Networked Information Resources and Services: Next Steps on the Road to the Distributed Digital Libraries of the Twenty-first Century*

ABSTRACT

The aim of this paper is to generate discussion about and reflection on what is meant by networked information resources and services and to provide a practical appreciation for what currently constitutes these relatively new information resources and services and how they will likely evolve as the 1990s unfold. In addition, the author hopes to convey some of the excitement that a growing number of information technologists and librarians are beginning to feel about networked information resources and services and to suggest how the efforts of those information technologists and librarians can be orchestrated for mutual benefit with the efforts of a host of other concerned and materially affected parties.

INTRODUCTION

The often-predicted and long-awaited transition from information distribution and access by exclusively print means to information distribution and access by electronic as well as print means now depends upon a variety of institutional, organizational, and marketplace

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“readiness factors” more than it does upon any specific technological innovation and development.

It is extremely important to place the contemporary scene in the context provided by the approximately fifty-year effort to marshal information technology to the service of scholarship and pedagogy. Doing so helps us to keep in mind what this long-term effort is really about. It is not about “electronic libraries,” “virtual libraries,” or even “distributed digital libraries.” These popular and evocative phrases say something about the technological and service architectures that shape the efforts and aspirations of contemporary information technologists and librarians, but they say nothing about what really motivates those efforts. The mission of all of these efforts, no matter how technologically or bibliographically esoteric they may appear to be, is to improve information distribution and access by using high-performance computers and advanced networks to support research and education communication.

ADVANCED NETWORKS

So why are so many information technologists and librarians so excited about advanced networks in general and about BITNET, the National Science Foundation Network (NSFNET), the global Internet, and the proposed National Research and Education Network in particular? What's the big deal? There are three basic reasons for this excitement: simplification, connectivity, and performance.

Simplification

First of all, an advanced network provides a common framework by which to interconnect and to interoperate the great variety of highly heterogeneous departmental, institutional, regional, and other individual networks that have sprung up by one means or another over the past twenty years or so. This interconnection and interoperation results in a major technological simplification of the global networking scene and in the reduced costs and the increased values that always accompany such simplifications.

Connectivity

The second reason is that the connectivity provided by these advanced networks is expanding at a truly fantastic rate. It is becoming progressively easier and more cost effective to connect research and education communities to each other and to the growing variety of
resources and services to which they contribute and on which they depend. One specific indicator of this phenomenon is provided by the growth of the NSFNET (Figure 1).

As of January 31, 1991, 2,338 individual networks, including 688 foreign networks, can be reached through the NSFNET. In the past two years, the total number of individual networks that can be reached by this means has increased by 675 percent, while the number of foreign networks that can be reached through the network has increased by over 2,000 percent. No one knows precisely how many individual computers are interconnected by these networks or how many individual users are served by those computers, but an educated guess is 200,000 computers and 10,000,000 users. This is an impressive amount of connectivity, and it is increasing at an equally impressive rate.

Another view of the simplification and connectivity being offered by these advanced networks is provided by what they promise for library functions and interfaces. Figure 2 provides a simplified conceptualization of typical library functions and how these functions interface with a variety of external agencies and actors. For instance, the diagram shows, at six o'clock, that patrons interface with the library's reference staff and system, the library's catalog and information resources, and the library's circulation and interlibrary loan staff and systems; it also
shows, at eleven o’clock, that the library’s acquisitions staff and system interface with publishers, brokers, and other information resources.

Figure 3 observes that a variety of networking technologies are already being used to enhance the effectiveness and increase the efficiency of these interfaces. For instance, it shows, at between nine and ten o’clock, that private networks are being used to interface the library’s cataloging staff and system with bibliographic networks such as the Research Libraries Information Network and OCLC; it also shows, at seven o’clock, that the library’s reference staff and system interface with services such as DIALOG and LEXIS primarily using commercial networks.

