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Libraries and the Internet:
Education, Practice, & Policy

Thomas D. Walker
Issue Editor

University of Illinois
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Libraries and the Internet: Education, Practice, & Policy

Thomas D. Walker
Issue Editor

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Libraries and the Internet: Education, Practice, & Policy

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Introduction

THOMAS D. WALKER

As long ago as the 1930s, H. G. Wells (1938) proposed the establishment of a world brain. He could not have predicted the existence of specific sources and systems available through the Internet, but his proposal seems, in some ways, finally to have been met. Wells's proposal and the Internet go beyond the centuries-old idea of universal bibliography. Bibliographers of the past, such as Konrad Gesner, would surely be astounded by the capabilities of the Internet, yet some of them would be indignant over the haphazard way it has developed and would be concerned about the low editorial standards of many of the sources it makes accessible. What might take the "universal bibliographers" a time to realize is that the success and rapid evolution of the Internet is due in great part to the relatively disorganized way it has developed and to the practice that has allowed any of millions of users themselves to contribute texts, other data files, collections of materials, and correspondence and to gain intellectual access to them in powerful ways. As is demonstrated in this issue of Library Trends, increasing attention is being directed toward both organized intellectual access and quality control.

Some of Wells's (1938) thoughts apply verbatim to the Internet:

This World Encyclopaedia would be the mental background of every intelligent man in the world. It would be alive and growing and changing continually under revision, extension and replacement from the original thinkers in the world everywhere. Every university and research institution should be feeding it. Every fresh mind should be brought into contact with its standing editorial organization. . . . It would do just what our scattered and disoriented intellectual organizations of today fail short of doing. It would hold the world together mentally. (pp. 20-21)
Wells saw the world brain as a tool in scholarly communication, presently one of the most heralded functions of the Internet:

To [the specialist] even more than to the common intelligent man World Encyclopaedia is going to be of value because it is going to afford him an intelligible statement of what is being done by workers parallel with himself. And further it will be giving him the general statement of his own subject that is being made to the world at large. He can watch that closely... He will be able to criticize the presentation of his subject, to suggest amendments and re-statements. (p. 24)

Likewise, and in response to Wells's proposal, Smith (1941) agreed that "in a way characteristic of the spirit of the whole, the Living Encyclopaedia would turn the intellectual organisation of whatever unit of society it had come to serve into an organic community activity rich and joyous with the spirit of mutuality" (p. 60).

Concerned about organization and structure, Wells suggested that an Encyclopaedia Society be formed to survey the available material, which he considered to be in "a state of impotent diffusion" and to assemble authoritative subject bibliographies, perhaps even a master bibliography, and to form a general editorial board and departmental boards (pp. 27-28). At the same time, he proposed that the project represent the entire world:

So that while I believe that ultimately the knowledge systems of the world must be concentrated in this world brain, this permanent central Encyclopaedic organization with a local habitat and a world-wide range... nevertheless I suggest that to begin with, the evocation of this World Encyclopaedia may begin at divergent points and will be all the better for beginning at divergent points. (p. 74)

Smith (1941) elaborated by suggesting that, in order to avoid the destruction of intellectual freedom in such a vast and diverse plan, "the users themselves must in the ultimate be the controllers" (p. 61) in a situation in which contributors would heed the users to a greater degree than they would heed their readers in the traditional publishing world.

Very well aware of the developments of documentation projects in the 1930s, Wells emphasized the availability of a variety of materials for a wide readership:

It seems possible that in the near future, we shall have microscopic libraries of record, in which a photograph of every important book and document in the world will be stowed away and made easily available for the inspection of the student... The time is close at hand when any student, in any part of the world, will be able to sit with his projector in his own study at his or her convenience to examine any book, any document, in an exact replica. (pp. 76-77)

Wells's proposal has not been completely realized. He believed that the new encyclopedism "should consist of selections, extracts, quotations, very carefully assembled with the approval of outstanding
authorities in each subject, carefully collated and edited and critically presented” (p. 20). While there is certainly a large and growing mass of texts and other sources, they are not always carefully assembled; uneven or no attention is given to textual quality, and subjects are not systematically represented. Further, Wells suggests that the system “would not be a miscellany, but a concentration, a clarification and a synthesis” (p. 20). As it now stands, the Internet—arguably for the better—is a monumental miscellany, is regularly diluted, is by no means clear, and synthesizes nothing.

Many people consider the Internet to be a living, growing, world brain-like organism with a life of its own. Upon reflection, and as the following articles indicate, it may well be living and growing, but its life, which is not self-sustaining, depends on many factors. We know its health depends on the existence of conscientious hosts and users; we know less about the future of its political, economic, educational, social, and cultural life. The need for research related to electronic networking and networked resources is manifold. It is important to develop storage, retrieval, and communications technologies. It is as vital that we understand the organization of the networks themselves as it is to come to terms with the range of sources present on them. There exists a social imperative for us to manage the Internet and its successors within the contexts of its economic and political environments. Likewise, we are obliged to understand the related issues of accessibility to networks. Most of these needs fall into the categories of applied and theoretical research. Several journals, including *Internet Research: Electronic Networking Applications and Policy*, reflect the perceived need for serious attention. Also needed are perceptive examinations from historical and philosophical perspectives.

Some of these problems are addressed in this issue of *Library Trends*, which is intended to present to the general information community research concerned primarily with external research networks. Several major aspects of the Internet and networked resources are addressed: accessibility; organizational problems; policy; educational issues; library and other applications; evaluation; and the potential of networks and networked information as aids in research.

Two articles focus on the evaluation of networks and the resources available through them. In his article about the assessing of, and planning for, networked information services, Charles R. McClure suggests the use of several user-based data collection and evaluation techniques.
The Internet and its future incarnations are widely perceived to be of great educational potential. Tschera Harkness Connell and Carl Franklin survey broad and fundamental issues associated with the existence of networks in educational contexts. Among other topics, they point out problems of network use in classroom and library settings, difficulties of access to the Internet, and the role privatization may have in the future. A study by Constance Wittig and Dietmar Wolfram demonstrates the value library educators place on electronic networking and the roles it should play in library science curricula.

Two articles discuss library applications of the Internet. Diane K. Kovacs, Barbara F. Schloman, and Julie A. McDaniel, in their contribution concerned with the use of Internet resources in library reference services, address several issues that, while applying to other electronic and print resources in predictable ways, illustrate some of the fundamental problems the Internet presents. Yuan Zhou suggests a three-phase approach to collection development that will gradually accommodate all forms of scholarly communication and take advantage of the Internet and commercial external networks.

A major concern shared by proponents of networks and outside observers lies in the disparity in access to the Internet and other networks that exists among different segments of the population. Judith J. Senkevitch and Dietmar Wolfram survey important issues of networking technology in rural libraries and suggest a model for improving accessibility.

The Internet will continue to be useful in many research areas, two of which are surveyed in this issue. Susan Hockey, who has long been concerned with the availability of high-quality electronic texts in the humanities, addresses several related and fundamental issues, including the creation, markup, use, documenting, and cataloging of primary source texts, which are increasingly available through the Internet. Last, in order to provide an understanding of the use of networking in a technical (rather than a scholarly, scientific, or educational) environment, Ann P. Bishop has examined several major issues concerned with the varieties and uses of network applications in aerospace engineering.

One of the major difficulties in coming to terms with the Internet, its growth, and its future lies in the conceptualization of something we cannot see. Cultures have confronted knowledge and systems of organizing knowledge in different ways—not all of them easily visualized—but the recent development of electronic information storage and retrieval methods and communications technologies have created a seething and growing organism. It is supplied with energy from thousands of power plants; its contents and functions result from many thousands of external stimuli. While certain advances
have recently been made, including improved means of intellectual access to Internet sources such as gopher systems, keyword-searching capabilities such as "Veronica," and the National Center for Supercomputing Applications' hypertext access tool, Mosaic, much remains to be done before the whole enterprise will be able to be used intuitively.

Not covered in this issue are the basics of Internet access and use. For such information, and for general introductions, see Krol's (1992) book (a new edition is planned) and Kehoe (1992), to name the oldest and best known. At least two book-length directories of Internet sources exist in paper form (in addition to many lists and finding aids available in other books and within the Internet itself)—Braun (1994); Rutten, Bayers, and Maloni (1994). Several guides for new users, which also serve as reference works for those with experience, have been published very recently to meet the increasing demand—Badgett (1993); Dern (1994); Falk (1994); Gardner (1993); Hahn (1994); Hardie and Neou (1994); LaQuey (1993); and Marine, Kirkpatrick, Neou, and Ward (1994). For individual users without institutional connections, Estrada (1993) and Gilster (1993) have provided guides. To these will be added many more in the near future. Several works for network administrators have recently appeared, including Estrada (1993), Quarterman and Carl-Mitchell (1994), and Rose (1994). Of interest to new users may be some of the hundreds of introductory or popular treatments to be found in magazines and newspapers, which can easily be found in standard indexes.

The contributors to this issue as well as many other researchers, policy-makers, educators, and practitioners have forward-looking, pragmatic attitudes about the future of the world's information infrastructure. Likewise, Wells was realistic and not merely fantasizing about an encyclopedic project from the world of science fiction. He foresaw the necessity for a new large-scale system in the same sense as we do:

And for me at any rate this [prediction] is no Utopian dream. It is a forecast, however inaccurate and insufficient, of an absolutely essential part of that world community to which I believe we are driving now. . . . I have been talking of real intellectual forces and foreshadowing the emergence of a vital reality. I have been talking of something which may even be recognizably in active operation within a lifetime—or a lifetime or so, from now—this consciously and deliberately organized brain for all mankind. (pp. 79-80)

REFERENCES


User-Based Data Collection Techniques and Strategies for Evaluating Networked Information Services*

CHARLES R. MCCLURE

ABSTRACT

The rapid development of networked information resources and services has not been matched with ongoing assessments of how well these resources and services meet user needs. This article stresses the importance of developing and implementing a range of user-based evaluation techniques as a means of assessing the usefulness of the services, and planning for future services. A number of user-based data collection techniques appropriate for evaluations within the networked environment are described. The article concludes with specific suggestions for enhancing the overall effectiveness of such evaluations.

