Introduction

ELECTRONIC NETWORKS

Networked digital communication is one of the most rapidly maturing technologies in computing. Systems are now in place for conveying electronic messages, documents, and images rapidly and efficiently across long distances; for reaching multiple sites simultaneously; and for linking dissimilar computers interactively in an open communications environment. What is notable about networking is not only the remarkable technology on which it is based but the rapid expansion of its influence. Networked computing was once known mainly to scientists and other specialists fortunate enough to have access to the technology and willing to learn the necessary skills, but that is changing. With costs and administrative barriers to the networks falling, and useful applications and network access points increasing, networked computing is on the verge of entering the mainstream. A principal question for some observers has become not whether digital networks will become as commonplace as the telephone but when. Many other questions remain, however, especially for organizations considering the possibilities of converting from conventional to network processes. Electronic networks pose a variety of operational, economic, and social problems, only some of which have been solved.

Research libraries are among the organizations that are feeling the effects of this convergence of technologies. Not only are innovations in networking likely to transform a variety of traditional library operations (acquisitions, cataloging, interlibrary loan, reference work, resource sharing, and document delivery, to name a few), but they will equip libraries with the tools to create new kinds of services as well.
Research librarians are now beginning to ask themselves, with a new sense of urgency, how they might take advantage of this new environment while preserving the best of their traditional roles. These are difficult decisions because development costs are high, support for college and university libraries is already spread too thin, and in spite of progress in the setting of standards there is a great deal of movement and instability in the technical environment.

Whether these new circumstances constitute a crisis or an opportunity depends partly on local conditions. Some libraries, especially those with plentiful resources, an administrative taste for experimental system development, and key staff members to take leadership roles, have been successful in adapting the emerging network technologies to fit existing services and devising new services specifically for the networked environment. Other libraries with less flexibility and fewer resources have proceeded more cautiously, opting for fewer immediate benefits in exchange for fewer risks. At stake is not just the operational issue of how research libraries will do their jobs but the changing role of the research library itself. Not everyone involved is convinced that progress towards the networked library is compatible with the research library's established academic identity and purpose. For some observers, the research library is too bound to its historic mission of storing and organizing printed materials, too well adapted to its traditional niche and unable to evolve quickly enough, and will have to adjust to a diminished role in the future if it survives the transition at all. But other observers see the research library as an organic, adaptive institution, capable of riding the forces of change to emerge as a leader in networked information services. A unified vision for the research library of the future does not yet exist.

Coming to terms with the consequences of library networking, and contributing to its realization, is the collective task of everyone who has a role in the future of the research library. The essays in this volume are part of that effort. The writers, who address a range of issues in computer networking and its application in research libraries, include academic library directors, system developers and administrators, members of the scientific computing community, library consultants, and university administrators. Some are technical authorities, but many are not. The diversity of the expertise they bring to the question of higher education, research, and networked information systems is as varied as the conclusions they have drawn. Collectively they present a realistic picture of the adaptive processes that are taking place at the intersection of the research library and advanced computer networking.
INTRODUCTION

THE ORIGINS OF LIBRARY NETWORKING

The emergence of the network model of digital communication and its adoption by the library community cannot be traced to any single event or organization but has developed along several fronts simultaneously. One of the first networking systems to become widely used in colleges and universities was BITNET, a mainframe-based messaging and file transfer system. Besides taking advantage of the electronic mail services of BITNET, academic librarians have used BITNET’s LISTSERV software to establish a number of computer conferences devoted to library topics. The scientific community, working in conjunction with the government and the computing and telecommunications industries, have fostered the development of other networks, including ARPANET, established under the auspices of the Advanced Research Project Agency of the Department of Defense, and its successor, NSFNET. These systems, faster and more interactive than BITNET, have evolved into what is now known as the Internet, the global network of networks that has become the most direct means for interconnecting the educational, research, and library communities. The Internet is the model and inspiration for the more powerful and inclusive networking systems that are still in the planning stages.

Although the academic community has carried much of the responsibility for creating these networks, government has played a critical role, both administratively and financially. The seriousness of the federal commitment to the national network has been manifested most recently by the High-Performance Computing Act of 1991. This legislation, championed by Senator Albert Gore, will establish the National Research and Education Network (NREN), an administrative structure designed to promote the continued development of the national computer network, which will in turn support development projects in both education and industry. Constituting the primary links in this network is the national “backbone,” a set of fiber-optic trunk lines operated by the National Science Foundation. This backbone, already in place but constantly being upgraded, provides fast long-distance data transmission services to various regional, state, and organizational networks, which in turn extend network access to their own communities. The capacity of this network for moving data, projected to reach 3 billion bits per second before the end of the decade, has suggested the operating metaphor of a “superhighway,” analogous to the federal interstate highway system begun in the 1950s. Although these electronic highways are constructed of fast transmission lines and advanced processing machines rather than asphalt and concrete, the analogy is a useful one. Like the federal highway system, the network is planned to be a public resource, established with public funds,
constructed by commercial contractors, and made freely available to a wide variety of users at many different levels. Advocates of library networking have recognized that the NREN's primary roles, facilitating educational communication and disseminating information, are also the primary roles of the academic library, and they believe that the network represents a golden opportunity for libraries to lend their expertise to the effort of developing a productive new research environment.

