entered the market with on-line bibliographic search services. Librarians could bypass printed reference tools and turn to machine-readable databases for rapid citation verification and customized bibliographies. Technological advances made a wider range of information resources more rapidly available.

By the 1980s, significant progress had been made in applying computers to library operations and services. Not surprisingly, large academic and public libraries have done the most with automation. Technical advances and reduced costs have placed automation in the form of microcomputers within reach of those libraries which could never support a mainframe computer. Many libraries, no matter how small, are now using some aspect of automation for specific applications. The two most common are cataloging via a bibliographic utility and on-line searching of indexes and abstracts.

A number of larger libraries are using integrated automated systems in which a single bibliographic file supports a variety of traditional library functions. These integrated systems are designed so that the same record is updated, regardless of the subsystem in use. The result is that the entire database stays up to date at all times. Early automation projects tended to reject "the integrated approach in favor of automating only those functions that appear to lend themselves to rapid and less expensive automation" (*13*). Automation was implemented in stages by installing discrete computerized systems, systems which often remained unlinked. Circulation and acquisitions were functions frequently automated first in this approach. Automating these internal recordkeeping functions was often transparent to library users. However, many aspects of library automation do directly affect the users and their perceptions of library service.

The development of on-line public access catalogs (OPACs) either as part of an integrated system or as a separate application enables library users to obtain bibliographic information without resorting to time-consuming manual card catalogs. In an integrated environment, on-order and receipt information plus circulation availability may display to the user through the OPAC. Interlibrary loan has improved through participation in national bibliographic utility networks which enhance fill rate and timeliness.

Many other new technologies are being implemented in libraries. Electronic alarm devices prevent theft. Photocopy machines have changed library users' notetaking patterns in less than a generation. The rapidly increasing use of microcomputers portends even greater changes for libraries. These machines are now being successfully used for card production, circulation, serials check-in, acquisitions, local databases, expert systems, and other library activities. Microcomputers are improving office productivity and the analysis of management statistics. Some libraries have microcomputers and software available to patrons for use in and out of the building.

As microcomputers become more widely available, more patrons will also expect to access information from their homes. Many academic institutions are becoming "wired universities" with enough on campus scholar workstations available to serve all faculty and students. Public libraries are also providing dial-up access to their catalogs for off-site patrons with personal microcomputers. Library users can have access to library information and services without being physically present in the library.

The following sections present an overview of the major technological changes experienced in libraries over the last twenty to thirty years. They are not intended to be exhaustive, but to offer a sense of the variety and wide range of innovation affecting collections, technical services, public services, and staff. None of these technologies can be considered as static. Instead, they represent shifting points on a continuum of constant technological change.

Changing Collections and the Electronic Library

A number of writers have used the term "electronic library" to describe the changes libraries are experiencing as a result of new technologies (*14*). Libraries have traditionally been viewed as on-site storehouses of materials and knowledge, generally in the form of books or other printed material. As the volume of information grows and the technical means of transmitting it changes, libraries are expanding their traditional role to survive and even flourish in an electronic age.

Much has been written about the movement from print-on-paper communication to electronic communications. Briscoe feels the shift in publishing from print to electronic media is due to "1) rising costs of book and journal manufacturing; 2) need to decrease the time required for publishing; 3) need to control and provide access to ever increasing amounts of data and information; and 4) recognition of some unique and special attributes of electronic media (e.g., interaction between the user and the information system; Boolean search logic, continuous updating and exceptional graphic displays including superimpositions, movement, 3-dimensional rotation, and variable colors)" (*15*).

F. W. Lancaster is the most pessimistic of the writers on the future of the library in an electronic environment. He flatly states that he sees little future for the library and predicts that it will be bypassed by technological developments (*16*). Lancaster foresees a paperless society by the year 2000 and says that whether we like it or not, print on paper will give way to electronics. He regards databases, available only in machine-readable form, as electronic reference books (*17*). Lancaster predicts that by the year 2001 only a few high-circulation journals will still be published in printed form. Most will be issued on line, as well as on tape cassettes, videodiscs, and in other electronic forms (*18*).

Several on-line journals are already available in EIES (Electronic Information Exchange System). ADONIS (Article Delivery Online Information System), a system to deliver full-text journal articles on demand, has been developed by several European publishers. Other new technologies already in use include video and optical digital disks, videotext systems, and digital telefacsimile equipment. All such innovations permit the user to identify and locate information, while never entering a library. Moholt speculates on the disembodiment of libraries, or the Cheshire Cat syndrome, as information becomes electronically available on demand directly to the consumer (*19*).

Walters, reacting to Lancaster's pessimism, provides sound reasons for expecting the print medium to survive and the library to absorb the new media. Examining the possibilities of the "electronic journal," he concludes that, if useful, it should be accepted into the canon of information carriers. "In so doing we should be mindful of the fact that no major communication format in the twentieth century has yet succeeded in displacing older forms that preceded it. They have merely moved alongside older forms as an alternative method of communicating" (*20*). Despite the new and powerful information technologies appearing in and outside libraries, it seems unlikely that libraries will completely cast aside their traditional role as keepers of printed materials. Print information will continue to exist simultaneously alongside electronic information for some time.

Impact of New Technologies on Technical Services

Since the advent of library automation in the 1960s, the environment in which technical services staff carry out their work has been changing drastically. In preautomated technical services, departments and workers clustered in small groups around paper files which they managed and maintained. Many of these librarians took great pride in their files and their ability to extract information from them which was all but invisible to the novice or to the uninitiated (*21*). Each technical services unit had its own unique files. Anyone who wished to use those files had to go to or telephone that unit. Once automated, those who selected, acquired, and cataloged materials began working with machine-readable files. Workers who typed, arranged, filed, withdrew, refiled, or discarded 3 by 5 inch slips no longer perform these tasks. Instead they communicate with computer-stored files (*22*).

The two technological developments which seem to have had the widest impact to date on technical services in libraries are the growth and development of bibliographic utilities and the more recent development of integrated automated local systems. Bibliographic utilities have prospered in large part because of the role they play in cataloging. Automation, in the form of bibliographic utilities and MARC format, has revolutionized the practice of cataloging. These changes have occurred at a very accelerated rate. Less than twenty years ago, graduate libraries schools were still teaching professional librarians how to lay out and type a catalog card and to master the complexities of Library of Congress filing rules. Today's librarians rely on MARC format to provide proper punctuation and spacing and debate which MARC fields will be indexed in specified automated files.

Library catalogs in one form or another have existed as long as library collections. Cataloging provides physical and intellectual control over individual items. Cataloging includes the tasks of classifying, describing, and providing access to the materials in a library's collection. Original cataloging can be a time-consuming task. The Library of Congress has estimated that its catalogers need from three to five hours to catalog a typical book (*23*).

The intellectual tasks of describing the physical item, establishing authorized entries, and analyzing subject content remains much the same in an automated environment, though these tasks may be performed using computerized resource tools. Computers have proven useful in handling clerical processes, such as file management, and supporting a variety of products from the machine-readable cataloging record, from cards to on-line public access catalogs. The ease with which cataloging records can be shared among many libraries is one of the greatest benefits of library automation. Individual libraries no longer have to catalog each item for the first time; this can drastically reduce the costs of cataloging.

The Library of Congress has always been the largest contributor to shared cataloging and continues in this role through the distribution of the MARC tapes. The MARC project, begun in 1965 at the Library of Congress, is often considered the most significant development in the history of library automation (*24*). The implementation of MARC made it possible for the Library of Congress to distribute its cataloging data in standard machine-readable form. Individual libraries, commercial vendors, and bibliographic utilities use these files for a variety of purposes. The bibliographic utilities, in particular, have made the Library of Congress machine-readable cataloging records available to a large number of libraries who could not afford to mount and maintain the complete MARC tapes locally.

Bibliographic utilities have played a major role in library automation by permitting individual libraries to share the benefits of new technologies without having to bear the full cost of its development and operation. Markuson has pointed out that the bibliographic utilities are true utilities in the realm of library automation. She calls them technological "change agents" in three critical areas: automation research and development, capital acquisition, and mechanisms for technology transfer (*25*). The utilities have promoted the development and application of library automation by serving as brokers for information, training, and computer and on-line services.

However, as automation costs decrease and local expertise increases, many libraries are reducing their dependency on the bibliographic utilities for processing functions. The trend is toward the implementation of local, integrated, multifunction systems that can handle a variety of library operations. This development has led a number of libraries to limit the role of their bibliographic utility to that of a supplier of database resources (*26*). These records are then transferred either via interactive telecommunications or via batch process tape from the utility into a local on-line catalog.

OPACs can substantially reduce the cost of maintaining a catalog. Many paper files can be eliminated and decentralization is possible because staff can access the on-line files wherever a terminal is located. If the OPAC is integrated with other technical service files in a full-function automated system, work throughout the department can be streamlined and reorganized (*27*). The impact on staff responsibilities and assignments can be significant.

Staff who in the past laboriously searched the printed multivolume *National Union Cataloging* for cataloging copy now draw on cooperatively shared databases to do fast, inexpensive cataloging. Original catalogers often find informative machine-readable records which they can manipulate electronically to create new cataloging. While professional catalogers still prepare original records, most "cooperative" cataloging is now performed by paraprofessionals. The introduction of OPACs has eliminated the need to maintain many of the formerly essential card catalogs, authority files, and other labor-intensive paper files. Staff at lower levels are assuming more sophisticated responsibilities. The working environment in these catalog departments is changing radically and never will be the same (*28*).

With paraprofessionals doing much of the on-line cataloging and with fewer professional librarians involved, some writers are speculating about the future of catalogers. Indeed, Robert Holley thinks they are an endangered species. He sees the greater use of paraprofessionals, reduced budgets, standardization, de-emphasis of perfection cataloging, and automation as profoundly affecting the professional responsibilities of catalogers. He feels that their numbers will continue to recede in the future and that the few remaining catalogers will be located at the Library of Congress, in large research libraries, and in important specialized collections. In other libraries, catalogers will become managers and planners and will do little original cataloging (*29*).

Prior to automation, acquisitions staff spent many hours manually searching the local card catalog, the *National Union Catalog,* and other bibliographic tools to verify book orders. They manually typed and mailed orders, claims, and cancellation forms. In addition, they maintained a number of paper files: on-order/in-process records, invoices, standing orders, correspondence, and encumbered/expended records. Automation has greatly simplified these procedures. The library's holdings are searched in an on-line catalog or network file and titles not held by the library are verified on a bibliographic utility. Orders may be completed by sending them electronically to vendors (*30*).

Claiming of nonreceipted orders is an acquisitions task which greatly benefits from automation. When this process is carried out manually, it is both tedious and time-consuming. The on-order file must be searched, slips pulled, claim notices typed, and order slips refiled. A computer completes this process in a matter of seconds, producing claim alert lists and automatically generating claim notices (*31*). Direct telecommunication with vendors and suppliers can transmit claims instantaneously.

Other activities aided by automation are cancellation of orders, correspondence concerning incorrect or damaged items, maintenance of desiderata files, and monitoring vendor performance. Fund accounting is another process greatly improved by automation. It is no longer necessary to post encumbrances and expenditures manually and to wait for periodic cumulative reports. Instead, transactions are automatically posted and fund balances are kept current. In libraries with OPACs, the status of an acquisitions order may be available at both staff and public terminals located throughout the library. Thus, from the time the acquisition record is first created, the user is able to determine the availability of the item. Once the item arrives, it becomes "in process" and users can request rush processing (*32*). Through the use of on-line acquisitions systems, departments can perform functions more quickly and efficiently and at the same time provide better service to the public.

Serials automation has proceeded more slowly than that of other technical services operations. The undertaking has been difficult, complex, and frustrating. Efforts initiated in the early 1960s frequently met with failure. The vagaries of serial publication patterns, lack of a MARC serials format, and the variety of serial publishers were difficult to manage in early automated systems. Automated serials control and, in particular, automated serials check-in, proved to be much more complicated to develop than originally anticipated (*33*).

During the 1980s, successful implementation of automated serials control, including check-in, claiming, binding control, and routing of materials has become more feasible. In a 1983 survey of 47 bibliographic utilities, serials subscription agencies, automated library system vendors, and library software vendors, McQueen and Boss found nineteen automated serials control systems that were operational and twelve being developed and expected to be completed within the following year (*34*). In the late 1980s, several serials subscription agencies, working with library system vendors, began to develop programs to tape-load serials invoices.