INTRODUCTION

Networked information services are increasingly being developed for a range of network users and potential users. The passage of the High Performance Computing Act of 1991 (P.L. 102-194) authorized the development of the National Research and Education Network (NREN). The Clinton Administration's National Information Infrastructure: Agenda for Action (Office of the President, 1993) will promote even greater development of information services

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Charles R. McClure, School of Information Studies, Syracuse University, Syracuse, NY 13244
LIBRARY TRENDS, Vol. 42, No. 4, Spring 1994, pp. 591-607
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over the networks. But the development and implementation of those services have not kept pace with ongoing evaluation of networked services. Increased attention must be given to the evaluation of networked information services. Moreover, the evaluation of these services must be user-based as opposed to system-based. To date, there have been very few formal attempts reported in the literature of user-based assessments of networked information services.

The notion of networked information services is an evolving one. Such services can be offered by individuals, libraries, computer centers, publishers, networks, government agencies, or a host of other organizations and groups with access to the Internet and the evolving NREN. Networked information services comprise bulletin boards; e-mail; listservs; remote access to distant databases, software, and high speed computing; and collaborative efforts among geographically dispersed individuals—to name but a few (LaQuey, 1992). A key aspect of "networked information services" is that there are numerous providers—local and remote; there is a range of electronic information services available to users; and access to and use of these services continues to increase.

Evaluation is the process of identifying and collecting data about specific services or activities, establishing criteria by which their success can be assessed, and determining both the quality of the service or activity and the degree to which the service or activity accomplishes stated goals and objectives (Van House et al., 1990). As such, evaluation is a decision-making tool that is intended primarily to: (1) ensure that the highest quality services are provided to intended users of that service, and (2) assist decision makers in allocating necessary resources to those activities and services that best facilitate the accomplishment of organizational goals and objectives (Hernon & McClure, 1990). Unfortunately, many networked information services are designed without user input and, worse, are inadequately (if at all) evaluated by those for whom the service was originally intended.

User-based evaluation and determination of user needs should be considered as part of the strategic planning process for the development of networked information services. Thus, developers of networked information services constantly need to ask:

- Who are the users of the service and how well are they able to identify and access a particular service?
- To what degree do networked information services enhance or detract from users' ability to accomplish specific tasks?
- What information resources and services are "most" important for network clientele and how well does the network deliver these services?
What are the costs and benefits of specific networked information services and to what degree do these services meet the objectives of both the provider and the user?

What are the specific strengths and weaknesses of the information services and how do these services affect different user groups?

Would the provider of the networked information service receive more or better benefits by reallocating resources to new or different information services?

While this list is not intended to be comprehensive, it suggests that user-based evaluation of networked information services should accompany the design and implementation of such services. Overall, we need a better understanding of how well networked information services meet (and anticipate) user information needs.

The purpose of this article is to: (1) provide an overview of the importance of user-based evaluations of networked information services, (2) review a number of data collection techniques that provide a user perspective when assessing networked information services, and (3) offer practical suggestions and guidelines for using such techniques. The data collection techniques discussed in this article have been used by the author in a number of studies related to electronic networking (McClure et al., 1994). A key theme throughout the article is that ongoing evaluation—as part of the strategic planning process—is essential in the design and successful operation of networked information services.

**NEED FOR A USER PERSPECTIVE**

If the Internet/NREN and other new electronic systems and services are to be successful, they must be integrated into the working lives of users in those communities they are meant to serve. Such integration depends upon identifying and addressing a number of social and behavioral issues related to the use of networks by the various users (McClure et al., 1991). A user perspective should consider the culture of the communities and subcommunities involved; the relationship between community norms and the use of electronic networks; effects of networks on collaboration and scholarly communication; definitions of eligible users and acceptable uses; relationships among users in academia, government, and the private sector; and the training and support of onsite and remote users of networked facilities.

A user-based evaluation perspective considers issues such as:

- How can the use of electronic networks facilitate the tasks and goals of particular communities of users?
What problems do particular groups of users face in attempting to exploit networks for the accomplishment of those tasks and goals?

What design, management, and policy strategies can alleviate those problems and maximize network use and effectiveness?

These and similar questions can be approached by developing and implementing ongoing user-based evaluations of networked information services.

A user perspective assumes that information technologies should not be designed and implemented according to technical criteria alone but should take into account the particular communication behavior, information use patterns, and work environments of potential users. This perspective will help network designers, managers, and users:

- avoid conflicts;
- understand and estimate the impact and benefits of network use;
- choose appropriate network designs, features, and services;
- devise appropriate strategies for marketing network services and promoting network use;
- develop effective policies for network management and use;
- develop appropriate mechanisms for user training and support; and
- evaluate the effects of network implementation.

Adopting a user perspective for evaluating networked information services offers a useful model to better understand the role, importance, and impact of networked information services in a range of organizational settings (McClure, 1992).

**Importance of User-Based Evaluation**

It is important to differentiate the notion of user-based evaluation of networked information services from a systems or technology perspective of evaluation. The systems perspective might consider total number of packets transported over the network, the number of log-ins to a particular server, or the accuracy with which a particular router moves messages from one system to another. While such assessments are useful, they do not address the degree to which users of the service have their particular needs met, the impact that use of the service may have made on the user, or the ease of access encountered in using a particular service. Systems or technology based criteria for a “successful” networked information service do not ensure successful use of the service from a user’s point of view.

Approaches for evaluating networked information services can be based on:
• **Extensiveness**: How much of the service has been provided—e.g., number of users logging-in per week on a bulletin board or the number of participants of a particular listserv.

• **Efficiency**: The use of resources in providing or accessing networked information services—e.g., cost per session in providing access to remote users of an online catalog or average time required to successfully telnet to a remote database.

• **Effectiveness**: How well the networked information service met the objectives of the provider or of the user—e.g., success rate of identifying and accessing the information needed by the user.

• **Impact**: How a service made a difference in some other activity or situation—e.g., the degree to which faculty network users increased their research productivity or teaching effectiveness by use of networked information services.

Although evaluations of networked information services need to consider extensiveness and efficiency criteria, much more attention needs to be given to effectiveness and impact measures.

Because networked information services are multidimensional, the type of evaluation needed will be multidimensional as well. A single measure provides only one “snapshot” of a particular service; multiple “snapshots” of measures are needed. Moreover, evaluators of networked information services will need to know what type of evaluation approach and data collection techniques will be appropriate for what types of services. The key point is that we need to develop evaluation strategies that are user-based—that is, they examine networked information services from the point-of-view of the user.

Providers of networked information services must not accept as a “given” that their services, resources, and technical procedures are effective; rather, they must test their assumptions about the quality of networked information services through an ongoing process of evaluation. Ongoing evaluation activities are essential to support the provider's planning process. Planning and evaluation are two sides of the same coin. Each will be more successful when the other is part of the overall services design and implementation approach.

**User-Based Data Collection Techniques**

Although the focus of this article is on user-based data collection techniques, it is well to remember that these techniques evolve within a larger context of evaluation research. A discussion of evaluation research designs and social science research methods is beyond the scope of this article. Additional information on these topics can be found in a number of useful texts including Rossi and Freeman (1993),
Babbie (1992), and Marshall and Rossman (1989). The intent of this section is to highlight a number of data collection techniques useful in developing a user-based evaluation of networked information services. Specifics for using these techniques can be found in textbooks listed earlier or in other research methods texts.

**Focus Groups**

This qualitative data collection technique is an extremely valuable one for obtaining naturalistic insights on how individuals perceive networks and networked information resources (Morgan, 1993). In this technique, the evaluator identifies a particular group of individuals (usually five to eleven people) that meet certain criteria (e.g., very knowledgeable about accessing and using government bulletin boards). The individuals (who typically do not know each other) are brought together and discuss aspects of the topic at hand. The session typically lasts from one to two hours, is conducted in a conference room setting, and there are usually a moderator and a note taker from the study team participating in the session (Krueger, 1988).

A focus group session differs from a group interview in that the participants in the focus group determine for themselves the topics to be discussed and the conversations “evolve” during the session with little guidance and direction by the moderator. The point, in fact, is to allow the topics and discussions to be those of most interest to the participants rather than forcing the group to talk about the topics that the moderator believes to be important. This approach encourages a user perspective, provides data based on the topics that users believe most important, and allows the data collection to inform the evaluator about additional topics that might need attention which otherwise would not have been identified.

**Critical Incident Technique**

To better understand user perspectives, sometimes it is helpful to have users recall a specific recent experience or incident that occurred regarding use of the network or network information resources. For example, the evaluator is especially interested in difficulties that users might be having in telnetting to remote databases. Either through an individual interview or a survey format, the evaluator asks the user to recall the most recent time when he or she experienced a problem in telnetting to a remote database.

First the person describes the general experience he or she had with this particular situation, and then the evaluator either probes (if an interview) or asks a standard list of exploratory questions (if a survey) which the user then answers. The preference of this writer is in using individual interviews. When using the interview format,
the evaluator has much greater flexibility in probing and follow-up on specific experiences which cannot be done via a survey. The critical incident technique is an excellent approach to focus a user's attention on a particular type of experience.

**User Logs**

Another very useful approach is to have users maintain a log that records: (1) the nature of their activities regarding some related network activity, (2) the amount of time spent on that particular activity, and (3) the user's assessment of the usefulness or success of that particular activity. A user log can be designed to collect information on a range of network activities, or it might focus on a particular activity of special interest to the evaluator. It is important that the participants maintaining the log have a high degree of commitment or are provided with some rewards for engaging in this data-collection technique since maintaining the log can be somewhat time consuming. Examples of such logs can be found in Doty, Bishop, and McClure (1992).

