of advanced services and applications.

The American Library Association Comments are endorsed by the American Associations of Law Libraries, Association of Research Libraries, Chief Officers of State Library Agencies, and the Urban Libraries Council.

Respectfullly submitted,

AMERICAN LIBRARY ASSOCIATION

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April 10, 1996

APPENDIX A

# Realizing the Information Future

## *The Internet and Beyond*

NRENAISSANCE Committee

Computer Science and Telecommunications Board

Commission on Physical Sciences,
Mathematics, and Applications

National Research Council

NATIONAL ACADEMY PRESS
Washington, D.C. 1994

# 3

# Research, Education, and Libraries

The research, education, and library communities have been information infrastructure pioneers. Their use of networking to create new channels for scholarly communication and collaboration is pointing the way to broader and deeper participation by individuals at all levels of society in the process of learning. The Internet has been the vehicle for most of the networking explorations of research, education, and libraries, but it so far has been used most heavily by segments of the research community.

"Research" includes scientists across a wide range of disciplines as well as research in the humanities; "education" includes K-12 and a range of higher- and continuing-education institutions and activities; and "libraries" includes research and specialty libraries typically associated with research institutions as well as public libraries that, like K-12 schools, are embedded in a general community setting.[1] Research, higher education, and libraries subsume a number of elements that are sometimes separately addressed under the health care umbrella, such as health-related research, education, and library support.[2]

The experiences of the research, education, and library communities illustrate some of the tensions among what different groups of communities need, want, and can afford—tensions that will be replicated or expanded as the nation moves to a truly national information infrastructure (NII). They also illustrate that the value of the Internet—regardless of whether that value is measured in terms of program effectiveness, productivity gains, or returns on investments—increases as a function of (1) the size and diversity of its user population, (2) the power and sophistication of its applications, and (3) the capability of the infrastructure.[3]





Movement toward an NII and away from stand-alone, separate research networks will solve some problems but may give rise to others for the research, education, and library communities. To understand and provide adequately for their future networking needs, it is necessary to examine how these communities differ from other communities to be served by the NII, and to appreciate as well their continuing force for positive change in the growth of U.S. society.

## RESEARCH

Within the research community, individuals and disciplines differ in terms of their use of electronic networks: some primarily use electronic mail, some emphasize access to shared databases, some require access to special tools or devices (e.g., supercomputers and special sensors), some depend on networks for rapid transfer of large data files, and some take advantage of "news" (i.e., discussions and bulletin board groups), as there are thousands of "newsgroups" addressing a multitude of topics and disciplines. The upgrade of the NSFNET backbone to T3 service has enabled new applications such as teleconferencing, multimedia electronic mail, visualization, and on-demand electronic publishing (Box 3.1). Qualitative benefits have arisen with changes in the nature of the work being done: broader interaction can change the questions being asked, the review accorded to research, and the scope of participation.[4]

Quantitative benefits or gains in efficiency may be seen in the sharing of scarce resources (obviating the need for duplicative investments), from the network facilities themselves to expensive devices and information resources attached to them. Another quantitative benefit is the effective reduction of the cost of reproducing and distributing information—it is often cheaper to duplicate and transmit information electronically rather than in paper or other physical media.

For example, a University of Colorado group funded by the National Aeronautics and Space Administration (NASA) built a prototype system for distributing satellite data over the network via an on-line access system. In this system the user is responsible for locating, reviewing, and ordering the data, an approach that saves human time and cost in locating, copying, and shipping data tapes. The system is made possible by a network that can accommodate the transfer (FTP) of modest-size data files (the size of a typical file is 1 to 4 Mbytes), using the usual techniques of data compression and user selection of data file size to minimize the impact on the network. During the recent TOGA-COARE[5] oceanographic experiments in the western Pacific, satellite sea-surface-temperature maps were produced and made available to users over the Internet; researchers not having Internet access required production of a contour

**Box 3.1 Research Applications of [illegible]**

- Communication via electronic mail with [illegible] tionally, and worldwide
- Sharing and transfer of data files [illegible] searchers and data sources (especially [illegible]
- Contribution, sharing, and accessing of [illegible] (e.g., conference announcements, current affairs, electronic bulletin boards, meeting abstracts, developments in individual fields, and so on)
- Electronic reference searches (e.g., access to on-line library catalogues, directories of special collections, and databases with abstracts)
- Access to special-purpose computing resources, such as supercomputers and sensor-based instrumentation
- Access to shared and community resources, including national and global databases and data systems
- Electronic submission of reviews and proposals
- Access to articles, books, and other materials published electronically
- Development of and access to community software
- Access to remote, remotely controlled instruments for research

map of the images that could then be faxed to them. Even the ability to electronically access text can present real savings: physicists, for example, have enthusiastically developed and used electronic archives in areas such as high-energy physics that are stored at Los Alamos National Laboratory facilities as an alternative to buying journals that cost hundreds to thousands of dollars per year for subscriptions.

One of the many new Internet tools that has facilitated information sharing and collaboration in biomedical research is the Mosaic hypermedia browser used by researchers studying the genome of the fruit fly, *Drosophila melanogaster*. Through the efforts of a large number of researchers in many laboratories, approximately 90 percent of the genome in this species has now been cloned onto 10,000 fragments, where approximately 3,000 conventional loci have also been mapped. A researcher at any participating site can open a computer screen window, use a mouse to click on (select) increasingly detailed photographs of the region in which he or she is interested, and then open lists of the relevant clones, deletions, and loci of that region, which include the corresponding literature references. This software was first developed for the nematode *Caenorhabditis elegans*[6] and is now available for a variety of other species.



Laboratories throughout the world, connected by the Internet, have begun collaborating to sequence completely the DNA of several organisms, leading ultimately to sequencing of the entire human genome.[7] The databases that must be linked include DNA sequences (GenBank), chromosome mapping information (Genome Data Bank), and protein sequences and structure (Protein Information Resource).[8]

New network capabilities and technologies will generate a continuing flow of new network applications that will lead to significant changes in the conduct of research. If development of high-performance computing and communications technologies in academia and industry continues, network capabilities should expand at rates that may initially exceed the demand generated by the science community. The increase in capabilities will make possible an overall shift from electronic mail exchange and modest file transfer activities to on-line distribution of large volumes of data (both measured and modeled), fueling in turn continued rapid growth in scientific researchers' demands for network services. One possibility is that high-performance computing in the future will involve networking dozens to thousands of workstations and other computers in different locations. Initially these computers will be running applications in the background and at night; but at some future time, people may collaborate through relatively continuous collaborative computing. Given such possibilities, it is hard to predict the ratio of transactions to bandwidth over time. *It is clear that the "experiment" of network use in the research environment is only just beginning.*

The nature of research is itself changing. Today scientists are seeking answers to more complex problems, while the instruments and facilities needed to conduct research are becoming increasingly expensive and the funding for scientists' projects is becoming scarce.[9] This is a scenario that strongly encourages increased collaboration, although the nature and extent of collaborative research may differ within disciplines and across disciplinary boundaries. There is considerable impetus for collaboration in oceanographic research, for example, where research projects not only cross the lines of the traditional subdisciplines of the field (i.e., physical, biological, chemical, and geological) but also require collaboration among international scientists.[10]

Aware of such trends in funding and the increasingly interdisciplinary nature of such research, some scientists have recently introduced a new concept: a center without walls in which the nation's researchers can perform their research without regard to geographical location—interacting with colleagues, accessing instrumentation, sharing data and computational resources, and accessing information in digital libraries. The name given to this concept is "collaboratory," a term derived by combining the words "collaboration" and "laboratory."[11] In this envi-

ronment a scientist's instrumentation and information are virtually local, regardless of their actual locations; research teams separated by continents and disciplinary boundaries will be able to conduct joint experiments in ways that will greatly expedite the transfer of knowledge and thus will change the scientific process involving interdisciplinary and collaborative research. The collaboratory concept suggests that in addition to transmission and switching capability, information infrastructure for research will also need to provide more basic services and tools, such as mechanisms to easily identify and assemble the needed experimental components from across the network.

Today's research projects are increasingly multisite, and many involve numerous entities; universities, laboratories, industry, and other organizations may participate. Principal investigators are often geographically distributed, but they require opportunities for real-time interaction and, in many fields, capability for remote experimentation. For example, research in quantum chromodynamics, involving efforts to investigate and define intranuclear forces, is heavily data oriented and requires large amounts of bandwidth. Moreover, applications consume and produce huge amounts of data that need to be stored, processed, and transferred at different sites. To meet such a range of needs, a network service must support multimedia (including real-time audio and video) traffic, provide large amounts of bandwidth to those sites requiring it (smaller amounts to those that do not require the "kitchen sink"), and be quasi-ubiquitous in order to connect investigators and sites. Such a network service is also needed to provide for others, such as educators, access to the eventual results of scientific research and to enable educators to carry out their own research using network resources.

An example of the emergence of international, collaborative research is the International Thermonuclear Experimental Reactor (ITER), a Department of Energy (DOE)-sponsored project involving a multinational team (from the United States, Germany, Russia, and Japan) that is trying to design and build a reactor for energy production. The collaboration is among four major sites (one in each of the four countries) with additional other sites participating both within the above-named countries and elsewhere. The project has progressed to the stage that participants need the ability to exchange engineering (computer-aided design/computer-aided manufacturing) designs in real time and to concurrently analyze, discuss, and annotate these designs. Such capabilities require high-bandwidth connections for the transfer of engineering data and for the support of a "real-time" collaborative, distributed (internationally) environment. Today's networks do not have such connections. Near-term improvements may entail increasing the capacity of the deployed infrastructure; greater support for real-time collaboration would entail extending the



infrastructure architecture along the lines outlined for the Open Data Network described in Chapter 2.

Several groups of researchers are already beginning to move large volumes of scientific information over the Internet. Those conducting global change research (oceanographers, earth scientists, and atmospheric scientists, among others), for example, obtain massive quantities of information from satellites and other collection devices, and those quantities are expected to increase to 1 terabyte per day through the implementation of the Earth Observing System Data and Information System (EOSDIS) and other programs organized through NASA, DOE, the National Oceanic and Atmospheric Administration (NOAA), and other federal agencies. The contemplated data volumes are so large that even with substantial (e.g., factors measured in hundreds) amounts of data compression, high levels of bandwidth will be needed to do research in these areas.