The third and final diagram in this series, Figure 4, shows how a contemporary advanced network, shown as the large “U” that provides a setting for all the functions and a framework for all the interfaces of the library, can simplify the technological characteristics of existing interfaces while increasing the number of connections that exist among the full range of library functions and between the library functions and the full range of external agencies and actors.
Performance

Performance is the third reason why information technologists and librarians are so excited about these advanced networks. Performance levels are already mind-boggling and promise to be dumbfounding by 1995, if not sooner. Again, the NSFNET provides an object lesson (Figure 5). In January 1991, the network transported 5.87 billion packets of information that averaged approximately 350 characters each. This impressive figure becomes all the more so when one considers that it represents a 237 percent growth in traffic transported by the network in the single year that ended in January 1991, a compound growth rate for the year that averaged 20 percent per month. No one knows precisely how much traffic is transported within but not between the individual networks that are interconnected by the NSFNET, but most analysts believe that a ten-to-one ratio is a fair estimate. This estimate implies that in January 1991 alone, nearly 60 billion packets of information were transported within the networks that are interconnected by the NSFNET. This is a mind-boggling level of performance. Once again, theory predicts an exponential shape to this
Once again, we are clearly in the early stages of this growth process, or the growth process is being constrained by resources. And once again, both implications are true.

One way to try to grasp what these levels of performance mean and will mean to research and education communities is to pose the question of how many typewritten pages can be transported at a variety of illustrative performance levels. Some relatively straightforward quantitative assumptions lead to some very interesting results. For instance, if we assume that there are 200 words on a typical typewritten page, that each word has 10 letters, and that each letter requires 10 bits to encode, then we can conclude that it takes 20,000 bits to encode a typewritten page. These numbers can be used to generate Table 1.

Starting with the first line of Table 1, we see that a performance level of 2.4 kilo (thousand) bits per second (kb/s), also known as 2400 baud, enables just over a tenth of a typewritten page to be transported each second. This is the performance level of most contemporary personal computer modems and circuits when they operate at perfect efficiency. The third line of this table indicates that a performance level of 1.5 mega (million) bits per second (Mb/s) enables 75 typewritten
Table 1
Performance Level Examples

<table>
<thead>
<tr>
<th>Performance Level</th>
<th>Transportation Rate</th>
</tr>
</thead>
<tbody>
<tr>
<td>2.40 kb/s</td>
<td>0.12 p/s</td>
</tr>
<tr>
<td>9.60 kb/s</td>
<td>0.48 p/s</td>
</tr>
<tr>
<td>1.50 Mb/s</td>
<td>75.00 p/s</td>
</tr>
<tr>
<td>45.00 Mb/s</td>
<td>2,250.00 p/s</td>
</tr>
<tr>
<td>500.00 Mb/s</td>
<td>25,000.00 p/s</td>
</tr>
<tr>
<td>1.00 Gb/s</td>
<td>50,000.00 p/s</td>
</tr>
</tbody>
</table>

NSFNET Monthly Traffic in Packets

January 1991 traffic represents a 237% increase over January 1990

January 1990
2.47 billion

January 1991
5.87 billion

Figure 5
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pages to be transported each second. This is the performance level of most contemporary network controllers and circuits operating at perfect efficiency. Finally, the last line indicates that a performance level of 1 giga (billion) bits per second (Gb/s) enables 50,000 typewritten pages to be transported each second. This will be the performance level of the network controllers and circuits that will be in production use in 1995, if not sooner, when they operate at perfect efficiency.

The meaning of these performance levels can be made clearer still by considering the case of a personal library of 2,000 books. If one assumes that the typical book starts life as a 1,000-page typewritten
manuscript, then it would take this personal library 40 seconds to be transported at 1 Gb/s. It would take a typical academic library of 1,000,000 books 6 hours to be transported at 1 Gb/s. It would take a relatively large research library of 5,000,000 books 1.25 days to be transported at 1 Gb/s. There are many analysts who believe that it is a much better than fifty-fifty proposition that by 1995 we will achieve production performance levels of 3 Gb/s rather than 1 Gb/s. This is a dumbfounding technological prospect; no one fully understands what it will mean for research and education communities.