In the preautomated library, serials invoice processing, check-in, and claiming were time consuming, complicated, and tedious. While it is true that automated serials control benefits serials personnel, the library user gains significantly, as well. Through the use of public terminals, users can determine exactly what serial holdings the library has. As soon as an issue is checked in, the information becomes available to everyone (*35*).

Automation has often led to a re-evaluation of the organizational structure of serials units. Some serials specialists advocate the abolition of separate serials departments. Merging serials activities into those of other technical services departments may be more efficient and cost-effective. Organization by function, such as ordering and receipting, rather than by format may prove more economical. Automation is eliminating the need for separate serials and monographs departments in some libraries (*36*).

Collection development may be treated as part of public services or as part of technical services. It may be carried out within the acquisitions department or in a separate unit. Regardless of the organizational arrangement, librarians who select materials for the collection use a variety of bibliographic tools. Automation has made available many of these tools in machine-readable format and offered new ways of monitoring collection development and management activities.

Collection development librarians are utilizing various automated systems to determine the quality of their collections, the habits of their users, and the ways in which collections might be improved. Quantitative data are frequently gathered through automated circulation and acquisitions systems. Circulation statistics can be manipulated and analyzed to determine which books circulate and how frequently, which subjects circulate heavily, how much of the collection circulates at one time, and who the borrowers are. Acquisitions systems collect and summarize data on newly acquired materials and identify their distribution by subject, price, publisher, or fund charged (*37*).

Cooperative collection development and management have become increasingly important in libraries due to tight budgets, rising prices, and the information explosion. Bibliographic utilities facilitate these efforts through shared holdings information and automated interlibrary loan subsystems to speed resource sharing.

A number of machine-readable bibliographic tools are becoming available to libraries for use in the selection of recently published and retrospective titles. This increased use of machine-readable information to select new titles can eliminate much duplication of effort that exists in manual systems, provide information in systematic manner, and greatly reduce typographical errors in the preparation of orders (*38*). Aveney suggests that the day is not too distant when a librarian will be able to sit at a terminal and review all of the week's new publications, order or reject each title by touching a single key, and receive an up-to-date summary of ordering activities and fund status at the end of each session (*39*).

Impact of New Technologies on Public Services

As noted earlier, the distinctions between technical and public services are diminishing as personnel in both areas and library patrons use the same new resources and systems. Bibliographic utilities, originally designed to share cataloging and processing functions, quickly became major tools for public services. By 1974, twenty-three distributive regional networks were operating (*40*). These networks have not been limited to one type of library and often extend beyond state boundaries. In addition to facilitating the sharing of cataloging records, these consortia support union catalogs, interlibrary loan, electronic communication, verification and location of materials, and cooperative collection building.

OPACs, which provide speedy on-line access to all the library's holdings by means of a computer terminal, are affecting library operations as powerfully as has the appearance of bibliographic utilities and automated regional networks. OPACs serving either a single institution or a group of institutions are now widespread and continue to be implemented in libraries across the country. New optical technologies make possible and affordable the mounting of CD-ROM (compact disk read-only memory) public catalogs at standalone microcomputer stations an operational reality in virtually any library.

Library catalogs organize a library's collection and permit easy access to the materials it owns. Through the years, the physical form of the library catalog has varied. Book catalogs were common before 1900, but with the turn of the century, the card catalog became the accepted format in most libraries. The National Union Catalog at the Library of Congress was begun in 1901 and ultimately facilitated the distribution of standardized cards to participating libraries across the country. Some libraries returned to book catalogs and, later, microform catalogs, both usually produced through some form of photoreproduction of existing cards.

OPACs, however, introduce a fundamental change in the way users get access to information about the local collection. The on-line catalog makes the computer's extensive and intricate retrieval capabilities directly available to library users and permits users to have access to information in a more decentralized manner. The flexibility of computer searching permits many access points, allowing the patron to seek information in ways beyond those limited by alphabetical filing of author, title, series, and subject. MARC format has made possible the retrospective conversion of a library's entire paper catalog into machine-readable records. Complete catalogs in the guise of computer terminals can be located throughout the library and in remote locations, as well. The on-line catalog has great appeal for users, who have quickly seen its benefits.

Commercial on-line bibliographic databases preceded OPACs in bringing new technologies directly to library users. The number of commercial databases grew dramatically during the 1970s. Librarians use on-line database to prepare customized bibliographies, verify bibliographic citations, and answer reference questions. A short time at a remote access terminal can provide information that would have previously taken hours to compile manually.

Many of these earlier databases were the consequence of electronic publishing. The exponential growth of journals during the 1960s prompted publishers to seek new ways to more efficiently compile and print abstracts and indexes. As they turned to computer files to manage information for efficient printing, these same files became searchable by computers. One of the first organizations to use this technique was the National Library of Medicine, which computerized the production of *Index Medicus* in the mid 1960s, and began the MEDLARS (Medical Literature Analysis and Retrieval System) files (*41*).

Telecommunications networks like Telenet and Tymnet dramatically reduced the costs of connect time and accelerated the spread of on-line searching of remote databases. In 1988, Hanson estimated that over 2,000 on-line databases were currently available, with between forty and fifty being added each year (*42*).

Because of the costs of accessing remote databases and the differing search protocols, most searching of this type of database is still performed by librarians. Some institutions are also experimenting with end-user searching of remote databases, eliminating librarian mediation after initial training. The rapid advances in optical technology have placed many indexing and abstracting databases within the library in the form of CD-ROM. Some libraries are also purchasing complete or partial databases and mounting them on local mainframe computers, accessible through the OPAC. These resources are often self-explanatory and relatively easy for patrons to use.

In addition to bibliographic databases, textual and aggregate data files are becoming widely available through libraries. These range from encyclopedias and dictionaries to census data and other statistical compilations. They may be accessible either via a local mainframe computer or self-contained microcomputer work stations. Rapid searching and machine manipulation of data to meet individual needs add to the appeal of these formats.

Automated serials holdings lists, an early byproduct of serials automation, met with popular success. Such paper or microform offprints, which contain varying amounts of information, range from simple alphabetical lists of titles and holdings to those providing more detail. Libraries can update them frequently and easily distribute them to multiple locations. Serials holdings lists have been well received by users who find them convenient and easy to use (*43*).

Advances in automation also made possible the rapid development of union lists of serials, combing holdings information for a number of libraries. Library networks made available a central agency which could assemble, merge, and maintain the bibliographic and holdings information of member libraries. State and regional union lists serve as basic resource-sharing tools and are the result of a form of detailed, cooperative information sharing impossible before library automation (*44*).

Library automation has provided significant improvements in interlibrary loan operations. The bibliographic utilities, as a result of supporting regional or national union catalogs, permit users across the region and nation to know which member libraries own which specific titles. Additionally, interlibrary loan requests can be transmitted and redirected immediately via the utilities' communications systems. Digital telefacsimile machines are facilitating instantaneous transmission of printed information.

Circulation of library materials was one of the early areas of automation and, in many cases, preceded the implementation of OPACs. By automatically recording check-outs and returns, computers can replace many of the paper files maintained in circulation operations. Most early automated circulation systems were custom-developed batch systems for a single library or library system. The first turnkey systems, available in the early 1970s, were a single-purpose product exclusively for library circulation activities (*45*). Newer systems are integrated components of full-phase automated systems and perform a variety of functions from the generation of recall and overdue notices to reporting availability of items in the on-line catalog. These functions save staff time, enhance efficiency, and improve patron service.

As in technical services, public services operations have experienced movement of the more routine functions to lower levels of staff as a result of library automation. The verification of bibliographic citations has often become routine and is handled as "ready reference" searching by support staff. The new emphasis on access to sophisticated information sources has placed new demands on librarians, who must master a variety of computer files. Additionally, librarians are often expected to train and advise patrons in their use of these files.

Woodsworth and Hoffman write of the new opportunities as well as new problems facing librarians, who are expected to have expertise in database management, computer system design and operation, and telecommunication (*46*). Librarians may be involved in the design of local user interface terminal screens and in defining local modifications of turnkey systems. New information technologies place new demands on librarians in understanding and applying copyright law. Librarians are expected to remain current with a variety of rapidly changing information technologies and to assist patrons in their use.

Impact of New Technologies on Library Organizational Structures

Peter Drucker has predicted that the typical large organization in the year 2000 will have fewer than half the levels of management of its counterpart today, and no more than a third the managers. The typical organization will be knowledge based, an organization composed largely of specialists who direct and discipline their own performance through organized feedback from colleagues, customers, and headquarters—an information-based organization (*47*). Organizational structures will flatten as responsibility is distributed and individuals will operate more autonomously.

What information is available indicates that the organizational structures of libraries are changing in ways very similar to those predicted by Drucker and other organizational theorists. Many of these changes imply significant deviations from the familiar organizational structures of libraries. Libraries have often been characterized by hierarchy, tradition, and clearly demarcated responsibilities and stratified staffing. In 1971, Smith said "The . . . functions that librarians perform are, more often than not, circumscribed by regulations and routine, so lacking in autonomy, individual judgement, and expertness, as to qualify far more as bureaucratic rather than professional activity" (*48*). This scenario is fading as a consequence of new technologies.

Much speculation exists about exactly what the structure of libraries will be in the future. Firm predictions are risky since the changes are now in process, but a number of writers have identified what they see as significant trends. Cline and Sinnott examined the effect of automation on the structure and functioning of four university libraries in their 1983 study (*49*). At that time they saw a movement toward reorganization of libraries as a result of greatly diminished workload for acquisitions and original cataloging, the adoption of a matrix form of organization, and the grouping of library staff to serve subject fields and disciplines with librarians having multiple functional assignments within their specific disciplines.

An article on the impact of implementing an OPAC in the North Carolina State University libraries reports the introduction of new lines of authority within the library's traditional organizational hierarchy. Communication increased among all divisions of the library system, as well as between the library and the rest of the campus. An additional advantage is that staff members have gained increased opportunities for professional decision making (*50*).

Many writers mention "blurring" of the distinction between technical and public services and question the traditional separation of these functions. The argument is that units have been historically organized around different physical files (such as cataloging, acquisition, serials check-in, etc.). As single, integrated on-line systems become widely available and on-line authority files eliminate the need for multiple paper files, anyone can tap into these files if a terminal is available. There is less need for the more rigid divisions as these functions can be integrated (*51*). Responsibility becomes more evenly distributed.

An Association of Research Libraries 1985 study addressed the issue of automation and reorganization (*52*). Of the 82 respondents to the survey, 46 indicated that they were still organized along traditional technical/public service lines. Thirty-six reported some integration but none indicated complete merger. Nevertheless, evidence of movement toward new organizational structures could be seen in greater use of committees and task forces, thereby distributing responsibility, and of multiple reporting relationships.

Libraries are experiencing increased communication among departments, bridging the traditional gaps between technical and public services. For example, system designers need to turn to reference librarians to learn about how users are dealing with new systems; public services librarians need to get more information from the technical services staff as reference librarians find that instructional work increases with teaching people how to use machines (*53*).

Studies are finding some integration of staff through assignment of multiple roles, dual functions, or job rotation (doing part public services/part technical services work) (*54*). Various writers have alluded to the fact that technical services professionals are being deployed into public services. The result is improved communication and better understanding. According to Gorman, the worst thing about the traditional separation between technical and public services has been that it has deprived the public of contact with some very fine librarians. Technical services librarians with an enormous amount of knowledge about the material they process have seldom been called upon to communicate that information to the library's users (*55*). The blurring of previously rigid organization lines offers new opportunities for maximizing staff resources.

Arguments in favor of centralization are fading with the implementation of new technologies for document storage and retrieval and the growth of various on-line systems. Several writers have suggested various decentralized structures, among them, Atkinson, Martell, and Cline and Sinnott (*56*). Stueart writes of transforming services into "specialized user-oriented information centers" (*57*). Independent decision making becomes important in such an environment.

The new role of professional librarians is described by Nelson: "The librarian today must be capable of dealing with management and budget, preservation and public relations, architecture and cooperative planning, networks and document deliver, on-line services and information systems, and a long roll-call of other matters that in their sum provide a partial definition of modern librarianship" (*58*). Stueart sees a trend to place "the brightest, the most innovative individuals in non-traditional settings where they see opportunities for self-expression, for implementing their own ideas and for innovative change which they don't see in what they perceive as rather rigid, traditional hierarchical structures" (*59*). Independence will be the key word for these new personnel and fitting them into the staffing patterns that must be maintained to meet the logistical needs of the library will be as great a challenge to library management as any heretofore experienced (*60*).