Although the excitement over the Internet is the most immediate source of librarians' interest in networking, shared access to remote computers is an idea that is well established in the library community. Like many other public and private organizations, libraries have practiced their own forms of networking for many years. Since the development of the first automated systems, libraries have found ways to provide enhanced electronic access to their holdings, beginning with locally designed, mainframe-based circulation systems in the 1960s, which were succeeded by the efficient turnkey systems of the 1970s, and more recently by hybrid systems taking advantage of small but ubiquitous and increasingly interconnected microcomputers in the 1980s. The introduction of the MARC (machine-readable cataloging) record and other standards helped to launch OCLC, RLIN, and numerous regional library networks dedicated to the sharing of cataloging and authority records and other automated services. These developments helped make possible collaborative automation efforts in which a single system could provide collective access to the holdings of cooperating libraries, facilitating resource sharing that benefited libraries both small and large.

The success of automated systems has fostered the development of numerous new features: online public access catalogs supporting enhanced searching techniques, supplementary bibliographic databases mounted alongside the public access catalog, CD-ROMs mounted on local area networks. At many sites, these library resources have been linked to other information utilities in campuswide networked information systems, and some have even been opened up to remote users over wide area networks. Librarians are also users of other kinds of networks, including the commercial packet switching services that provide access to remote commercial database providers such as DIALOG and BRS, direct lines to book jobbers, and networks established by vendors of automated library systems for their clients. The Internet has already begun to absorb some of the traffic generated by these applications. The point is that when libraries compare the new networks with their own operations, their standard of comparison is not manual operations, but a well developed, though more localized and controlled, form of networking.
Finally, it is worth noting that the inspiration for networking has not come exclusively from institutional sources, whether government, industry, or the universities. Much of the creative energy that has gone into the development of network resources has come not from formal organizations at all but from self-educated experimenters working locally in less-structured environments. Individual users working on multiuser machines, or even on microcomputers equipped with inexpensive modems, have created, with very little central planning or supervision, a highly distributed, decentralized, grass roots kind of telecomputing that has helped pave the way for more institutionalized networks. It is these users, enthusiastically embracing the concept of “cyberspace” and pioneering computer conferences and bulletin boards in networks such as USENET, FIDONET, and more recently the WELL, that are now calling for the democratization of the networks and the removal of barriers separating the public from the powerful networks that well-placed academicians take for granted. It is not without significance that these values of open access and cooperation are also basic to the traditional library ethic.

NETWORK APPLICATIONS IN LIBRARIES

The national network is essentially a communication system that constitutes an environment for performing certain tasks, but it does not specify what those tasks should be. Like the computer itself, it is a multipurpose tool that can be adapted to serve a diverse range of activities. One of the main tasks for libraries, in fact, is to invent interesting new uses for this powerful resource. The Internet has already been the setting for a variety of experiments in information dissemination potentially useful to the library community, only some of which have been created in library settings. These experiments are the early stages of a development process that will eventually yield new multimedia communication systems, new forms of electronic publishing, transmission that will be for practical purposes instantaneous, and direct access to data collections larger than many sites could store locally. Many leaders in the library community believe that research libraries, because of their long experience in organizing information, should take a leadership role in developing these new network applications. Several contributors to this volume, particularly Clifford Lynch and Paul Peters, discuss in some detail the potential of library networking in this environment.

Although predicting how network applications will eventually unfold is difficult, it is possible to identify from current practice the various sorts of functions that are most likely to receive attention in
the future. Among the simplest and most widely used network features are electronic mail and file transfer between individuals. In libraries, these tools can serve not only as a medium for maintaining professional contacts, but these tools have potential in collaborative reference work and the delivery of search results to patrons. Extended to public bulletin board and conferencing environments, these applications make it possible for special interest groups to carry on open discussions with unprecedented immediacy and efficiency. With some additional development, these basic communications tools will make it possible for a wide variety of more formal library business transactions, such as book ordering and interlibrary loan requests, to be handled in the paper-free environment of the network.