ORIGIN OF ADVANCED NETWORKS AND PERFORMANCE LEVELS

Where did these performance levels and the advanced networks that utilize them come from, and where will they come from in the future? Research and education institutions and organizations have played the most important role to date in building and operating these networks. They have played that role by making significant technological innovations as well as by making significant financial investments. Nearly every higher education institution in the United States already has a campus network or a plan by which to obtain one; by 1995, this most certainly will also be true for the overwhelming majority of research and education institutions and organizations throughout the nation.

The federal government, through the Advanced Research Projects Agency of the Department of the Army, the Department of Energy, the National Science Foundation, the National Aeronautics and Space Administration, and quite a few other federal agencies, has played the second most important role to date in building and operating these networks. However, state and local governments and related regional undertakings have recently begun to look to advanced networks to improve the educational and economic opportunities available to their citizens and residents and to enhance the effectiveness and efficiency of their many civic administrative functions such as vehicle registration, property title documentation, and the like.

Private and commercial enterprises like IBM and MCI have played the third most important role to date in building and operating these advanced networks. The role of such enterprises will become even more important during the 1990s as a result of their shift of emphasis from the analog world of switching telephone circuits to the digital world of routing datagram packets. It is very important for policy and technology planners at research and education institutions and organizations to recognize and plan the growing importance of the roles that are played by state and local governments and related regional
undertakings on the one hand, and private and commercial enterprises on the other.

In this context, it is vital to recall that research and education networks have always been designed to address at least three requirements that are fundamental to research and education communities, requirements that have historically been much less important to private and commercial ones.

**Horizontal Integration, Technological Diversity, and Knowledge Creation/Use**

First of all, research and education networks strive for horizontal rather than vertical integration. This is to say that research and education networks are built and operated to accommodate the fact that humanists at two different institutions or organizations have more in common with each other than they do with, for example, scientists at their respective institutions or organizations. Private and commercial networks, on the other hand, are usually built to integrate the efforts of a variety of different actors in a common, vertical value or production chain.

Second, research and education networks must also account for a wider degree of technological diversity than must private and commercial networks. This mostly reflects the wide range of institutions and organizations that research and education networks must encompass, but it also manifests the high degree of innovation that characterizes research and education communities. Finally, as a general rule, research and education networks are used in a greater variety of disciplinary and interdisciplinary settings and by a more highly skilled population than are private and commercial networks. Thus the users of research and education networks are generally engaged in knowledge creation and use to a much higher degree than are the users of typical private and commercial networks.

All this will change in the 1990s as research and education networks begin to support the requirements of populations that have been typical of private and commercial networks and vice versa. This convergence is a widely predicted outcome of the conversion of industrial economies to information and services economies. As this conversion progresses, private and commercial enterprises will play an increasingly important role in building and operating advanced research and education networks. It is vital that research and education communities do not lose sight of their unique requirements during this necessary transition, and that they gauge the success of the transition by the genuine passing of the need for their vigilance in this regard.

**METAPHORS FOR NETWORKING TECHNOLOGY**

Before ending this discussion of advanced networks and turning attention to the information resources and services that have been and
that are being enabled by these networks, the following list offers four metaphors for the future that is being created by the march of networking technology that has occupied our attention up to this point:

1. building infrastructures,
2. navigating virtual superhighways,
3. drinking from fire hoses, and
4. managing ecologies.

We are clearly building and operating an electronic infrastructure that has the potential scope and scale of the many physical infrastructures, such as road, water, and sewage systems, for which we have already mobilized the expertise and found the resources. This new electronic infrastructure will both stimulate and constrain our activities and aspirations in the same ways that these other types of infrastructures have throughout modern history.

We will conceptualize and experience this new infrastructure much as we conceptualize and experience the interstate highway system of today, the single most popular metaphor for what these advanced networks will represent to us some day. Only we will use maps, guidebooks, and other reference tools to navigate and travel in a new space that is a "virtual" rather than a "physical" presence in our lives.

