

Academic Information
in
The Academic Health Sciences Center
Roles for the Library
in
Information Management

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ASSOCIATION OF AMERICAN MEDICAL COLLEGES

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Summary

The nation's capacity for meeting the information needs of its health professionals, a traditional role of the health sciences libraries under the leadership of the National Library of Medicine, is likely to be radically affected by the rapidly evolving electronic information environment. New technologies improve our ability to access information selectively and offer an approach to managing the overload caused by the continuing expansion of knowledge so pronounced in the biomedical sciences. We are seeing a shift from paper to electronic means of managing information, and the academic community is exhibiting a growing awareness of a need to incorporate new information technologies into the processes of medical education, research, and health care practice. The implications of changing information technologies for faculty, students, and practitioners are examined in this report. It is argued that even though we are facing financially constrained times, academic health sciences centers should invest resources to control and manage better their intellectual information support systems. Specific strategies for strengthening the existing information systems which undergird the health sciences enterprise are suggested.

While the electronic information revolution holds great promise for enhancing the study and practice of medicine, as well as for improving the efficiency and efficacy of biomedical research, academic health sciences centers have not moved aggressively to exploit this potential and in general are poorly positioned to respond to the new demands of an electronic information-based society. Their information-

support systems are fragmented mixtures of single-function, manual, and computer-based files that can neither communicate nor exchange information effectively. Administrative support systems have received substantial attention as tools for improving the business functioning of the enterprise, but far too little energy has been devoted to upgrading the academic information systems—those that are integral to the discovery, transmittal, and utilization of knowledge in the service of science and medicine. In fact, the academic community seems generally unaware of how dependent it is on the quality of these systems and the prospect for radical improvement inherent in the technologies now available. There is little evidence of any institutional appreciation of alternative mechanisms to equip faculties, students, and practitioners with the knowledge and skills they need to ensure proper use of computers as memory extenders, consulting-knowledge systems, and decision-making aids. Equally striking is the inattention to transforming the capabilities of libraries, the traditional custodian of the world's knowledge base, to enable them to function in the world of electronic information acquisition, management, and transfer. This report describes how a technologically sophisticated library system—radically transformed in concept from custodian to active partner in the management of biomedical information—can play a new role in maintaining the preeminence of American medicine.

Academic health sciences centers need fresh policy analysis, wise planning, and new commitments in this new era. A common strategy in financially tight times, in

order to protect the academic staff and other programs, is to cut back on information resources and library personnel. The rationale is that the faculty members and practitioners, through their collective memory and informal communications channels, can sustain a rich and reliable knowledge base for teaching and clinical decision-making until more funds become available to maintain a community institutional resource. Such a strategy today carries new risks. More and more, information is available only from computer-based systems. Getting and using timely information now and in the future means technological capability and information-handling sophistication. Under these conditions, it is not only unwise but also potentially dangerous to reduce access to information.

Academic health sciences centers need to make their existing information systems more efficient and cost-effective. Integrating academic information-management concepts into the education and practice processes can help to ensure that faculty members, students, and practitioners have the best information-processing environment available. A network system approach is an effective response to these needs. Networks can accommodate a collegial structure and allow individuals to draw on institutional information resources unhampered by barriers of time and distance to build personal information files to support their needs regarding research, learning, and clinical decisions.

Leadership must be identified to spearhead the development of an institutional information policy. Strategic planning should be initiated to (a) identify key components and functional requirements of an institutional information network, (b) sanction and sponsor adequate education programs in medical information sciences, and (c) set priorities for network development.

Information in Academic Health Centers

Pivotal to any information transfer network is a unit that can bridge the world's knowledge base and institutional information support systems. One of the first steps academic health sciences centers must take in the near term is to see that such a pivotal unit is in place and functioning. Senior academic center executives and faculty members can exercise one of two options. They can help to redefine, retool, and reorient the traditional information-handling unit, the library, and give it the resources to develop the technological capability and staffing to perform these essential functions. Alternately, they can create a new facility or adapt an existing academic unit to develop and manage the academic information resources of the center. The first of these options is likely to be the least costly, the most efficient, and the most logical. This report depicts through several scenarios how the technologically sophisticated library can dramatically simplify and improve the recall and use of information by faculty members, clinicians, and students. The report also covers the principal technical requirements and service features of two stages in the evolution of libraries from where they are today to what they must become tomorrow.

Technology adaptation occurs in three stages. In the first stage, older methods are replaced by newer technologies that do the same tasks more effectively. Technology makes new and different approaches possible in the second stage. The third stage is transformation of behaviors. Academic centers have barely entered stage one. They need to take steps that will strengthen their information systems at the same time they move forward. An essential first step is to transform the library from a repository to an interactive information transfer and management system.

The adaptation of technology to manage the world's biomedical knowledge base is

Summary

a national concern. Changes and of students, and practice in an electronic common cause. In the industrial, the academic public sector national agency, with other public provide the catalyst the nation's academic centers into a network Library of Medicine. It has come of achievements. Information technology sources, however: individual institutions needed for the ahead. A new center resources are essential.

Accordingly, this report are responsible for the professions and services in this health sciences associations and and private age that:

1. Academic hospitals take implement a network recorded knowledge institutions in as possible. The first technological center serve as stage one.

2. Professional organizations assist academic centers to take academic and a information base. The practitioner information network can Medical Center

Information transfer network can bridge the world's academic and institutional information systems. One of the first health sciences centers in that term is to see that is in place and functioning. Academic center executives can exercise one of the ways to help to redefine, the traditional information, the library, and give develop the technologically performing to perform these. Alternately, they can or adapt an existing develop and manage the resources of the center options is likely to be most efficient, and the report depicts through the technologically can dramatically simplify recall and use of faculty members, clinical. The report also covers all requirements and two stages in the evolution where they are must become tomorrow.

Transition occurs in three stages, older methods are technologies that do the actively. Technology development approaches post-stage. The third stage behaviors. Academic entered stage one. The steps that will transition systems at the forward. An essential from the library from interactive information system. Technology to manage the knowledge base is

a national concern. The burden of financing and implementing institutional changes and of training faculty members, students, and practitioners to function effectively in an electronic environment is a common cause to be shouldered by the industrial, the academic, the private, and the public sectors. A strategically placed national agency, working in conjunction with other public and private entities, can provide the catalyst and leadership to link the nation's academic health sciences centers into a network system. The National Library of Medicine is the logical coordinator. It has compiled a remarkable record of achievements as a front-runner in information technology applications. Its resources, however, as those of many individual institutions, fall short of what is needed for the magnitude of the tasks ahead. A new coalition of forces and new resources are essential.