Numerous writers have noted an increasing need for continuing education. Myers sees a trend toward more intensive, structured, formalized, and centralized staff training (*61*). According to Davis, automation training provides an opportunity for a much broader program of continuing education and staff development (*62*). Stueart notes that implications for staff renewal and development are at their height in a library's change process (*63*).

As noted in the earlier sections on technical and public services, roles of both professionals and nonprofessionals are changing. The reallocation of task-oriented work from the professional staff to the support staff illustrates that "once a technology is applied to carry out very complex, routine mental work, that work is driven downward in the work hierarchy, away from professionals, whose work then expands to comprehend new and more challenging responsibilities" (*64*). One consequence of this migration of responsibilities is the creation of a second type of library professional, individuals without masters degrees who now supervise operational units previously managed by professional librarians. These individuals supervise operational units such as ILL, circulation, acquisitions, etc. They hire, train, supervise, and have an increasingly larger role in the management and goal setting of the organization (*65*).

This reassignment of responsibilities has led to some role confusion between professional librarians and support staff and to a growing dissatisfaction on the part of some support staff about their organizational status. Dougherty states that professional "librarians spend more time away from the 'desks.' They actively engage in the governance of libraries, and they spend more time at conferences. The tasks they performed now must be performed in their absence by assistants" (*66*). Questions of who has the expertise for decision making and how decisions are being made can cause dissonance and stress.

Professional and nonprofessional staff often express increased interest in planning and governance. The result may be tension between the need of the library director to retain administrative accountability and the desire of staff to have greater participation in decision making. Many libraries use committees, task forces, and working groups to collect information and prepare recommendations regarding new initiatives. Most major automation projects involve the creation of working groups composed of members from departments throughout the library. Such participation in planning and implementation draws on the skills of staff and facilitates automation acceptance and support. Administrative responsibility remains clear and staff play a meaningful role in policy decisions.

Implications for the Future

Librarians are seeking to merge new technologies into an existing organization while maintaining and supporting many of its traditional features. This goal is further complicated by the wide variety of new technologies found in present-day libraries and the fact that new technologies seldom replace old ones (*67*). Libraries may be somewhat unique in their need to sustain this mix of old and new technologies. Libraries which retain successive generations of audio and video recordings are often expected to supply the appropriate playing devices. Research libraries' collections may range from papyrus and vellum to microform and digital optical discs. New technologies have always existed alongside the old, requiring staff to support both. This dualism is compounded by the rapid rate with which technologies are now changing.

The challenge facing libraries is to continue to implement those new innovations which are appropriate and to integrate them into existing operations. The result is a transformation. Inevitably, the introduction of automation requires new procedures, new staffing patterns, new budget and program priorities, shifts in authority and decision making, changes in expenditure patterns, and new and changing services (*68*).

This need to consciously devise methods of planning for and responding to rapidly changing technologies is not unique to libraries. Shoshana Zuboff argues convincingly that society as a whole is experiencing a significant, perhaps cataclysmic change in the way the world is viewed, experienced, and organized (*69*). She states that history reveals the power of certain technological innovations to transform the mental life of an era and that computer-based information technology is one such innovation, inaugurating a "historical transformation of immense proportions" (*70*).

In earlier sections we presented fairly concrete evidence that the library paradigm—how libraries are viewed, experienced, and organized—is changing, driven by new technologies. The severity of the problems that are confronting libraries during this period of rapid technological change are not insignificant. The transition period to the new electronic library will not be easy for either librarian or user. Many librarians may have trouble adapting to a working environment very different from that in which they began their careers, and some may resist technological change (*71*). They seek what Toffler has called "a separate 'peace,' a diplomatic immunity from change" (*72*). Veaner warns that without extensive retraining, some librarians may suffer occupational displacement as the practice of librarianship changes (*73*).

Matheson observes that many librarians share the belief that new roles will evolve, that libraries are engaged in an evolutionary rather than a revolutionary process. She states that this is a dangerously passive perspective for the profession, stressing that "there is a total restructuring in progress of who, what, and how information is created, owned, and shared. We librarians...will be out of work, unless we... reexamine our basic assumptions and develop new strategies for staying in business" (*74*).

There appears to be recognition, at least at the philosophical level, that the library paradigm is changing, but Matheson doubts if there is a group commitment among the library profession as to what it should be. She affirms, "We all understand that the time has passed for building definitive collections of books and materials. But we seem to be engaged in compiling definitive collections of bibliographic data instead" (*75*). Martin observes, in a similar vein, that librarians have given scant attention to the fundamental shift in the nature of libraries and what librarians do (*76*). Their response has been minimal and concentrated on the marginal effects, on how to catalog a book in the on-line environment rather than on the larger issue of the meaning of pervasive automation for library users and staff.

These writers warn of the problems such a narrow, passive approach presents. Librarians need to institute formal planning and management controls and ensure the availability of staff trained to work with new technologies (*77*). Issues relating to organizational design, management techniques, staffing and personnel are critical.

Unfortunately, as Drake has observed, "libraries have traditionally not approached change systematically" (*78*). In 1985, the Association of Research Libraries reported that few organizational models for the 1990s and beyond existed, although several libraries participating in the study confirmed a need for organizational change (*79*).

Conclusion

Without a doubt, libraries are changing and these changes are escalating. Librarians who recognize the shifting paradigm are in a position to actively reinvent the library and reform the organization. New strategies must be developed if libraries are to be reformed to meet the challenges facing them during the rest of this century. Many questions remain unanswered. The ARL study on automation and reorganization stresses the need for more information with respect to how change comes about, who is involved in decision making, how better use can be made of present staff, and what measures can be used to determine the success of reorganization (*80*). Answering these types of questions will better prepare librarians to creatively and actively participate in shaping the future of libraries. Technological change in inevitable; the future of libraries is open-ended.

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TYPESETTING: FROM HANDCASTING TO THE LASER

One of the many milestones in the evolution of a civilization is the development of written language. When a language has a written form, the culture that produced it will live as long as there are people to read it. People no longer have to rely on memory and oral tradition; the words and deeds of historical people can be read as recorded at the time of their occurrence. Capturing a language in written form presupposes some symbolic representation for the language, and in Western languages, this representation is based on a set of building blocks, an alphabet. The basis of a language may be its words, but the foundation of its printed form is a set of letters. These letters can be preserved by placing them on some permanent material; people have scratched letters into bone and wood, carved them into stone and clay, and inked them onto leather, paper, and other surfaces.

From the genesis of writing in ancient times, the fundamental idea—recording ideas permanently—hasn't changed much, but the production of the records has. Writing by hand is prohibitively slow and too susceptible to error for mass production, but technology for printing many copies from one original speeded up the process. As demands increased, more efficient ways to create the originals had to be found. Carving entire plates by hand is a slow, demanding process. The invention of separate, movable type changed this, and spun off a series of developments for setting or "composing" characters. Typesetting has evolved from the hand placement of individual letters to mechanized placement, and the machinery involved has changed from slow, noisy mechanical beasts living at the turn of the twentieth century to fast, computer and laser contraptions hurtling toward the brink of the twenty first century.

Writing has been discovered at different times by different isolated cultures all over the world, so much so that none seems to deserve credit for "inventing" it. Printing, the reproduction of images from some original, *is* attributable to a particular culture, the Chinese. Printing from wooden blocks developed during the T'ang dynasty (618–907) as a means of ensuring magical benefits by precise reproduction of sacred images (*1*, p. 498). The practice was used to make all sorts of things, from games and ornaments to money. The Western excursions of the 1300s into the East imported the idea of block printing onto paper when travelers returned with playing cards. One of the earliest block-printed images made in Europe is an image of St. Christopher, dating from 1423. Books could also be printed this way; the text was carved out by hand and used as a block for printing. This is a painfully slow way to print a book, especially a long one, and the Western printing industry did not really take off until Johann Gutenberg (c. 1394–1468) invented his movable typecasting device.

Gutenberg's type enabled printers to assemble pages by connecting several pieces together as plates and then disassemble them and reuse the parts. The printing house armed with movable type presses was equipped to print not only multiple copies of books but many different titles as well. The proliferation of printed material is credited with stabilizing European tongues, coalescing a bewildering array of regional dialects into reasonably coherent languages (*2*). [Curiously, the Chinese invented movable type during the Ch'ing-li period (1041–1048), but the languages of the time lacked an alphabet in the Western sense and were not well suited to the potential of movable type (*1*, p. 505).]

The method of producing cast type remained largely unchanged from its introduction in the 1440s until the early 1800s. Type casting, as described by Lawson (*3*) can be broken into two basic steps: the creation of a matrix and the actual casting. The matrix, prepared by the punchcutter, is a piece of metal containing an impression of the character to be cast. It is created by first carving the letter into a bar of soft steel, called a punch blank. Another piece of metal, the counterpunch, is driven into the punch blank, resulting in a raised letter on the end of the counterpunch. This letter form is shaped and refined until the desired print impression is achieved. The counterpunch is then hardened and struck into a piece of brass or copper to create the matrix.

At this point, the typecaster takes over. The matrix is placed into an adjustable (because letter widths vary), handheld mold encased in wood. The mold is filled with a molten mixture of lead, tin, and antimony, which is allowed to harden. When cool, the type is removed and any flash or jet is removed. A skilled caster could work at a rate of up to 4,000 characters a day. Not until the 1800s were any substantial changes made in the process, and these changes involved mechanizing steps. In 1811, Archibald Binney introduced a spring-lever mold that doubled the rate of handcasting, and in 1838, David Bruce's pivotal typecaster fully automated the casting step, with an achievable rate of 3,000 characters an hour (*3*).

Even with the substantial increases in the speed of typecasting, the process of composing individual characters into text still had to be done by hand. Handsetting of type involves choosing characters—one by one from the available letters—and placing them into a composing stick, which restricts the line length to some premeasured constant. This process, like many hand-performed tasks, is a bottleneck to production. However, attempts to mechanize the process had not fared well. The type compositor had to spell words correctly, handle multiple typefaces in various sizes, make end-of-line decisions (particularly regarding hyphenation), and justify each line. Hyphenation and justification, in particular, resisted mechanization (*4*).

The effort over six decades to create an acceptable device for setting type climaxed with an invention by a man who was not a printer but a watchmaker, experimenter, and entrepreneur: Ottmar Mergenthaler (1854–1899). His machine allowed a single operator to gather matrices for an entire line from a keyboard and cast the whole set at once, creating a "slug." This technique is called linecasting. The principal idea behind the machine was that of a "circulating matrix." The operator typed the desired words for the line at a keyboard, which leaves end-of-line decisions to the operator. Striking a key on the keyboard releases the matrix for the character, which is placed in order with the other matrices. When the line is ended, the type is justified by pushing wedges, called "spacebands," into the word spaces and forcing the line measure to be filled. The line of matrices is clamped and filled with molten metal, and the complete line is then delivered to the operator (*5*).

The first of these machines was installed at the *New York Tribune* in July 1886. Seven feet high, six feet wide, and six feet deep, the machine turned out a slug, which was grabbed by Whitelaw Reid, *Tribune* publisher, who reportedly exclaimed, "Ottmar, you've done it again! A line o' type!" (*6*). Thus was the machine dubbed the Linotype. These machines and their relatives became the work horses of the printing industry for setting body type. At least four times faster than hand composition, they reduced the composition bottleneck in the industry. The Linotype and subsequent developments determined the course of modern typesetting.

Among other developments of the era, several warrant mention. In 1887, Tolbert Langston pioneered remote typesetting with his Monotype machine, enabling the operator to use a keyboard to punch paper tape, which was used in turn to set individual characters. The Typograph of 1911 cast lines of handset display type, the large type used for advertisements and headlines. In 1928, Walter Morley expanded on the Monotype with the Teletypesetter, which allowed linecasting (rather than single character casting) from punched tape. This became very popular in the newspaper industry (*3*). Aside from these developments, there were no radical changes in the Linotype design. The advent of phototypesetting in the 1950s rendered the Linotype, called by Thomas Edison the Eighth Wonder of the World, and other hot type technologies more or less obsolete. The last Linotype was built in 1972, but parts are still available (*6*).