For example, researchers investigating global climate change currently use models that require very large amounts of data before, during, and after construction of the models. Their analyses are typically done visually with a high-end workstation. The limiting bandwidth available on ESnet and other segments of the Internet constrains the ability of these scientists to view their results in real time and, even worse, prohibits them from performing an analysis that incorporates both surface and air models—since these models are implemented on different machines in different locations, and very large amounts of data would have to be transferred for use in an integrated model. An additional complication for global climate change researchers is that data collected in NASA's Earth Observing System (EOS) is also likely to be used. Because these data will be located at various sites, including Oak Ridge National Laboratory, the transfer of large volumes of information will be required.

Similar requirements can be seen as arising from the growth in applications involving graphical images and video. One driver for these applications is scientific visualization, which makes massive data sets more comprehensible. High bandwidth will also continue to be required to support real-time interactions (e.g., to support remote access to special instruments or even video conferencing) and remote access to high-performance computing devices—the performance of which continues to increase.[12] In addition, interactive activities such as commanding spacecraft and monitoring remote instruments entail networking needs that greatly exceed current capacities and sophistication.

For example, the Advanced Photon Source (APS) comprises 22 separate collaborative action teams that involve industrial companies, national laboratories, and universities accessing the 40 to 50 APS beam lines. These teams require the ability to employ "telework" tools and techniques

to perform remote experimentation and collaboration in real time. The hope is to extend this ability to an educational setting in at least a real-time monitoring or visualization mode. That prospect cannot be realized until the network supports multimedia traffic, provides the needed large bandwidths, and provides a more secure environment.

A central question regarding the supply of information infrastructure to the research community is the distribution of needs. At this time, specific communities can be identified that need very high bandwidth. The expectation that this group is relatively small is reflected in the NSF's plan to support a very small research network operating at very high speeds (the vBNS). How large will requirements for such infrastructure grow, and how quickly will they spread? The answers may depend on the degree of ease of access to high-bandwidth infrastructure.[13]

The degree of innovation, the diversity of applications, and the dependence of researchers on the Internet have been nurtured by an environment in which cost has not been a major constraint for the individual user (see Chapter 5). The benefits of connection to the Internet are underscored by contrasts within the research community: researchers in disciplines and at campuses without easy (or any) Internet access have not had the opportunities to collaborate, learn new results quickly, and broaden their professional interactions that their connected colleagues have.

The problems and opportunities inherent in broadening access within the research community are especially evident outside the natural and physical sciences. New technologies and Internet access are opening up new avenues for humanities research, teaching, and scholarly communication. Used far less commonly but enthusiastically among a small group of proponents, humanities computing and networking have grown significantly in recent years. Electronic bulletin boards, e-mail, and discussion groups are the most widely used mechanisms for day-to-day communication. In addition, literary text analysis can be carried out with unprecedented detail due to the availability of machine-readable texts and complex text-analysis software.[14] Thus, the Internet has allowed humanities professors at several institutions to assist in building a multimedia database for the study of ancient Greece under the Perseus project. With the collection and storage of text, translations, color images, maps, and drawings contributed by museums and archaeologists, the Perseus database will bring the world of ancient Greece alive for students and researchers across the country.

Humanities buildings, departments, and scholars are often among the last on a campus to be connected to the Internet.[15] Disciplines in the humanities have not been well capitalized in part because the need for capital (such as computing equipment and networks) has not been recognized, yet without access to the capital these researchers cannot demonstrate its value in their fields. Overall differences in funding across disciplines reflect societal choices about where to invest. The new National Initiative on Arts and Humanities Computing is currently planning the next steps in gaining a voice for the humanities and arts in the development of the NII.[16]



Broadening of access was a goal of the original National Research and Education Network (NREN) proposals, and substantial progress has been made through expansion of the original NSFNET, the Internet, the National Science Foundation (NSF)-catalyzed regional networks, and the NSF Connections program, as well as growth in the targeted ESnet and NASA Science Internet (NSI) programs.[17] The Branscomb report[18] has called for broadening the access to advanced workstations across the scientific research community, a move that would fuel demand for network-based infrastructure. The possibility of slower growth in research networking—implied by a shift toward commercialization and user payments compounded by some tightening in the availability of research support—raises the prospect of competition for infrastructure resources between those with no access (who argue for ubiquity and aggregate bandwidth to serve them) and those with high individual needs for bandwidth. However, as has been seen in the provision of access to ESnet and NSI, there may be special solutions developed to meet special needs. There is little question that researchers in engineering, science, health, and the humanities have benefited greatly from their use of the Internet. That benefit can be expected to grow considerably with the greater reach and capabilities of the NII.

## HIGHER EDUCATION

Higher education networking presents a chicken-and-egg problem. Networking for this and other segments of the education community attracted federal attention somewhat later than networking for research partly because teaching faculty, most college students, and academic librarians—except for those involved with scientific research—had no access to the network until it was opened to them in 1988 with the expansion of the original National Research Network program into the NREN program. What they had were only their own visions of potentialities, often growing out of experiences with television and satellite broadcasting, which introduced telecommunications into the teaching-learning process.[19] The renaming of the federal NREN program to include education was a result of the library, academic computing, and education communities' intense, aggressive lobbying, political activity that also spurred the development of new organizations and activities dedicated to developing and applying information infrastructure for higher education.[20]

For example, the push for the "E" in NREN was associated with the establishment of the Coalition for Networked Information by the Association of Research Libraries, CAUSE, and EDUCOM.

On the whole, higher education is positioned to make extensive use of the NII to enhance the delivery of academic programs and to enrich their content by broadening the mix of inputs and participants. For example, BESTNET is an international consortium of colleges and universities using the capabilities of telecommunications to enhance the teaching and learning experiences of students across geographic and cultural boundaries. Using computer conferencing, e-mail, shared databases, and interactive computing, participating institutions are experimenting with collaborative teaching. Initially started as a cooperative effort among three California State University campuses, Texas A&I University (Kingsville), the Centro de Enseñanza Técnica Y Superior (Mexicali via Baja California Norte, Mexico), and Tijuana Instituto Technologico de Mexicali to share Spanish language instruction, it is now expanding its reach into other continents and other disciplines.

The NII will also help educational institutions to reach students where they are or prefer to be located. Students, especially graduate students, will want to pursue degree programs and professional development courses at teleconferencing sites that are convenient for them. For many students, especially older or adult students, convenient teleconferencing and remote access, in combination with the quality of their courses, may become more important than many of the campus experiences that accompany the traditional attending of classes at the institution itself.[21] In addition, the "electronic outreach" capability provided by the NII can enhance the recruitment and retention efforts of all educational institutions.

X Window and the Mosaic hypertext interface for the World-Wide Web offer broad possibilities for applications in undergraduate education. For example, Mosaic is incorporated into some of the "electronic studios" being developed at Rice University for courses ranging from an introductory biology laboratory to a graduate seminar in architecture. Electronic studios combine a variety of computing tools, some available over electronic networks. Tool sets vary by discipline; engineers may need circuit design programs, for example, while sociologists may seek statistics programs.[22]

The use of interactive video as a medium for the delivery of instruction in multiple sites is beginning to emerge. For example, the "CU-SeeMe" videoconferencing program was used in the Virtual Design Studio project for collaborative housing design among Cornell University, MIT, the University of British Columbia at Vancouver, the University of Hong Kong, Washington University at St. Louis, and an institution in



Barcelona, Spain. Three of the teams worked for two weeks using CU-SeeMe and gave a final video presentation using a PictureTel videoconferencing system. According to Kent Hubbell of the Cornell University Architecture Department, teams designing with CU-SeeMe were far ahead of the teams that did not use the technology: "It is really amazing what a difference just a little live video image makes to the entire communication process."[23]

Shared databases for print, video, voice, and image are anticipated. The cost savings possible from resource sharing are illuminated by existing information resource applications within higher education. For example, an increasing number of colleges and universities are contracting for networked access to information resources available from commercial providers. The California State University (CSU) system, with 20 campuses serving 350,000 students, illustrates the potential for significant savings on the acquisition of information resources through partnerships with vendors, such as Mead Data Central and Dow Jones News/Retrieval, which have been willing to offer services at a discount in return for being able to effectively promote their services to students. For example, the database service set known as LEXIS-NEXIS is accessed by students and faculty at all CSU campuses (at present, by approximately 200 concurrent users system-wide) through the Internet. At the average commercial rate of $10 per search and at the current volume of 125,000 searches per month by CSU users, the service would cost $1.25 million per month and the total annual fee, at commercial rates, would amount to $15 million; under its negotiated agreement with Mead Data Central, CSU pays approximately $200,000 per year. Note that while CSU was able to use its centralized procurement to its advantage, many libraries and educational institutions have raised concerns about the cost of site licenses relative to the service demand they generate.

The principal constraint on network-based applications is one of access; significant numbers of higher-education institutions remain with limited or no Internet access. By early 1994, approximately 1,100 institutions of higher-education (including all schools in the top two Carnegie classification categories, "Research" and "Doctorate") were connected to the Internet; the total number of higher-education institutions in the United States exceeds 3,000. The limited extension of the intracampus telecommunication infrastructure into classrooms and faculty offices, the shortage of desktop computers, the lack of resources for faculty development, and the scarcity of technical staff support have been major obstacles in programs mounted to date. Without extensive stimulation at state or federal levels, it may be more than several years before there will be ubiquitous access at institutions not already connected to the Internet.

One illustration of the challenge is provided by conditions in Michi-

gan. Michigan-based MichNet was founded (circa 1970) to provide data networking connectivity among Michigan's publicly funded universities. Merit, the service provider, began by interconnecting the three largest public universities, i.e., Michigan State University, the University of Michigan, and Wayne State University, in 1971. Today MichNet provides 135 dedicated attachments to 92 organizations distributed over all of Michigan's two peninsulas. These include 42 four-year colleges and universities (including all 13 public universities) and 11 (of 29) community colleges.[24] Thus, only approximately one-third of Michigan's community colleges are served by MichNet currently. Because there is a statewide network backbone in place in Michigan, there is not a technical barrier to attaching new organizations. Rather, for each category of organization MichNet serves, the two primary inhibitors are funding and motivation. Community colleges, for example, like other organizations, usually weigh committing funds for data networking against other communication priorities, such as distance learning (which can be supported with conventional telecommunications). With the current attention being given to the Internet and the NII, there is increased awareness and interest in data networking access. But funding remains a challenge, although some relief has been found from NSF's Connections program.