Accordingly, the recommendations in this report are addressed to three sectors responsible for the education of the health professions and the provision of health services in this country: (a) academic health sciences centers, (b) professional associations and societies, and (c) public and private agencies. It is recommended that:

1. Academic health sciences centers and hospitals take immediate steps to implement a network that facilitates the flow of recorded knowledge throughout their institutions in as a direct and useful form as possible. The first step is to strengthen the technological capabilities of libraries to serve as stage one network nodes.

2. Professional associations and organizations assist academic health sciences centers to take the next steps to link the academic and administrative organization information bases to hospitals and individual practitioners in an interactive information network. The Association of American Medical Colleges should begin a plan-

ning process to involve the leadership in business and industry, academic institutions, and professional associations and societies related to health in a coalition to support the development of prototype information-management networks leading to interinstitutional networks. Health professional associations should collaborate in sponsoring programs that promote the rapid acquisition of knowledge and skills in faculty members, students, and practitioners in the use of computer systems. These organizations should use their own information programs and dissemination systems to demonstrate the applications of newer technologies.

3. Industry, foundations, federal and state agencies, the federal executive, and the Congress of the United States acknowledge their responsibilities in supporting state-of-the-art information technologies to ensure that the world's biomedical information base is readily accessible through academic health sciences center libraries and networks. These agencies should support (a) the development of prototype network systems, (b) programs that encourage the rapid integration of information technologies in the learning and practice of the health professions, and (c) programs that attract and retain qualified people in medical information and knowledge-base development in academic centers. The National Library of Medicine should continue as the lead agency to foster the continued improvement and advancement of the academic information management network in support of the biomedical sciences. It must be appropriately staffed and budgeted to bring about substantial improvements in the transfer of academic information through health sciences libraries and network support systems.

A unique opportunity exists today to shape the biomedical information environment. The unequalled leadership position

of the United States in biomedicine is due in large part to the development of academic health sciences centers as foci for the generation of new knowledge and use of this knowledge in the practice of medicine and the training of new practitioners. The world leadership of the United States in communications and information management technologies is due in large part to the joint efforts of the public, private, academic, and industrial sectors. The synergism of these extraordinary strengths

holds enormous promise. Leadership is needed to bring about the concerted and coordinated involvement of multiple organizations and institutions in both the public and private sectors. Academic health sciences centers must step forward and become partners in the management of the world's knowledge base in biomedicine in order to ensure the continuation of this nation's preeminence in biomedical research, education, and patient care.

Background

In the early 1960s there was a loss of new knowledge, an enormous postwar biomedical research effort, and a loss of the nation's scientific knowledge base. There was no access to recorded knowledge, and it was cumbersome to use and maintain. Most importantly, the services were inadequate to meet the community's demand for new scientific knowledge. It was critical to leading health care practice that dilapidated physical facilities in health sciences were not adequate; serious shortages existed. There was no response from management.

Recognizing the importance of quality information, the Association of American Medical Colleges (AAMC) published guidelines for information services prepared by the AAMC and the Medical Library Association (MLA) (1). This report was based on timely studies (2-5) bringing about a major effort, the Medical Library Association (MLAA) of 1965, a commitment of the National Science Foundation's leadership in national health sciences information system network.

Over the next 17 years, the AAMC published three additional reports with the scholarly

mise. Leadership is at the concerted and ment of multiple or- itutions in both the sectors. Academic rs must step forward in the management ledge base in bio- ensure the continua- 's preeminence in education, and pa-

Background

In the early 1960s the exponential growth of new knowledge, one of the results of the enormous postwar federal investment in biomedical research, threatened to break down the nation's system for managing its scientific knowledge base. The crucial keys to access to recorded knowledge were cumbersome to use and expensive to produce. Most importantly, these bibliographic services were inadequate to meet the scientific community's demand for rapid dissemination of new scientific information so critical to leading-edge research, to high quality medical training, and to advancing health care practices. Libraries were in dilapidated physical condition; the collections in health sciences centers were far from adequate; services were limited; and a serious shortage of well trained personnel existed. There was a crisis that required a response from many parties.

Recognizing the fundamental importance of quality information to the medical endeavor, the Association of American Medical Colleges (AAMC) in 1965 published guidelines for medical school libraries prepared by a joint committee of the AAMC and the Medical Library Association (1). This report, along with three other timely studies (2-5), was instrumental in bringing about a major piece of legislation, the Medical Library Assistance Act (MLAA) of 1965, and with it the establishment of the National Library of Medicine's leadership role in developing a national health sciences library and information system network.

Over the next 17 years the AAMC published three additional studies concerned with the scholarly scientific information

base of academic health sciences centers. Each of these studies contributed to the development of new initiatives and responses in a changing information environment.

A major thrust of the Medical Library Assistance Act's first years was to improve the physical facilities and strengthen the intellectual resources of libraries. The AAMC's second study, *The Health Sciences Library: Its Role in Education for the Health Professions* (6), published in 1967, articulated the principles that should guide the design and construction of new health sciences library facilities. Between 1966 and 1975, 86 health sciences libraries were built or expanded (7). The importance of applying new educational technologies to medical education and practice prompted the Stead report in 1971, *Educational Technology for Medicine: Roles for the Lister Hill Center* (8). The study called on the National Library of Medicine to assume significant responsibilities for research and development in educational technologies and biomedical communications, chiefly through the Lister Hill National Center for Biomedical Communications. Its recommendations led to innovative work in medical knowledge representation and the training of critically important specialists in biomedical computing. This study was followed by a supplemental report in 1972, *Educational Technology for Medicine: Academic Institutions and Program Management*, which examined institutional strategies and guidelines for developing learning resources centers to utilize better the new media and technologies to support health education (9).

Need for New Study

The achievements over the past 15 years in expanding the provision of academic science information have been remarkable and the National Library of Medicine has played a key leadership role in most of them. Today few libraries are in need of physical replacement. Collections are reasonably adequate to meet the demands of faculty members and students. A rich variety of multimedia learning resources is available to facilitate learning. MEDLINE revolutionized bibliographic searching; other new online methods of accessing printed bibliographies such as Chemical Abstracts, Science Citation Index, and Biological Abstracts have significantly reduced the human costs of library research. The results of a peer review system that evaluates medical audiovisual materials is available through AVLINE. A nationwide network of health sciences libraries augments individual library collections through interlibrary loan linkages that annually transfer nearly 2 million documents (10). Services such as OCLC and CATLINE significantly improve the effectiveness of library operations. A major expansion of MEDLARS capabilities is underway. And innovative expert knowledge data bases in hepatitis and human genetics are under development.