More familiar to most people than a Linotype is another machine for generating type, the typewriter. The typewriter was conceived by Henry Mill in 1714, but the first practical machine was devised by C. Sholes and marketed by Remington in 1873. By 1886, when the Linotype premiered, 50,000 typewriters were already in use (*7*). Typewriters were the office typesetters; not nearly as expensive, complicated, or imposing as typesetting machines, and some even offered justification, interchangable fonts, and a narrow range of sizes. However, for the world of newspaper and book publishing, typewriters were no match for typesetters.

Typesetting offered, from its inception to now, several advantages over typewriting. It allows for more expression and attention manipulation through good use of typefaces and sizes, especially in advertising. Important information can be stressed by using large, bold type or belittled by using small type (the proverbial "fine print" on a contract). Such capabilities permit the construction of engineered documents, giving important information whatever emphasis a client desires. For books and papers, the density of typeset copy provides an economic incentive. Typeset copy contains more words per line (with comparable fonts) than typewritten copy, and higher density means less paper, reduced storage, and lower printing and shipping costs. For long passages, good typesetting has a more graceful appearance and is easier to read. These benefits, combined with relatively low cost, contribute to the success of today's desktop publishing industry. Basic typesetting capabilities are married to the high-tech typewriter, a personal computer.

Computerized typesetting is considered to have begun with the paper tape storage of keyboarded data, a process that predates computers. Although the first-generation typesetters were not "computerized," they did use external storage media. Second-generation typesetters do not cast metal type; they use photographic images. They are also characterized by use of application software and magnetic storage (*8*). Phototypesetting replaced cast metal type as the printing industry switched from impression printing from metal plates to chemical printing from photographic plates. Although the idea had been around since 1871, phototypesetting got its start in the 1950s, when the Intertype company altered a Linotype machine. The modifications consisted of replacing the metal matrices for casting with matrices that held, instead of engraved impressions, photographic images of characters. The casting mechanism was replaced by a camera (*3*). The Fotosetter looked and operated much like a Linotype, but it produced exposed paper rather than slugs of type.

Along with development in photographic technology came advances in computer technology for word processing. Typesetting resembles word processing to a large extent; both involve typing text, manipulating it and eventually printing it. The similarities between them make them naturals for sharing technology, but there are differences. Typesetting requires the ability to handle variable width characters in fonts of differing sizes, while word processing uses a typewriter-like output device. The need to handle variable characters, called "character counting," therefore necessitates some abilities beyond word processing.

Modern phototypesetting systems break tasks up similarly, but the mechanisms for handling them vary (*9*). Fonts are held on photographic negatives, called font masters. The font master may be a film disk with the letters placed in concentric rows around the center or on a film strip placed on a rotating drum. Also placed on the font master are timing marks for locating specific letters. The font width information for proportional spacing may be encoded directly onto the font master or encoded in read-only memory cards that are inserted into the typesetter. Text is usually typed in, proofread, and stored on floppy disks; type is rarely set as it is entered. In this sense, the machine acts as a word processor. When the typesetting unit is engaged to actually set the type, text is read from the floppy and characters are set individually. Exposure cannot take place until the character on the font is in the correct place, determined by counting timing marks. The letter is exposed by a strobe flash behind the font master, creating a positive image on photosensitive paper. The size of the letter is determined by lenses of various magnification. The system may use a single lens in a zoom mechanism, which allows for fine changes in type sizes. Another popular arrangement places several lenses in a rotating turret; however, it only permits type to be set in discrete sizes. A combination of mirrors and tractor wheels determines the position of characters on the paper, and as lines are set, the exposed paper is scrolled into the lightsafe box and developed. Once processed and dried, the copy is ready for proofreading, correction, and pasteup.

Phototypesetting is a major improvement over metal-cast type. The photographic composition of lines is much faster than casting slugs of type. The use of computers enables floppy disk storage of text, so large-scale alterations such as changing a typeface or size do not require retyping of a body of text. The required parameter is changed and the text is reprocessed through the photo unit. However, for all their good points, phototypesetting systems have their restrictions. There are limits on available sizes, especially in lens-turret systems. The process of size manipulation by magnification means that large type tends to be fuzzy, and any imperfections in the font masters are also magnified. The fact that fonts must be inserted means that only a small number of fonts can be available to the typesetter at any one time. The available fonts are static, as well—to use boldface, a boldface version of a font must exist. Italics cannot be created from an existing Roman type; a font to be used must physically exist. Certain elements are not handled well on a phototypesetter, for example, simple rules and leaders are possible, although they may suffer registration (alignment) problems, much like the roughness often seen in typewritten underscoring. Phototypesetters fail at setting borders, diagonals, and curves, for the same reasons that typewriters do: only certain characters exist for building them. But the greatest limit on phototypesetters becomes apparent as the quest for speed progresses. Although faster than linecasting, phototypesetters are still fairly slow, setting between 10 and 80 lines per minute. The more complex a line—the more font or size changes—the longer it takes. The act of changing a font or a size involves moving wheels, mirrors, or lenses. In an age of computer-driven laser printers, phototypesetting is just too slow.

The third generation of typesetters are truly computerized: the type is stored, processed, generated, and printed by computers. These typesetters are also closely related to the technologies of the burgeoning field of desktop publishing , which uses many of the same techniques. The fully electronic nature of these systems increases both the flexibility and speed of the typesetting operation.

Third-generation typesetting uses digital type; characters are stored in the computer as electronic data rather than on film font masters. Digital fonts can be created in several ways. One common way to make them is to draw letters on a digitizing tablet to obtain a rough form and then use a graphics editor to refine the shape (*10*). Another popular way to generate a font, especially for nonprofessional publishing, is the use of a font-creation language like Knuth's Metafont (*11*). Metafont allows a user to specify a set of 28 features of letters; these include things like height, slant, ascender and descender height, stress, and weight. The Metafont program uses these characteristics to generate harmonious letters and other characters.

Once the characters have been created, they must be stored. Storage of digital fonts is a space-consuming task, akin to storing graphics. Two popular methods for storage are bitmaps and splines. A bitmap is simply an electronic image of a letter space, indicating whether a pixel is on or off. They are good for the actual typesetting—the image produced is just the result of scanning a bitmap. They are also easy to edit and alter. However, they do not facilitate manipulation of the characters, like rotation, obliqueing (slanting type artificially), and sizing. Altering a bitmap for these uses is difficult because the letter is just a collection of bits; there is no holistic representation of the letter. Also, the stepping ("jagging" or "aliasing") inherent in digital images is magnified if a bitmap is enlarged even proportionally. Thus, in addition to storing a bit for every position in an image (already storage intensive), several bitmaps per letter may be needed for quality reproduction of various sizes (*12*).

Storage of letter forms using spline encoding uses less space than bitmap storage. Splines are lines fit between points, and storage involves simply recording the key points in the letter form and allowing the computer to calculate lines to join them. Spline encoding is well suited to letter forms that will be resized or distorted; only the relative positions of the key points need to be found to generate new splines (*13*). The fact that the splines must be recomputed for each occurrence of the letter makes this method computationally expensive, and the problem grows as the quality of the letters is improved. Linear splines, which use polygonal approximation to curves, are less expensive than true curved splines, which produce the best letters.

Actual typesetting with digital type is usually accomplished with either high resolution CRTs or laser printing. In CRT typesetting, the characters are created on a high resolution screen and the image is carried by way of mirrors or optical fibers to photosensitive paper. This method of producing type allows for effectively continuous sizing of characters, and the characters are as clear in large sizes as they are in small sizes. Having characters electronically produced means they can be electronically distorted, and there are no film fonts to scratch. The number of fonts accessible at any one time is limited by the memory of the computer, not the number of positions on a rotating drum, so many fonts are available at all times. Typesetting can also take place at very high speeds because there are few mechanical parts, i.e., no mirrors and wheels have to be repositioned or timing marks to be counted. Digital typesetters are also good for producing rules, borders, and curves; they are not limited to a predetermined set of characters from which to build them (*8*).

For all their good points, digital typesetters are not problem free. Established fonts are often detrimentally altered by digitization, much to the chagrin of typographers whose art is type design. Frequently, a desired font may not be available in digitized form (*14*). Fonts stored on floppies are easily stolen, making control of fonts difficult (*10*). These floppies are also easily damaged, a real concern in a print shop environment. Also, the typesetters themselves are susceptible to problems due to fluctuating magnetic fields, which can distort scan lines. These machine are also expensive.

A variant of CRT typesetting, laser typesetting uses a high-resolution (1,000–2,500 dots per inch) laser to paint images rather than using a CRT and fiber optics. Lasers produce very sharp images at amazingly high speeds. They can handle any one digitized image as easily as any other. Additionally, the brightness of the laser also enables output directly to printing plates, bypassing expensive photosensitive paper (*8*). The field of a laser is wider than the field of a CRT in typesetting, which permits lasers to treat entire pages as images instead of single characters. With lasers, it is possible to do layout and pasteup before anything is actually set on paper. The idea for full-page processing was first expressed in 1974, but at the time, there was no way to do it (*15*). Type, line art, halftones, and reverses all have to be represented in a consistent manner. The answer was found in bitmaps and raster image processors. A raster image processor converts files into bitmaps for laser printing. It pulls together files that many contain digitized artwork, type, and anything else that can be digitally stored. The images are meshed according to page makeup specification and printed on a screen or other output device (*12*). The first of these machines, the SuperSetter, was introduced in 1984, and the technique is becoming increasingly popular.

Laser technology has also played a key role in the rise of electronic and desktop publishing. These fields use personal computers to drive all kinds of software for preparing documents. Included among software needs are word processing and report-generating packages as well as text formatting programs. The availability of low-resolution laser printers (300 dpi) and good dot matrix printers has changed text formatters from programs that produce justified typewriter output into programs that create letters more like typesetters. Desktop type generation uses essentially the same technology as does digital typesetting, only at a much lower resolution (300 vs. 2,500 dpi) and cost. Replacing many office typewriters, these systems put many of the benefits of typesetting into the hands of employees who would otherwise be using typewritten documents. Office correspondence and inhouse documents can now have a more impressive appearance without the cost and time of having them professionally typeset (*16*). This has spawned an industry for quick document production as well as controversy in the printing industry.

The controversy involves the role of low-resolution-type generation within the printing industry. Few would decry the rising use of electronic publishing within offices and homes—most of the work done there would not have been appropriate work for the typesetting world in the first place. The print industry has found use for electronic publishing systems in producing proofs, determining layouts, and obtaining customer approval of jobs before the more costly final type is set. But the growing quick document business—for which ads can be found in any campus newspaper—has raised the hackles of the graphics world, and not without some justification. Quick print shops often advertise low-cost, professional quality typesetting when the product is actually low-resolution laser or dot matrix output. Typesetting operations cannot compete with the price and time advantages of electronic publishing, even though the quality is incomparable. Unfortunately, many naive consumers do not know the difference and are easily convinced that the typesetters are charging a lot more for the same product.

Before the digital revolution, the meaning of "type" was clear. It could be picked up and held; it was physical. No definition was needed. The situation today is different. "Type" is no longer physical—it's just magnetic beetle tracks on a disk, and the controversy over the role of electronic publishing has raised questions about the definition of type. Weltz (*17*) highlights several questions in this debate, which essentially reduce to "where is the line between electronic publishing and typesetting?." Among them is the issue of truth in advertising. Should the purveyors of low-resolution output be permitted to call it typesetting with impunity, when "typesetting" should denote another product? Does a consumer have the right to withold payment if a product advertised as typesetting turns out to be dot matrix output? When bidding for contracts, what distinction is fair to both buyers and sellers? The answers to these questions hinge on a definition of "type," which Weltz suggests should cover the assembly of letter forms for reproduction by using cast or photographic masters or digital images with a resolution of not less than 1,000 dpi. The acceptance of some standard for type would establish a distinction between typesetting and its lower quality approximations.

As we approach the end of this century, the art and science of typesetting remains a vital endeavor. Humanity has been putting words into print for close to 1,300 years, and although some have sounded death knells for typography with each change in technology, the need for information and desire for beauty have proved them wrong each time. There is no reason to expect that the art of typesetting will be sacrificed to the computer. As with any new development, there are still bugs to be worked out and traditions to be established, but the flexibility of computerized type offers us possibilities of which Gutenberg never could have dreamed.

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MARY TABASKO

UNESCO COMMON COMMUNICATION FORMAT

History

The Common Communication Format (CCF) has to be seen in light of efforts made by Unesco to coordinate the exchange of bibliographic data. These had begun in earnest with the project known as UNISIST which involved cooperation between Unesco and ICSU-AB (the International Council of Scientific Unions Abstracting Board).