Until the reality of these advanced networks measures up to the full potential of this vision, though, the experience of using them will be rather like trying to drink from a fire hose. For some time, information will gush forth from such networks at much greater rates and in much greater volumes than we will be able to capture, manipulate, or assimilate. This means that, for the foreseeable future, there will continue to be a compelling need for informational intermediaries, such as librarians and other information specialists, who will acquire, organize, store, and add value to information even though it is being distributed and accessed by electronic rather than printed means. It is even arguable that advanced networks will increase the need for such intermediaries.

It is very important for all of us, be we authors, intermediaries, or readers, to recognize that we cannot predict all, perhaps not even most, of the new things and behaviors that will emerge and occur in the new ecologies of thought and communication that these advanced networks represent. Accordingly, we need to think of ourselves as managing such ecologies as well as building and maintaining such infrastructures.

One additional metaphor will, one hopes, help to illuminate the role of librarians in this new world of networked information resources and services. At the 1991 Mid-Winter Meeting of the American Library Association last January in Chicago, Senator Albert Gore, Jr., drew an interesting parallel between contemporary librarians and navigators
in the day of Christopher Columbus. Senator Gore expressed his belief that in times of revolutionary discovery, people tend to hug the shore until the knowledge of those who have made a science and an art of how to get from "here" to "there" becomes recognized and accepted. In the time of Columbus, for instance, the stature and rewards of navigators increased dramatically as a direct result of the success of the expeditions of Columbus and other explorers of the time. Analogously, the new world of research and education using advanced networks provides librarians with at least as many opportunities as it does threats. The librarians who will prosper in this new world will be those who take to heart the lesson of the navigators in the time of Columbus, a lesson that counsels that it is not the stars themselves that matter but what the stars can tell us about how we should plot our courses of action.

NETWORKED INFORMATION RESOURCES AND SERVICES

Supercomputers

Most research and education networks to date have been built and operated to provide access to computational resources and to other types of powerful and expensive scientific and technological instruments. Supercomputers represent the most important contemporary example of this type of resource. However, once the first research and education networks became operational and the uses to which they were actually being put became a subject of investigation, it was discovered that there was another resource that was at least equally, if not more, important to the users of such networks: people.

Electronic Mail, Conferences, and Journals

An analysis of the traffic being transported by the NSFNET makes the importance of people abundantly clear. As Figure 6 shows, at least 20 percent of this traffic is accounted for by electronic mail, and some very large portion of the file exchange traffic percentage results from people sending files to each other rather than from computers sending the results of computations to their users. These figures compare to the almost 20 percent of the traffic that is accounted for by interactive computational processes. New applications and extensions of electronic mail are now occurring on a self-sustaining basis. In particular, the past year has witnessed the explosion of "special interest discussion groups" such as mail reflectors and listservers and the appearance of nearly twenty refereed journals.
Databases and Digital Libraries

Library catalogs and campuswide information systems represent a third category of networked information resources and services. It is this category that accounts for the lion's share of the growth and excitement in contemporary networking. Library catalogs are already far and away the most frequently found type of database on the Internet, and the databases of the Research Libraries Group and OCLC are the most frequently used “fee for service” databases on the Internet. These early efforts may not be self-sustaining—there is certainly much more to come than has arrived to date—but it is important to take note of just how quickly libraries have embraced the potential of advanced networks and how aggressively they are now seeking new ways to put these networks to work. Databases of primary research and education materials, known as “digital libraries,” and of secondary materials, which provide reference information about the contents of print collections as well as the contents of digital libraries, are beginning to appear on research and education networks. The rate at which they will continue to appear promises to accelerate exponentially.