## K-12 EDUCATION

This is a time of great opportunity to expand information infrastructure for K-12 education, because such applications have attracted considerable political attention and support. The expansion of programs relating to mathematics and science education at NSF, the launch and proposed expansion of the National Telecommunications and Information Administration (NTIA) Telecommunications and Information Infrastructure Assistance Program, the signs of greater interest in technology at the Department of Education and that department's inclusion in the new Information Infrastructure Technology and Applications (IITA) component of the High Performance Computing and Communications (HPCC) program, the administration's challenge goal of connecting all classrooms to the NII by the year 2000, and industry efforts to connect schools make this a time of great expectations.

However, the K-12 education community to date has not generally been a major consumer of information technology. Some infrastructure applications are already in place, one example being the distance learning techniques that were rapidly deployed and accepted at many institutions, although these efforts may rely on more conventional telecommunications or other media. While networking has spread in the research community through the relative ease of access to seemingly "free," shared



networks and the "contagion" effects of peer pressure or observation of colleagues, the number of educators with direct experience in using this technology has been limited to the early adopters, those who had special funding, or those with access to special single-purpose administrative networks.

Networking for education has followed a significantly different history from research networking. First, where it has occurred it has been inherently more expensive, characterized by the prominence of dial-up access (at telephone service rates, plus the applicable computer service charges, usually including on-line connection time charges plus occasional transmission charges) to bulletin-board or other central-host-based services. Much of this activity has been independent of the Internet, at least until relatively recently; networking in K-12 education has been inhibited by the lack of broad access to an open information network. There have been multiple services serving small and separate communities (militating against the achievement of a critical mass of users on any one service). Cost has been a major obstacle, given the chronic budget pressures confronting schools and the lack of predictable costs associated with educational networking.

Indeed, cost is a key reason that data networking connectivity among the educational community has basically only trickled down from the major research universities to other four-year schools and then to the two-year schools, with the K-12 and public library communities bringing up the rear. For example, Michigan has over 5,000 K-12 school buildings, a number dwarfing the 135 MichNet attachments (for all kinds of research and education institutions) in place today. To bring the Internet to all these sites will be a major challenge. As a result of an Ameritech overcharge, Michigan's K-12 community has a one-time opportunity to access additional funding to enhance its networking access. These funds may be used in various ways, for example, for video conferencing, distance learning, and data access. Yet even if all the available funding were used for Internet access, at best about 25 percent of the schools would have some of their access costs covered.[25]

Second, networking of any kind has been difficult to launch in education because of a lack of basic physical infrastructure. *The majority of K-12 educational institutions are ill-equipped to participate in an information society.* At the most basic level, schools often lack telephone connections and even sufficient electric outlets to support broad—or sometimes any—computer-based access to electronic networks. The deployment of telephones in the schools was limited because telephones were viewed as business tools, not instructional tools. By contrast, television technology was adopted quickly because the connection to instruction was easier to understand. In the business plans of cable franchises, many cable com-

panies offered to network the schools as an incentive for the local community to accept their offer. Before long, school hookups were a standard part of the franchise agreement.

Although research users of the Internet typically effect connections through local area networks, where LANs are found in K-12 schools, the motivation has often been to support computer-aided instruction in a single classroom rather than to link multiple classrooms or provide access to external networks. Also, many personal computers in schools are not capable of connection to LANs and/or they may not have the necessary disk or memory capacity to support network applications.[26] Finally, schools also lack the resources to install new technology.

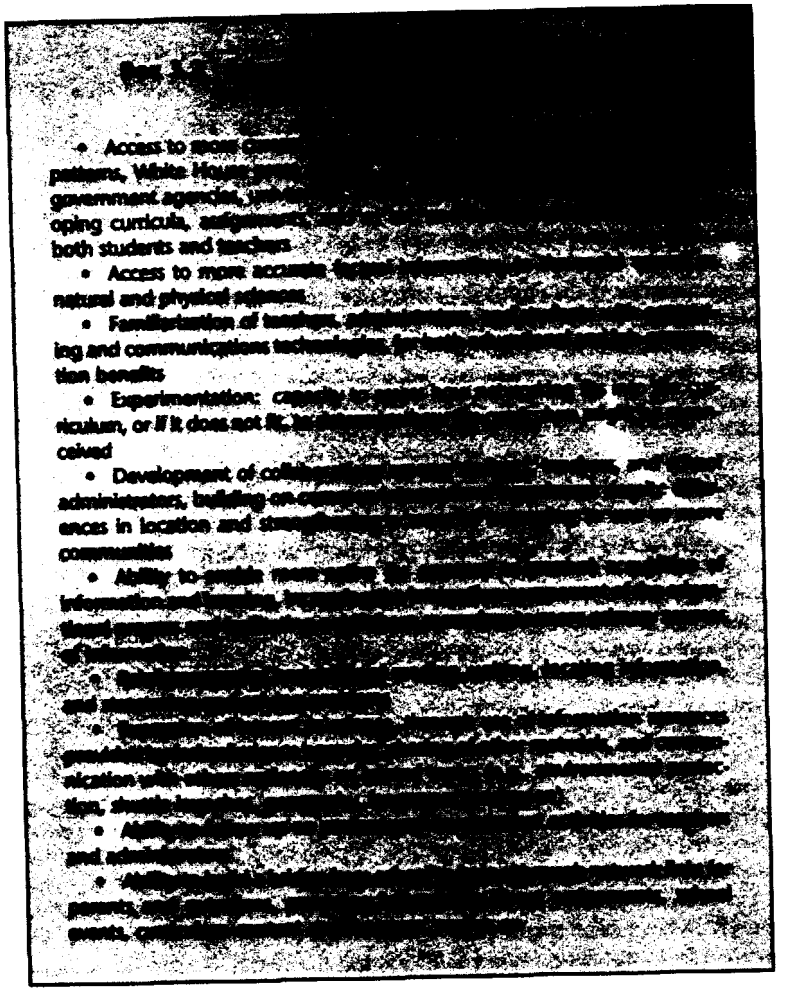
Upgrading computing and communications within schools is complicated by what are often inefficient approaches to procurement: procurement on an individual school or even a school district basis may not provide the volume sufficient to gain meaningful discounts. This situation suggests that even within specific areas (such as states), it should be possible to organize procurement to achieve economies. More efficient procurement can better leverage resources provided through corporate activities, such as programs like a recent Pacific Bell proposal to connect schools in its service area.

Third, a critical infrastructure deficiency relates to the human element: training and support in electronic communication are needed for educators. Most efforts to engage in networking for education have been undertaken on a do-it-yourself basis, requiring substantial dedication and time to overcome the difficulties of installing, using, and maintaining sometimes inscrutable systems. Usually, the first teacher who has experimented with the technology is labeled the "computer expert" and is rewarded by being given more responsibilities to cope with during a very busy school year. A large number of educators need to be trained to use the new methods of communication. This problem particularly affects schools serving lower socioeconomic students, where educators generally have less training and awareness of the Internet (and therefore are less likely to even desire access). The need for professional development in network applications and resources includes both the classroom instructor as well as the building-level administrator who will adopt the new technology.

Part of the problem is a lack of involvement on the part of teacher education programs and institutions. Colleges of education have tended to have limited network access. Teachers emerging from preparatory programs that have used electronic networking tend to ask for access, but most such programs provide little such exposure.

Of the many educational applications and benefits foreseen (Box 3.2),





communication among people is the prime benefit of networking for education as colleagues, teachers, students, and parents gain access to a level of communication not possible before. Educators in both higher education and K-12 education are now being enabled to participate in collaborative projects. Much like the science "collaboratories," the In-

duction Year project at the Regional Education Source Center in Huntsville, Texas, which has provided an electronic support network for first-year teachers with mentors both in the public school and among university faculty, suggests new avenues for collaboration. A variety of international collaborations have developed among educators connected to the Internet.

As educators do gain access to the Internet (and other networks), their applications are evolving. As a result, it is dangerous to assume that educational networking needs are inherently simple and "low-end." For example, K-12 programs are using scientific data generated by such agencies as the DOE, NASA, and NOAA; there are K-12 programs (e.g., SuperQuest) providing access to high-performance computers; and graphics, video, and multimedia programs are inherently attractive to educators trying to convey complex information to children and other students. Nevertheless, given the constraints outlined above, much educational networking to date has been low-end.

To achieve many of the benefits anticipated by educators will require access to the high-end networking that would make possible better video and multimedia exchanges. This implies higher bandwidth, reliable service, and so on. More sophisticated systems and higher bandwidth enable better graphical interfaces and functionalities, which can reduce training costs, possibly offsetting higher transmission costs.[27] Use of the latest Internet tools such as the World-Wide Web and its Mosaic interface are limited only by the bandwidth and hardware found in K-12 institutions. Other important ingredients include development of suitable content and curricula. Networking in K-12 will never achieve critical status unless mainstream educational services are available over the network.

Perhaps most importantly, information infrastructure holds the promise of changing the processes of teaching, education, and learning (Box 3.3). Where this happens, resources will be reallocated from print-based to on-line resources (depending, in part, on publishers' support for electronic source material). Educators' roles are changing to include participation as researchers, instructional designers, and managers of information who collaborate as they develop educational programs with the help of their remotely located colleagues and mentors from many sectors of the community. Students will need to be able to better articulate study problems, identify and access necessary resources, and work with their peers (who may be classmates or even students in another country) to solve their problems. The roles of both the educator and learner may reverse as both explore new information resources; both will need new skills.