A new crisis is emerging that is equal to that of the 1960s. The generation of new knowledge has continued its unrelenting course, doubling at least every 10 years. The world's knowledge base is shifting inexorably from a paper to an electronic base. New ways of synthesizing, compacting, and representing knowledge are developing. Most business-related information is computer-based. Transfer of quantities of data and information can be accomplished relatively inexpensively and nearly instantaneously with the use of phone lines, satellites, and microwaves

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over any distance. The societal view of the importance of individualized access to and control of information is changing; in a highly competitive technologically based world, individuals and organizations with better quality information services are more productive and effective.

The need today is not more information resources. The challenge is to apply new technologies appropriately and to assist faculty members, students, and administrators to develop skills to make new and better uses of the knowledge base that is available. The academic health sciences center (AHSC) today is poorly positioned as an information system. It is a conglomerate of uncoordinated, autonomous, incompatible, information files serving many different organizational and intellectual needs. Both the concept and the technologies for managing one of its most precious resources—the academic knowledge base from which it teaches, practices, and generates new knowledge—are inadequate in today's electronics dominated world. A network of interactive information files to support the work carried out in the AHSC and associated hospitals is essential to effectiveness in a collegial, information-intensive, and information-dependent environment. In this new era, the library as a center for academic information management services—not as a collection of books and resources—is potentially one of the AHSC's most important units. AHSCs need libraries that perform broadened as well as different information management functions and link individuals to information and to systems that respond to individual needs for personal memory extenders and lifelong learning and knowledge support.

Study Approach

This report relies heavily on the literature describing trends in medical education,

Background

medical information and industrial uses of technologies, developing technologies, and library services.

Data used in this study are from primary sources.

1. The results of a study of the future implications of changing technologies (11). The respondents were the directors of 27 libraries and 11 other academic libraries.

2. Data from the Academic Health Sciences Center (AAHSLD). Selected national data on health sciences libraries are from editions of *Medical School Libraries in the United States and Canada* (12). The predecessor, *Medical Libraries in the United States*, published data from a survey of 97 academic libraries provided information. Additional data are available by individual libraries.

3. Site visits. The study team visited the following health information centers in education at the University of Maryland, Vanderbilt University, Southern Illinois University at Springfield, Missouri, Kansas City University of California (UCLA) School of Medicine, Stanford University, University of California, School of Medicine, Washington School of Medicine, and University of British Columbia School of Medicine.

The societal view of the individualized access to and distribution is changing; in a technologically based and organizations with information services are and effective.

is not more information challenge is to apply new appropriately and to assist students, and administrative skills to make new and knowledge base that is academic health sciences may is poorly positioned system. It is a conglomerated, autonomous, information files serving organizational and intellectual concept and the teaching one of its most pre-academic knowledge teaches, practices, and knowledge—are inadequate in a dominated world. A new information files to be carried out in the AHSC is essential to effective, information-intensive era, the library as a information management is a collection of books potentially one of the important units. AHSCs perform broadened as information management individuals to inform systems that respond to personal memory exchange and knowl-

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medical information technology, business and industrial uses of information technologies, developing telecommunications technologies, and library operations and services.

Data used in this study come from three primary sources.

1. The results of a 1980 Delphi study of the future implications to health sciences libraries of changing information technologies (11). The respondents in this study were the directors of 95 medical school libraries and of 27 teaching hospital libraries and 11 other experts in health sciences libraries:

2. Data from the Association of Academic Health Sciences Library Directors (AAHSLD). Selected financial and operational data on health sciences libraries are from editions of the *Annual Statistics of Medical School Libraries in the United States and Canada* (12–14) and its predecessor, *Medical Library Statistics* (15–17). Unpublished data from a 1981 AAHSLD survey of 97 academic health sciences libraries provided unique program information. Additional data were made available by individual AAHSLD members.

3. Site visits. The principal investigator visited the following institutions and discussed health information management issues in education and practice with a variety of faculty and staff members: University of Maryland School of Medicine; Vanderbilt University School of Medicine; Southern Illinois University School of Medicine, Springfield; University of Missouri-Kansas City School of Medicine; University of California, Los Angeles, (UCLA) School of Medicine; University of Southern California School of Medicine; Stanford University School of Medicine; University of California, San Francisco, School of Medicine; University of Washington School of Medicine; and the University of British Columbia Faculty of Medicine.

Advisory Mechanisms

An advisory committee to the study provided the project director and principal investigator with a spectrum of AHSC interests, concerns, and professional expertise. The committee members, named in the front of this report, are key figures in information policy formulation at national and institutional levels. They repeatedly tested the validity of the study assumptions and hypotheses and provided indispensable expert guidance. Robert S. Blacklow, M.D., Rush Medical College of Rush University, contributed to the early design stages of the study. The penultimate draft was critiqued by ad hoc advisers: David Bishop, university librarian, University of California, San Francisco, representing the Medical Library Association; David A. Kronick, Ph.D., librarian, the University of Texas Health Science Center at San Antonio; Gertrude Lamb, Ph.D., librarian, Hartford Hospital, Hartford, Connecticut; and Gloria S. Werner, biomedical librarian and assistant dean, Library Services, UCLA School of Medicine. The staff of the National Library of Medicine (NLM) provided additional comments that led to strengthening the report.

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Study Purpose

In this report the complex and broad-scaled problem of information management in the academic health sciences center is examined from the perspective of the academic health sciences library as a major resource contributing to the flow of information through which the highest quality of education, research, and care is achieved. Powerful information technologies are being used to create new and different methods of managing the world's knowledge base. The continuing discovery, transmittal, and utilization of information and knowledge depend on the capability of faculty members, clinicians, and students to tap these new systems and

Information in Academic Health Centers

to exploit them effectively as memory extenders, consulting-knowledge systems, and decision aides.

The purpose of this report is to present the rationale for the long-range development of integrated institutional information management networks; to describe how such networks can be achieved through the development of a technologically sophisticated library; to explain why a new library concept is essential in the emerging electronics dominated information environment; to describe the benefits to faculties, clinicians, and students of a retooled and reoriented library; and to show how the library of the future can be achieved with today's technologies within today's financial constraints.

While this report concentrates on roles played by the academic health sciences library in the academic health sciences center, the conceptual framework and guiding principles should be valid for libraries in other settings. Libraries in community hospitals, teaching hospitals, industrial firms, associations, colleges, and universities will vary individually and as groups; but all are basically interdependent and interrelated, all operate on similar principles, and all work toward the same goals. While generally applicable, this report is not presumed to represent the concerns of all types of libraries.