Typically, the evaluator will identify specific individuals to maintain the user log over some period of time. The users may be segmented to obtain data from specific user types—i.e., naive users versus experienced users. And, depending on the nature of the study, the specific types of information to be collected on the log may vary. User logs tend to be more useful if maintained over an extended time period—i.e., a month—so that patterns in use may be more easily identified by the evaluator. User logs are an especially important technique as they mirror actual behavior rather than asking the user to describe his or her behavior—behavior which may not be easily recalled or might be skewed in light of other factors.

**Network-Based Data Collection**

One excellent approach to obtain evaluative information about users, networks, and networked information resources is to use the network itself. The evaluator can establish an online conference on the network about a particular topic and invite selected individuals to participate in the conference. Participants are informed that the discussion on the conference will be used as data and input for the evaluation study. Software is available that organizes the conference into particular topics, encourages individuals to send messages to one or more members of the conference, and otherwise manages the operation of the conference.

An interesting aspect of this approach is that the moderator can play virtually no role in the development of the conference or he or she can take a very active role in the conference by participating and directing the conversations into certain topics or otherwise
ensuring that everyone participates and offers their opinion. Moreover, this data collection technique allows participants' views to evolve and inform each other as the conference proceeds. Another benefit of this approach is that users can participate in the conference at times best for them rather than at times determined by the moderator.

Another related technique is to use the network as a means of administering a survey or a set of discussion items. For example, someone might put a short questionnaire on PACS-L asking for responses (to the evaluator and not the list). This technique, while having the merits of being easy to do, has a number of possible problems. First, the evaluator has no control over who will respond or if they will respond at all. Second, there are so many messages on lists that some receivers of the electronic survey may perceive it as junk and discard it immediately—or worse, be put off that you sent the survey out to them at all. In short, response rates on this approach may be so low as to invalidate the results obtained.

**Interviews**

Of course, one of the old standbys for data collection is an interview. Interviews can be done with individuals or with groups. The questions posed in the interviews can range from unstructured (little predetermination of topics to be covered) to structured (complete determination of the topics to be covered). The success of this technique is largely dependent on the interviewer's skills as a moderator and facilitator. Interviews have the advantage of allowing the evaluator to probe into topics which cannot be done on surveys. They have the disadvantage of requiring considerable time in both organizing the interviews, conducting the interviews, transcribing the interviews, and analyzing the data resulting from the interviews.

**Group Process Surveys**

A group process survey is halfway between a survey and an interview. In this technique, the evaluator selects a particular set of participants to examine a topic or issue. In preparation for the meeting, the evaluator has developed a set of discussion topics as a hand-out to participants. During the one to two hour meeting, as the group discusses a particular topic, each participant writes on the hand-out their view of the topic. The moderator can ask that participants write their thoughts on the topic as the discussion is in progress, after the discussion occurs, and before moving on to the next topic, or both before and after the actual discussion.

There are a number of advantages to using this technique. First, and perhaps most importantly, the participants write, in their own words, their views on the topic being discussed so that the moderator
does not have to do so from his or her notes at a later time. Second, this approach allows participants to be informed by the discussion and to modify their views in light of how the discussion evolves. Finally, writing one's views on the handout usually results in a 100 percent response rate from participants—which rarely occurs in surveys or in group discussions where a small number of participants can dominate the conversations.

**Site Visits**

Site visits are similar to a case study approach (Yin, 1989) except that site visits are not likely to be as time consuming and detailed. Generally, case studies have some longitudinal dimension to them since they are conducted over a period of time. A site visit, however, entails less time and is a bit more informal. A site visit generally is planned to obtain first-hand information from tours of specific facilities and services, interviews with individuals or groups, or observation of specific activities at the site. In addition, another aspect of the site visit is also to obtain reports, brochures, and examples of products or services made available at the site. An interesting aspect of site visits is the potential to directly compare and contrast different types of data collection techniques from different sources on the same topic.

In site visits, it is not always possible to predict in advance the range of data collection activities in which the researcher might engage. Clearly, some of the data collection strategies can and should be planned in advance of the site visit—i.e., scheduling interview times, tours, and so on. Additional data collection opportunities, however, may arise as the site visit progresses. Indeed, the evaluator should be extremely conscious of opportunities to meet with individuals or groups that perhaps he or she could not have known about until the site visit occurred. Two major benefits of such site visits are the opportunity of: (1) having first-hand information about users or activities in a particular setting, and (2) evolving the data collection strategies on site depending on the topics the evaluator deems important to probe for obtaining additional information.

**Scenario Development**

An interesting but underutilized data collection technique is scenario development. This technique can be done either as a group or as an individual process. The basic idea with this approach is to have participants discuss "what if..." types of questions and construct a scenario or likely series of events that would need to occur if a particular vision or goal is to be accomplished. Scenario development is an especially useful technique for having participants consider possible future events, speculating about what key
assumptions may drive the development of future events, and suggesting what designers of networked services and resources might need to consider if they are to be successful in a particular future scenario.

There are a number of methods for using scenario development as a successful data collection technique (see Amara & Lipinski, 1983). One approach used successfully by this writer is to first carefully define the nature of the scenario to be explored, develop a one-page written draft of an example scenario to use with the group (making sure it is pretested and revised before use), and identifying appropriate topics and questions that need to be explored. As an example, the scenario might be that there are T3 lines into all the branches of the public library. Given that scenario, a number of discussion questions might be used with a group: What services might be provided by the library? How would increased remote access to the library affect the management of the library? and so forth.

The views of group participants when discussing the implications and assumptions for a scenario (or group of scenarios) can provide very useful and insightful perspectives on what users think might or should happen in the future. From the evaluator’s point-of-view, these perspectives and insights can be used to identify issues and possible policies that might be needed to deal with the issues.

*Observation*

An important and useful idea within a user-based perspective is describing the activities of users, being able to know what network users do, the amount of time they are engaged in various activities, the tasks for which they use the network, and to learn how they actually go about using particular services and resources. Observing users (in a range of situations or in the use of various services/equipment) is an extremely valuable approach for obtaining a user perspective.

Observation can be either obtrusive (the user knows that he or she is being observed) or unobtrusive (the user is unaware that he or she is being observed). There are trade-offs and issues to consider for selecting one over the other (Hernon & McClure, 1986). There are a number of useful texts that provide suggestions for conducting a formal observation as part of a data collection technique (Epstein & Tripoldi, 1977, pp. 42-54). But one of the most important aspects of using this type of data collection is having a well-developed data-collection form upon which the evaluator can easily and quickly summarize the activities observed, the length of time in which the user was engaged in that activity, and any comments the observer might have at the time of the observation.
Surveys

And finally, there is the well-known, but increasingly difficult to use, survey technique. In recent times, successful survey research has become quite difficult because of problems in obtaining adequate response rates. Nonetheless, a well-developed and carefully designed survey can oftentimes be used successfully in obtaining user perspectives on networked information resources and services. The experience of this writer, however, is that other types of data collection techniques should be considered prior to using a survey approach.

Surveys have the advantage of being relatively inexpensive to develop and distribute to the intended target audience. They can be designed to be easily analyzed. Their primary drawbacks are obtaining an adequate response rate and ensuring that responses from the intended target audience are, in fact, the ones that were sought. Moreover, people are suspicious of filling out such surveys and are increasingly concerned about confidentiality and privacy issues. Given these concerns, it is essential to have participants who are committed and interested in the study and to provide some rewards (either tangible or intangible) to those who participate in the study.

KEY ISSUES FOR SUCCESSFUL USER-BASED EVALUATIONS

The above section offers an introduction to selected user-based data collection techniques of networked information services. But in the use of these techniques there are a number of key issues that evaluators of networked information resources should keep in mind. In the experience of this author, evaluators should consider these issues carefully as a means of increasing the likelihood of a successful user-based evaluation.

Know Your Audience

When conducting an evaluation of networked information services, it is important to recognize who the audience will be for the evaluation results prior to designing the evaluation and determining what data collection techniques will be used. Potential audiences might be the users themselves; network managers; providers of the service; organizational administrators; government policy makers; or others. A concern, however, is that different audiences may require different evaluation data collection techniques.

Thus, part of the evaluator's responsibility is to understand the information needs of the audience for whom the evaluation is being done. While it is likely that the evaluator will be asked simply to "evaluate" a networked information service, some thought should be given to the measures and thus the data collection techniques that might be of special interest to that specific audience.
Carefully Decide What Exactly will be Evaluated

Evaluators will not have the luxury of being able to collect all the data they might want about a particular networked information service due to lack of time, limited budget, inability to acquire the needed information, and a host of other reasons. Thus they will have to have clearly defined objectives of what is to be evaluated. Usually those aspects of the networked information services to be evaluated will be those that are “actionable”—i.e., interventions or strategies could be put in place to improve and modify that aspect of the service. Thus the evaluator will usually target specific types of data to be collected and make certain that they provide the needed information to make the required evaluation assessment.

Develop Appropriate Measures

Another aspect of this issue is recognizing that performance measures for a particular networked information service may have to be developed. For example, in the assessment of the information made available to organizational members from a particular remote file server, the measure “references to file-server information in organizational research reports” might be established. To use this performance measure, however, the evaluator will have to carefully define and operationalize key terms such as “reference to file server information” and “organizational research reports.” Then data collection techniques (from those listed above) would have to be considered in light of how well they would provide information on these two data elements.

Determine Costs and Schedule

For user-based evaluations to be successful, they must be done in a timely fashion and with a clear sense of the costs needed to complete the study. In preparation for the evaluation, costs associated with standard budget items—e.g., personnel, supplies, travel, equipment, contract services—should be identified. There is no use in initiating a user-based evaluation for which there are inadequate resources available to complete it. Indeed, it is better to complete a smaller less costly evaluation than to do none at all.

Equally important is to develop a schedule for the completion of the project and detail the key tasks that will have to be done over the duration of the study. There are many types of GANTT tasking charts and project management software programs currently available that can assist the evaluator in scheduling the evaluation. Such scheduling ensures that everyone involved in the project knows what tasks are to be completed when. Further, scheduling allows the evaluator to monitor the progress of the evaluation more effectively and identify possible problems while they can still be resolved.
Identify the Correct Study Participants

One problem often encountered by new evaluators is attempting to obtain assessments from sample participants that may not have the necessary information. For example, in the evaluation of a particular government bulletin board, simply collecting data from a random sample of network users may not produce enough participants that have actually used or know about the bulletin board. The general rule of thumb is to not expect users to provide you with information about things that they know nothing about.