Even broader shifts in roles and relationships are also on the horizon. The organized involvement of parents in the education process is essen-



**Box 3.3 K-12 Teacher Experiences with the Internet**

- My students are beginning their ray-tracing project in computer science. Now if my school system would buy a Cray supercomputer class machine (costing approximately $20 million today), then I would have less need for telecommunications. But it is great that students in rural Wisconsin can use a supercomputer in California. This occurs because of telecommunications. Of course the argument could be made that they don't need to work in three-dimensional geometries where not only the objects can be manipulated, but also the observer. Too much like the real world.
- Our preservice teachers feel freed of many bonds that had held them previously—now they are completely free to explore the electronic libraries on the Internet, to make and maintain contacts with fellow teacher education majors at other universities, to collect and share lesson plans and ideas for teaching with other educators around the world, to ask questions of experts they are able to ferret out, to stay abreast of current events in the field, to become immensely more familiar with salient legislation, and to improve their professional literacy through communication with officers and contacts in national-level teacher organizations. A bonus is that they take great pride in the fact that they are "connected to the world." Class discussions have taken on an entirely new flavor. There is justification for more seminar-like classes in which students can have open discussions about a wide variety of topics—and this is enhanced by the remarkable quantity of information they share with each other.
- My classes have participated in a variety of educational projects on the Internet. The students have communicated with Paul Smith, a researcher from Melbourne, Australia, who was stationed at Casey Research Base in Antarctica. The students, via the Internet, were able to participate actively in Paul's research in Australia, a wonderful living lesson in science, reading, and language arts. This project will continue this fall, when Paul returns to Antarctica for 15 months of study. The children are also looking forward to returning to Antarctica, via the Internet, to share in his work.
- As a teacher, it is difficult to imagine the world of the future, yet this is the very world that I must prepare these children to enter. Change is rapid. I can only teach the children the pursuit of learning, and to develop a strong sense of inquiry, discovery, and investigation. These are the rudimentary skills these children will need to function successfully in the future. Computer telecommunications is one of the necessary tools that I need in order to prepare the children for their future. It is not a luxury.
- Regardless of how good a chemist I am, and regardless of the chemical expertise in my local area, there are always questions that I cannot answer or find answers to locally. With networking, students and teachers have an almost infinite resource pool from which to seek information and knowledge.

*continued on next page*

**Box 3.3—*continued***

- Results that seem to be documented:

1. Holding power, especially in inner-city schools. Students get interested in computers and stay in school;
2. Reaching students with special needs;
3. Geographic awareness (through KIDLINK);
4. Foreign language skill improvement;
5. Greater sharing of ideas, lesson plans, and so on—a combination of having a sense of belonging (less isolation) and "things you can use tomorrow if not today"; and
6. Development of workplace skills.

I have rank-ordered these in terms of my perceptions, which are open to discussion.

- Virtually all of the students that I have dealt with over 15 years have been involved in chemical research. Electronic networking has provided them with electronic mentors worldwide, access to computing platforms (including supercomputers for high school students), and access to substantial on-line databases and information banks. In spite of living in a resource-rich area (Research Triangle Park, N.C.), many of my students have done projects that required resources not found in the local community.
- In working with physically impaired students, it has been clear that one of the substantial benefits of networking has been a "leveling of the playing field." Unless the student describes his or her "disability," the people he or she interacts with electronically have no concept that the person is disabled. This also applies to work with minority students or other students not from the "majority" culture.
- My all-time favorite was the use of e-mail in a junior high school "resource room." That area was normally packed with kids who were disruptive and perceived as having learning and social problems, and it was generally not a high-status area in the school. After being introduced to electronic messaging to exotic places (between Nova Scotia and the southeastern United States), the kids became really excited about writing, started attending (for the first time) to language conventions, and generally became motivated about at least one aspect of school. Here's the spin-off. Now the "low-status" resource room has a lineup of normally high achieving kids who thought the resource program suddenly had more promise. Then came the role reversal—the formerly lower achieving students became technical tutors to the formerly otherwise high achieving kids. Smiles all around.
- I have found the Internet to be the most important tool I use in my class this year. I have become very involved with Academy One, and use the various Gophers and other outside services to get information for my classes on a timely basis. For example, today I brought into class a posting of data regarding yesterday's earthquakes in Oregon. The information about the 17 larger earthquakes that had occurred in that area in 20 hours (date, time, latitude, longitude, depth, magnitude, and notes) provided us with an excellent base of material to discuss how telecomputing can assist us on a timely basis. The story of what happened in that area . . . and how it might serve to help us prepare for our own earthquakes here in Los Angeles . . . was very clear in the data that we were able to get so quickly.
- When I first began working with fourth grade students and telecommunications, they thought that the ONLY thing an Apple II was good for was to play games like Nintendo. At the end of four months of doing on-line projects and simulations, these kids were talking about selling their Nintendos to buy "real computers." These same kids were furious to find another student from another class playing a game on the Apple II and would insist, "Get them off! I've got work to do!"
- I talked to a class about exchanging e-mail with students in other countries. At the end of class a boy came to me and asked, "Can I use Grandma's computer to write a letter to a boy in another country?" That might seem like a simple request, except that I knew the child. He lives with Grandma when his Mom isn't living with a new boyfriend. He's the kid who never turns in homework and is barely passing from year to year. The words "can I write" are like music to the ears of any teacher who wants to help students learn to read and write better. It does not matter what they are writing. If they are motivated to write something, their skills will improve as a result of the practice. That doesn't even take into account the fact that they would be learning the technology, the keyboarding skills, and information about other cultures.
- Several teachers have expressed pleasure at not needing to type materials by hand that I have made available on the network. Everything from lesson plans to laboratory exercises to curriculum development guides is now being used by classroom teachers. In most cases they can use the material quickly with a minimum of fuss on their part.
- The connection that the Internet provides is invaluable. Here I am, a research biochemist at a major university, thinking about changing to high school science teaching for the next half of my working life. Any student can access the resources of this and other labs around the world and have real-life answers to real-life questions without having to leave whatever isolated environment he or she happens to be in. We are all alive in the midst of this biological revolution, and this type of communication makes it possible for all of us to participate. Is there any real question of the educational advantage of such a system? I am no expert on the network, but I have been able to provide resources for my Earth Space Science classes that I had not even dreamed of a year ago. My students have been able to ask Danish astronomers and mathematicians questions about the history and proper pronunciation of Tyco Brahe. We have been able to get information on tropical deforestation directly from researchers in Brazil. We are now analyzing images recorded at telescopes from the summit of Mauna Kea, Big Bear Solar Obser-

*continued on next page*

**Box 3.3—*continued***

vatory, and the Hubble Space Telescope. Yes, we might have been able to obtain the images from the Canada-France-Hawaii telescope directly without the electronic interface, but we never would have been able to make them available for student research so quickly or efficiently.

- My students have never been so excited about any technology as they are about access to the network. We are now beginning to learn together more ways to explore the net, and they look forward to obtaining their own user accounts so that they can continue to explore from their home computers. One of their first activities will be an electronic cultural exchange with students in Brazil, Florida, Central America, and Europe.
- If I participate in a workshop per month via the network, I can share most of the information to be gained by my physical attendance, and save the taxpayers over $10,000 in air fares at the same time.
- Our sixth graders needed current information about countries on which we have some historical materials but few that are up to date. So we went to the CIA World Factbook (Outside services, TENET> open 137.113.10.35—William and Lee; login: lawlib; search CIA World Factbook; of country (Egypt, India, Israel, West Bank, Gaza Strip, Greece, Italy, Syria, etc.)). The students needed information about what was formerly Mesopotamia, plus the other countries. The available information about each included area, population, government, transportation, economics, general information, languages, religions, money, and more. The Factbook was the 1992 edition, and it gave better information than we could have obtained from hundreds of dollars worth of books about these countries. We were searching immediately after the meeting between Israel and the Palestinians, and so the information was especially pertinent. The students were so excited to find so much information on every country they searched for. To test the system, they went on to look up other countries not on their list—most of which were part of their own heritage.
- This message is to let you know that as an elementary teacher I can no longer survive without e-mail! E-mailing is a truly wonderful learning tool for teachers and students. Students who have never had a desire to read much or write anything are now very interested in doing both because of e-mail. They see how important it is to be able to read so that you can read messages concerning your project, directions for the computer, and sources of information for your project both on and off the computer. They realize how important it is to clearly communicate your data on a project. Even punctuation and capitalization have become important to them.

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NOTE: These anecdotes were compiled from electronic mail messages sent by educators in response to an electronic request by a member of the study committee. Educators who use the Internet to varying degrees and for diverse purposes were asked to document how network use has affected teaching and learning.



tial and will occur more frequently and naturally through networks that connect the home to the school and to libraries and other repositories of information. In time, the teacher-parent relationship will change as teachers take on new roles as facilitators who broker research and monitor student progress, often assisted by specialists, such as nutritionists, who provide guidance in areas that affect student behavior and performance. Another contributor, made possible by the Open Data Network, will be the employer of the future. The needs of the workplace, rather than mere job listings, will play an integral role in defining the curricula for a select number of students, especially those seeking vocational or professional pursuits after college.

Realizing process-change benefits will not be automatic. Compounding insufficient physical resources have been cultural barriers. For example, schools tend to be managed as a hierarchy with implicit (and explicit) expectations about who gets information first; collaboration with colleagues, especially those outside one's school building, is not the norm. Open, especially student-driven, communications challenge those expectations and (in the behavioral sense) protocols. Finally, telecomputing projects have been seen as an add-on, requiring extra effort. Changes in schooling require support and involvement from all segments of the education hierarchy—the administrators, parents, community, support staff, and classroom practitioners. Provision of the broad NII envisioned in this report is an important step in this direction. *But until a systemic approach is taken that applies to all types of education professionals and activities and addresses the requirements of implementing a new communications system, much work will be needed to truly integrate networking and information infrastructure into schooling.* Accordingly, leading education professionals, their organizations, and some policymakers have begun to explore the linkages between educational reform and the emerging NII.[28]

The absence of consensus on how to incorporate network-based applications into education suggests a need for research into appropriate technology, appropriate levels for providing networking and internetworking support, the economics of school networking (funding, policies), content standardization, and information-age skills and knowledge assessments. As one workshop report observed, "Educators will not use networks to teach just because the technology is pervasive in society."[29]

Initial federal programs have concentrated on computer and networking activities relating to mathematics and science; for example, that is the focus of the NSF activities through the Education and Human Resources Directorate, including the National Infrastructure for Education (NIE) program (which also involves NSF's Computer and Information Science and Engineering Directorate). Yet "educating the whole child"

or the process of education as a whole extends beyond math and science; the process of communicating over a network has been shown to have benefits in the areas of reading and writing, for example (see Box 3.3). Also, true NII support for education must encompass administrator, principal, and teacher preparation; public awareness; and other facets of the education process that may not be captured in programs focusing on enhancing science and math education.

Several states have taken a leadership role by potentially eliminating restrictive state provisions in order to facilitate and support the development of teacher and administrator preparation programs and to assist in the restructuring process. In Texas this effort integrates technologies and innovative teaching practices into preservice and staff development training of teachers and administrators. Through regional Centers for Professional Development and Technology—a collaboration among universities, school districts, regional education service centers, and the private sector—systemic change is occurring in the professional development programs.