The AHSC is faced with new and inescapable demands as well as new opportunities as a result of changing worldwide information-handling technologies. The need to plan for the effective management of these demands is urgent. The time to begin is now.

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Background

Carolyn Flynn, res project, and Kenneth Kenn for the project, both Institutional Development Keys, director, Institutional Development

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Chapter 1

Information and Its Management

"The flow of technology is so rapid it can acquire a momentum of its own and sweep us into lifestyles we may not like. . . . We have barely enough lead time to prepare for an effective control." (18)

The Problem

The above quotation epitomizes the management problem facing an increasingly information-intensive and information-dependent society. The business community is vigorously promoting the use of new telecommunications technologies to close the gap between an exponentially expanding information base and its efficient management. The academic community lags far behind industry in its response to both the short-term problem of organizational information resource management and the long-term, and potentially more serious, problem of managing the intellectual information base on which society depends.

IMPACT OF NEW TECHNOLOGIES

The new information technologies based on a marriage of computer and communications technologies are beginning a process of transformation of the world's uses and management of information. Technology adoption follows a pattern: in the first stage, technology replaces manual or traditional methods, and activities are performed faster and more effectively; in the second stage, technology fosters new applications, and things are done that were never done before; in the third stage, technology transforms or changes life-styles

(18). The telephone is a typical example. In 1876 the idea of the telephone was ridiculed: few believed that voice transfer would replace the letter as a reliable and authoritative communication device. Today the telephone has completely transformed communications. It has spawned new industries and newer technologies. Phone lines carry digital text as well as voice and image messages and make possible the printing of newspapers and magazines simultaneously at geographically distant locations across the country.

Most popular writing about the post-industrial, information-based economies of technologically developed countries describes the stage I technology applications. The effect of microwaves, cables, satellites, and telephone linkages on daily living is obvious in areas such as banking, national election returns, entertainment, real estate, air transportation, publishing, and office practices. The handling and transfer of information is much easier, more reliable, accurate, and secure for more and more functions. The rate of adoption of technologies has speeded up. Where the telephone did not achieve a 50 percent level of household penetration until 70 years after its introduction, television reached that level in only eight years (19). By conservative estimates, most people by 1990 will conduct much of their personal business of purchasing and paying for goods and services through personal computing devices. The next stage may bring less dependence on centralized work locations and changes in many of our fixed habits in conducting our affairs. Finally, the work

itself may be different; traditional professions may change, and new professions may evolve; life-styles will change.

In the transition between stage 1 and stage 2, behaviors and attitudes toward information management and control will have potentially greater long-range import to academic centers than the way information is produced and disseminated.

INFORMATION AS A COMMODITY

Information has become a commodity to be bought and sold on the wholesale level and repackaged for sale at the retail level. Computer terminals make it possible to read stock market data that are updated every few minutes, to consult newspapers, and to read encyclopedias. Within the past five years more than 600 information files have become publicly accessible online through computer terminals. While the majority of these files are bibliographic, an increasing percentage are numeric and information data bases, such as selected reference books and journals, the NLM's Laboratory Animal Database, and Census statistics. Many of these information sources are proprietary, and users pay royalty fees as well as communications access fees each time they read and use information provided by information vendors.

Two traditional concepts are being reshaped by the new information marketplace:

1. The acceptance of information as an overhead expense that should be freely available without fees to all sectors of society is giving way to the concept of information as a basic commodity, an essential power source much like gas or electricity.

2. The one-time purchase of information for subsequent reuse, for example, buying a book, is giving way to purchase of information on demand, as needed, through online communication with a remote storage source.

Information in Academic Health Centers

A typical example is a legal information system that is available only by leasing special hardware and purchasing access codes under a highly restrictive use contract. The contract may permit a library to use the system to serve only specified individuals within a law school or law firm.

Books will not disappear, but their uses will concentrate in those areas where their portability, relative low cost, and ease of production for stable information is incontestable. Television did not do away with movies, but it did eliminate the newsreel; the electric light did not do away with candles, but it did eliminate the gas lamp. Important or valuable information that is dynamically changing is likely to be exclusively available through online access. The economic and social impact of this trend is increasingly significant.

A serious national policy issue is emerging as a result of the new marketability of certain information services. Unhindered access to knowledge about sources of information has been considered in the public interest and for the public good. As more and more information is available only to those with financial means, fears grow about the potential of disfranchising the less affluent.

The impact of access costs on the funding of information provision in many academic sectors is already significant. Searching data bases of major relevance to health care can range from \$16 to \$100 per connect hour in addition to \$5 to \$8 per hour telecommunications costs and 5 to 20 cents per citation for offline printing. More money must be allocated to access online data bases. Does this mean less money for print resources? What is the most appropriate balance? Where is the most value for the dollars available? The need for strategic planning and policy development in this area is obvious, especially in research-intensive institutions.

Management

INFORMATION AS RESEARCH

Complex organizational information constantly be renewed bringing in relevant information. A rational system internal and external is crucial to organizational industry (20, 21). This AHSC as for any industry. In fact, few organizations are dependent on AHSC, and few professions are information-intensive as technology industries have the organic relationship management Bell Telephone, IBM Monsanto, among others of the most effective systems in the world less than elaborate support systems. At 3M, patent files in all laboratories reviewed. We pounds to be patent company cannot afford reduction of effort. All reports, correspondence online; individual products through online data identical for informationable for adapting technology company productivity information management

The two major traditional information resources are both products of The first is the need internal files more in supporting the work The second is to fill edge base and bring relevant and useful for it to advance the work.

INFORMATION AS RESOURCE

Complex organizations generate complex internal information systems that must constantly be renewed or validated by bringing in relevant outside, public information. A rational system of coupling the internal and external information systems is crucial to organizational health in industry (20, 21). This is as true for the AHSC as for any industrial organization. In fact, few organizations are as information-dependent or as complex as the AHSC, and few professions are as information-intensive as medicine. High technology industries have long understood the organic relationship between information management and corporate health. Bell Telephone, IBM, Exxon, 3M, and Monsanto, among others, have built some of the most effective corporate information systems in the world, which are nothing less than elaborate organizational life-support systems. At 3M, for example, multiple patent files in all languages must be constantly reviewed. With over 8,000 compounds to be patented annually, the company cannot afford the luxury of duplication of effort. All text processing for reports, correspondence, and manuscripts is online; individual projects are monitored through online data analyses. A vice president for information services is responsible for adapting technologies that improve company productivity through effective information management.

The two major problems in organizational information resources management are both products of information overload. The first is the need to make the ordinary internal files more efficient and effective in supporting the work of an organization. The second is to filter the external knowledge base and bring in only that which is relevant and useful at the time and place for it to advance the effectiveness of the work.