This concern is especially important in focus group sessions. If some members of the focus group are extremely knowledgeable about a particular networked service and others are not, the group dialogue can be extremely skewed. One strategy is to carefully consider whether you need information from naive, beginning, or expert network users. Another is to use a filter question in interviews and surveys to determine the type of user and his or her background before you proceed with collecting the information you require.

Develop, Pretest, and Refine Data Collection Instruments

No data collection instrument should be administered without it first being carefully developed, pretested, refined, and oftentimes pretested a second time. User-based data collection techniques require data collection instruments that make sense to that particular group of users. One useful approach is to have the data collection instruments reviewed by: (1) someone with experience in the data collection technique you wish to employ, and (2) a group of individuals who are members of the user group from whom you will be obtaining data. To ensure reliable and valid data, pretesting and refining of data collection instruments is essential (Kirk & Miller, 1986).

Administer Instruments Successfully

The logistics associated with administering data collection instruments can oftentimes be formidable. And since the notion of a user perspective is to make the study participants at ease and able to relate social and behavioral concerns in arranging for a focus group session, one has to not only identify and obtain the cooperation of participants, one also has to (among other things):

- arrange for a pleasant setting to conduct the focus group and, typically, provide some refreshments and amenities;
- consider the order and development of topics to be discussed in the session;
- have a technique for recording and analyzing the content of the session while it is occurring;
• manage and moderate the session in a positive and productive manner; and
• provide follow-up thank you notes.

Similar logistical concerns affect the use of other data collection techniques such as surveys, transaction logs, interviews, and so on. Once again, it is essential that these logistical concerns are considered and resolved as part of the data collection process.

**Presenting Study Results and Findings**

Evaluations incorporating user-based data collection techniques typically fall under the heading of “action research”—i.e., research that is intended to assist in the decision-making process or assist in policymaking. Thus, if the evaluation is to be successful, the findings have to be presented to decision makers in such a manner that: (1) the decision makers are aware of the findings, (2) the findings are adequately explained and made understandable, and (3) specific implications and recommendations are made explicit.

**Integrating Evaluation into the Planning Process**

One of the most important challenges facing the development of successful networked information services is to assess these services in light of a user perspective. One of the best possible strategies for meeting this challenge lies in the development of a comprehensive strategic planning approach that integrates evaluation with strategic planning. Such a comprehensive and integrated approach to network development is essential if evaluators are to provide leadership in accessing, managing, and disseminating networked information to users effectively in the future.

Strategic planning is a disciplined effort to produce fundamental decisions and actions that shape and guide the networked information services being provided currently as well as those being designed. At its best, strategic planning requires broad-scale information gathering, an exploration of alternatives, and an emphasis on the future implications of present decisions (Bryson, 1988). Strategic planning and ongoing evaluation is a critical management process for the development of networked information services if they are to be effective, if designers are to allocate resources wisely, and if user information needs are to be met. More specifically, strategic planning and evaluation:

• provides a rational response to uncertainty and change: We will never have complete certainty about the future, but we can minimize some of the risks.
focuses attention on organizational outcomes: It is essential that networked information providers identify and assess the services and products that are placed on the network and how users use these services.

establishes priorities for resource allocation decisions: There are inadequate resources to provide all the networked information services one might like; the most important services for the most important target audiences must be identified.

provides a basis for accountability: Providers of networked information services must be able to justify and be accountable for what they offer and how well it meets user information needs; such may be the basis for future funding requests.

encourages the development of management information systems to support the planning process: The collection and use of planning and evaluation data requires that the information is managed successfully—both analysis and reporting.

educates providers and users about factors affecting the success of particular information services: The planning and evaluation process can serve as an excellent vehicle for staff training and development.

informs governing boards and external communities about the success of the provider: A provider can neither be isolated nor have its governing board be ignorant of what it does—their activities must be supported by making certain that its governing board and clientele know what it does, and that it is doing a good job.

forces informational input into the organization from clients and other stakeholders: Providers of networked information must receive ongoing information and knowledge about its users and nonusers as a basis for program development.

orients the organization to identify opportunities and be future-oriented rather than responding primarily to daily problems: The providers of networked information services that will survive and flourish will be those that identify problems and concerns with current services and create future strategies to deal with these concerns; if the provider is unaware of problems with a service, it is unlikely that those problems will be resolved.

The benefits of strategic planning and evaluation contribute to the overall effectiveness and impact of networked information services on clientele. Without a plan, without ongoing evaluation, providers will engage in "crisis management" and be so busy dealing with day-to-day problems that they cannot develop strategies to flourish in the future.
But strategic planning and evaluation have yet to receive the attention they deserve in the networked information environment. Information providers seem to find reasons not to plan and engage in evaluation rather than to do it, they talk more about planning and evaluation than actually doing the planning process and, frequently, after a plan or an evaluation approach is developed, they do not implement or evaluate it. But strategic planning and evaluation are much more than going through a process that produces a written plan and evaluation results; the process makes networked information services providers think about the success of their current services and then create future plans to support the innovative development of enhanced or innovative information services.

A commentator recently noted that the future was really important, "since I plan on spending the rest of my life there." And indeed, thinking about and creating future network strategies is a primary responsibility for providers of networked information. Strategic planning and evaluation forces us to move beyond the day-to-day responsibilities and the day-to-day crises to address two key questions: (1) how successful are the existing networked information services we provide, and (2) what services should we provide in the future? Strategic planning and a program of regular user-based evaluation of networked information services will be essential to answer these questions.

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The Internet: Educational Issues

Tschera Harkness Connell and Carl Franklin

Abstract

The Internet can reinvigorate education and libraries, but this outcome is not certain. A key factor in achieving this goal is distinguishing between the technological content of the Internet and embedding it in a particular context. One useful context is information literacy. In addition, a number of other important issues must be addressed. These include the changing role of the Internet in the classroom, library, and workplace; the economic and geographic barriers to accessing the Internet; the implications of different privatization approaches; the impact of the Internet on professional school curricula; and the need for better tools and user interfaces. One additional concern should be the integration of Internet resources with the existing infrastructure of the nation's libraries and library systems. In short, educators and librarians must ensure that the evolving National Information Infrastructure (NII) reflects their needs and concerns. To do so, they must gain cooperation from the public and private sectors. The result may be an education revolution in which teachers and librarians help students develop the job readiness skills necessary to succeed in an information-intensive economy.

Introduction

One justification for the existence of the library is its role in the education of society (Reith, 1984). The Internet, an international network of networks, can open up new avenues of cooperation between educators and librarians as well as enhance the role of librarians as educators. As the Internet strengthens the links between...
libraries and education, several issues will need to be addressed. These include changing roles in the classroom, library, and workplace; unequal access to the Internet; privatization of the Internet; professional school curricula; and tools and user interfaces.

Discussion of these issues should take into account how new technologies are dispersed among, and integrated within, organizations. Adopting a new technology creates ambiguity in both the organization and in the technology. The potential applications for a new technology may lead to an ambiguity in its definition and uses. Tornatzky et al. (1983) suggest that this ambiguity may be reduced by distinguishing between the "technological content" and "embedding content" of a technology (p. 5). The technological content includes the definition of what the technology is and what it does; the embedding content refers to the organization behaviors or processes that make the application of the technology possible.

At first the efforts to adopt a new technology are directed toward technological content: learning about the innovation, its potential, how to obtain it, how to use it, and how to incorporate it into existing structures and budgets. Currently this concern with technological content dominates the discussion of Internet applications in classrooms and libraries. The Internet is seen as an extension of older technologies—a more efficient and faster way of doing what was done before. However, as individuals and organizations increase their understanding of the Internet's technological content, its potential should become clearer. As educators and librarians gain experience in using the Internet for traditional purposes, they will begin to consider how it can reorganize the classroom; transform learning; and change information seeking, organizing, and using behaviors.

As users shift from a focus on technological content to embedding content, new applications will be developed for the Internet. Already academia and business are searching for ways to foster electronic collaboration among students, faculty, and practitioners. Collaboration benefits everyone because it promotes information sharing, guides learning, and helps integrate experience. As the economic and social benefits of the Internet become more clear, the public and private sectors will formulate new roles and rules for handling this valuable asset. Altering behaviors and policies is always difficult because the necessary changes are hard to predict. However, it is certain that embedding the content of new technologies will shape the future. Educators and librarians should consider how embedding the content of the Internet will affect their roles in society.

**Changing Roles in the Classroom, Library, and Workplace**

The most important factor in determining whether the United States will continue to be competitive in the global marketplace is
the improvement of education and training. Improvement will require the adoption of new technologies but this cannot be done in a haphazard fashion. Turkle (1991) cautions that the "computer's greatest promise as an educational aid depends on its use as a personalized environment for learning..." (p. 8). Adams and Bailey (1993) suggest the time has come to switch from traditional instruction, which makes little effort to engage students in information literacy, to Information Age teaching, which incorporates technology and information literacy throughout the curriculum. This switch will have a significant impact on the roles of students, teachers, and librarians. Its influence will also extend to the workplace.

Before discussing the impact of this change on roles, a brief examination of information literacy is in order. Cleaver (1987) defines information literacy as a set of skills and attitudes for lifelong learning. Information literacy is directly related to critical-thinking skills and emphasizes such activities as selection, rejection, evaluation, organization, topic definition, and question definition. Also, it covers such topics as the value of information, ethics of information use, and information consumerism. In short, information literacy seems a natural choice for embedding Internet technology in the classroom, library, and workplace.

Because information literacy makes different demands on the student than the traditional curriculum, the role of the student must be redefined. Bruner (1985) notes: "You cannot improve the state of education without a model of the learner. Yet the model of the learner is not fixed but various. A choice of one reflects many political, practical, and cultural issues" (p. 8).