The local basis for educational funding contributes to substantial differences in the ability of schools and school districts to make use of networks today. Several states have moved to augment local capabilities; for example, the state of Florida has implemented a grants program to retrofit schools. In Texas the state legislature implemented the Technology Allotment Fund, which provides an allocation that districts may apply for if they submit a plan for the integration of technology. The amount is $30 per child and is based on the average daily attendance of the school district. There are also equity concerns among individual students, only some of whom may be able to afford their own, home-based technology. Where access has been achieved, teachers report that disadvantaged students have gained access to resources and have responded far beyond what has been observed with more conventional educational approaches (see Box 3.3).

Equally important will be the outreach capability of the networks to ensure that the poor or rural residents of a community are not excluded.[30] Realizing that potential, however, is a function of time: the NTIA Telecommunications and Information Infrastructure Assistance Program can make only one contribution, the NSF Connections program and NIE program two others, and it may be several years before all K-12 schools (of which there are more than 110,000) are connected to the Internet. As in the case of higher education, a variety of organizations have emerged to pursue opportunities relating to K-12 networking. These include the International Society for Technology in Education (ISTE) and the Consortium for School Networking (CoSN).



## LIFELONG EDUCATION

There is consensus across the research and industrial communities that people should expect to be retrained periodically throughout their careers. An NII is an attractive vehicle for this purpose.

In some career fields the relevant base of information is doubling every three or four years, a situation that is redefining what is meant by "certified" or "qualified" as regards professional competency. This is perhaps most apparent in areas that are affected by science and engineering or are heavily positioned within the regions of public interest and subject to regulatory controls. An example is medicine and health care, where change is continuous and ranges from new, or upgraded, government regulations to the latest developments in bioengineering. Given this avalanche of information, "professionalism" may some day be defined in terms of a trained user's access to and familiarity with "search" procedures that are friendly and analytical, and that enable the user to acquire information efficiently on a need-it-now basis or to perform serendipitous browsing.

Self-education, beyond formal school educational programs, will be accomplished by individuals at ease with networking procedures that permit easy access to on-line digital libraries and make available virtual trips to museums and science projects without leaving home. Continuing education via teleconferencing will enable the learner to participate in preprogrammed or live academic courses remotely and to receive academic credits, if desired. Acceptance of the latter by educational institutes may, however, bring to the surface a wide range of issues regarding accreditation and the changing role of the institution and the instructor in the education process.

The NII will create important changes in professional-layperson relationships. As nonprofessionals gain increased access to databases on the network, they will begin to increase their awareness of a multitude of topics that previously were the strict provinces of the professional. The long-term result will be the creation of a much better informed citizenry. The potential for information infrastructure to support paraprofessionals and allied health professionals in medicine, for example, is already in evidence. An extension of this facility will be seen in the growing number of information entrepreneurs providing information for a fee to laypersons on selected professional subjects using such resources as electronic bulletin boards and specially designed electronic libraries.

## LIBRARIES AND THE BROADENING OF PUBLIC INTEREST NETWORKING

Libraries complement both research and education. They figured first into NREN and now into the vision of an integrated, broadly useful

### Box 3.4 Contributions of Public Libraries

The United States has the world's most extensive public library system, with some 15,482 physical locations, including branches. In the past year, more than half (53 percent) of the adult population used a public library, as did 74 percent of children aged 3 to 8. A picture of the role and impact of public libraries can be derived from statistics presented in "America's Libraries: New Views in the '90s," a four-page 1993 update to *America's Libraries: New Views*, a special report published by the American Library Association, Chicago (1988).

Users of public libraries are diverse. A 1991 household survey by the National Center for Education Statistics revealed that 42 percent of African Americans said they had used a public library in the last year, as did 32 percent of Hispanics, 55 percent of whites, and 52 percent of all others. Expenditures for collections and services total $4.3 billion annually, or about $17.80 per person, and represent less than 1 percent of all tax dollars. Support for public libraries comes primarily from local communities. In 1991, sources of funding were approximately 76.8 percent local, 13 percent state, 1.2 percent federal, and 9 percent other sources.

The information resources available to and used by the public are vast. More than 1.4 billion books, magazines, video and audio tapes, computer software, and other items are borrowed each year. Public library circulation increased 5 percent in 1991, the latest in a steady series of increases over the last decade. Some 222 million reference questions were answered by public librarians in 1991.

The general public itself has already identified the library as a key provider of information. Participants in a 1992 Gallup poll indicated the following as "very important" roles for public libraries:

- Formal education support center (90%),
- Independent learning center (83%),
- The preschooler's door to learning (82%),
- Research center (67%),
- Community information center (63%),
- Reference library to community businesses (54%),
- Popular materials library (50%),
- A comfortable place to read, think, or work (49%),
- Reference library for community residents (47%), and
- Community activities center (40%).

The number of public libraries offering electronic information services is growing rapidly; according to a survey conducted by Opinion Technology, more than 80 percent of all public libraries and 99 percent of all academic libraries now offer such services. Computer-related services are available to the general public in the following percentages of public libraries serving populations of 100,000 or more:



**Box 3.4—*continued***

- CD-ROM databases (79%),
- Remote database searching (71%),
- Microcomputers (62%),
- Microcomputer software (57%),
- On-line public access catalog (60%), and
- Dial-up access to on-line catalog (29%).

NII. The High-Performance Computing Act of 1991 (PL 102-194) envisioned libraries as both access points for users to utilize the network as well as providers of information resources via the Internet.[31] The administration's characterization of the NII carries forward this expectation, expanding it to include a training function.

Libraries have long played a central role in society as providers of information resources (hence the dream of digital libraries[32]), as points of access to information (information that is increasingly in electronic form), and as interfaces with the end user (librarians teach users how to locate and interpret information) for many constituencies. The United States has about 125,000 libraries, including public, academic, research, and special libraries (Box 3.4). Research and academic libraries resemble the research and higher-education communities that they serve in terms of problems and prospects; public libraries resemble K-12 education in terms of severe financing conditions and service to a broad community.[33] Also, as in K-12 education, public libraries often are limited by inadequate physical infrastructure and training, and they tend to be extremely sensitive to cost.[34]

In the NREN environment, research and academic libraries have taken a leadership role in advancing network-based initiatives to provide access to information resources in support specifically of research and higher education through interconnection and interlibrary loans. They also support wider segments of the public.[35] Reduced operating hours at local public library facilities, reflecting budget constraints, have shifted demand to research and academic libraries, a shift enabled in part by network connections. Cooperation among different types of libraries extends beyond resource sharing to such activities as preservation, education, and training, especially relating to network-based applications. For example, the "CIC" libraries (components of several primarily midwestern state universities) have been coordinating on plans for acquisition, storage, cataloging, preservation, and retrieval relating to over 600 electronic journals, the contents of which will be supplied to member institutions over the mid-level CICnet.[36]

The nature and mix of services provided by libraries are changing with the evolution of information infrastructure. Recent Association of Research Libraries' statistics indicate that research libraries are moving from the "just-in-case" model of on-site resources to the "just-in-time" model of resource-sharing.[37] As physical acquisitions costs for scholarly information in print form mount for libraries, interest in "no-fee" (or low-cost) information through the Internet grows as well. Printed service subscriptions and monograph acquisitions are declining.[38] Internet access enables libraries to leverage their resources so as to acquire more of the scholarly record, and to own materials collectively and share them between libraries and their end users (Box 3.5). On the other hand, it is not without its difficulties; Box 3.6 outlines barriers to broader library activities involving the Internet.

In the years ahead, libraries will communicate and provide access to information in a variety of formats—digital, voice, graphic—and employ multimedia technologies via a ubiquitous and seamless web of interrelated networks. Public access programs and policies proposed and implemented today will be central to this emerging information infrastructure.

Libraries participate in numerous experiments and pilot programs that demonstrate the utility of high-capacity networks for the exchange and use of information for all disciplines (Box 3.7). Research and academic libraries already engage in and/or provide electronic document delivery, electronic journals, full-text databases, end-user searching, training, network access, development of network navigational tools, Online Public Access Catalog enhancements, cooperative development of databases and hardware, and policies, services, and strategies that promote access to information in lieu of ownership. There are numerous discussion databases and electronic forums developed by and aimed at library professionals, who access them through the Internet. The tradition of service to those who cannot afford books and other sources of information is being and can be further expanded in libraries to include not only local access to terminals and other network-access devices but also possibly even loan of such devices.

Network applications in libraries today focus on access to resources such as books, journals, and on-line files; in the near future, the focus will be on access to and use of research materials and collections generally inaccessible but of extreme research value, including photographs, satellite and related spatial data, archival data, videos and movies, sound recordings, slides of paintings and other artifacts, and more. This development presumes that digital facsimiles or digital records are available for access and distribution over a network.[39]

The development of such digitized resources is central to the concept of digital libraries. Characteristics of digital libraries include the following:



**Box 3.5 Advantages of Internet Access via Public Libraries**

- *Equitable and ubiquitous access provider.* Libraries offer access to the network; the equipment, technical support, and software needed to access it; and the information resources available through it.
- *Affordable access.* Library experience with current commercial electronic information services indicates that several services tend to be priced for the institutional or corporate subscriber, and not for the individual user who may have only occasional need for access to a small portion of an information source or database. In this environment, the public library provides the electronic equivalent of one of its traditional functions—to provide access to a wide variety of information sources and viewpoints regardless of a user's economic status or information-seeking skills.
- *Network information resource provider.* A 1992 journal article* identified some of the databases developed by and uniquely available from public libraries: community-based information and referral files listing government and social services; query files of questions frequently asked by the public, with answers; genealogy files for specific local geographic areas; local newspaper indexes; annotated reading lists; catalogs of holdings; tour and day-trip itineraries for local historical sites; and so on.
- *Access to government information.* Libraries have long had responsibilities under law and custom for partnering with governments to provide public information. This has been accomplished through the federal Depository Library system, with libraries in every congressional district, and state depository systems. The library as the local access point for electronic government information is a natural extension of this partnership.
- *Training and assistance for the public.* Unlike most sites for public access terminals (which range from government buildings to universities, from shopping malls to laundromats), public libraries have trained staff available for consultation and training in the use of the library's resources, including electronic information resources. A logical extension is to provide training for the public in the use of networks and networked information resources plus point-of-use consultation, guidance, and technical assistance, as well as to develop on-line training and interpretative aids.
- *Library as electronic gateway.* Libraries of all types have more than 25 years of experience in using computer and communications technologies to link together to share bibliographic information for cataloging and interlibrary loan. The Internet and the National Information Infrastructure have the potential to link libraries further for electronic sharing of full-text, graphic, and multimedia library resources; to link library personnel electronically for new kinds of reference services; to link libraries to nonlibrary sources of information; and to provide access to the local library from any location with a computer and modem.**

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**Box 3.5—*continued***

*Isenstein, Laura J. 1992. "Public Libraries and National Electronic Networks: The Time to Act Is Now!" *Electronic Networking* 2(2, Summer):2-5.