The Challenge

Ironically, academic centers which might be considered knowledge industries have contributed little recently to the concepts or technologies of information management and use. High technology industries were among the first to recognize the importance of quality information systems in competitive business. The academic sector has only begun to respond to the challenge of information management for teaching, learning, and research.

BUSINESS SECTOR RESPONSE

The problem of information overload in business is as critical as in the academic world. American business deals with 325 billion documents annually, and this data base grows each year by 72 billion pieces (22). The Department of Commerce estimates that technical data in the world double every seven years (23).

The response of business to this problem has been vigorous. Business and industry leaders recognize that:

1. A corporate information management policy is a necessity.
2. Interactive data bases and personal computer-based information systems save money and increase productivity at all organizational levels, from the chief executive to the clerk.
3. A capital investment to convert from manual paper-based files to electronic office systems makes economic sense.
4. Special personnel—"information executives" to plan and coordinate the design and maintenance of appropriate systems and services—are essential to successful corporate information management.
5. A network concept facilitates the economical use of existing information systems by linking traditionally separated data bases.

That good information is a vital resource and that a high performance information

is a legal information available only by leasing and purchasing access by restrictive use contracts may permit a library to serve only specified in-law school or law firm. appear, but their uses those areas where their low cost, and ease of information is incon- did not do away with iminate the newsreel; did not do away with iminate the gas lamp. le information that is g is likely to be exclu- gh online access. The impact of this trend cant.

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resources management system is critical to corporate success are widely accepted views (24-27). High performance depends on homogeneous information systems. The typical information chain is heterogeneous and highly labor-intensive. For example, dictating is electrical; secretaries are verbally based; typewriters are keyboard oriented; signatures are graphic; and filing cabinets are organized alphabetically. Communication in this system is a discontinuous multistep handling process that is personnel-dependent at every juncture. Add to this the multiple handling of the mail collection and distribution system, then consider that 80 percent of communications is local in an organization, and the potential effectiveness of a homogeneous electronic communications system becomes obvious. In such a system, the basic communication element is digital. Once a message is keyboarded, its destination, filing, editing, and reformatting are electronic. Mail is delivered electronically and read on a CRT terminal. Its filing and storage are automatic, and information is retrievable on the basis of the sender, date, subject, and special codes. Paper is used as the information-bearing mechanism when its special communications attributes are called on.

Historically, business has increased productivity through capital investment. There seems to be a consensus in the business community that the electronic office is integral to worker productivity at all levels and the more rapid the conversion the better (28). The capital investment in electronic work-station equipment, word processing, and communications links is expected to rise from \$3,000 per office worker in 1980 to \$15,000 in 1990 (22). The executive and middle-manager are also being equipped with an "intelligent desk." Individuals have consoles with keyboards that give access to company files and data, along with preprogrammed al-

Information in Academic Health Centers

gorithms that allow them to manipulate the data and to reformat the results. The mail comes to and flows from the electronic desk, which has become a highly personal support system intended to intensify productivity. One study showed a time saving by using electronic mail equal to \$4.35 per message (29). A financial analyst, given a personal microcomputer and Visicalc software, can improve productivity by 500 percent (30).

The management research literature shows that the failure of many information systems to support decision-making effectively can be traced to poor understanding of the purposes of information. The support technology to date has been more of a barrier than a help to executives. Content specialists, who understand the executive decision process and point of view, are needed to design systems and to serve as information providers. One commentator identifies the missing link as an "information executive" (31); another calls it an "information middleman." (25)

Lastly, the organization is conceived as an information system. The information transfer network is considered integral to and inseparable from the business of the organization, and all members become responsible for it and are accountable to it (22). Employees at all levels use the information in the system for problem-solving; they contribute appropriate information to it and control and guide its utility to the organization.

ACADEMIC SECTOR RESPONSE

In a sense, an information overload problem has always existed in the scholarly academic world. The problem of choice, selection, and emphasis in the transmission of knowledge is inherent in scholarship. Only in recent times has the university become a modern corporate presence and served society in broadened roles.

The academic institution today is a cor-

Management

porate entity with a: On the corporate situation experiences a dilemma of large business information management study in 1971, the C a business-sponsored pressed grave concern community had lagged and industry in technologies and in the view of the importances to society and (32). These concerns more recently by the itself (33-35), including health care sector (2

Universities have national informatization, although the less vigorous than the approximately 45 percent expenditures for computerized to administrative systems.

Some institutions do recognize the significant information management their mission. Stanford University, Carnegie-Mellon University, Massachusetts Institute of Technology, examples of institutions that have implemented information systems. The executive for example, uses electronic communications and online information files.

The result of the change and the slow academic community growing disparity between demand for technologies. Business corporations are equipped with computers compared to use communicating to informatization. With few ex-

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porate entity with an intellectual mission. On the corporate side the academic institution experiences all the overload problems of large businesses. In an influential information management policy analysis study in 1971, the Conference Board, Inc., a business-sponsored research group, expressed grave concern that the education community had lagged far behind business and industry in using information technologies and in taking a comprehensive view of the importance of these technologies to society and to their organizations (32). These concerns have been raised more recently by the education community itself (33-35), including those within the health care sector (36-39).

Universities have not neglected organizational information resources management, although their response has been less vigorous than that of industry. In 1977 approximately 45 percent of university expenditures for computing support was allotted to administrative information systems.

Some institutions of higher education do recognize the significance of a corporate information management approach to their mission. Stanford University, Carnegie-Mellon University, and the Massachusetts Institute of Technology are examples of institutions that have sophisticated information resource management systems. The executive level at Stanford, for example, uses electronic mail communications and online decision support information files.

The result of the fast pace of technology change and the slow response of the academic community to the challenges is a growing disparity between the supply and demand for technologically literate graduates. Business complains that graduates are equipped with archaic skills, unprepared to use common, everyday tools relating to information transfer and handling. With few exceptions, only students

enrolled in a technical field such as engineering are systematically introduced to information technology tools or skills.

The number of persons majoring in technical studies is too small. Universities produce insufficient numbers of graduates in computer engineering and computer sciences to meet either their own or industry's needs. A shortfall of 100,000 electronics engineers is expected over the next five years (40). Talented students are lured away from university studies before completing their academic work by high salaries, well equipped laboratories, and the promise of challenging problems and responsibilities. As a result, universities face increasing difficulties in recruiting and retaining gifted and promising faculty members and students to build strength in academic departments. The threat implied to the crucial role of the university as the generator of new knowledge and ideas through research is obvious.