Bruner (1985) discusses several models of the learner. Among these are tabula rasa, constructivism, and novice-to-expert. The tabula rasa model assumes that the mind is passive in that it reflects only what order exists in the world. The learner is seen as an empiricist whose knowledge structure is entirely driven by experience. Constructivism asserts that the world is not found but made through interaction with experience. The learner acts as a theorist who continually refines his own structure of knowledge based on experience. Finally, the novice-to-expert approach analyzes what experts do and trains novices to follow in their footsteps. The emphasis is on the practical steps needed to move a student from an initial understanding of a subject to an expert understanding.

Of the models discussed by Bruner, the constructivist approach may be the most complementary to embedding Internet technology and integrating information literacy with K-12 and postsecondary curricula. The constructivist model of the learner makes the following assumptions (Franklin, 1989).
Truth and reality are made, not discovered.
Learners are active epistemological agents.
New knowledge is processed in relation to existing knowledge.
Both content and context are important to learning.
Learning is a never-ending process, not a product.
The primary responsibility for learning rests with the student. (p. 51)

In the constructivist model, the teacher can no longer claim a monopoly on knowledge. This implies a student-centered classroom and not a teacher-centered one. As a result, the role of the teacher shifts from instructor to facilitator and coach. The goal of the teacher is to empower students. Empowerment is achieved through helping students improve their critical thinking and collaborative and integrative skills. It is also important to help students develop a sense of responsibility for their learning behaviors. Some of the skills needed are discussed briefly below

**Critical Thinking Skills**

Critical thinking skills include abstract thinking, problem solving, and inference. These skills have long been recognized as important, but now they are essential for learners in a student-centered learning environment.

One of the major difficulties in using information technologies is the problem of information overload. The quantity of information available calls for analytic skills in selection and evaluation. The ease of obtaining an answer may hide from students the need to sift through information for the best answer. However, finding the best answer requires defining what is best. Is it accuracy? Is it currency? Is it usefulness? Dervin (1977) sees value in information in terms of a process by which individuals combine external descriptions of reality with their own ideas, structures, or pictures of reality. In this context, the ability to evaluate information requires students to formulate some concept of the value of information (Cleaver, 1987).

**Collaborative and Integrative Skills**

Projects requiring teamwork are becoming more prevalent in the workplace. Among the situations calling for collaborative efforts are collective problem solving, group decision making, and collaborative design. Information technology is particularly well suited to supporting collaborative work. Specific skills needed to take advantage of the new technologies include good articulation (written and oral), the ability to work in groups, "modes of reasoning that are ... procedural and systemic ..." (Zuboff, 1991, p. 5), and an ability to understand how individual parts of a project fit together to achieve the success of the whole.
Integrative skills include the ability to synthesize different types of sources (oral, print, graphic, and typographic) and then organize the information for presentation.

**Working Definitions of Responsibility**

Cleaver (1987) stresses integrity as an important component of responsible scholarship and includes integrity as a needed element of a personal concept of information. However, if responsibility exists only in the context of responding to "what happens to one, to what is to be seen and heard and felt" (Buber, 1965, p. 16), then there are characteristics of computer innovation which may make responsible computer use more difficult. Friedman (1990) identifies three characteristics that have particular importance in the educational setting. First, with remote interactions, an irresponsible user may not fully know the consequences of his or her actions. The remoteness of the interaction diminishes the concept of a "victim." Second, with computers programmed to do more tasks, routine decisions are taken out of the hands of the user and the user can lose a sense of control of those tasks. As decision making is delegated to computers and team environments, it becomes more complicated to assess moral responsibility for computer use. And third, since computers are a relatively recent innovation, there are few agreed upon and pervasive social conventions governing computer use. Friedman suggests that one approach to helping students develop definitions of responsibility is to use student self-government to resolve issues of in-class computer use. This approach makes visible the consequences of computer-mediated actions so that personalized definitions of computer responsibility can take them into account.

Fostering these skills requires that educators create an environment in which multiple processes to learning are recognized as integral to the development of diverse ideas and products. What this means is developing activities that place students in charge of their own learning while they interact with existing knowledge. With respect to the Internet, teachers can set up exercises in which students exchange opinions on controversial subjects via e-mail, participate in online discussions and simulations, and conduct collaborative research with academic experts. Librarians can teach the use of resources on the Internet, design services that are customized to individuals or groups, and promote standards that support international sharing of information.

The critical thinking, collaborative, and integrative skills important for learning have also become essential in the workplace. Zuboff (1991) suggests that the obstacles to achieving innovation with information technology lie not in the technology itself but in the
persistence of nineteenth-century forms of organization and conceptions of management. These outdated approaches regard information as something to control—a source of personal power within the organization. Information technology can help shift the emphasis from control of information to sharing it. Zuboff observes that “information technology symbolically renders processes, objects, behaviors, and events so that they become visible, knowable, and shareable in a new way” (p. 5). In order for firms to stay competitive, management must use technology as a way to share information so that work gets done. This shift in the roles of the manager and worker parallels the shift in the roles of the teacher and student. The manager needs to empower workers. Because workers at all levels have more information available for decision making, they must have the information literacy skills to use that information effectively. Educators and special librarians can help foster those skills.

Within the context of societal demands, Hunter (1992) identifies several grand educational challenges that can be addressed by the Internet. These include meeting the needs of a multicultural population, reforming instructional methods and curricula to better meet the needs of diverse students within the context of an information society, forging closer links between the school and community, fostering collaborative learning, adopting constructivist views of learning, and continually updating curricula and teacher knowledge. The author warns that educators need to get involved now while the national telecommunications and information infrastructure is being designed and deployed. Otherwise, the resulting system may not reflect their needs or concerns. This warning applies equally to librarians and other information specialists.

Information Power: Guidelines for School Library Media Programs, a joint publication of the American Association of School Librarians (AASL) and the Association for Educational Communications and Technology (AECT), provides some guidance as to how the role of the librarian could change with an emphasis on constructivism and information literacy in K-12 environments. This vision of library service promotes collaboration between school library/media specialists and teachers in developing classroom activities. Technologies, such as the Internet and more traditional library tools, can play a vital role in creating classroom activities that develop information literacy and critical thinking skills.

School, public, and academic librarians have long based their service on a constructivist model of the patron. That is, the librarian already takes the role of facilitator and coach. The shift to integration of information literacy with the curriculum will require the librarian to place a heavier emphasis on the nature, value, and life cycle of
information when working with students. For example, the librarian can introduce students and teachers to Internet's basic services, show applications appealing to student interests, and help students create and disseminate information resources, such as newsletters, using the Internet. For many schools and libraries, however, access to the Internet must be achieved first.

**Unequal Access**

While there are an estimated 15 million users of the Internet worldwide (Southerland, 1993, p. f1), this group represents a narrow elite. One dissertation in progress indicates that the majority of Internet users are academics, scientists, and engineers (Brandon, 1993). This must change in order for the Internet to achieve its full promise. The greatest barriers to the Internet are economic and geographic.

In 1989, about 13 percent of the U.S. population lived below the poverty line (CENDATA, 1990). Children make up about 40 percent of this group and the elderly, about 11 percent (CENDATA, 1990). Nearly half of the poor family householders (49 percent) never worked at all in 1989 and only 17 percent worked full-time throughout the year (CENDATA, 1990). Thus, most of the poor do not have free access to the Internet through an employer. They must pay for access through a service like Prodigy or do without. The challenge is not just overcoming the inability to pay for access but also the inability to afford the necessary computer equipment and the training to use it. The public library is one of the few institutions capable of addressing this problem. As yet, however, only a few hundred U.S. public libraries are connected to the Internet, according to Stephen Wolff at the National Science Foundation (Bajak, 1993, p. E4). Making the Internet an integral part of service at all public libraries will require substantial assistance from the public and private sectors.

The second major barrier to equal access is geographic. According to the 1990 census, 75 percent of the U.S. population lives in urban/suburban areas and 25 percent in rural areas. Most telecommunications nodes are based in urban areas. Coupled with evidence that deregulation has removed incentives for telecommunications companies to serve rural areas, a serious question arises about the ability of rural users to link into the Internet ("Bringing the Information Age...," 1993). Of course, it is possible for rural citizens to dial long distance to connect to the Internet, but this assumes that rural users have touch-tone service. Even if touch-tone service is available, many future Internet services, such as compressed video, will require a higher bandwidth than twisted pair lines can carry.
Rural areas are destined to be among the last to get fiber optic lines unless the federal government installs them or provides incentives to the telephone and cable companies now serving rural America.

Dillman and Beck (1988) point out the vital need for a telecommunications infrastructure in rural areas. Without this infrastructure, rural areas will not be able to compete against urban areas in the growing information economy. In addition, the authors note that rural workers are generally less knowledgeable about information technology than their urban counterparts. Thus, rural workers share some of the same problems as the poor.

Those who are both rural and poor face the greatest barriers to using the Internet. In 1989, about 16 percent of those living in nonmetropolitan areas were poor versus 12 percent of those living in metropolitan areas (CENDATA, 1990). This is not a small problem. The 16 percent translates into millions of Americans who will have no access to the National Information Infrastructure (NII) for the foreseeable future. The rural poor represent a major test of the Clinton administration's commitment to universal Internet access.

There are positive signs of collective efforts to address these problems. The purpose of what may become the first annual Rural Datafication Conference (Chicago, May 1993) was to promote "ubiquitous access to the Internet" (Cady, 1993, line 4). The conference was sponsored by the ClCNet and nine cooperating state communications networks or organizations: netILLINOIS, INDNet, IREN, MichNet, MRNet, NYSERNNet, PREPnet, WiscNET, and WVNET. More than 200 people from all over the United States and Canada attended the conference. Sessions were devoted to government networking, legal and policy issues, and building on the experience of community access television specialists. Discussion groups were held on such diverse topics as ways that networked information can be used to address the preservation of Native American cultures, the needs of agriculture, the roles of libraries, K-12, and post-secondary education. However important this event, it is a small beginning. The obstacles to universal access are many, and it will take a mammoth concerted effort by all segments of society to overcome these.