Resolutions adopted at the 14th (1966) and 15th (1968) Sessions of the General Conference of Unesco authorized the Director-General of Unesco to undertake and complete jointly with the International Council of Scientific Unions (ICSU) a feasibility study on the establishment of a World Science Information System (UNISIST) (*1*).

The UNISIST-ICSU/AB Working Group on Bibliographic Descriptions, set up in 1967 as part of the UNISIST program, decided that it was necessary to develop a standard for the recording and exchange of data in machine-readable form. The outcome of this was the *UNISIST Reference Manual for Machine-Readable Bibliographic Descriptions* (*2*), a manual describing what has come to be known as the Reference Manual format or UNISIST format. The group that worked on it included representatives from the British National Bibliography, the Centre National de Recherche Scientifique, France, the Institution of Electrical Engineers who had set up INSPEC, and Chemical Abstracts.

During the development of the format, the Working Group had only the early MARC formats as models. The Group decided that they should take great care not to cause confusion with the existing MARC formats with tags ranging from 001 to 999 and decided that tags should begin with an alphabetic character, and subfield identifiers should be numeric. Otherwise, in its outward appearance, the format was very similar to MARC. However, it was different in terms of the data elements it supported. Whereas MARC formats had focused on the book with some attention to the serial, the Reference Manual focused equally on the journal article and contribution in a proceedings. It was clearly aimed at the secondary services and it could equally well hold records of monographs, though it held them in a different way from the MARC formats. In conjunction with the British Library, Unesco set up in 1976 an office in London to maintain the Manual which was known as UNIBID–UNISIST International Centre for Bibliographic Descriptions.

Although Unesco had developed the Reference Manual with the help of ICSU/AB, it had not been accepted unquestionably by the audience it was intended to serve, the secondary services. Furthermore, many organizations, particularly in developing countries, continued to approach Unesco for assistance in developing bibliographic information systems; sometimes these organizations were tied to national libraries and needed to establish databases that were compatible with MARC. Sometimes they were organizations that straddled the divide conventionally believed to exist between the libraries and secondary services. Some were even situated within national libraries but were secondary services, so it was difficult to ascertain whether they should follow the Reference Manual developed for the secondary services or UNIMARC, developed by and for national libraries. Because of the difference in the way that different types of material were treated, it was difficult to achieve mutual compatibility with both. Choosing one approach made it difficult to provide records to the other community. In 1973, Unesco set up the UNISIST Working Group on Bibliographic Data Interchange, which consisted of many representatives of the same organizations who had been on the Working Group that developed the Reference Manual. There were also representatives from the Library of Congress and ISO TC46—the Technical Committee of the International Organization for Standardization that deals with matters relating to libraries and documentation. The group was "created with the aim of developing recommendations to facilitate the interchange of bibliographic data in a compatible form among all types of users and producers and for all types of bibliographic material" (*3*). At its second meeting, it studied ISO 2709 and made recommendations for its revision which included the provision of an optional fourth subfield in each entry of the directory which was later to be used in the CCF. At its Third Meeting, it was proposed that work should start on establishing a standard for tagging structure and field definition of monographs (*4*). In order to solicit still wider opinion on the problem and thereby to help in its decision making, Unesco sponsored the International Symposium on Bibliographic Exchange Formats. This took place in Taormina in April 1978 and was organized by UNIBID, the office responsible for maintaining the Reference Manual. The Symposium also enjoyed the sponsorship of ICSU/AB, IFLA and ISO. Papers were given on a number of issues relating to the then state of the art of exchange formats and outlines were given of the main features of the major international formats. The proceedings were published in late 1978 (*5*).

The Symposium made the following recommendations:

1. The Symposium, recognizing that the systems used in various sections of the information community are actually subsystems of the total information system, recommends that any working group mentioned be composed of representatives of a broad spectrum of the information community and that the requirements of both industrialized and developing countries be taken into account.
2. The Symposium, recognizing the importance of interconnecting information systems encompassing document identification, analysis, and delivery requirements, finds that the development of a common bibliographic exchange format which would be implemented at various levels of completeness by various segments of the information community is desirable and may be feasible. The Symposium therefore recommends that the development of the common format be treated as a high priority item by ICSU-AB, IFLA, ISO, Unesco, UNIBID, and other interested parties.
   The Symposium further recommends that the common exchange format be defined as consisting of
   a. record structure
   b. content designators
   c. data elements
   and that the record structure be defined in ISO 2709 and the emphasis now be placed on the establishment of standards for content designators and the data elements and that the coordination and support of Unesco be sought to achieve this goal.
3. The Symposium, recognizing the need for integrating the various components of the information community recommends that any work undertaken within IFLA and UNIBID on an ISBD for analytics and/or authority control should include representation from the entire information community.
4. The Symposium, recognizing the need for standardization of the ISO 2709 implementation codes, for example, "type of record," and "bibliographic level" codes, recommends that a standard be prepared containing the attributes necessary for inclusion and a method for encoding them.
5. The Symposium, recognizing the need for a bibliographic data element directory, including elements for all areas within the information community, and its maintenance, recommends that ISO undertake this work as an item of high priority. Depending on the availability of funds, contractual support should be sought to accelerate this effort.
6. The Symposium recommends that the working group which develops the common bibliographic exchange format make arrangements to have the format tested in a pilot or operational mode, and that the format then be revised if necessary to reflect the results of the test.
7. The Symposium agreed that certain detailed recommendations proposed by participants be forwarded to the appropriate bodies. In particular it is recommended that ISO prepare guidelines for the use of ISO 2709.

As a result of these recommendations, Unesco set up the Ad hoc Group for the Establishment of the Common Communication Format. This Group contained experts from ICSU/AB, ISDS (the International Serials Data System), IFLA, ISO, and UNIBID, as well as an expert from the group that had devised MEKOF, the format of the CMEA (Eastern European) countries (*6*). The Group worked on the basis that the new format must be compatible with the MEKOF, UNIMARC, and UNISIST Reference Manual formats. It also took into account derivatives of these formats, namely the USSR/US Exchange Format (based on UNIMARC) and an ICSU/AB Extension to the Reference Manual developed by the Four Ways Committee (*7*). The Group agreed with the resolution of the Symposium that the record structure of the format should be that specified in the ISO 2709 standard (*8*), which was in any case used by all the formats being taken into account. A consultant prepared a data element directory which included the majority of the data elements from those formats. This enormous compendium in two volumes was never published.

Initially, the Group met annually, though, between meetings, much work was done by correspondence. Much of the discussion centered on the adoption of a basic set of mandatory data elements (which was felt to be the next important point of agreement after agreement had been reached on the format structure). It was clear that the secondary services were not prepared to adopt the mandatory elements of ISBD. For instance, the statement of responsibility was not provided by many of their databases. Certain representatives from the libraries' side felt that they could not support an exchange format where such elements were omitted. Discussion seemed to forget or ignore the fact that the statement of responsibility is not the most useful of data elements in the library context; the name access points formulated according to rules rather than transcribed from the title page are more important, but they tend not to be labelled mandatory because they are not always present. (In the definitions of most exchange formats, data elements tend to be labelled mandatory or optional. It would be helpful to have a category 'mandatory if present'.) Once the meeting participants began to appreciate that the access points were just as important as the descriptive data elements for the identification of records, particularly for the unique identification of records to avoid duplicates in a database, the two sides became more closely allied. A number of the representatives of the library side, perhaps feeling that further work on the Unesco format would jeopardize the standing of UNIMARC, expressed their concern to Unesco that they could see no purpose for the exchange format and withdrew from the group. After persuasion from Unesco pointing out that the CCF was never intended to replace UNIMARC, technical experts replaced the earlier senior management representatives from the library side, and thereafter work continued at a much greater pace.

In retrospect, the libraries community may have justifiably felt that the intention of certain parties was that the CCF should replace all other formats. With hindsight, even if it did not appear to be the case at the time, that would have been impossible. It is difficult enough in the UNIMARC community to seek agreement on format changes because the users all have their own national formats and they need to ensure that UNIMARC is always in line with them. If UNIMARC had been adopted as a common communication format for both communities, it would have been very difficult to make changes to suit the requirements of the other community of users. It may have been that the members of the group around the table on all sides came to realize that the format was going to be of most use to the smaller services that straddled the divide between the library and secondary service community and that they themselves had been invited to be experts in an advisory capacity rather than had been asked to develop something that they had to accept for their own use.

In this light, the libraries community was persuaded that though the ISBD elements were, in principle, desirable, records without certain of them from sources lacking the tradition of fullness of the record that is found in the national libraries would nevertheless be of use to someone somewhere, those for whom the format was ultimately intended. The format then became more clearly aimed at operations which needed to provide records to and receive records from both the library and the secondary service community, and, as many of these organizations were in developing countries, it was decided to keep the format simple in terms of its data elements and data element definition. Taking into account the fact that there was not then, and indeed still is not, any international agreement on cataloging rules, the format was kept free of anything resembling cataloging rules. In order to achieve compatibility between the different record structures of the formats and their differently defined bibliographic levels, a record structure was defined for the CCF implementing the latest version of ISO 2709. Most exchange formats, and probably all national library formats (the MARC formats), implement the first edition of ISO 2709 published in 1973. The second edition published in 1981 is compatible with this, but has an important extra feature known as the extended directory or the fourth element of the directory. CCF records are divided into segments. The CCF uses the fourth element of the directory to indicate to which segment of the record each field belongs. The structure of the format has at times been criticized as overcomplex. It might be true that it is not easy for catalogers to understand: that is because it requires a different approach from that of traditional cataloging on which, incidentally, secondary services practices also are usually based. However, the CCF is, as a standard, required to be implemented only as an exchange format, so a computerized system should take this into account, and allow records to be created in a way that more closely resembles traditional data entry practices which have been incorporated into other automated systems that data entry personnel have been accustomed to using. This will require a data entry format which is different from the exchange format. It is then the task of the system to allocate each field to its segment as appropriate, probably when the CCF exchange format is provided as output from the system. It may be obvious to many users that this can be done to simplify data entry. However, there are other users who are still of the opinion that to follow the CCF it is necessary to use the data elements as described in the manual, and their identifiers, at every possible level in the system. This is more easily done for the MARC formats than for the CCF as they were developed to automate existing manual systems geared up to the production of catalog cards. The CCF, on the other hand, was designed from a data element directory and is neutral as regards any intention for the final output of the records contained within the format.

The format was published in 1984 (*9*).

Further Developments

No sooner had the format document been published than users began to require more of it than had been originally intended. The idea of an exchange format is that users convert data from their system into the format. It is not, though, completely true to say that the exchange format does not dictate the internal format of the system, though in the case of the CCF, the original idea was that users of existing formats would make conversions into the CCF. However, anyone wishing to build a new system would do well to model their data element definitions on those data elements in the exchange format which they think will be most useful to them. Consequently, Unesco began to receive requests for assistance in implementing the CCF. Various attempts were made to devise manuals that could help organizations implement the CCF. Much discussion took place at the meetings of the Ad hoc Group on the Establishment of the Common Communication Format and the Working Group on Methods, Norms and Standards in Information which was the successor to the Working Group on Bibliographic Data Interchange (*v. supra*). The outcome of these discussions and various attempts at writing manuals was a document *Implementation Notes for Users of the Common Communication Format (CCF)* (*10*). This is intended to help organizations wishing to make their internal system formats compatible with the CCF so that they can easily exchange with other users. It tells the reader how to avoid using subfields if his software will not support subfields. It explains in more detail such concepts as bibliographic level and segments. It gives better and fuller examples than the format document. A document was prepared in draft called "Using the CCF: a guide to cataloguers using AACR" which was intended to help the cataloguer in a CCF-based system which had adopted the second edition of the *Anglo-American Cataloguing Rules*. This took AACR and indicated rule by rule how data were to be entered in the CCF. On completion, it was felt that this exercise was not as useful as had seemed at first sight; data entry procedures are very specific to the software system which is being used and, though a number of individual systems might all implement the CCF and AACR, they would not necessarily be able to gain by having the same manual. Indeed, many data entry modules conceal completely from data entry staff anything relating to field identifiers, and, less often, subfield identifiers. Additionally, AACR is frequently subject to revision and can be implemented at a number of different levels; all these factors would contribute to the guide being less than universally applicable. Unesco are now developing instead an integrated database implementing AACK and CCF on the CDS/ISIS software package, and an accompanying manual.