Up until now, technology has had little influence on productivity in the educational process. Faculty and student access to computing support is frequently limited and cumbersome; once access is achieved, the system is often unsatisfactory, as it is unable to serve a wide set of purposes. Removing these limits is one major challenge today.

An important strategy is to use network systems to multiply the effect of both computing resources and scarce computing skills. EDUNET is an international network linking 130 colleges and universities. It distributes new software, facilitates file transfer and other general resources access routines, and fosters standardization of common elements. In science and medicine, SUMEX-AIM links researchers into a communications and data base management support system. Another strategy is to retrain staff members to act as integrators and interpreters to bridge gaps between systems and users.

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is likely to be crucial to survival in tomorrow's environment.

Faculty and staff members fear displacement by technologies. Experience has shown, however, that automation has created as many jobs as it has displaced. Educational technologies have not reduced the need for instructors; in fact, the demand for faculty time to create instructional packages exceeds the human resources available. Information management technologies will not reduce the role of faculty members as major sources of information or knowledge; faculty members are more likely to be in demand to create new and better forms of memory-support and decision-support.

Although computer technologies are pervasive, their application to academic information management is relatively recent and has been limited in scope. Faculty members have yet to appreciate fully the opportunities the new technologies offer to release them from the drudgery of information research and personal information file management. Branscomb estimates that systems to help professional information workers (and faculty members are professional information workers in the highest sense) "have at least 20 times more potential for improving office productivity than today's systems designed to help secretaries." (42)

Fears of faculty and staff members about the lack of confidentiality and security of data are another barrier. Recent experiences with MOLGEN, a specialized computer service for molecular biologists accessed through the SUMEX-AIM net-

work, suggest these fears are exaggerated. Initial reservations about the security of data residing in a remote data base accessed by many people were overshadowed by the power that the computer programs offered for manipulating the data. The service was so successful that within a few months the volume and intensity of use dangerously overburdened the system and threatened its collapse.*

NEEDED ACTION

The introduction of newer technologies in libraries to make better information available to faculties and staffs is potentially transformative. The removal of traditional barriers between information users and intellectual resources is within realistic economic reach. Geographical distance from information sources, time-consuming and frustrating methods of locating information, and the need to devise elaborate reprint collections and note files need not block access to information. A modest investment in equipping faculty and staff offices, libraries, and research laboratories can mean greater efficiency and utility of existing resources. Time saved searching for information, added to fulfillment of previously unmet needs, is likely to offset the costs for automating information transfer. On a national scale, the enhanced ability to share resources more efficiently can lead to lower unit costs of information transfer.

* Personal communication, D. A. B. Lindberg, M.D., professor of pathology and director of the Information Science Group, University of Missouri-Columbia School of Medicine, March 1982.

Information Technology In the Academic Health Center

Faculty and staff members need the best and most advanced information technologies to carry out their research and teaching roles. Students need to build lifelong memory adjuncts. The health practitioner and the administrator need quick delivery of information products of high quality. The continued leadership of the United States in science and medicine depends on state-of-the-art information services.

The Present

From a corporate perspective information is an organizational resource that is vital to the effective and efficient development and manufacture of products and services. The academic institution, as a corporate entity, and especially the AHSC, has an added responsibility—the development and stewardship of knowledge, which is the intellectual foundation of scientific endeavor and cultural advancement. These two information resources, organizational and academic information bases, can be characterized as short-range and long-range concerns. The organizational information resource base, for example, supports the provision of patient care and consists of medical information systems for patient records, laboratory records, research data, and hospital logistical records. The academic information resources, on the other hand, include an array of information files that faculty and staff members use: libraries, personal information records, and instructional materials. In adapting information technologies, the AHSC

has concentrated its attention and resources on the short-range goal.

ORGANIZATIONAL INFORMATION BASE

Efforts to adopt computer-based information technologies in nearly all AHSCs over the past 20 years have focused mainly on the goal of efficient and effective hospital and administrative information management systems. And rightly so. Up to 40 percent of hospital expenses relate to clerical reporting and other routine information transfer processes (43). From one perspective, the hospital exists to permit physicians to gather information, to diagnose their patients' illnesses, and then to order therapy on the basis of that information. Hospital employees spend between one-half and one-third of their time and nurses nearly two-thirds of their time executing patient-related orders with accuracy and speed (43, 44).

Extensive investments in equipment and systems development have laid a base on which to build networks. The foundation is flawed (37, 45-47), but its crucial importance to the academic center is no longer in question. These systems in the long run must link to the world's clinical practice knowledge base as well as to the world's recorded academic knowledge base in order to function fully as information support systems. The superstructure for the companion system, the academic information base, has yet to be constructed. It is with this structure and its interface with the organizational and administrative in-

formation systems that this report is concerned.

ACADEMIC INFORMATION BASE

Next to the faculty, the library is the academic institution's main instrument and resource for acquiring, conserving, and making available the world's knowledge base. The institution's primary intellectual resource is its faculty and staff. The information files essential to their work—the library, individual personal-information bases, data collections, correspondence, instructional records and materials, manuscripts in preparation, and the like—are increasingly dependent on technological support for efficiency and effectiveness. Together, the library and the faculty represent a significant capital resource in an academic organization. The management of this capital may constitute the competitive difference among institutions in the future. Faculty members, students, practitioners, and patients will want the best and most technologically sophisticated environment in which to work, train, and be cared for, and the future we are moving toward is an electronic information-centered society.

OPPORTUNITIES

Corporate planning for information resources management in academic medicine is needed. The academic information systems that underpin research, patient care, education, and the AHSC administration are currently developed to meet special local needs and have little reference to overall institutional goals. Information-handling units are generally fragmented and uncoordinated. One health sciences campus visited in the course of this study operates five different instructional production units, three learning resource study centers, a health sciences library, a dozen independent departmental libraries containing both books and media, four

Information in Academic Health Centers

independent large-scale computer centers using different hardware systems, another dozen departmental minicomputer installations, and an uncounted (perhaps even "uncountable") number of microcomputers. New network protocols allow different hardware and software systems to communicate. Networks, which accept pluralism, diversity, and collegiality, offer the best opportunity for better coordination and use of available resources.

In the area of patient care, particularly in solo and group practice settings where academic information resources may not be extensive or easily located but are important for up-to-date patient management, new communications technologies have not yet made an impact. According to one vendor, more than 10,000 small computers have been installed in these locations for practice management. Linking these computers to AHSC academic information management networks offers important new opportunities to enhance the physician's use of recorded information in clinical practice.