High-Volume Print Facilities

High-volume print facilities represent a relatively new fourth category of networked information resources and services. These
facilities are destined to replace the generation of high-volume photocopiers that is currently in use at so many research and education institutions and organizations. They will soon offer a cost-effective alternative to the laser printers that have become such a familiar feature of academic and corporate life. These facilities will be used to print information as soon as a person finds and requests it at the institution or organization at which he or she is located. For certain types of information and users, such “on demand/on site” printing will represent a vast improvement over the current approach of printing and storing all information for all users in anticipation of demand. Insofar as most studies estimate that one-third of the cost of conventional printed research and education materials can be attributed to the inventory activities and distribution channels for those materials, this new resource holds particular promise for reducing the expense and increasing the responsiveness of acquiring such materials.

The likely impact of these high-volume printing facilities should not be discounted by the widely felt desire, at least in some quarters, for a completely electronic information distribution and access system. These facilities will allow us to experiment with a “just-in-time,” in contrast to the long-established “just-in-case” information distribution and access system. They will also allow us to reconceptualize the role of paper. The role of paper in the emerging just-in-time system is as the most affordable and acceptable interface by which to access and use the information that is contained in an expanding number of electronic storehouses. This contrasts markedly to the role that paper plays in the existing just-in-case system as the exclusive means by which information is delivered, stored, and used.

These high-volume print facilities located in copy center operations may also provide an effective way to address the lack of universal access to advanced networks. Dial-up connections to information resources and services on such networks are adequate and affordable ways to look for and to find relevant information in electronic formats, but they are too slow and unreliable to be used to access such information in any volume. The ability to route such information to a high-volume print facility that is on the network and that is located at a nearby copy center operation provides the answer to the question of how to benefit from the low cost of dial-up connections to advanced networks and from the relatively large information objects that are found on such networks.

“Knowbots” and Intelligent Databases

Just over the horizon of contemporary networked information resources and services can be seen a new generation of such resources
and services that apply artificial intelligence techniques in new and useful ways. Knowledge robots, or "knowbots," are algorithmic constructs engineered to wander advanced networks searching for information of interest to the human being whose interests and requirements they represent. The term *cybernautics* has recently come into use to refer to the science and practice of creating and using these network travel agents and navigational advisors. *Intelligent databases* are collections of information that are capable of knowing when and how they grow or are changed and what the significance of their growth and modification is to a variety of interested parties with whom they are in regular or even continuous communication.

**LIBRARIES AND NETWORKS: PROBLEMS, PROMISES**

These networked information resources and services are interesting in their own rights, but what can they do to ameliorate some of the pressing problems that face libraries and their constituencies in contemporary research and education communities? For instance, the skyrocketing costs of library materials illustrated in Figure 7 shows that serials expenditures in the 119 members of the Association of Research Libraries (ARL) increased 53 percent in the past three years while monographic expenditures increased 19 percent. The number of serials titles purchased dropped 1 percent in the same period, and the number of monographic volumes purchased dropped 16 percent. All these facts add up to the same thing: Much less information is being obtained for much more money. The larger, darker bar at the top of Figure 8 shows that nearly 40 percent of ARL members reduced their rate of acquiring new monographs by 21 percent or more in the past three years. Clearly, the attention that has been paid to what is known as the "serials pricing crisis" needs to be complemented by a heightened level of concern about what this crisis has done to the pattern of monographic acquisitions in academic and research libraries.

The size of library collections and, therefore, the amount of space that is needed to house library collections continues to expand at an exponential rate as well. One effect of the extraordinary increases in the costs of library materials has been to reduce the rate of acquisition of new materials and, therefore, to reduce the rate of growth of space requirements. But this can hardly be put forward as an acceptable way to manage a library and to address its space needs.

Another pressing concern of libraries in research and education communities is the underutilization of materials once they have been acquired. A familiar pattern emerges: Less than 60 percent of the materials in academic and research libraries ever circulate, and 80 percent

...of the materials that do circulate do so relatively soon after they have been acquired. Too many analysts have been all too quick to explain this phenomenon by decrying the declining quality of the literature record. But information cannot be used if it cannot be found, and better access mechanisms increase levels of use. This has been repeatedly affirmed by collection use studies performed both before and after the advent of online library information systems.