**An excellent discussion of the advantages of Internet access via public libraries—and the source from which this box was derived—can be found in: Henderson, Carol C. 1993. "The Role of Public Libraries in Providing Public Access to the Internet," prepared for a conference, Public Access to the Internet, John F. Kennedy School of Government, Harvard University, May 26-27, 1993.

- *Large size:* The total of all printed knowledge is doubling every eight years, and many research databases dwarf past collections of information;
- *Manipulability:* The use of an electronic digital format means that data of any kind can be potentially communicated, analyzed, manipulated, and copied with ease;
- *Inclusion of mixed media:* The digital library will consist of multiple forms and formats of information including images, sounds, texts, computer programs, and quantitative data;
- *Distributed:* The digital library is not a single entity or database in a specific geographic location. Instead it consists of resources that are constantly changing and available on a distributed basis. The evolution of the digital library and its distributed nature are fundamental characteristics relating to the digital library's value to the user; and
- *Accessibility and interactivity:* Digital libraries will be accessible to new communities and a wider-range of users. The resulting availability of new research and new knowledge will in turn increase the value of the digital library, a benefit that will come from the interactivity between the user and the digital library.[40]

Creation of digital libraries will likely exacerbate information management and policy issues and will require additional research to resolve problems that may thwart progress (see Chapter 4).[41] Many if not all of the information policy issues requiring attention are not new. They relate to freedom of expression, intellectual property, access, privacy and confidentiality, security concerns that include the integrity and reliability of the date resources, and the preservation and archiving of data resources.[42] The nature of the technologies either exacerbates existing tensions (e.g., relating to copyright and fair use) or presents new questions and opportunities to rethink existing practices.

Notable among the technical issues relating to library participation in an NII is the need for librarians—working together with publishers and



**Box 3.6 Barriers Facing Public Libraries as Public Access Points**

- *Few public libraries on the Internet.* The first major barrier to public libraries as public access points on the Internet is that so few are connected currently, perhaps on the order of a few hundred out of 9,000 (located at 15,000 sites, including branches). Gaining access has not been easy. University computer centers closely monitor their "guest accounts." The primary mode of access offered by most of the regional affiliates and networks, as well as private providers, requires a direct high-speed line, with the user serving as a full node on the network. For most libraries, even in relatively large municipalities or corporations, the finances and other resources required for start-up of dedicated line operation are simply too great. While there are some less expensive dial-up options available, most of these offer electronic mail only and do not provide FTP and the telnet functionality that is especially important to libraries. Increasingly, library or library-related networks—cooperative, not-for-profit regional or state-based library service organizations that broker Online Computer Library Center electronic bibliographic network services and/or other technological services for groups of individual libraries—are becoming the providers or brokers of Internet connectivity.*
- *Lack of affordable access.* Dial-up, entry-level connectivity is only the beginning of the cost for libraries, many of which will also incur long-distance charges. A good example is found in the state of Wisconsin, where it costs about $14,000 annually to be a full member of WiscNet, the state network providing Internet access. For an entire campus, that is not a major expense. But 45 percent of U.S. public libraries have budgets under $50,000; in Wisconsin it is 54 percent. For such libraries, $14,000 annually is a major expense. In addition, these costs probably do not include local staffing costs for technical support, user support, and training.
- *Lack of user-friendly interfaces.* Lack of user-friendly interfaces and tools, the lack of databases and resources geared to public use, and the seemingly limitless information on the Internet, not all of it useful to public libraries and their users, constitute additional barriers. The lack of organization of much of the information on the network is another serious barrier to using it effectively.
- *Training and support needed for staff and the public.* Librarians need to know what is available, how to find it, and what the technological problems may be and how to solve them, before using the Internet on behalf of users or providing direct access to the public. Persuasion is needed that a new set of procedures and costs will be worth the investment of scarce time or money. Some of upper library management is not conversant with the latest technologies. In other cases, librarians need ammunition to convince parents, school boards, or local governments that are themselves technologically out of date or challenged. Especially important is the need to train staff before offering Internet service for public access.

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**Box 3.6—*continued***

- *Policy issues.* As public libraries begin to move toward providing direct public access to the Internet, they face a host of administrative and policy issues that must be addressed. In general, these are not unique to public libraries, and so they are listed but not discussed. They include:
  - Privacy and security issues,
  - Intellectual property protection and fair use of copyrighted materials,
  - Affordability of commercial information services,
  - Interoperability and standards,
  - Whether and how to impose limits on public use when demand outstrips resources (time, equipment, capacity, or budget),
  - Scalability of Internet address system, and
  - Censorship, access by minors.

Tools and policies developed by the library field and put to regular use in libraries can help in coming to grips with these various problems.

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*An excellent discussion of the barriers facing public libraries—and the source from which this box was derived—can be found in: Henderson, Carol C. 1993. "The Role of Public Libraries in Providing Public Access to the Internet," prepared for a conference, Public Access to the Internet, John F. Kennedy School of Government, Harvard University, May 26-27, 1993.

other information providers, research users, and information and computer scientists—to develop standards, common formats, and controls that will permit users to identify, locate, and access needed resources in a consistent fashion. Standards and protocols will also be needed for those users of digital libraries who may lack the needed skills to effectively utilize the networked environment and who may not have a librarian to call upon.

Broad use of digitized resources outside of a library facility with professional staff is expected to increase with home-based and other remote access to information infrastructure. Overall, the future role of libraries will evolve to reflect and interact with developments in individual, personal information retrieval systems and also developments in the publishing arena and other sources of supply for electronic information resources.



**Box 3.7 Experimental Library Projects**

- *The Electronic Text Center and On-Line Archive of Electronic Texts at the Alderman Library, University of Virginia.* Opened in 1992, the Electronic Text Center combines an on-line text archive with computer hardware and software systems for the creation and analysis of text. The archive, including electronic texts encoded with Standard Generalized Markup Language, includes the entire corpus of Old English writings, several hundred Middle English and Modern English works, and smaller selections of French, Latin, and German works. Considerable effort has gone into creation of on-line and printed documentation, much of it available over the Internet via gopher and World-Wide Web servers. Over 7,500 remote logins from over 1,600 on-line users were counted in 1993. The electronic texts have been used in a wide range of research and educational activities.
- *The North Carolina State University Digitized Document Transmission Project.* Scanned images are transmitted over the Internet to libraries, researchers' workstations, and agricultural extension offices. Collaborating on this project are the National Agricultural Library and 14 land-grant university libraries in 11 states.
- *The Economic Development Information Network, or EDIN.* This collaborative effort between Pennsylvania State University, the Pennsylvania State Data Center, and the Institute for State and Regional Affairs provides access to bulletins and news releases, issues of *Commerce Business Daily*, directories of economic development centers and agencies, database files pertaining to demographic and economic data, and more.
- *The Chemistry Online Retrieval Experiment (CORE),* a prototype electronic library of 20 American Chemical Society (ACS) journals that is disseminated over Cornell University's local area network. The project is a collaboration among four participants—the ACS and its Chemical Abstracts Service division; Bell Communications Research (Bellcore, the research arm of the regional telephone holding companies), Morristown, N.J.; Cornell University's Mann Library, and the Cornell Computer Library Center. The CORE system enables Cornell faculty and students to search a database that eventually will include more than 10 years' worth of issues of 20 chemical journals and information from scientific reference tools. Users can retrieve articles electronically, complete with illustrations, tables, mathematical formulas, and chemical structures. They can also choose to display an entire article, or to additional articles, using hypertext-type links. The database is constructed with the same composition data used to publish the print-on-paper versions of the journals, thus minimizing the labor needed to create it and keep it current.
- *TULIP (The University Licensing Program).* This project of Elsevier Science Publishers is a collection of 43 [illegible] chemical science journals. Researchers at 17 universities, including the [illegible] of Ten University of [illegible]

## CROSS-CUTTING OBSERVATIONS

The key parameter for the research, education, and library communities is cost. Limited ability to pay for services is typical; a related factor is a need for predictable charges because of the limited, fixed budgets of schools and research institutions. Higher costs may mean a reduction, elimination, or preclusion of access for those actual and potential users with the least robust funding: K-12 education, smaller and less affluent institutions, smaller and more poorly funded departments or researchers, absent targeted support. Higher—or in some cases any—costs will force users and their sources of funding to confront the issue of whether there is a trade-off between networking and their "basic" activity (research, education) or whether networking is so connected to their basic activity that they would prefer to reduce spending elsewhere to support it.

At the time the NREN concept was conceived, some members of the research community characterized funding as zero-sum: for those with limited or no use of networks, money for networking was perceived as money lost to research.[43] Although the benefits of networking are now more broadly appreciated in the research community, the transition from free service to a fee for service revives questions about possible trade-offs and how integrated networking is or should be in research or education. The problem may be particularly acute in K-12 education, where the institutional barriers to commercial fulfillment of a public service must be addressed by public institutions.

Higher costs should also prompt some consideration of possible gains in efficiency. Efficiency does not receive the kind of attention in the research community, in particular, that it receives in industry. Information access is one way in which networks increase efficiency in education, although such a classical benefit is not the principal benefit in an area where the dominant cost is an already leveraged resource: personnel and teachers.[44] On the other hand, this situation underscores the need for training and skill development, which will affect how much benefit is received, and how fast.

In research and education, outputs, inputs, and the relationship between them are hard to characterize and control. Yet cost savings can be an important benefit of the use of information infrastructure, because they are inherent in the notion of networks and information infrastructure as shared resources. That sharing enables broader use of resources than would be possible if each researcher, educator, librarian, or student had to be individually capitalized. In addition, as the Internet experience demonstrates, information infrastructure can facilitate cross-sectoral sharing, including the building of bridges between K-12 education and higher education and research. For example, many states are now working to connect universities, colleges, community colleges, K-12 schools, and public libraries via networks to support both learning and research.