Another promising area of network development is direct electronic access to library resources across institutional boundaries. Many research libraries, having created in-house online public access catalogs (OPACs), have taken additional steps to make them available to local users via dialup lines, and more broadly to remote users over the Internet. Although it is true that the primary clients of remote library catalogs are professional staff and others with Internet skills and access privileges, some libraries have begun to build within their own public access systems bridges to selected remote systems as a service to all users. For example, at this writing, users of the University of California's MELVYL system have access, if they want it, to university library catalogs in Colorado, New Mexico, Tennessee, Massachusetts, and several other states. One problem is that users of remote systems, for the time being anyway, must learn to use each system and the peculiarities of its interface separately—a rather daunting prospect for those who may not even know their home systems very well. The implementation of standards such as the Z39.50 protocols for information retrieval may eventually provide for more transparent remote access, but at this stage using remote systems requires patience and practice.

Online library catalogs are no longer restricted to being electronic versions of the card catalog but are becoming multidimensional information systems. Many research libraries now provide access for local users to supplementary databases of journal literature from commercial sources such as Wilson or DIALOG. These resources are usually subject to license restrictions that permit access to local users only. Remote users are becoming familiar with the frustration of seeing them listed on the OPAC's opening menu, only to find they have no access privileges. Some libraries, however, have developed their own supplementary databases that are not restricted and are freely available to guest users from outside the community. Such systems, developed locally but designed for open network access, are already common in the scientific community. Charles Catlett and Jeffrey Terstriep of the
National Center for Supercomputing Applications describe in this volume research that will lead to the development of “digital libraries” for the storage and network dissemination of scientific data. Some libraries, too, have established interesting and useful resources that are accessible via the Internet, such as Dartmouth’s full-text Shakespeare database and CARL’s collection of book reviews from Choice. At some sites, the online library resources are part of comprehensive campus information systems offering information on campus events, faculty directories, course schedules, bookstore inventories, and other useful topics. Other systems, such as the Cleveland FreeNet, are public systems serving the entire community.

Still in the experimental stages, but potentially capable of radically altering the way research results are disseminated, is the electronic journal. Whether peer reviewed or not, free or fee based, issued regularly or irregularly, these network-distributed sources of scholarly writing enjoy several advantages over their printed counterparts, particularly in the speed with which research results can be made available to a community of interested scholars. A number of issues remain unresolved. For the research community, details relating to peer review, credit for promotion and tenure, copyright, and cost recovery have yet to be worked out. For libraries, the challenges include solving the unique acquisitions, storage, and public access problems presented by electronic publications. Also unresolved is the very form such journals will take. Most of the existing journals are distributed as simple text files, similar in form to standard electronic mail, but there is some interest in providing more sophisticated formats. An example is the recently announced electronic publication, the Online Journal of Current Clinical Trials, produced jointly by the American Association for the Advancement of Science and OCLC. This publication will be distributed in a graphics format permitting, with the use of appropriate software, the display of illustrations and typeset-quality printing. Such journals, if successful, could become an important new source of scholarly information, and libraries will have to find ways to access and manage them.

The presence on the network of electronic archives containing documents, directories, back issues of electronic journals and newsletters, and even software, all available for copying across the network, constitutes another potentially useful resource for research libraries. Such repositories could serve as elements of a large distributed database, permitting remote storage and fast access to certain classes of documents, thus sparing smaller libraries from having to maintain their own local copies. With the appropriate software to facilitate single-copy printing and binding of these electronic documents, these sources could also serve as dissemination points for on-demand publishing, a potentially effective way to manage the distribution of older or more specialized
documents for which formal publishing would not be cost-effective. With electronic scanning, it becomes possible to preserve rare and fragile documents and to make them widely available over the networks. These techniques are providing models for new, efficient forms of resource sharing, where access is instantaneous and the information delivery does not deplete the supply. These models stand in contrast to the traditional library model of local acquisition and local use and could lead potentially to the redefinition of the archival function of research libraries.

Taken together, these highly fluid network resources suggest the outline of a new information structure, not limited by the boundaries of any single institution or possessing much of a distinct structure of its own, but capable of bridging the spaces between institutions—a "virtual" library or "library without walls" some have called it. The terms may be somewhat metaphysical, but the prospect of an electronic network seamlessly and transparently linking libraries and other information sources into a single entity is not a mere fantasy. The virtual library is a reasonable extension of resource sharing goals that libraries have been pursuing for years. Pieces of such a system are already in place, and more are under construction. The pairing of interesting and unique local information sources with fast and efficient large-scale networks is a powerful combination, capable of transforming a modest desktop computer into an information-gathering device of unprecedented reach.