Failure to provide access to the Internet for needy rural and urban groups may exact a high price. No less than the democratic and economic future of the country is at stake. The Clinton administration's own "National Information Infrastructure: Agenda for Action" reiterates Thomas Jefferson's statement that "information is the currency of a democracy" ("National Information Infrastructure," 1993, p. 11). Citizens cannot participate effectively in a democracy without information, and the Internet may become the single most important source of information. Yet access to the Internet is
not enough. Citizens must have the skills to seek out and use information effectively. This makes information literacy a critical ingredient of democracy.

Access to the Internet is important for economic reasons as well. The majority of jobs in the United States are information based (Rubin, 1983). This is not likely to change in the near future. In fact, it is virtually certain that the information component of work will intensify. This may lead to the Internet becoming a vital tool for business. One projection indicates that the Internet may reach 50 million business users by the year 2000 (Nelson-Rowe, 1993, p. S-57). The result may be that those without access and the skills to use the Internet will be unable to compete in the national information economy. Those who fear this outcome are pushing the federal government to take a larger role in the development of the Internet. Others believe that the Internet should be completely privatized.

Privatization

The Internet privatization debate involves three different approaches to information. These are the resource, commodity, and social control approaches (Mosco, 1989). The resource view regards information as an economic asset with two main forms: public and private. As a public asset, information is owned by all and every citizen has equal access. As a private resource, information is either owned by an individual or owned by an organization. Currently, the Internet encourages the perspective of information as a public resource. The commodity approach views information as a private good that can be precisely defined, measured, and exchanged. This approach is the direction in which the private sector would like to take the Internet. The last approach, information as a means of social control, looks at information as a way to manipulate society and restrict individual freedom. Mosco (1989) concludes that American society is dominated by the commodity approach and our implementation of this approach may lead to information as a means of social control by large corporations. The most desirable choice for the Internet may be the full implementation of the resource approach because it balances the interests of the public and private sectors. Under this arrangement, all K-12 and postsecondary schools would benefit from the public resources, and additional private resources would be available to those with the ability to pay.

Another part of the debate over privatization of the Internet involves the amount and kind of government regulation. The regulatory environment of the Internet will have a major impact on freedom of speech and other intellectual freedoms. There are at
least four regulatory models from which to choose. These are the
print, common carrier, nationalized broadcast, and regulated
commercial broadcast models (Gorka, 1993). The most familiar model,
that of print, is protected by the U.S. Constitution. In the print
model, the Internet is seen as both a printing press and a soapbox.
There would be very few restrictions on what could be published
or said short of libel or slander. Some even suggest the need for a
constitutional amendment that would specifically extend print-based
rights, including copyright, to the electronic sphere. However, others
have argued against copyright as an artifact of print technology. This
point of view notes similarities between electronic medium and oral
cultures where much of the communication is informal and the
sharing of ideas is a communal free exchange. Brent (1991) points
out that “[a] crucial difference between oral and literate diffusion
of knowledge is that, as knowledge diffuses through knowledge
networks or modern research disciplines, it leaves behind the tracks
of its passage in the form of earlier texts linked by webs of citations”
(Brent, 1991, lines 196-199). In modern societies, authors retain
ownership of the ideas at the same time they release them to the
world—“in a sense leasing rather than transferring them to others”
(line 207).

In the next model, the main concern is not intellectual freedom
but access. Here the Internet is seen as a common carrier similar
to the post office or telephone company. The Internet would be
regulated as a monopoly for the public good. Access to the Internet
would be guaranteed for a minimal price but there would be
restrictions on certain types of content such as obscene matter. This
is the model currently favored by the Clinton administration.

The two broadcast models would draw an analogy between the
Internet and other mass media such as radio and television. The
nationalized model would place control of the Internet solely in the
hands of the government. While this would eliminate commercial
advertising, the dangers of information as a means of social control
make it an unacceptable choice. The regulated broadcast model would
place the control of the system in private hands with government
oversight. This approach might result in low quality programming
like that found on the three national television networks.

Gorka (1993) concludes that the print model is best for the Internet
because it promotes diversity and protects intellectual freedom. For
librarians, this has substantial appeal. From an education standpoint,
however, the common carrier model is most desirable because it
guarantees universal access.

While useful, the four regulatory models discussed do not provide
a full picture of the privatization debate. This is because ownership
of the Internet is distributed among many different groups and nations. Nonetheless, the players may be characterized as belonging to either the public or the private sector with a corresponding emphasis on information as a resource or a commodity. While ownership of the shared Internet will always be by public and private interests, the balance seems to be shifting in favor of the private sector. If this trend continues, more parts of the Internet, such as the NSFNET, may be turned over to the private sector. In addition, cooperative efforts among businesses may lead to the expansion of services like the Commercial Internet Exchange (CIX), which work around government restraints on business uses of the Internet. The danger is that unrelenting privatization of the Internet may destroy the spirit of sharing that forms the basis for USENET and other free services. Changes in professional education are needed to ensure that future educators and librarians are able to foster and extend the Internet's philosophy of sharing information and expertise.

Changes in Professional Curricula

Hunter (1992) notes that the national telecommunications and information infrastructure can be a tool for promoting educational reforms. In order for this effort to be successful, educators and librarians, both present and future, must learn about the Internet and its applications. Dinham and Stritter (1986), in their review of research on professional education, conclude that the technological education of students has received far less attention than it merits. Therefore, there is little research to guide efforts to incorporate the Internet into professional education. The discussion begins with a focus on incorporating the Internet into the professional programs of educators and librarians. The second part will cover continuing education. The final part will consider the need to fund these changes.

Education faculty from all areas should integrate the Internet within their courses, but one area should assume the responsibility for teaching an introduction to the system. The most logical area to assume this role is instructional design and technology. This area also happens to be the one which often serves as a home for the school library/media program. Instructional design and technology is a logical choice because it has most of the expertise and facilities needed to integrate the Internet with the curricula of other programs and departments within a college of education.

Dinham and Stritter (1986) also point out the need for a clinical or apprenticeship component in professional education. For education majors, this means spending time student teaching under the supervision of an experienced practitioner. The practitioner should have a commitment to constructivism, collaborative learning,
and use of the Internet in the K-12 classroom. This commitment helps the practitioner model appropriate behaviors and successfully guide the student.

Like colleges of education, schools of library and information science should integrate the Internet throughout their curriculum. At the least, all students should be required to take a course which introduces them to the Internet and its applications in libraries and information centers. Leadership may come from the information science and technology faculty, but the entire school should be committed to the effort. In fact, the Internet makes it possible to combine the strengths of both traditions. For example, students of an advanced cataloging and an advanced technology class can work together to build an electronic discussion group to address issues of organization of information for access in an electronic environment. The management and the policies of the group can be accomplished by teams. One team can be concerned with the technical aspects of getting the discussion group established, another can propose policies to govern participation, another can be concerned with indexing, another with screen design. Discussions can involve issues addressed by the teams, but the primary purpose of the discussion group would be to address broader professional issues. One such issue might be the effect labeling has on online catalog displays, both on the user's understanding of bibliographic displays and on international standards for data exchange. Ultimately, it may be useful to consider a school's success in integrating the Internet and other technologies into its curriculum as part of the reaccreditation process.

The kind of interaction discussed earlier can be carried on among classes within a school of library and information science, among disciplines such as education and library and information science, among main campuses and branch campuses, and among universities. The joint learning experience addresses not only the technological content but also the embedding content of the Internet. Students must learn to work differently in electronic collaboration and teamwork in addition to using the Internet as a vehicle for discussion.

Many schools of library and information science offer practica and internships. Like clinical programs for educators, these should be structured so that the student gains an understanding and appreciation of the practical aspects of using the Internet in a particular setting. For example, the practicum supervisor should show the relevance of the Internet to technical services and how it serves the needs of patrons.

Making the Internet part of continuing education programs for educators and librarians is critical. In order to continue their certification, K-12 teachers must take a certain number of continuing
education credits over a set period of time. A strong argument can be made that a portion of these credits should be set aside for teachers to learn about new technologies, such as the Internet. In the case of librarians, there are no widespread certification requirements. This makes it much more difficult to ensure that librarians are current with new technologies. The American Library Association and other interested groups should discuss establishing national certification requirements for this reason.

In conclusion, the federal government should consider making grants available as part of its National Information Infrastructure Agenda to assure that professional programs in education and library and information science take full advantage of the Internet. H.R. 1557, passed in August 1993, does provide training monies for libraries and schools but not schools of library and information science and education. Additional funding is urgently needed. The most appropriate grant administrator may be the Department of Education and not Commerce, which is leading the Clinton administration's NREN efforts. The grants would be used not just to revise curricula but also to buy equipment and improve facilities for student and faculty use of the Internet. This funding would also help library and information science faculty and students design and develop better interfaces and tools for the Internet.

**Need for Improved Tools and User Interfaces**

The difficulties of locating, accessing, and using information resources on the Internet are well documented. West (1993) expresses frustration at having so much information available but not quite being able to get at it. Neuman (1992) notes specific difficulties of identifying information, keeping track of information once it is found, sharing information about what is available or maintaining accurate up-to-date information, and needing different mechanisms to access different types of files. Another difficulty, less frequently addressed, is the problem of knowing when one is done searching the Internet. When nothing new is discovered, is it because the searcher has found all that is to be found or that the searcher did not try all options? Organization and standardization have become major issues.

According to Neuman (1992), there are four approaches to addressing the barriers to Internet use: retrieval, indexing, search, and organization. Systems such as the Andrew File System and Gopher provide for the retrieval of files. The Wide Area Information Server (WAIS) and the Semantic File System provide two approaches to indexing. WAIS maintains a full-text collection of documents and allows users free text searching to access the collection. The Semantic File System maintains an index for all files in a collection of file
servers. The Archie database indexes files from selected directories on major File Transfer Protocol (FTP) sites. Entrance search strategies, such as the UNIX `find` command, are used to select the most obvious potential sites. Browsing directories using interactive search techniques is another approach to searching.