Thus the use of networked information resources and services promises to reduce the costs of acquiring library materials, to stabilize the rate of growth of the space required to house library materials, and to increase the rate of use of library materials. It is not yet clear that these specific promises will in fact be realized, but a great deal of contemporary effort is motivated by the hope that they will.
Cost/Benefit of Networked versus Print Resources and Services

Two things are very clear in the extremely complicated and somewhat theoretical area of the "cost/benefit" performance of networked information resources and services as compared with their print equivalents. First, the transition from card (paper) form catalogs to online ones may have something to tell us about the transition that we may or may not now be making from paper-form publications to electronic ones. In the author's experience, card catalogs collapsed and became unworkable under the pressure of the information explosion. Something quite similar is happening now with printed primary research and education materials: the existing system is collapsing and becoming unworkable. No matter how difficult it is to imagine, the transition from an exclusively print to a progressively more electronic
information distribution and access system may well be something about which we have very little choice, and it is certainly something about which our constituencies may have no choice at all.

Second, research and education communities, and particularly their libraries, are beginning to shift toward a “make” posture and away from a “buy” one as the business strategy by which they gain access to the information resources and services that they need. In addition to the cry to “take back the rights” that is heard in contemporary forums devoted to the serials pricing crisis, a new call is voiced to “take back the means of production.” This new interest in self-publishing, both personal and institutional and in partnership undertakings that build new networked information resources and services in not-for-profit and barter settings, is well worth watching and experimenting with.

Networked information resources and services also promise to improve access to brittle books that have been preserved on microfilm and then digitally scanned, and to enable library services to be available around the clock and from any point on the campus network. These resources and services allow faculty, students, information technologists, and librarians to work together to effectively manage the information and knowledge that is essential to the integrity and success of all research and education communities.

Networked Resources and Information Systems Design

Networked information resources and services also force us to rethink the design assumptions of most of the current generation of local library information systems. Most such systems assume that they are providing service to a smart user using a dumb terminal right around the corner from a large computer that contains descriptions of information owned by the library. The problem is that in today’s world, we are all dealing with “dumb” (i.e., inexperienced) users who are using personal computers and workstations located almost anywhere to access computers of all sizes to obtain information that is sometimes neither owned nor licensed by the same institution or organization that owns or licenses the computer. Designers and vendors of such systems are well aware of how completely their systems need to be rethought in terms of a “networked information” rather than a “housed information” architecture. The buyers and funders of such systems now need to recognize this fact and to account for it in their strategic plans and, even more important, in their depreciation schedules.

Redesigning local library information systems is only one of the things that we need to do to get ready to benefit from networked information resources and services. In general, research and education institutions and organizations must focus on improving their readiness
in four key areas: campus networks, the automated library, skilled and equipped end-users, and hospitable culture. It is tautological to say that campus networks have to become ubiquitous, affordable, and responsive for the promise of networked information resources and services to be realized. It is equally important to have a vital, evolving library technology program and a skilled and equipped group of end-users. But these three readiness factors, no matter how necessary, are not sufficient. Efforts directed at these factors need to be planned and executed in a cultural setting that is hospitable to their purposes and problems. Promotion and tenure practices, for instance, need to recognize and reward excellence in authoring networked information as well as recognizing and rewarding excellence in authoring printed information. Accreditation and statistical practices and criteria need to rate libraries on how well they deliver information as well as on how well they buy and maintain information. And information technologists and librarians need to work together to construct a "single information system image" for the faculty, students, administrators, and other stakeholders who depend so much on their vision, talent, and energy.

It is also extremely important to recognize that contemporary efforts devoted to advanced networks provide the opportunity to merge two quite different and equally powerful research and education networking traditions. During the 1970s and 1980s, librarians were funding and building the Research Libraries Group and OCLC, arguably the only integrated, nationwide applications of networking that the research and education community have ever successfully made. During the same period, information technologists were funding and building the ARPANET, BITNET, the NSFNET, and the global Internet, among other advanced networks. What we are about right now is the leveraging of each tradition to the benefit of the other and to the benefit of the constituencies that are shared by librarians and information technologists.