Technical Aspects

As mentioned above, the record structure of the CCF has been criticized as overcomplex. In fact, as a machine-readable format it is the opposite, and it can be thought of as complex only when it is regarded as a data entry format which it was not intended to be. It is complicated for catalogers to enter data into the format, especially if they try and create manually the links between records or between segments in a record. In order to understand the main features of the format, it is necessary to appreciate the concept of *bibliographic level.* Bibliographic level is defined in the CCF document as 'a designation assigned to a bibliographic item that indicates the placement of the item in a structure based on vertical relationships.' Publications can be conceived of as being in hierarchies, with monographs within series, journal articles within journals, and contributions within conference proceedings which can be treated as a kind of monograph. Some monographs are parts of monographic series and may in turn be split into volumes. Most formats recognize four bibliographic levels, analytic (articles), monograph, collection and serial. The Reference Manual uses *collection* to mean a collection of monographs, which most library cataloging codes would call a monographic series. UNIMARC uses *collection* to a mean 'a bibliographic item that is a made-up collection,' for example a collection of pamphlets in a box which may be related only for the convenience of shelving them. A second important concept is that of the *segment*; records are divided into segments. The data relating to any particular bibliographic level are assigned to a segment containing only data at that level. Segments may also contain data describing related documents such as earlier serial titles, or editions, or translations of the document being recorded.

There are, then, two main features of the format that distinguish it from other formats. The first feature is its simple set of data elements that can be used at any bibliographic level and are disassociated from cataloging codes. The second is the logically defined record structure which uses the fourth element of the ISO 2709 directory to denote bibliographic level and field occurrence. The use of both of these features is a product of the circumstances in which the format was devised.

Since the format was designed to be compatible with a number of other already existing international formats, it was necessary to include either all data elements from these other formats, or a subset. Including all data elements, in particular those that are seldom used, would have decreased the level of compatibility in the CCF. It is in the lesser used data elements that the formats have gone their own way. Therefore, it was decided to include the basic elements in the format for exchange and let the less commonly used data elements be added as private data elements between parties to an exchange agreement. Another reason for there being fewer data elements than there would otherwise be is that data elements relating to different bibliographic levels are not allocated to different fields at each level but appear only once at one designated field. Most formats provide different identifiers for titles of monographs, titles of serials, and titles of analytics. The CCF does not. Field 200 is the field for title. If the title is the title of a monograph, it will be assigned to a segment containing all the fields relating to the monographic level. If the title is that of an article it will be assigned to a segment containing all the fields relating to that article. The record structure of the CCF was devised to take into account different structures in the formats from which records would originate. The Reference Manual and formats related to it have fields designated for different bibliographic levels. UNIMARC has fields intended primarily for the monographic and serial level but can also use those fields embedded in linking fields as fields describing an analytic. The Reference Manual has four bibliographic levels, analytic, monograph, serial, and collective, while UNIMARC has analytic, monograph, serial, and collection. Collective in the Reference Manual corresponds to multivolume monograph which is in UNIMARC only as a subset of monograph. In both source formats, the fields relating to appropriate bibliographic levels can easily be identified. However, the relationships could more easily be converted into a third more logical structure than into the structure of the other of the original formats, so the structure of the CCF was designed to be logical. It was designed to make use of a then new feature of ISO 2709, the fourth element of the record directory, so that each field is denoted (in this fourth part of the directory) as belonging to its bibliographic level and each field in the record is uniquely identified there by an occurrence identifier. So, two character positions are used in the fourth element of the record directory, the first for the segment identifier and the second for the occurrence identifier. Each of these codes is set at zero if there are no repeats of segments or occurrences. This occurrence identifier takes into account the segment identifier so it will be set at 0 (for the first occurrence) when a field is the only occurrence of that kind in a segment. There may be other titles in the record, but if one is the title of a monograph in segment 0 and another is a title of a series in segment 1, then each will be the zero occurrence in its own segment.

Each segment contains an indication of the bibliographic level. The primary segment (numbered as segment 0) contains an indication of the bibliographic level in its record label. The label, or leader, as it is alternatively called, is a set of 24 character positions defined by the ISO 2709 standard which contains data important in the processing of the record. The CCF therefore assumes that the bibliographic level of the primary segment is identical with that of the record. Other segments, known as secondary segments, contain their bibliographic level in field 015 within that segment. This field was added in the second edition of the CCF.

An interesting note is that the structure of the record depends on the bibliographic levels in the item (for determining what belongs to each segment), but it is not necessary when structuring the record to determine what bibliographic level each segment is. The Reference Manual format, on the other hand, requires the bibliographic level of many of the data elements in a record to be known in order to allocate the appropriate tag to the field containing the data. Diminishing the importance of defining the bibliographic level makes it easier for the CCF to act as a switching format between the MARC formats and the Reference Manual, since it does not matter in defining the structure of a record being converted to the CCF what the bibliographic levels of the data elements were in the source format.

The CCF has the following bibliographic levels in order to remain compatible with the formats which were taken into account when it was developed: s; serial; m: single volume monograph; c: multivolume monograph; a: component part (analytic); e: made-up collection.

Field to field links have also been included in the CCF. The second edition includes codes to denote links between an author name and his affiliation (which will usually be entered in its own field and may be formatted like a corporate body if the rules permit) and between publisher and ISBN where a record includes two publishers of a simultaneously published work.

A CCF record relating to an article in a journal is reproduced below.

Bibliographic level: a (Indicated in record label)

001	00	1192
020	00	00@ AI.D.S.
021	00	0021
022	00	10@ A19870917
030	00	00@ B2
031	00	00@ Aeng
040	00	00@ Aeng
050	00	00@ A010
060	00	00@ A120
200	00	01@ AIs European Community food aid in dairy products cost-effective?@ BEdward J. Clay and Mark Mitchell

300	00	11@AClay@BEdward J
300	01	11@AMitchell@BMark
440	00	10@A19830700
490	00	00@Avol. 10 (2)@Bpp. 97-121
620	00	00@Afood aid@AEEC@Aadministration@Adairy production
A90	00	00@AC514
015	10	00@As
080	10	00@A02@B0
200	10	01@AEuropean Review of Agricultural Economics

Note that in the example, the directory is broken down from how the record appears structured according to ISO 2709. In each line, the first three characters represent the tag, the next two the character positions in the fourth element of the directory, the first of which identifies the segment and the second is the occurrence identifier. The data relating to each field follow, each field beginning with two indicators followed by subfields each of which begins with '@'. '@' is used in the format to denote the character code ASCII 31 which indicates the start of a new subfield in ISO 2709-based formats.

The following are brief definitions of the fields used in the example:

001 Record identifier
015 Bibliographic level (of segment: used in secondary segments)
020 Source of record
021 Completeness of record
022 Data entered on file
030 Character sets used in record
031 Language and script of record
040 Language and script of item
050 Physical medium
060 Type of material
080 Segment linking field: general vertical relationship
200 Title
300 Name of person
440 Date of publication
490 Part statement
620 Subject descriptor

A90 is a private field for bibliography number.

It can be seen in the example that the last three fields are indicated as belonging to segment 1. If we suppose that the record of the journal *European Review of Agricultural Economics* is also on the database as record 9999, then segment number 1 may be represented as follows, using the record control number (in field 010) to link to the record.

010	10	00@A9999
015	10	00@As
080	10	00@A02@B0

Note that in both methods of creating links, the linking field 080 must appear. This contains two subfields, subfield @A containing a code that denotes whether the link is up or down the hierarchy, subfield @B indicating the number of the segment to which the link is made. This method of segmentation can easily be correlated with data in a relational database.

Other points to note are that field 001 follows ISO 2709 and includes neither indicators nor subfield identifiers. The remainder of the fields up to 099 are used for codes of various kinds. 'Local' or 'private' fields may begin with an alphabetic character, hence field A90 which contains a bibliography number in this example.

The record could appear as below in a printed bibliography.

Clay, Edward J; Mitchell, Mark
Is European Community food aid in dairy products cost-effective? / Edward J. Clay and Mark Mitchell, 1983. In: European Review of Agricultural Economics, vol 10 (2), pp. 97-121
Descriptors: /food aid/ /EEC/ /administration/ /dairy production/
Bibliography no.: C514 (Record no.: 1192)

Evaluation of the CCF

In evaluating the CCF it is necessary to remember three points:

Relationship with existing formats. The CCF was not designed from first principles, but was based on major existing international exchange formats and was intended to be used for the transfer of records between systems which were already capable of providing output into these major exchange formats.

The CCF was not expected to have to do anything that could not be done by any existing exchange format, though in some ways it is more powerful. For example, it is possible to take a bibliographic item such as a series of annual conference proceedings where each member of the series has its own individual articles and create one record containing all the data relating to what would amount in most bibliographic systems to a number of records (Fig. 1).

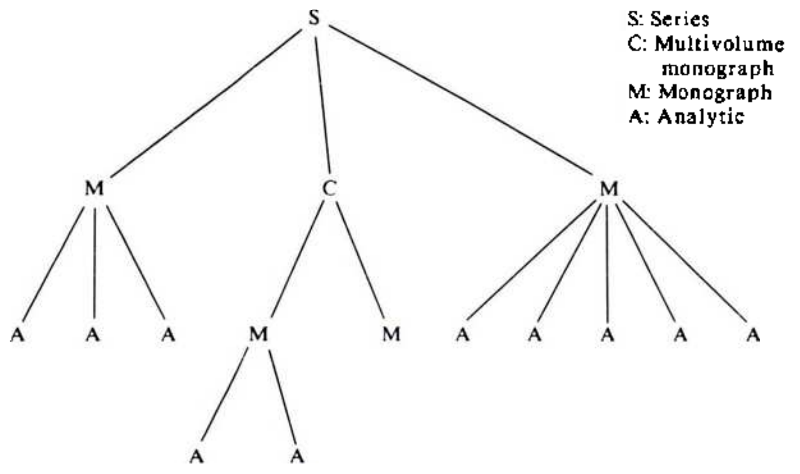

FIGURE 1. *Relationships in a complex CCF record.*

However to comply with the CCF, this record will contain a segment for each separately occurring instance of each bibliographic level. One of these segments has to be labelled the primary segment and this will contain certain elements of control information such as record control number. If the format had been designed from first principles, it probably would have contained a control segment in each record which would always be present and would contain information as to which segments would make up a complete bibliographic record. As it is, the primary segment contains this control information.

The CCF is an exchange format. The CCF is intended as an exchange format and as such has to contain bibliographic data for exchanging between systems. It does not govern what can be done within the systems themselves, so it cannot be looked to as a guide for creators of on-line public access catalogs. Of course, the definition of data elements will affect the internal architecture of systems using these data elements, but there is a large amount of agreement between organizations as to the definition of the key data elements in a record. This can be noted by comparing the data elements in a national bibliography and in a secondary service publication. The data elements author, title, publisher, date, to mention only a few, will be there in every case although they may be presented in different forms, according to different cataloging codes.

The CCF is intended for exchange of bibliographic data. When the system was developed it was intended for the exchange of those data elements of the bibliographic record that were needed for the identification of a document in a catalog or bibliography. It does not contain fields that would be required for library circulation systems or interlibrary loan. An individual system using the CCF as an exchange format to facilitate record creation by taking records created externally in the CCF may add any other fields required for its own purposes. Morever, systems wishing to exchange data elements other than those provided for in the CCF are free to allocate unused tags to those data elements or to allocate alphanumeric tags (e.g., AAA, BAZ, H97) as in the example above.

Users of the Format

Even before the format was formally published, two major organizations were already using it. The Dag Hammarskjold Library of the United Nations in New York adopted the CCF for its UNBIS system (see UNBIS, vol. 42, p. 243) but could not implement it fully as it could not be held in the internal format of their existing software system. However, they adopted it to the extent necessary to enable the records to be converted to the CCF standard format at some future date, and adopted the tagging scheme of the CCF, though not its subfields or segments. A data entry manual has been published, the UNBIS Reference Manual (*11*).