Two examples of organizational solutions are HYTELNET and Prospero. HYTELNET (HYpertext browser for TELNET-accessible sites) is a utility that allows an IBM-PC user access (by providing addresses and passwords) to TELNET sites on the Internet. TELNET sites include online public access library catalogs, library bulletin boards, campuswide information systems, FreeNets, full-text databases, electronic books, and network information centers. HYTELNET guides the user through directories of sites on the Internet using hypertext jumps (Scott, 1992).

Prospero is designed to allow the individual user to organize Internet resources of personal interest. An important feature of the system is that the same information can be organized in multiple ways depending upon the needs of the individual or a group, and that users can have access to multiple organizational schemes (Neuman, 1992). Neuman suggests that the usefulness of the individual schemes (directories) will be greatly enhanced when they are referenced from a higher level directory (such as a directory of authors) and that libraries or organizations (such as the ACM and the IEEE) can maintain a higher level of directories based on authors or topics.

Another example of meta-organization are proposals to integrate MARC (MAchine Readable Cataloging) records for electronic material, judged to be of long-term value, into the existing information infrastructure of libraries. Dillon et al. (1992) reported on a research project that "investigated the nature of electronic textual information accessible via the Internet," and tested the "suitability of current cataloging rules and record formats governing the creation of machine-readable cataloging records" for "electronic information objects available through remote network access" (p. 4). Automated categorization for all files at the 1,044 FTP sites available at the time of the study revealed that the amount of formal published information (news, text, data, and image files) is a small portion of the total amount of information available (28 percent). The results of the study indicate that, although some extensions to the MARC format are necessary to accommodate remotely accessed electronic objects, the format is practical and applicable for this type of information (Dillon et al., 1992).

Addressing the issue of meta-organization from another point of view is the work of six issue-oriented task groups of the Cooperative Cataloging Council (CCC). The CCC was established in January
1993 by the joint efforts of the Council on Library Resources, OCLC, the Research Libraries Group, and the Library of Congress to develop and implement a new national cooperative cataloging program. Two proposals related to linking the resources of libraries and library systems are: (1) to create a single Anglo-American bibliographic database comprising records from the various Anglo-American utilities (OCLC, RLIN, UTLAS, WLN), and (2) to create a single Anglo-American authority database comprising name, series, and subject headings created by the various Anglo-American national cataloging agencies (Cooperative Cataloging Council, 1993). These databases, which could include records for electronic information on the Internet, would provide an international resource for information as well as standardization for the international exchange of information.

Locating, accessing, and using information resources on the Internet is difficult and time-consuming. It will require coordinated efforts for educators and students to make effective use of the resources available. Librarians have extensive experience in solving problems related to the identification of potentially useful information and the need for discrimination among large retrieved sets. Teachers and librarians must be articulate on the kinds of retrieval, indexing, searching, and organizational tools that are most effective for assisting the student in the learning process.

Significant progress is being made in the area of the Internet user interface. One example is Mosaic, a software program developed by the National Center for Supercomputing Applications in Champaign, Illinois. Mosaic is a graphical user interface that removes the need to know arcane Internet addresses and procedures. The program is designed to let users browse through the World-Wide Web, a subset of databases available on the Internet. Best of all, the program is free to those willing to download it from the network. Mosaic and other interface efforts are critical to opening the Internet to widespread student use in K-12 and postsecondary environments.

CONCLUSIONS

The Internet can reinvigorate education and libraries, but this outcome is not certain. A key factor in achieving this goal is distinguishing between the technological content of the Internet and embedding it in a particular context. One useful context is information literacy. In addition, a number of important issues must be addressed. These include the changing roles in the classroom, library, and workplace; the economic and geographic barriers to accessing the Internet; the implications of different privatization approaches; the impact of the Internet on professional school curricula; and the need
for better tools and user interfaces. One additional concern should be the integration of Internet resources within the existing infrastructure of the nation's libraries and library systems. In short, educators and librarians must make sure that the evolving National Information Infrastructure reflects their needs and concerns. To do so, they must gain cooperation from the public and private sectors.

The education and library community should use its political clout to gain the support of the Clinton administration's Information Infrastructure Task Force (IITF). According to the National Information Infrastructure: Agenda for Action the Activities of the IITF include coordinating government efforts in NII applications, linking government applications to the private sector, resolving outstanding disputes, and implementing Administration policies. Chaired by Secretary of Commerce Ron Brown and composed of high-level Federal agency representatives, the IITF's three committees focus on telecommunications policy, information policy, and applications. (National Telecommunications and Information Administration, 1993, p. 7)

In addition, the education and library community should lobby the U.S. Senate for passage of H.R. 1757, the High Performance Computing and High Speed Networking Applications Act, and H.R. 2639, the Telecommunications and Information Infrastructure and Public Broadcasting Facilities Assistance Act. H.R. 1757 provides money to train educators and librarians. H.R. 2639 funds NII planning studies and demonstration projects for nonprofit schools and libraries.

With respect to the private sector, the education and library community should establish long-term partnerships with telephone, cable, and computer companies. It is difficult to imagine a National Information Infrastructure that does not involve all three types of business. Schools and libraries may want to turn to their telephone company and local cable operator for help with planning the implementation of NII technology and a demonstration project. Also, the education and library community should pursue opportunities for cooperation with the major computer companies, which may lead to the donation of hardware and software. The result may be an education revolution in which teachers and librarians help students develop the job readiness skills necessary to succeed in an information intensive economy.

REFERENCES


A Survey of Networking Education in North American Library Schools

Constance Wittig and Dietmar Wolfram

Abstract
North American library school faculties were surveyed on the adoption, impact, and role of networking concepts and resources in the library and information science curriculum. The findings indicate that, to a large degree, educators have kept up with recent trends and tools in networking in a variety of courses. There was overwhelming consensus on the importance of networked information resources and access tools but less agreement on their places in the library and information science curriculum.

Introduction
The explosion of networked information resources and access tools, many developed only in this decade, has presented a new set of tools for information professionals. The rapid development of new resources and technologies has left schools of library and information science (LIS) scrambling to keep up with these swift changes. The newest wave of computer-based resources represents the latest influx of information technology spawned by the growth in access to computer networks, particularly the Internet.

The changing role of the information professional—from one dealing primarily with print-based resources to one successfully confronting the growing number of electronic resources—has been underway for several decades. The development of online bibliographic databases in the late 1960s marked an important turning point for the profession. These centrally located resources have
permitted timely retrieval of information from large databases using computing and telecommunications technologies. The latest information storage and retrieval tools now permit access to decentralized resources with uniform ease.

The passage of the High Performance Computer Technology Act in December 1991 authorized funding for the development of the National Research and Education Network (NREN) which will include connections to libraries and the resources in those libraries. The library community's recognition of the importance of networked resources and interest in facilitating access is evident in its recent lobbying efforts (Brunell, 1991). In September 1989, information professionals testified at a congressional hearing that increased access to information through a national supercomputing network could expand the role and usefulness of libraries in the future (McClure et al., 1991). Pending legislation in the form of Senate Bill S 2813 and House Bill 2772, which authorizes funds for an electronic gateway to government databases, specifies free access to this information for libraries (Quindlen, 1992). This newest information resource should further the commitment libraries have to accessing electronic information.

The purpose of this article is two-fold. The authors first explore the current state of networking concepts, tools, and resources in American Library Association (ALA) accredited programs in library and information science in North America. The study also examines faculty attitudes toward the place of networking education and their perceptions of its impact on library and information science. Questions of concern to the authors include: Have LIS faculty kept abreast of the rapid developments in networking? What aspects are being taught? Where in the curriculum have they been adopted? How significant will these developments be to LIS education?

THE LITERATURE

The professional literature has seen a proliferation of monographs, particularly in the last two years, dealing with overviews of networking, networked resources, and specific applications in library and information science. This growth of literature supports the need for educating information professionals in the new networked resources. General guides to the Internet have become quite popular, beginning with Kehoe's *Zen and the Art of the Internet: A Beginner's Guide to the Internet* (1992) and continued by guides developed by Krol (1992); Tennant, Ober, and Lipow (1993); and the *Internet Resource Guide*, which is produced by the National Science Foundation (1993) and made available on the Internet.

The professional periodical literature has also seen a considerable increase in coverage of networking resources and tools since 1991.
Current literature covers the spectrum from general overviews of the Internet and its capabilities (Chadha, 1992a, 1992b; Lynch & Preston, 1992; Page, 1993; Polly, 1992); to specific access tools and resources (Bailey, 1992; Bickley, 1991; Kalin & Tennant, 1991; Nickerson, 1991a, 1991b, 1991c; Simmonds, 1993); to library-specific applications (Notess, 1991; OCLC, 1992; Dillon et al., 1993; Jackson, 1993; Zeeman & MacKinnon, 1993).

A small base of literature focuses on professional knowledge and proficiencies of networked resources and tools and their use in libraries. Larsen (1991), in a paper on the role of libraries in providing access to networked information services, espouses the need for library reference staff “to know how to find materials on the network and how to utilize those resources. Network-based resources are not limited to computers, libraries, and databases; people also are an invaluable network resource” (p. 44). In a study on public libraries and the use of Internet/NREN information services, McClure, Ryan, and Moen (1993) found that 92 percent of the public librarians surveyed felt that librarians have a limited knowledge of what is available on networks. This resulted in a recommendation for research on “how best to develop and implement a national education program for practicing librarians on the importance, uses, and applications of national networking” (p. 29). Tillman and Ladner (1992) report the use of Internet resources by special librarians mentioning that, “the Internet has a special value for special librarians” (p. 127) due to their isolated working conditions and the rapidly changing “world of libraries and the workplace” (p. 131).