**PROBLEMS**

The network is a large and complex structure that has been built without the benefit of any master plan or blueprint and thus is constrained by no single design, but is rather the product of experiments and progressive refinements taking place simultaneously at numerous locations. This loose, organic, emergent characteristic of the network is one source of the problems that newly networked libraries are now facing: network processes do not always respect the economic, legal, political, technical, and functional boundaries within which libraries customarily operate. Much of what we thought we knew about the legal and ethical aspects of the information business will have to be relearned as library services become network services. Some of these problems are not amenable to technical solutions and will challenge the research library's ability to adapt administratively to a radically new model of librarianship. Concerns about the traditional library's ability to make
the necessary changes has led pessimists to predict the demise of the library as we know it, and optimists to call for a bold reconstruction of the research library to meet the anticipated changes.

Library directors know that a research library is anything but virtual. It has walls, a roof, substantial physical holdings that must be processed, disseminated, and preserved, and a large number of users still interested mainly in printed documents and traditional services. The comments of the research library directors presented in this collection help isolate the conflicts that the new networks raise in academic library settings. Among the most vexing are the economic problems. With the costs required to perform traditional library functions already high and getting higher, and with long-term funding unstable, the prospect of extending the library's operations into a networked environment is not always very inviting to administrators involved in the budget process. Martin Runkle provides an informative account of the economic predicament of research libraries, looks at the costs of networking, and asks the reasonable question, who will pay? Government funds for network development will not be available indefinitely, and it is likely that the involvement of the private sector in the network will become more prominent as some form of privatization takes place.

Another problem raised by the current model of the national network is the lack of control. The typical academic library is founded on the principle of centralized control and organization, but the networks are, at the moment, highly decentralized and largely self-organizing. It is fortunate that groups such as the Coalition for Networked Information, ALA's Library and Information Technology Association, the Electronic Frontier Foundation, and CICNet (cosponsor of this conference), have voluntarily taken a leadership role in network research, education, and planning. But what is still notable about the Internet are the things that we do not know about it, such as who exactly is connected, what services are available at any given moment, and what constitutes legitimate network use. A few network directories exist in both electronic and printed forms, but none is comprehensive. Some loose agreements about appropriate and inappropriate network activities have been established by certain groups of network users, but there is no policy-making body and no centralized authority for monitoring network activities or controlling users and resources. Libraries taking part in such a system may well find themselves in the unaccustomed and perhaps uncomfortable role of being part of a larger institutional structure in which they do not exercise any particular authority. The decentralized library is an administrative paradox, and linking the actual library to a more abstract virtual one will probably require some retooling.
Another set of problems has to do with ease of access. There are at least two dimensions to this problem, one technical and one political. Technical expertise, experience, and specialized software are among the requirements for achieving network access, and at the moment only a small group of users possesses these qualities. The lack of standardized operating commands makes the network a hazardous environment for the inexperienced user, who must make do without comprehensive training materials or even simple documentation. Librarians dream of a seamless web of information access, but in reality the network environment is strewn with traps for the unwary. At the moment, the network is still a frontier, and untamed, but many developers believe that it will have to be civilized in order to achieve its potential. Attempts to provide better training and to achieve true interoperability are underway, but progress is slow.

The second aspect of the access question is political because it concerns network access policies. Network users are increasingly becoming a highly diverse lot, and it is not yet clear how to construct a system that can accommodate in a balanced way users ranging from kindergartners to research scientists. A particular problem is that, although the network infrastructure is supported in part with public funds, many interested potential users, including librarians eager to extend the information reach of their institutions, simply do not have a way to get in. Some fee-based Internet access points have recently become available, but in general only users at institutions that are already linked to the Internet and who have access to the necessary hardware, software, and support enjoy ready, subsidized network access. Information providers such as research labs, government agencies, and research libraries may be willing to open their doors to network users, but only the privileged few are able to take advantage of those resources. For many libraries, to learn of the network is to experience the frustration of the kid peeking through the fence at the ballpark, who can hear the cheering but cannot get close enough to enjoy the game.

The political question, it should be pointed out, has another side: not every institution is willing to leave its electronic door unlocked and may prefer to restrict access to outside users. It is a reasonable response to economic pressures. Even large computer systems are finite, and when each outside user takes up a port and consumes machine cycles, it seems appropriate for libraries to draw distinctions between their primary and secondary user communities and to offer access accordingly. At the present time, networking technology is more advanced than networking policy.
CONCLUSION

An extended process of adaptation is taking place as libraries, along with many other kinds of organizations, come to terms with their future roles in the networked communications environment that, increasingly, they all share. It is a process of considerable complexity and extended duration and is not likely to be quickly resolved. This collection of essays is presented as a contribution to that part of the process relevant to research library services, an effort that has also produced, in recent months, several national conferences, a handful of new serial publications, numerous local workshops and training sessions, and many instances of experimentation, testing, and evaluation. In keeping with the growing significance of the network communications model, many of the results of these efforts are being disseminated over the network itself, which is ultimately where the success of this process will be measured.

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Editor

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