*It would be a mistake, however, to frame NII planning for the research, education, and library communities simply from the perspective of financial aid requirements.* These communities have been information providers as well as consumers, and they will continue to make important contributions to network information resources in this regard in the future. The fact that these communities typically do not charge for their information services might be considered an important factor in considering how to charge them for their network access. Another important factor may be the fact that these communities also actively train their constituents in network use.

Viewed from a national and even a global perspective, research and education in all fields will continue to provide the bedrock for U.S. social and economic growth. Competitiveness in international markets, education of all members of society for positive and meaningful participation in the coming decades' tasks and opportunities, and breakthroughs in scientific and nontechnical scholarly pursuits that will improve our way of life are among the goals that can be fostered by ensuring equitable access to the NII. The steps we take now to realize the potential benefits of the information future will be a significant measure of the country's progress in shaping its agenda to reflect its ideals.

## NOTES

1. In networked environments, museums, archives, and other information providers are expected to play an increasing role, complementing libraries.

2. CSTB has planned, together with the Institute of Medicine, a comprehensive study of information infrastructure for health care.

3. Peters, Paul Evan (Executive Director of the Coalition for Networked Information, Washington, D.C.). "Responses to Questions," message (electronic mail system) to Susan I. Nutter, August 13, 1993. Stone-Martin, Martha, and Laura Breeden. 1994. *51 Reasons: How We Use the Internet and What It Says About the Information Superhighway*. FARNET Inc., Lexington, Mass.

4. For example, the electronic physics publishing activities centered at the Los Alamos National Laboratory are recognized as helping to democratize the field, allowing new insights to go beyond the "old boy network" that previously was the only group to know of key results when they were still new.

5. TOGA-COARE refers to the decade-long Tropical Ocean-Global Atmosphere international research program, including the Coupled Ocean-Atmosphere Response Experiment.

6. Pool, R. 1993. "Networking the Worm," *Science* 261:842.

7. Computer Science and Telecommunications Board (CSTB). National Research Council. 1993. *National Collaboratories: Applying Information Technology for Scientific Research*. National Academy Press, Washington D.C.

8. Cuticchia, A.J., M.A. Chipperfield, C.J. Porter, W. Kearns, and P.L. Pearson. 1993. Managing All Those Bytes: The Human Genome Project," *Science* 262:47-48.

9. Carey, John. 1991. "Could America Afford the Transistor Today?" *Business Week* March 7, pp. 80-84.

10. CSTB. 1993. *National Collaboratories*.

11. CSTB. 1993. *National Collaboratories*.

The Branscomb report recommended broadening access to scientific and engineer[illegible] workstations for NSF's 20,000 investigators and contemplated increasing simulation and visualization activity using personal computers and more powerful systems. These desktop systems, in turn, require high-performance input-output, distributed access to databases, and other infrastructure-related complements. Branscomb, Lewis, et al. 1993. *From Desktop to Teraflop: Exploiting the U.S. Lead in High Performance Computing*, NSF Blue Ribbon Panel on High Performance Computing. National Science Foundation, Washington, D.C., August.

12. One concern already being raised is whether those with greatest proximity to a vBNS [illegible] access.

13. "Scholars quickly understand that electronic documents have several obvious bene[illegible] can be searched quickly for phrases, words, and combinations of words, allowing [illegible] and hypotheses with great speed; they encourage large-scale searches [illegible] and continuous searches that are difficult and time-consuming with [illegible] with access to texts otherwise unavailable, and they allow [illegible] work to be done from one's home or office." Seaman, David. 1993. "Gate-keeping [illegible] Delight: Electronic Texts and the Humanities at the University of Virginia [illegible] *Gatekeepers and Roles in the Information Omniverse: Proceedings from the* [illegible] 1993, Washington, D.C.

14. Hider, P. 1991. "Information Systems, Services, and Technology for the Hu[illegible] *Annual Review of Information Science and Technology* (ARIST) 26:287-346.

15. Peters, Paul Evan. "National Initiative on Arts and Humanities Computing," message (electronic mail system) to CNI-Announce subscribers, January 1, 1994.

16. Mandelbaum, Richard, and Paulette A. Mandelbaum. 1992. "The Strategic Future of the Mid-level Networks." Pp. 59-118 in *Building Information Infrastructure*. Harvard University Press, Cambridge, Mass.

17. Branscomb et al. 1992. *From Desktop to Teraflop*.

In the early 1980s Carnegie Mellon University and the Massachusetts Institute of Technology were the pioneers in incorporating technologies that wove telecommunications [illegible] Oklahoma State University now uses telecommunications [illegible] students at rural high schools. Chico State University provides a range of courses to sites in rural northeastern California as well as a graduate program in computer science to industry locations across the nation. State systems in Oregon, Utah, Texas, and [illegible] are planning major telecommunications efforts as a means to increase student access, and utilization of resources. An advisory commission to the California community colleges recently recommended the expansion of telecourses to increase the productivity of the system.

20. This initiative was discussed by federal agency personnel in 1988, and it was urged by EDUCOM and its Networking and Telecommunications Task Force, in 1989; it had antecedents in proposals to the National Science Foundation by computer scientists Robert Kahn and Vinton Cerf. Mandelbaum and Mandelbaum. 1992. "The Strategic Future of the Mid-level Networks," personal communication. Stephen Wolff, National Science Foundation, June 1993. Lynch, Clifford A., and Preston, Cecilia M. 1990. "Internet Access to Information Resources." *Annual Review of Information Science and Technology* (ARIST) 25:296.

21. The Fielding Institute represents a higher-education institution that is built around



the virtual campus, serving a geographically distributed student body dominated by adult professionals pursuing graduate and doctoral programs.

22. Burr, Elizabeth. 1994. "Electronic Studios," *News from FONDREN* 3(3, Winter):1-3.

23. A Macintosh-based, real-time, multiparty videoconferencing program, CU-SeeMe, is available free from Cornell University under the copyright of Cornell and its collaborators. CU-SeeMe version 0.60, with an improved user interface, provides a one-to-one connection or, by use of a reflector, a one-to-many, a several-to-several, or a several-to-many conference depending on user needs and hardware capabilities. It displays 4-bit gray-scale video windows at 160 × 120 pixels or at double that diameter, and does not (yet) include audio. At this time CU-SeeMe runs only on the Macintosh using an IP network connection over the Internet. A PC version is under development and is expected soon. With CU-SeeMe each participant can decide to be a sender, a receiver, or both. Personal communication, Jill Charboneau, Cornell University, April 1994.

24. Also connected are 10 K-12 schools or school districts, 14 state or federal government agencies, 11 health care organizations, 34 nonprofit organizations, and 13 businesses. Personal communication, Eric Aupperle, Merit Inc., April 13, 1994.

25. Personal communication, Eric Aupperle, Merit Inc., April 13, 1994.

26. Klingenstein, Kenneth. 1993. "The Boulder Valley Internet Project: Early Lessons in Early Education." *INET '93 Proceedings*, pp. ECA 1-8.

27. Klingenstein, 1993. "The Boulder Valley Internet Project."

28. For example, the National Coordinating Committee on Technology in Education and Training (NCC-TET), which includes a large number of K-12 and higher-education organizations as well as industry and government members, recently issued a statement on educational needs associated with the NII. It noted that "the NII (as it develops) and related technologies can be key supports for education reform and therefore be incorporated into education reform initiatives at the national, state, and local levels." National Coordinating Committee on Technology in Education and Training. 1994. "The National Information Infrastructure: Requirements for Education and Training," March 25, electronic communication.

29. "The CoSN/FARNET Project, Building Consensus/Building Models for K-12 Networking." n.d. Report of October 28, 1993, workshop, electronic distribution.

30. Telecomputing can enhance interactions within communities in the context of strengthening K-12 education. In Texas, for example, where 70 percent of the counties are medically underserved, the means to link existing infrastructure and higher-education institutions with schools to share information about health, education, and medical care is provided by a state network developed for education, TENET. One collaborative initiative links TENET and the South Texas Center for Preventive Genetics at the University of Texas. A pilot project has begun to develop a monitoring and treatment system for children diagnosed with certain birth defects. An integral part of the project is communication with school nurses, school clinics, and teachers via TENET. For example, teachers and nurses are asked to become involved in monitoring compliance with dietary requirements at school. The goal is to remove distance as a barrier to effective treatment, improve prognoses for individuals being undertreated, increase dietary treatment compliance, and provide a database to answer researchers' queries about efficacy of treatment as it relates to cognitive function.

31. "The Network is to provide users with appropriate access to high-performance computing systems, electronic information resources, other research facilities, and libraries. The Network shall provide access, to the extent practicable, to electronic information resources maintained by libraries, research facilities, publishers, and affiliated organizations." PL 102-194, section 102.

32. Note that in an environment filled with jargon, it is important to distinguish between

a virtual library—a facility for accessing information, which can be stored in various forms or media—and a digital library, which usually refers to a collection that is itself digitized. The virtual library is more easily implemented.

35. "Public libraries" means public libraries as defined in the Library Services and Construction Act, state library agencies, and the libraries, library-related entities, cooperatives [illegible] through which library services are delivered.

36. McClure, Charles R., Joe Ryan, Diana Lauterback, and William E. Moen. 1992. *Public [illegible] and the NSFNET/NREN: New Challenges, New Opportunities*. School of Information Studies, Syracuse University, Syracuse, New York.

37. According to Clifford Lynch:

> [illegible] the interlibrary loan] area has ranged from the use of electronic ILL systems linked [illegible] national database of holdings (such as OCLC) which allow a requesting library to [illegible] identify other libraries that probably hold materials and dispatch loan requests [illegible] through the exploitation of technology to reduce the cost of the actual shipment of [illegible]. The first step in this latter area was for the lending institution to send a Xerox of [illegible] rather than the actual journal copy, so that the borrowing library did not have [illegible] the material and the lending library did not lose use of it while it was out on interlibrary loan. More recently, libraries have employed both fax and Internet-based transmission systems such as the RLG Ariel product to further speed up the transfer of [illegible] from one library to another in the ILL context, and with each additional [illegible] of technology the publishers have become more uncomfortable and more resistant [illegible] legal grounds for doing so, though again this has not been subject to test [illegible] in the past few years we have seen the deployment of a number of commercial document delivery services (the fees from which cover not only the delivery of the [illegible] to the requesting library but also copyright fees to the publisher) offering rates [illegible] indeed perhaps substantially better than the costs that a borrowing [illegible] obtaining material such as journal articles through traditional interlibrary loan processes. Now consider a library acquiring information in an electronic [illegible]. Such information is almost never, today, *sold* to a library (under the doctrine of first sale) rather it is licensed to the library that acquires it, with the terms under which the [illegible] library can utilize the information defined by a contract typically far more restrictive than copyright law. The licensing contract typically includes statements that define the user community permitted to utilize the electronic information as well as terms that define the specific uses that this user community may make of the licensed electronic information.