In medical education, technologies to cope with gross information overload in the undergraduate medical curriculum have had mixed reception and limited overall impact. Instructional technologies are often rudimentary efforts. The goal of educating self-directed lifelong learners is espoused by all, but instructional methods or philosophies that support these goals are uncommon. Millis (48) said, "We have not matched our radical thinking about changes in health services with equally radical thinking about changes in medical education." More and more medical data are digitally processed and stored, and more and more information traditionally stored in books is being stored and retrieved from computerized knowledge banks and electronic books and journals. Students must be prepared to use these technologies in more sophisticated ways

Technology

than they use books in the country require in biomedical academic department significant area of study.

At the graduate library of Medicine programs from 1972 through the integration of into all phases of clinical of 288 postdoctoral students were trained, medical from participating in 1979 the NLM search program to care settings and cesses in health practitioner efforts, but to meet the cization of these crises occurred, and recent computer scientist cine is minimal.

In research, the data has made extensive result, there is no handled through communicating as Thousands of new covered and described future more than identified annually. The fronted by 100,000 year (18). The just effective mechanisms such information anisms are under cal digital disk format capable of packing per side, representing low-cost, archival for online access a variety of network known systems as MEX-AIM. PRO

Technology

than they use books. Yet no medical school in the country requires formal instruction in biomedical computing or has an academic department dedicated to this significant area of study.

At the graduate level the National Library of Medicine sponsored training programs from 1972 through 1980 to promote the integration of computer technology into all phases of clinical medicine. A total of 288 postdoctoral fellows and graduate students were trained in 16 programs. Regrettably, medical students were excluded from participating in these programs. And in 1979 the NLM initiated a special research program to encourage new applications of computer technology in health care settings and decision-making processes in health practice. These have been stellar efforts, but they have been insufficient to meet the challenge. Institutionalization of these critical programs has not occurred, and recognition of the need for computer scientists in science and medicine is minimal.

In research, the technology to collect data has made extraordinary strides. As a result, there is now too much data to be handled through traditional channels for communicating and storing information. Thousands of nucleotides are being discovered and described each year; in the future more than one million will be identified annually. The mathematician is confronted by 100,000 new theorems each year (18). The journal is no longer an effective mechanism to transmit and store such information (49). Alternative mechanisms are under development. The optical digital disk for data storage, presently capable of packing one billion characters per side, represents a very high density, low-cost, archival mass storage medium for online access (50). Scientists now use a variety of network services. Two well known systems are PROPHET and SUMEX-AIM. PROPHET provides research

pharmacologists and others working with chemical and biochemical interactions with facilities for maintaining files of chemical structures, experimental results, laboratory notes, and computational tools for manipulating and analyzing data (51). SUMEX-AIM supports research in computer applications in medicine. Two of its subsystems, one for geneticists (GENET) and another for biochemists (MOLGEN), provide examples of specialized network services (52).

Bibliographic methods to support research uses of the public literature have become extremely sophisticated, complex, and expensive to use. But the quantity of the material to be reviewed by the conscientious researcher still exceeds the time available to devote to this necessary work. Much needs to be done. Technology is little used to filter the data base, and there are few changes in traditional approaches to personal information file management.

CHALLENGES AND THREATS

The barriers to successful innovation in managing the biomedical knowledge base are formidable. The challenge to the faculty is to understand the need to invest in information technologies even in financially tight times. The ability to access the scientific knowledge base should have high priority in academic centers. The future promises higher costs to tap more complex and different information resources and services, although the density of data transmission provides greater economy in using network information systems compared with traditional modes. Newell (53) points out that the cost of a network connection between a terminal and a distant computer is about \$5 per hour of terminal use, irrespective of the distance separating the two. Interstate telephone calls, on the other hand, cost about \$20 per hour at peak rates. Delay in structuring an information transfer network between individ-

uals and systems means an ever widening gap among information generation, its management, and its productive application.

Finding the essential capital is an unwelcome challenge of the 1980s. Some financial resources may come from greater economies in the operation of existing facilities. Other resources should come from joint ventures with industry to develop improved biomedical information instrumentation. Certainly concerted effort on the part of many interests is needed to assemble the needed resources. The newness of the discipline of biomedical computing and information management challenges the faculty to learn to integrate this body of knowledge in medical training and practice. But the greatest challenges to the academic community may be to accept responsibility for the management and control of its intellectual foundations and to identify the necessary leadership in the AHSC to move ahead.

Choices need to be made—and some are being made—at national levels that will determine the shape of the knowledge base of science for some time to come. The academic medical communities should play a significant role in these decisions. Their absence from the scene and their silence in supporting the National Library of Medicine—a pivotal agency with programs and responsibilities in this domain—are matters for concern.

In 1963 the President's Science Advisory Committee (3) spoke to this same issue: "Transfer of information is an inseparable part of research and development. All those concerned with research and development—individual scientists, engineers, industrial and academic research establishments, technical societies, government agencies—must accept responsibility for the transfer of information in the same degree and spirit that they accept responsibility for research and development itself."

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It is nearly 20 years later, and we have technologies that did not exist then. It is important to broaden this challenge now and include the medical care, the medical education, and the AHSC management communities in shouldering a share of this responsibility.

The Future

The major barrier to change is often not a love of the status quo but the lack of a clear picture of where technology leads. The will and desire for action may exist; the financial resources may be available. Without a vision of the goal, and a concrete demonstration of feasibility, however, fruitful change is difficult to initiate. Prototypes can serve to demonstrate the concept in action. Information gatekeepers, individuals who are locally recognized as reliable information sources, need to alert colleagues to the potential value and utility of the prototype to their work. Locally, an entrepreneur, a "risk-taker," needs to be prepared to lead the way. The environment must be receptive for a successful transplantation. This is a classic technology diffusion model (54, 55).

The purpose of the following scenarios is to describe how the evolution of the present information-handling environment into more advanced stages might proceed. They draw from a number of sources that describe some libraries and information centers of the future (56-64). Prototypes for most elements in the first two scenarios exist, and the technology is available to develop them. These scenarios, limited to the uses of the academic knowledge base, follow the typical staging patterns: beginning with replacement technologies (doing the same thing better), proceeding to different ways of doing what was done before, and finally moving to a transformation stage. Making ice available in many different ways, even though the horse-drawn ice wagon is replaced, is still Stage 1 technology. Stage 2 is refrigeration,

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a different concept from refrigeration eventually led to innovative developments: buildings and frozen food.