The Office of Official Publications of the European Communities was developing new software and adopted the CCF because of its flexible record structure. There was interest not only in providing a mechanism for linking bibliographic records to each other but also in providing the facility for holding the actual text. The CCF is supplemented by the SGML for formatting the actual text. SGML is the Standard Generalised Mark-up Language. The Office of Official Publications publishes the

Official Journal of the European Communities which consists of small items of information in a daily journal with weekly supplements. These have been put in a file, with each item including its text constituting one record. The main aim is to enable the journal to be printed from tapes in different centers throughout the European Community. The bibliographic levels and segments of the CCF have been used to the full to enable the data from the different sections in the publication to be arranged in their appropriate segments. FORMEX has been published and from the document it can be seen that it adheres very closely to the CCF (*12*).

Probably the first network to adopt the CCF was the ICONDA Group developing an international construction database. They had originally planned to use the UNISIST Reference Manual, however, because they were intending to merge databases which had already adopted data entry rules, they found the CCF easier to implement and have based their manual on it (*13*).

Since publication of the CCF, a number of organizations have been helped by Unesco to investigate the advantage of using the format, and, where it has proved advantageous, to adopt it in one way or another.

The situation in Brazil makes an interesting case study (*14*). Brazil naturally participates in the many regional subject-based secondary services that have been established in Latin America: PAHO for health information, DOCPAL for population, etc. Brazil is also a member of such international networks as AGRIS (agriculture) and INIS (nuclear information). The country also has at least one cooperative cataloging agency, the Getulio Vargas Foundation which developed its own software called BIBLIODATA and took as its format a format called CALCO, based on the LC MARC format as it was then. It is situated in Rio de Janeiro near the National Library and soon after the software was completed, the National Library became one of the libraries in the cooperative. However, the format was, in this case, used only as a basis for data entry into the system. Brazil has attempted to develop an information infrastructure following Unesco guidelines and in so doing has tried to coordinate efforts within both the library and the secondary information (predominantly scientific) sectors. Many information systems had been developed using different international formats. There is, for example, a network based at the Ministry of Agriculture which uses a format similar enough to that of the Food and Agriculture Organization's to enable exchange of records with their AGRIS system. The Centre for Nuclear Energy uses the INIS format. BIREME in São Paulo is the Brazilian node of the Latin American health information system, part of the Pan-American Health Organization which uses the CEPAL format, a format based on the Reference Manual (*2*) which is used by UN agencies in Latin America. The Brazilian Institute for Information in Science and Technology (IBICT) was charged by the Council for Research in Science and Technology (CNPq) with developing a common format for all sectors in order to prevent the problem which already existed when an organization had to enter data into two systems by manually creating a separate record for each system.

It was a national policy decision to set up a network for bibliographic information. However, many organizations were already providing data for an international network or an interregional network and using a particular format for it. The national network needed a national format. How was the problem of conflicting formats to be resolved? The solution was as follows: many of the secondary services in Latin

America were using the CEPAL format which was based very closely on the UNISIST Reference Manual and adapted slightly to suit the capabilities of the software. The national library format CALCO was under development, but was based on US MARC on which UNIMARC was based. The CCF was compatible not only with these two formats but also with the formats of AGRIS and INIS which had both been influenced by the MARC formats and the UNISIST Reference Manual. Now, CALCO, which had been based on the US MARC format, had been developed ten years earlier, and had not been brought up to date. As it had deviated slightly from the US format, mainly because the US MARC format had been revised, it needed certain revisions in any case. The solution to the problem of bibliographic information interchange in Brazil involved bringing the CALCO format into line with the CCF and embarking on an exercise to write programs to convert the other formats into the CCF. As the new CALCO was not accepted readily by catalogers who felt that data entry would become more difficult into a system where data entry was done via a format which was not made primarily for data entry, it proved essential to develop two national formats; one for the catalogers so that all catalogers were inputting records in the same format, and one for the systems themselves which was much closer to the CCF. It is of course the computer which makes the conversion between the two formats, which amount to an input and exchange format. Work has been going on to develop a 'language' for the specification of format conversions. This has been stimulated by the need to be able to convert between the CCF-based national format and the formats used by the existing networks in Brazil including the CALCO data entry format.

The CCF has also been used in Colombia as the basis for the national format for reasons similar to those that persuaded the Brazilians to make use of it. However, since previous to the exercise to develop a national format they had had no provisional or draft format, they were able to start afresh. Simmons (*15*) relates how COLCIENCIAS, a semiautonomous government agency took on the task of creating and coordinating a cooperative national information system to include the resources of documentation centers, libraries, and archives, many of which were microcomputer based. These organizations were separately funded and chose their own computer hardware and software. A 'switching format' based on the CCF has been designed called the Formato Común de Communicación Bibliográfica para Colombia (FCCC). Each participating agency requires a pair of programs to be written, to convert its records to FCCC and back. Programs will also enable the conversion from FCCC to CCF and back.

The FCCC is at a first glance far removed from the CCF. The format does not include the ISO 2709 record structure. It has no indicators or segments. It retains compatibility by limiting relationship types in a record and by ensuring that all data required for a full CCF record can be generated automatically or stored in an FCCC field or subfield.

The International Co-ordinating Committee for Development Associations (ICCDA) has developed an implementation of the CCF on the CDS/ISIS Microcomputer Software Package which is intended for producing databases which can be exchanged between participants. A diskette accompanies the manual. (*16*). The work on the package was coordinated by OECD Development Centre and supported by the International Development Research Centre in Canada (IDRC). This package is being used as a model for other similar implementations outside the development community wishing to use the CCF and the CDS/ISIS package.

In China, too, the CCF has been translated and is beginning to be promoted in organizations that need to participate in both the library and secondary service the library and the secondary services community.

The second edition of the format was published in May 1988 (*17*), and in April 1989, the first Users' Meeting took place at the International Bureau of Education in Geneva, sponsored by Unesco, at which progress reports, technical papers and practical demonstrations were given on topics such as implementing the CCF on particular software systems, future extensions to the format for additional kinds of material and conversions between the CCF and other formats (*18*).

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ALAN HOPKINSON

UNIVERSITY-BASED TECHNOLOGY TRANSFER AND 2000: EXPLANATION, EXAMPLE, AND EXPECTATIONS

Introduction

Traditional dependence upon simple diffusion of innovation to facilitate economic development has proved unpredictable and slow. Where economic progress and job creation is central, technology transfer, the volitional movement of technology from source to recipient (*1*) becomes advantageous. University-based technology transfer, as modeled by Godkin (*2*) and illustrated by Godkin and Huckaby (*3*), holds promise of accomplishment in the 21st century if operational practices are refined in the 20th. The role that the university might play as an agent of technology transfer is the focus of this article. Based upon a reading of more than 300 technology transfer-related papers, this essay defines technology transfer, presents a model representative of university involvement in that endeavor, and discusses factors identified in the literature that are and will bridle such enterprise unless remedied.

An Explanation

Technology been described as the "...software 'software' of the utilitarian..." (*4*), the words or knowledge used in productive endeavor (*5*), and any tool or technique, any product or process, any physical equipment or method of doing or making, by which human capability is extended (*6*). Where diffusion of technology is the random process by which an innovation is communicated (7), technology transfer is the volitional movement of technology (*8*) from a Source to a Recipient (*9*). In that frame, the tools and knowledge, hardware and software of human endeavor are disseminated, adopted, and adapted for use. Though a conscious activity (*10*), technology transfer tends to be fluid and ambiguous (*11*), an "experiment innovation" (*12*), evolutionary in nature, resistant to strict mangement control, and subject to luck or serendipity (*13*). Creighton, Jolly, and Denning (*14*) and Jolly, Creighton, and George (*15*) suggest a microlevel model involving both a Source and Recipient of knowledge linked by a Transfer Mechanism. Two elements, Formal and Informal "knowledge flow enhancement factors" facilitate the flow of knowledge via that mechanism. From a macrolevel perspective, the multilevel, multiphase model accounts for the influences of government, industry, technology base, and economic forces on the technology transfer process in a given country (*16*).

An Example

Factors influencing university-based technology transfer are both external and internal to the institution. Godkin has discussed those extensively in another context (*17*). Following a survey of the literature, he suggested that university transfer action clusters into an adjunct group consisting of those functions which are neither academic, administrative, or profit making in nature; an administrative section within which university administration supports technology transfer and economic development activities; a quasi-profit area in which all elements contribute to the financial viability of the university; and an academic arena which accounts for technology transfer activities undertaken by faculty in the traditional college setting. Factors within the external or Task Environment (*18*) also were noted as contributing (*19*). Those will be discussed in the context of the Godkin model located in Figure 1.

EXTERNAL FACTORS

As in the general sense, university-based technology transfer consists of the volitional movement of technology from a source to a recipient. In this context, the label Industrial Constituency (*20*) specifically denotes the greater business and industrial base which the university, or Source of technology, targets as Recipient. It represents, collectively and individually, the business community within a university's sphere of influence. Where the university uses "discovery push" to promote technology and applications, businesses seek technology for adoption and adaptation to specific needs through "need pull" (*21*).

Regulatory intervention, no doubt, moderates transfer activities. Governments have power of the purse strings few "...universities have the financial strength to refuse..." (*22*). Patent rights (*23*) and licensure, (*24*), so characteristic of the free enterprise system, limit technology transfer. Antitrust, product liability (*25*), the "Taxation effect" (*26*), and real or perceived limits on the exchange of scientific information between foreign scholars and domestic colleagues (*27*) are all important.

Questions of "contextual fit" (*28*) or "source-recipient incompatibility" (*29*), as will be shown, also factor.

INTERNAL FACTORS

As mentioned earlier, technology transfer-related activities within the university seem to reside within four segments: (1) the academic quadrant, (2) the quasi-profit quadrant, (3) the adjunct quadrant, and (4) the administrative quadrant (*30*). The "glue" cementing these together are the coordinating and decision processes forming campus polity and the information documentation and distribution system which, typically, resides in the campus library. Informal agency, technology push, and the service Map at the port of entry compliment the process. A cursory review will illustrate.

The academic quadrant includes initiatives issuing from within traditional academic colleges. Essentially, preparation of educated graduates should be the major contribution a university makes to technology transfer, but others also figure. Affiliate programs, through which industrial sponsors who, for an annual fee, are granted a continuing "window" (*31*) on university research (*32*), are becoming common. Sabbatical and exchange programs incorporating faculty are common. Student consulting and part-time work arrangements, in industrial settings, are sometimes sponsored by student chapters of professional societies. Corporate sponsorship provides a stronger

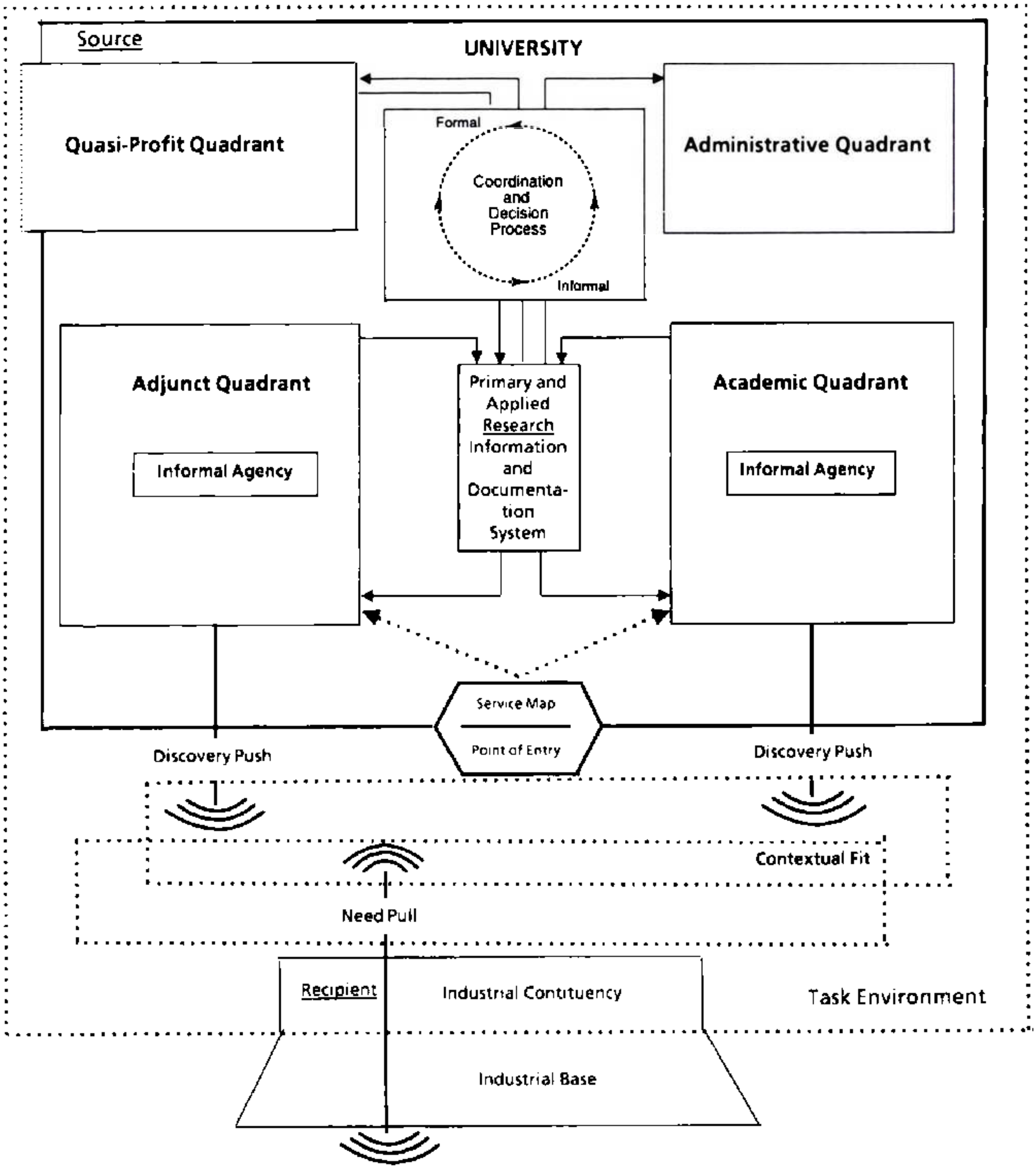

FIGURE 1. *University-based technology transfer.*

company presence on campus and provides an incentive to attract better students following their graduation.