See Lynch, Clifford A. 1993. *Accessibility and Integrity of Networked Information Collections*. Background Report. Contractor Report prepared for the Office of Technology Assessment, July 7, p. 16.

36. Shaughnessy, Thomas W. 1994. "Libraries Organize as a Virtual Electronic Library." *Library Line* 5(March):1-2.

37. Association of Research Libraries. 1992. "Key Issues to Consider in NREN Policy Formulation." *Proceedings of the NREN Workshop*, Monterey, Calif., September 16-18. Interuniversity Communications Council Inc., Washington, D.C.

38. The 100 members of the Association of Research Libraries paid $19.8 million more for services in 1992-1993 than in the previous year but purchased 30,000 fewer subscriptions and 30,000 fewer monographs. Association of Research Libraries (ARL). 1994. "State of Research Libraries and Importance of HEA Title II-C to Research and Education." ARL, Washington, D.C., March 2.

39. These records and network-based access to them present both technical and intellectual property management issues. See Library of Congress. n.d. "Delivering Electronic Information in a Knowledge-based Democracy," Summary of Conference Proceedings, July 14, 1993.

40. These characteristics of digital libraries were presented in a statement by the Association of Research Libraries to the Subcommittee on Science, Committee on Science, Space and Technology, from the Hearing Record of February 2, 1993, regarding the High-Performance Computing Act of 1991.



41. A new NSF-ARPA-NASA research program associated with the NREN program will fund relevant research.

42. Recent Supreme Court decisions relating to access and the availability of government electronic records underscore the need for rules and regulations that govern their preservation and disposition. Building concerns about archiving and preservation into existing network projects will be important.

43. See Computer Science and Technology Board, National Research Council. 1988. *Toward a National Research Network*. National Academy Press, Washington, D.C. (The Computer Science and Technology Board became the Computer Science and Telecommunications Board in 1990.)

44. Note that libraries may have greater integration of networking for public access and internal operational purposes than is typical of K-12 education.

# APPENDIX B

## EXAMPLES OF BARRIERS TO LIBRARY CONNECTIVITY IN RURAL, ISOLATED, AND HIGH COST AREAS

**California.** A pilot project described by the California State Librian used $2.5 million in federal Library Services and Construction Act (LSCA) seed money to fieldtest a project that would provide people with direct Internet access through public libraries. Although the project was successful, the California State Library "discovered that libraries in rural areas faced significantly greater difficulty in providing the service due to lines/equipment inadequate to transmit grahic images, a lack of local service providers, and the higher costs associated with the long distance tolls they were forced to invoke." The State Librarian recommended "that all rural areas be equipped with the capacity to access all information formats (i.e.multimedia) electronically, and that they be enabled to do so at costs equivalent to those of urban areas (i.e., the cost of local telephone call)." (3/29/96 letter to the FCC from Kevin Starr, State Librarian of California)

**Indiana.** "In Indiana, I am presently working with the Governor and Department of Education's Access Indiana initiative, which is our attempt to partner with the private sector to build the telecommunications infrastructure necessary for the Internet today and combined voice, data and video for the future. Our goal is to provide grants to connect every school and library in the state....Even with the monies we are making available the ongoing costs of 56KB and T1 lines are nearly impossible for smaller rural areas to participate. In these smaller areas it is important for there to be sharing of bandwidth, and that sharing should not preclude libraries and schools or local governments from the discounted rate. As a new member of the Intelenet Commission along with the State Superintendent of Public Instruction, we arae encouraging libraries and schools to participate in community networks as economical ways for the private sector to provide the needed telecommunication lines everywhere in the state. We are also finding it is advantageous to both the local units and the telecom providers for the state to aggregate bids for major infrastructure with local private providers managing local services." (4/5/96 e-mail message from Ray Ewick, Director, Indiana State Library, ewick@statelib.lib.in.us)

**Missouri.** "Public libraries need the capability to act as access points for distance learning, as they reach into many more communities than have 2 or 4 year college campuses. Both the access to and the cost of telecomferencing is an issue. Currently, any face-to-face meeting of committees may require a drive of up to 6 hours each way; access to telecomferencing will have to reach into rural and smaller communities to enable statewide committees to use it as an alternative.

...The average rural Missouri library operates with an annual budget of less than $50,000.

...There are several cities sharing common borders with other states, and the impact of interstate phone rates will affect the services libraries and educational institutions can share. In addition to the cities, there are regions of the state where the economical center is not in the state. An example of this is Joplin Missouri. It provides an economic center for both Northeastern Oklahoma and Southeastern Kansas.

...a flat rate cost for advanced interstate telecommunications would be the most effective way to provide access to advanced services....The predictability of a flat rate in telecommunications cost will mean that libraries will be able to budget for and encourage the usage of advance telecommunications...." (4/5/96 e-mail message from Barbara Reading, Interim Director, Library Development, Missouri State Library)

**Nevada.** "Public libraries are struggline with the telecommunication costs throughout the state. The three counties without a connection to the public library networks are remote, small communities which cannot support the long distance costs to connect. The telecommunication charges would be greater than their current total operating budget. Even the rural locations with the urbanized Clark and Washoe counties push up the cost of telecommunications of network beyond their proportionate use.

Some critical issues of telecommunications in Nevada are the existence of 11 telephone companies, great distance between communities (which translates into high telecomm costs), a LATA that bisects the state and a few border communities that are served by out-of-state telephone companies.

The rural locations would not have the means to support the costs for connections, even if digital service were available. The urban areas are struggling with the cost and usage. The Las Vegas area system has recently installed T1 lines to support their in-library and dial-in service. They have already had to order T3 lines in order to manage current demand. They are **not** using a system with high graphics interface or multi-media programs. The networks have great concerns if any form of existing bandwidth will be able to keep up with the booming demand.

Wireless technology might be useful in remote areas where no digital service is currently available (some areas don't appear on any timetable for digital service). Also, the areas that have out-of-state telephone providers might benefit from wireless technology." (4/1/96 fax message from Diane Baker, Assistant State Librarian, Nevada State Libray and Archives)

**New York.** A very useful case study of both the benefits to be gained and the barriers to be overcome in connecting very small rural libraries to the Internet appears in a 1994 report: *The Project Gain Report: Connecting Rural Public Libraries to the Internet*, by Charles R. McClure, Waldo C. Babcock, Karen A. Nelson, and Jean Armour Polly. Liverpool, NY: NYSERNet, Inc., 1994.

**West Virginia.** West Virginia has communities isolated because of terrain, lack of highways, and mountainous rural populations, sparsely settled and located at great distances from more urbanized areas....the electronic highway will be able to overcome the isolated communities which were never served by conventional highways....annual costs could run over $2,000 for 56k or nearly $5,000 a year for T-1, and the more remote the library the higher the cost. These costs in many cases would be equal to or greater than book budgets...It is difficult to consider telecommunication charges when people are being paid minimum wage and are on Government subsidy programs. (3/29/96 e-mail message from Frederic J. Glazer, Executive Director, West ./Virginia Library Commission)

APPENDIX C

# Using the Public Library in the Computer Age: Present Patterns, Future Possibilities

A National Public Opinion Survey Report by the Reference Point Foundation, in Cooperation with the American Library Association

Report Authors:

Alan F. Westin and Anne L. Finger

Based on Data from a 1990 National Survey by Louis Harris and Associates on "The Consumer in the Information Age," Sponsored by Equifax Inc.

## INTRODUCTION/BACKGROUND

The American public library is one of our proudest democratic traditions. What is happening to this major American institution in our fast-paced multi-media age? Incorporating previously unpublished data from a 1990 Louis Harris and Associates survey on "Consumers in the Information Age," this report sought to answer the following questions:

- Are people using the public library to the extent that they once did?
- Who is using the public library?
- And for what purposes?
- What is the impact of technology on this bastion of the printed word?
- What do we expect of the public library in the future?

In 1990, Equifax, Inc., the consumer reporting company, commissioned Louis Harris and Associates to conduct a large-scale public and leadership opinion survey on "Consumers in the Information Age." Dr. Alan F. Westin, of Columbia University, coauthor of this report, served as academic advisor to the survey.

Telephone interviews were held with 2,254 Americans 18 years of age or older, in a representative national sample. At this large sample size, the survey had a margin of confidence of plus or minus 2%. Each percentage point in the survey represents 1.85 million Americans. Thus, if 10% of the sample say they have done something or feel a certain way, this represents 18.5 million Americans 18 or older. Standard demographic questions were asked covering age, education, income, sex, race, religion, region, type of community, work status, and political philosophy.

In addition to the standard demographic categories, the survey included other very interesting indexes, such as cultural activity, home computer use, and membership and leadership in voluntary organizations.

The primary focus of the survey was the impact on consumers of new information technologies and organizational practices in areas of credit, insurance, employment, credit card, and direct marketing, and the issues of consumer benefits, privacy, and fair information practices that such developments raise in the "information rich" 1990s. A report of the survey's major findings was released in June, 1990.

As part of its effort to identify the cultural and lifestyle sources of public attitudes toward various consumer and other privacy issues, the survey included a series of questions about use of the public library. It asked respondents:

- whether or not they had used the services of a public library in the past year;
- if they had used them, how often;
- which library services they had used; and
- how interested they would be in accessing certain library services from a home computer.

This report analyzes the answers to those questions for the first time. To place them in perspective, it compares the Equifax-Harris survey findings with previous studies of library users conducted for the American Library Association: a 1978 survey by the Gallup organization; and a 1987 Life Style Profile prepared by Doremus Porter Novelli.

And, because some of the findings raise critical public policy issues concerning access to information in the Electronic Era, the report suggests there are far-ranging implications about the importance of the role of the public library in American life in the years to come.

Selected tables from the Equifax-Harris survey are found in the report.

[Please note: Throughout this summary, the term "survey," refers to the Equifax-Harris survey. The term "report" refers to Using the Public Library in the Computer Age: Present Patterns, Future Possibilities.]