THE INFORMATION MARKETPLACE

The readiness of the information marketplace must also be improved in at least five key areas—pricing, payment, protection, regulation, and experimentation. The marketplace does not currently know how to price networked information, and even if it did, we would not know how to pay for that information in all the ways and by all the schemes we need. The marketplace has not come to agreement on ways and means for protecting networked information from unauthorized modification as well as from misuse and misappropriation. The regulatory framework by which "conduit" is differentiated from
“content” is extremely fragile, having resulted from a series of ad hoc rather than deliberate decisions. The result is that some lines of business are not allowed for some enterprises, and some activities are judged to produce “unrelated business income” for some research and education institutions and organizations. Finally, experimentation with new networked information resources and services is too costly and risky and the results are too anecdotal for all parties involved. We simply must devise a much more satisfactory system of research, development, and dissemination than the one we have at present.

Coalition for Networked Information

The Coalition for Networked Information is particularly devoted to identifying and addressing such institutional and marketplace readiness factors. Its mission is to promote the creation of and access to information resources in networked environments in order to enrich scholarship and to enhance intellectual productivity. Founded in March 1990 as a joint activity of ARL, CAUSE, and EDUCOM, it has grown like wildfire to a membership of just over 135 separate institutions and organizations. The real story of the Coalition’s membership, though, is told by the variety of information, service, and technology providers that have joined numerous research and educational institutions and quite a few collaborating professional and scholarly societies in a common program of work devoted to a shared vision of how the nature of information management must change through the end of the twentieth century and into the beginning of the twenty-first.

SOME FUNDAMENTAL QUESTIONS

Four questions are fundamental to realizing the full promise of networked information resources and services, questions that all concerned parties, not just information technologists and librarians, can relate to and help to answer.

First, the technical question: What benefits can be realistically achieved? We have to find a way to spend less time on wishful thinking and more time on improving the performance of the systems and technologies that we already have. We must figure out ways to get new value out of these existing assets. We must also be ready, willing, and able to change the way we have been doing things to leverage these existing assets to get more things done faster and without a loss of quality. But the major thrust of the technical question is the pressing need to improve our ability to hold technology accountable to providing real benefits to real people.
Second, the political question: Who will experience these benefits when using what resources? This question has an economic as well as a political component but, especially in the United States, the political component is much more important. We must figure out ways to become more concerned than we have been to date about how access to the benefits of networked information resources and services is obtained. We also must become better at remembering that diverse user populations enrich and strengthen the design and performance of technological systems.

A third question calls attention to the role of institutions like libraries in consolidating the gains of technological advance. It is the institutional question: How will these benefits be secured and routinized as soon as possible? We must figure out ways to refit institutional and organizational facilities, to reallocate institutional and organizational budgets, and to re-skill relevant institutional and organizational professionals if we are to succeed at embedding networked information resources and services into the milieu of research and education communities.

Finally, we must assure ourselves that what we do contributes to improving the basic conditions of human existence and that we can explore that concern by asking the human question: Why will these benefits contribute to the quality of life and the inspiration of intellect? Without applying this test to our activities and aspirations, we can never know whether we are working on the things that can make the greatest difference in the course of human affairs.

CONCLUSION

Our facility with the technical question will determine whether networked information resources and services will become as useful as we hope or will, instead, become sandboxes in which technophiliacs play with their new and quite expensive toys. Our facility with the political question will determine whether these resources and services will become opportunities available to all who seek to learn and think or will, instead, become battlefields on which conflicts about ends and means reflect differences in opportunities. Our facility with the institutional question will determine whether networked information resources and services will become familiar and trusted features of the libraries of research and education communities or will, instead, become the products of new marketplaces in which financial means play a disproportionately influential role. Finally, our facility with the human
question will determine whether networked information resources and services will become esoteric tools used by limited populations for narrow purposes or will, instead, become "fields of dreams" for which the guiding principle is, "If we build them, the users will come."