STAGE 1: THE NEXT 5 TO 10 YEARS

There is a campus electronic network. Each departmental office has a terminal for communicating word processing, or closed-circuit TV conferencing with faculty members and students. Personal computers. Some departments have electronic file systems similar to those of the library. Library records are accessible on-line. Library records also include an inventory of materials throughout the campus. Library materials may be accessed by dropping in and browsing. Individuals may use an electronic terminal to call up the records from their offices or homes at any time of the night and find out whether a book is owned and available. Requests for books, journals, audiovisual media be delivered to the campus or home location through electronic mechanisms. If the material is not available, a hurry, pages are displayed on a closed-circuit TV or sent via teletext to a convenient receiver. Video materials are transmitted to terminals by cable or microwave carrier.

Individuals with personal computers, other intelligent terminals, or electronic mail services can check automatic status reports on library transactions, for example, when books are charged out, how much is owed for interlibrary loan requests, and services in process of being initiated.

Using the terminal at the library, in some cases a split-screen system, an individual can interact actively with the library.

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STAGE 1: THE NEXT 5 TO 10 YEARS

There is a campus electronic mail system. Each departmental office is equipped with communicating word processors. Each building has telefacsimile equipment and/or closed-circuit TV communication. Most faculty members and students own personal computers. Some departments have electronic file systems similar in principle to those of the library. All the library's records are accessible online. These records also include an inventory of resource materials throughout the AHSC. Access to library materials may be in the usual way: dropping in and browsing. Alternatively, individuals may use any communicating terminal to call up the library from their offices or homes at any hour of the day or night and find out whether what they want is owned and available in the library and to request that books, journal articles, or audiovisual media be delivered to a campus or home location through a variety of mechanisms. If the material is needed in a hurry, pages are displayed on closed-circuit TV or sent via telefacsimile to some convenient receiver. Video-based materials are transmitted to local receivers via cable or microwave carriers.

Individuals with personal microcomputers, other intelligent memory terminals, or electronic mail services can receive automatic status reports on their current transactions, for example, how many books are charged out, when they are due, how much is owed for services, the status of interlibrary loan requests, the status of services in process of being carried out.

Using the terminal and a telephone or in some cases a split screen conference system, an individual communicates interactively with the librarian to have litera-

ture searches performed or to request advice on—or be instructed in how to perform—data base searches. Librarians work with faculty members to maintain course syllabi and reading lists online. Lists of faculty publications are routinely compiled from scans of the bibliographic data bases and maintained in university files. Some faculty members' works-in-progress are registered in the library data base. Individual bibliographic files are automatically updated by the library using sophisticated search profiles. Librarians consult with individuals who want to set up personal information files on computers. Faculties from other institutions have access to selected services and materials through interinstitutional agreements that optimize use of scarce or little used materials. The library has access to public academic health related data bases; and, where it does not maintain its own searching expertise, it uses a consulting network of other librarians and information retrieval specialists to advise on or perform needed work. The library is a partner to a national network of libraries and information systems. Materials can be directed from another network library to the individual's files. Charges for services are managed through the university accounting system.

In Stage 1, the library is primarily a modern resource library. Its functions are to acquire, house, organize, and make available resources that support and advance the mission of the AHSC. It is an information transfer facility, securing desired information from wherever it is available and providing it to the individual or to the organization. It also instructs individuals in skills for gaining access to information and organizing it for future retrieval. Ice is still delivered, essentially, but in a timelier and more useful fashion. The philosophy of access has changed: people do not need physically to go to the library to secure materials or services, although

they may. The present and Stage 1 can co-exist.

STAGE 2: THE NEXT 10 TO 20 YEARS

Word processing systems have voice recognition and voice input capabilities. The library is a smaller facility. It consists of collections of current books, journals, and media in traditional format, but most of the collections will be on a few videodisks. Centralized regional libraries house older materials and transmit facsimile copies on request to any library or individual. Most scientific journals exist only in online form, but general purpose journals and review journals remain in paper form.

In the early part of Stage 2, libraries will have access to knowledge bases for which the National Library of Medicine hepatitis and human genetics data bases are prototypes. Many of these serve as online encyclopedias or textbooks available through the library videodisk system rather than through remote centralized files. The primary journal continues to flourish and serve an indispensable archival function, but the problem of quality filtering remains. The library computer records journal article use and citation by its faculty and staff. Others scanning the same bibliographic data bases will see these citation and selection records and employ them as general quality guides. Primary and secondary bibliographic files are identified that allow users to narrow their resource search pool. Specialized files to answer recurring information requests are developed by networks of librarians.

The library is a network hub. Decentralized institutional information units which support the major AHSC functions of patient care, research, education, and management employ librarians and information specialists. They serve as a faculty instructing students in the development of personal knowledge bases. They work with other faculty members to develop medical

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knowledge bases for use in clinical practice by sorting and filtering the data bases and reformatting information. These knowledge bases replace conventional textbooks and handbooks. The research base of medicine grows out of integrated information systems that connect patient-management data into interactive, interinstitutional networks.

At this stage, the library is an information management center. Ice is no longer delivered; instead, there is a refrigeration system for generating ice, storing it, and making it available for use.

STAGE 3: BEYOND THE NEXT 20 YEARS

The scenario of life in an electronics dominated environment is not all clear or certain. Few futurists hazard projections beyond the next 10 to 15 years. Generally, however, the world 20 years from now might resemble something not too radically different from today. Education may be largely individualized; professionals may receive most of their new information through electronic media; libraries may be less repositories than management systems for a variety of computer-stored files that they use to disseminate information. Researchers may work in groups irrespective of geographical location, using computer services extensively for data analyses. As research becomes more specialized, more people may be needed to evaluate results and relate them to the existing knowledge base. New kinds of information professionals, who may not be medical professionals, may match service resources with the client in need. Their functions may include "information and referral, and education toward prevention of the need for medical or legal services after preventable difficulties have arisen." (18)

House calls may return via satellite-mediated long-distance communications systems that permit two-way audiovisual and

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digital conferences between physician's office and most patients. Numerous new electronic systems eliminate the obstacles between physicians and human men. These intelligence systems, something resembling computer-aided physician and the patient, use these systems to evaluate treatment alternatives. Patients use medical information to depict the exact advantages

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return via satellite-me- e communications sys- o-way audiovisual and

digital conferences between any physician's office and most patients' homes. Numerous new electronic intelligence systems eliminate the obstacles imposed on physicians by human memory. Some of these intelligence systems demonstrate something resembling common sense. The physician and the patient jointly consult these systems to evaluate available treatment alternatives. Patients and their families use medical information systems to depict the exact advantages and disadvan-

tages of treatments and help them to choose wisely what they ask the physician to order.

Some futurists believe that we tend to underestimate what can be accomplished in one year and overestimate what can be accomplished in 10 years. The constant in modern society is rapid change. Moving into the future is like riding a bicycle; you keep your eyes on what is ahead, not on the front wheel; and you can't go too slowly, or you lose your balance.