The intent of all of the elements contributing to the quasi-profit quadrant is profit for the university. Research parks, for-profit incubators, and marketing groups all vie.

The Adjunct quadrant consists of those functions which are neither academic, administrative, nor profit making in nature. Examples include extension centers, small business development centers, and not-for-profit incubators which provide low-cost space, services, and technical assistance under one roof to small businesses during start-up. Innovation centers, clearing houses, and organized patenting and licensure efforts also contribute.

Indirectly supporting technology transfer, university administrators develop and maintain university-related technology transfer infrastructure, the coordination and decision processes, and the information documentation and distribution system. They also cooperate in related economic development initiatives requiring participation with outside groups such as technology venturing, industrial advisory councils, and visiting committees. It is the responsibility of the administrative quadrant to direct structural change conducive to development of the coordination and decision process and to create a climate supportive of the information documentation and distribution system.

Finally, the informal agent, a member of the university promotes his own invention or product or another's for its own sake apart from his official duties (*33*). Where business seeks needed technology through "need pull," the university uses "discovery push" (*34*) or "technology push" to promote innovation. The entrance to the university's technology transfer system, point of entry, might be staffed with an agent assigned the responsibility for maintaining a Service Map or catalog of university research services and projects and directing industrial base clients to services they need.

Problems associated with implementation and maintenance of university-based technology transfer programs are of increasing concern to the academic community. Among a growing minority, there is alarm. Therefore, prospects for immediate and future university involvement necessitate and obligate consideration.

Expectations for 2000

A broad range of factors have been empirically found or observed to influence technology transfer generally (*35*). A reading of related articles reveals a significant number of factors influencing university-based initiatives (Fig. 2). If the businesses are to compete in an international environment, managers must increase the pace of innovation and improve efficiency of operation all in a dynamic environment characterized by competition for ever higher quality in manufacturing. The year 2000 will only be as economically bright as our ability to define new and refine existing mechanisms now common to university-based technology transfer. Selected issues critically hindering at this juncture are: (1) the nascency of the field, (2) contextual fit, and (3) university information storage and retrieval capacity.

University inventions are almost always basic ideas, undeveloped in the industrial sense (Goldscheider, 1982)

Faculty shortage; demand for PhDs not meeting supply (Block 1984)

Lack of practical "hands-on" experience among faculty (Battenbur 1980)

Length of time necessary for research objective to materialize (Bayle 1986)

Fear that faculty will neglect traditional teaching and research (Bok, 1982)

Outdated university equipment (Block 1984)

Structural variables within the university (Block 1984)

Educational institutions are not organized to manufacture, produce, or market patentable inventions (Bremer 1982; Goldscheider 1982)

Industry concern for quality control (Boyle 1986)

Target organization fails to see the value of change as worth the cost (Roberts and Frohman 1978)

A shortage of Technology Transfer Managers (Gartner and Naiman, 1978)

Industry concern for confidentiality (Battenbur 1980, Bok 1982, Boyle 1986, Smith 1984)

Perception that the university cannot help with minor improvements in local conditions (Boyle 1986)

Different time constraints in industry and the university (Smith 1984)

Communication between university and industry (Johnson 1976)

Source-recipient incompatibility (Sharif and Hag 1980, Udis 1976)

University and industry misconceptions about each other (Burke 1985, Libsch 1976)

Differences in institutional tempo (Abelson 1982, Battenbur 1980)

Institutional differences (Melchiori 1984)

University accountability appears lower than that found in industry (Battenbur 1980)

Real world overtures from industry may threaten faculty (Battenbur 1980)

University coming into competition with company when projects reach development stage (Boyle 1986)

Belief that faculty live in an "ivory tower" (Boyle 1986)

Industry representatives frequently lack adequate technical knowledge to communicate needs (Battenbur 1980)

Bottom line consideration of stockholders (Battenbur 1980)

Short-term orientation of industry (Battenbur 1980)

Industry misunderstanding of academic mission (Battenbur 1980)

Industry failure to complete a thorough needs analysis and goal identification (Battenbur 1980)

Management failure to identify and provide support to liaison personnel (Battenbur 1980)

Successful university research parks become too expensive for new entrants (Glazer 1986)

Lack of "contextual fit" (Bradbury 1978)

Market competition and related confidentiality issues (Bradbury 1978)

Recipient organization functioning well below or above capacity (Mansfield 1971)

An overreliance on the scientist as transfer agent (Bradbury 1978)

FIGURE 2. *Hindrances to university-business technology transfer.*

(continued)

Transfer agents not speaking the same technical industrial or grammatical language (Bradbury 1978)

Structural variables inherent in the university such as promotion, tenure, and teaching load influence faculty involvement (Battenbur 1980)

The relative emphasis of universities on teaching, research, and service (Muttenrs 1985)

Issues surrounding academic freedom (Bok 1982)

Contemporary means of technology transfer "... are less familiar... to all except a few private universities" (Baldwin 1986)

Executive Order No. 12356 issued in 1982 which broadened the definition of what could be classified (Sullivan and Badler 1982)

The U.S. Inventions Secrecy Act which authorizes the Commissioner of Patents to keep patent applications secret and to withhold the grant of a patent for national security reasons (Sullivan and Badler 1982)

Government regulation (Sullivan and Badler 1982)

Patent rights and license questions (Melchiori 1984)

Legal risks (Fowler 1984, McHenry 1985)

A more effective means of processing information is absent (Bradbury 1978, Licklider 1966)

Libraries that are supply oriented rather than demand driven (Drake 1988)

Information overload to users' seeking to maximize the number of references located in online review (Wibberly and Daugherty 1988)

Limitations in current design of effective human–computer interfaces (Garg-Janardan and Salvendy 1986)

Librarians limiting role to information service provider rather than "professional" counselor on personal information management (Dow 1987)

Problems associated with training of professionals in the control of information (Williamson 1987)

Lack of environment-specific descriptive research and modeling (Boyle 1986)

Little research focus on industry as recipient of university-generated technology (Boyle 1986)

Outdated campus research equipment (Mai 1984)

The common university model of technology transfer stresses role of one hundred top research universities only (Burke 1985)

The common university model of technology transfer overemphasizes the FORTUNE 500 (Burke 1985)

The common university model of technology transfer overlooks the development of human resources (Burke 1985)

The common technology transfer model of university–industry cooperation is most likely to distort academic mission (Burke 1985)

Recipient proximity to source of technology (Eldridge 1984, Gartner and Naiman 1978, Roberts and Frohman 1978, Shelpetal 1984)

Disagreement over rights to use and ownership of research result (Wade 1981)

Differing aims and perspectives of the university and business communities (Abelson 1982, Azaroff 1982, Batternbur 1980, Block 1984, Bok 1982, Burke 1985, Cravalho 1985, Dietrich and Sen 1981, Fowler 1984, Gibson 1984, Glazer 1986, Norris 1978, Rogers 1986, Smith 1984)

FIGURE 2. *(continued)*

NASCENCY OF THE FIELD

As alluded to earlier, results of university research have, for decades, been commonly diffused into use through such as the production of graduates, publication and utilization of extension centers such as that at Texas A&M. Yet, within the academic community, contemporary means of technology transfer "... are less familiar... to all except a few private universities" (*36*). One apparent trend in the United States, involves the movement of transfer efforts to approximately one hundred of the, perhaps, three thousand colleges and universities there. Accompanying is the danger that university-business activity will "... mimic a monolithic model that works well in only a few exceptional cases such as Stanford..." (*37*), MIT or the Wisconsin Alumni Research Foundation. Unfortunately, this may be occurring in an environment in which modest firms, with mid-size companies and local plants of larger corporations, find smaller universities and junior colleges more approachable.

Complicating matters is the dramatic expansion of university efforts to profit from research. Concern that the technology transfer field is growing too fast has been raised in a number of quarters. Potential ethical, legal, and financial costs of licensing and related technology transfer initiatives have not been counted. As G. G. Stubbs, Assistant General Counsel for the Texas A&M System remarked, "Generally the courts have been kind to universities, maybe because they thought universities weren't so sophisticated. I think that might change" (*38*).

CONTEXTUAL FIT

The nature of "contextual fit" (*39*), or source-recipient incompatibility (*40*), poses peculiar uncertainty when one considers instituting university–business relationships. Organizational differences active in those situations affect the context of transfer (*41*). Udis (*42*), in a study of spin-offs from military research, determined that technology can only be transferred between sectors requiring similar levels of technology. Where the technological gap is too great, complexity hinders. Where small, there is little to transfer (*43*). Unfortunately, managers often lack the sophistication, ability, or will to specifically determine information needs. Similarly, few in the university community have the experience or incentive to appropriately address nuances of business malady and behavior. Ethical issues and those of campus governance interact (*44*).

Research provides evidence that organizational (nontechnical) factors are often the most critical barriers to effective innovation (*45*). Educational institutions are simply not geared to manufacture, produce, or market tenable inventions (*46*). Research on transfer is in a nascent phase of development. Diffusion-related findings have not been well analyzed from a managerial perspective (*47*). Worse, the miniscule number of papers considering the needs of small business did so tangentially.

UNIVERSITY INFORMATION STORAGE AND RETRIEVAL CAPACITY

A quarter century ago, Licklider (*48*) warned that a more effective means of processing information contained in research documents would have to be found. "It is evident that in considering the absorption of science and technology as they affect the innovator, we are back to the scientific and technology information retrieval problems which have for so long been the providence of information scientists" (*49*).

The rapidly growing applications of computer and telecommunications technology to library services and information systems does not guarantee ready access to such services. Yet, the forcing of technology "through the pipeline," so to speak, has been shown to be catalytic to local economic development in particular regions (*50*). Libraries that are supply oriented rather than demand driven (*51*) particularly bridle the movement of appropriate technology. Contrary to other disciplines, data and information appropriate to business use is not, typically, available in a few references. Rather, bits, scraps, and remnants of information must be collected and collated to be meaningful. Librarians who can take on the role of "professional counselor on personal information management" (*52*), rather than that of information service provider, are strategic to managers of all stripes.

On a technical level, limitations in current design of effective human–computer interfaces are problematic (*53*). The proliferation of data bases overwhelms even information specialists much less entrepreneurs. On a macro level, problems associated with the training of professionals in the control of information have been observed (*54*). On a micro level, information overload to users' seeking to maximize the number of references located in an online literature search has been noted (*55*). All are symptomatic of larger problems.

Conclusion

If local communities, anywhere, are going to thrive economically beyond 2000, intrapreneurial and entrepreneurial activity must be nurtured now. Colleges and universities can facilitate, but the "institutional gap" (*56*) separating the business community from higher education must be narrowed. Collaborative mechanisms and models peculiarly appropriate to the needs of business are required.

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