Few publications exist that examine the incorporation of networking into the LIS curriculum. Malinconico (1992) points out that, whatever type of work librarians do, they will have to “deal with applications of modern information handling technologies. Thus, their formal education must also advance their technological literacy” (p. 235). A few articles attempt to link networking access and tools to traditional online use classes. Armstrong (1991) provides a history of online training and an examination of current online training, emphasizing computer-aided instruction that might be helpful when thinking about education and information resources. Becker (1992) describes the introduction of the Internet and its resources to Rosary College library and information science graduate students as a part of the online searching course. Kochtanek (1993) provides an educational model for promoting and understanding the Internet in a separate networking and telecommunications course that includes course objectives and a list of recommended topics and proficiencies.
Method

A survey instrument was designed to elicit responses on a variety of networking concepts and services. The questionnaire included general topics on networking, information resources and resource discovery, and access tools. Concepts related primarily to autonomous local area networks were not included since the purpose of the study was to examine publicly accessible tools and resources. The first part of the questionnaire (ten questions) consisted of primarily closed-ended questions focused on specific types of network resources, teaching approaches used, related issues, and course information. The second half of the questionnaire presented respondents with open-ended questions on their attitudes and perceptions of networking in LIS education.

A packet containing four copies of the questionnaire and a letter outlining the study was mailed out in the spring of 1993 to the heads of fifty-six ALA-accredited programs in North America. Questionnaires were to be distributed to the most appropriate faculty members within each program.

Responses to closed-ended questions were tallied, and open-ended questions were coded according to the nature of the responses. Since the purpose of the study was largely exploratory in nature, analysis of the returned questionnaires was largely descriptive.

Findings

Sixty-five responses were received from thirty-seven library schools, representing a 66 percent coverage of accredited schools. Schools responding represented all regions of North America and included both doctoral and nondoctoral degree-granting programs. Data were tabulated in two ways: (1) individual responses were tallied over all the schools; and (2) data collected from each school were combined. The authors were primarily interested in individual responses for the open-ended questions and compiled school-level data from each of the questionnaires. In some cases, individuals responded on behalf of the school representing the responses of one or more faculty members.

Each responding school acknowledged that networking concepts and resources have been, or are in the process of being, included in their curricula. Respondents were unanimous in their belief that networking concepts and resources should be included as part of the LIS curriculum.

Curriculum Content

The first part of the questionnaire assessed current topic coverage in LIS programs. A summary of the school responses to the range
of resources and services appears in Table 1. Previous studies of professional use of Internet resources have found electronic mail to be the main resource used by professionals in special libraries (Tillman & Ladner, 1992). Almost all the responding schools indicate

<table>
<thead>
<tr>
<th>Resource/Service</th>
<th>Number of Programs (n = 37)</th>
</tr>
</thead>
<tbody>
<tr>
<td><strong>Electronic Mail</strong></td>
<td></td>
</tr>
<tr>
<td>Interest Groups, LISTSERVs</td>
<td>35</td>
</tr>
<tr>
<td>Directories</td>
<td>20</td>
</tr>
<tr>
<td><strong>Remote Login</strong></td>
<td></td>
</tr>
<tr>
<td>Library Catalogs</td>
<td>36</td>
</tr>
<tr>
<td>Database Services</td>
<td>33</td>
</tr>
<tr>
<td>Campus-wide Information Systems</td>
<td>32</td>
</tr>
<tr>
<td>Bulletin Boards</td>
<td>29</td>
</tr>
<tr>
<td>Electronic Journals</td>
<td>26</td>
</tr>
<tr>
<td>Freenets</td>
<td>24</td>
</tr>
<tr>
<td>Other</td>
<td>3</td>
</tr>
<tr>
<td><strong>FTP (file transfer)</strong></td>
<td>34</td>
</tr>
<tr>
<td><strong>Internet Utilities</strong></td>
<td></td>
</tr>
<tr>
<td>Gopher and Veronica</td>
<td>31</td>
</tr>
<tr>
<td>Archie</td>
<td>28</td>
</tr>
<tr>
<td>Wide Area Information Servers (WAIS)</td>
<td>25</td>
</tr>
<tr>
<td>HYTELNET</td>
<td>21</td>
</tr>
<tr>
<td>World-Wide Web</td>
<td>15</td>
</tr>
<tr>
<td>Knowbots</td>
<td>9</td>
</tr>
<tr>
<td><strong>Commercial Databases and Vendors</strong></td>
<td></td>
</tr>
<tr>
<td>DIALOG</td>
<td>38</td>
</tr>
<tr>
<td>OCLC</td>
<td>26</td>
</tr>
<tr>
<td>OCLC/EPIC</td>
<td>22</td>
</tr>
<tr>
<td>OCLC/First Search</td>
<td>18</td>
</tr>
<tr>
<td>BRS</td>
<td>8</td>
</tr>
<tr>
<td>Nexis/Lexis</td>
<td>6</td>
</tr>
<tr>
<td>WilsonLine</td>
<td>4</td>
</tr>
<tr>
<td>Infomart</td>
<td>2</td>
</tr>
<tr>
<td>RLIN</td>
<td>2</td>
</tr>
<tr>
<td>CAN/OLE</td>
<td>1</td>
</tr>
<tr>
<td>Data-Star</td>
<td>1</td>
</tr>
<tr>
<td>Infoglobe</td>
<td>1</td>
</tr>
<tr>
<td>Medline</td>
<td>1</td>
</tr>
<tr>
<td>Westlaw</td>
<td>1</td>
</tr>
<tr>
<td><strong>Other Resources</strong></td>
<td></td>
</tr>
<tr>
<td>CompuServe</td>
<td>2</td>
</tr>
<tr>
<td>Prodigy</td>
<td>1</td>
</tr>
<tr>
<td>CD-ROM servers and products</td>
<td>1</td>
</tr>
<tr>
<td>News readers</td>
<td>1</td>
</tr>
</tbody>
</table>
inclusion of the three main services available over the Internet: electronic mail, remote login (particularly for library catalogs), and file transfer capabilities. Resource discovery and navigation tools—particularly Archie, Gopher, Wide Area Information Servers (WAIS), and HYTELNET—are currently being used by more than half of the schools responding.

Using the Internet to access more established technologies in the curriculum—e.g., commercial database vendors such as Dialog and BRS—has also been quickly incorporated, undoubtedly due in part to reduced telecommunications charges. Other information services, not directly associated with the Internet—namely videotex services such as CompuServe and Prodigy—were also reported by a small number of schools.

The range of courses in which networking topics are included is quite large, having found its way into both traditional core courses and specialized courses. Table 2 summarizes the courses in which networking concepts and/or tools are covered. Typically, such topics are found in the more technology-oriented or information science-oriented courses. However, the relatively large number of schools reporting courses like Information Sources and Services (twenty), and Special Libraries and Information Centers (sixteen) gives a clear indication that many of the responding schools view networked resources as important in several areas of the curriculum. It should be noted that the courses with the highest tallies generally reflect more mainstream courses. For example, courses in library automation and online information retrieval may be offered more frequently and by more programs than specialized courses in telecommunications/networking. It may also be the case that some courses listed in the questionnaire may not correspond to courses offered at all library schools. One respondent indicated that the courses listed in the questionnaire did not “map” well to their curriculum.

Respondents were asked about teaching methods used when dealing with these topics. A large percentage reported that a variety of teaching techniques were used. Hands-on training was viewed as an important approach (thirty-five of thirty-six schools), followed by lectures (thirty-four of thirty-six), demonstrations (thirty-two of thirty-six), discussion (thirty of thirty-six), and guest speakers (twenty-three of thirty-six).

In addition to concepts and access tools, general issues discussed in the classroom were surveyed. A large percentage of the schools selected many of the issues listed on the questionnaire. Accessibility issues (thirty-three of thirty-six schools), services for libraries (thirty-two of thirty-six), the National Research and Education Network (NREN) (twenty-nine of thirty-six), virtual libraries (twenty-eight
of thirty-six), and standards (twenty-eight of thirty-six) were all selected as being incorporated into the curriculum by more than 75 percent of the schools.

**Faculty Views on Electronic Networking in LIS Education**

Four open-ended questions were asked dealing with teaching and the impact of networking developments.

— *What aspects of networking should be taught* (forty-three respondents)?

Responses indicate that there is great variation in what is perceived as being necessary in the curriculum. Forty percent (seventeen of forty-three individuals) felt that all the specific resources listed previously in the questionnaire should be covered. More general topics and issues were also listed by a number of respondents. The most commonly cited are summarized in Table 3. After tools and general concepts listed previously in the questionnaire, applications and social issues were listed most frequently by respondents. Other

### Table 2.
**Courses in Which Networking Concepts/Tools are Taught**

<table>
<thead>
<tr>
<th>Course</th>
<th>Programs (n = 36)</th>
</tr>
</thead>
<tbody>
<tr>
<td>Library Automation</td>
<td>29</td>
</tr>
<tr>
<td>Online Information Retrieval</td>
<td>28</td>
</tr>
<tr>
<td>Information Technology</td>
<td>22</td>
</tr>
<tr>
<td>Bibliographic Control</td>
<td>20</td>
</tr>
<tr>
<td>Information Science</td>
<td>20</td>
</tr>
<tr>
<td>Information Sources and Services</td>
<td>20</td>
</tr>
<tr>
<td>Special Libraries and Information Centers</td>
<td>16</td>
</tr>
<tr>
<td>Management</td>
<td>12</td>
</tr>
<tr>
<td>Government Documents</td>
<td>10</td>
</tr>
<tr>
<td>Telecommunications/Networking</td>
<td>8</td>
</tr>
<tr>
<td>School Libraries/Media Centers</td>
<td>7</td>
</tr>
<tr>
<td>Public Libraries</td>
<td>4</td>
</tr>
<tr>
<td>Specialized Information Sources and Services</td>
<td>3</td>
</tr>
<tr>
<td>Collection Development and Management</td>
<td>2</td>
</tr>
<tr>
<td>Microcomputer Applications</td>
<td>2</td>
</tr>
<tr>
<td>Academic Libraries</td>
<td>1</td>
</tr>
<tr>
<td>Economics of Information</td>
<td>1</td>
</tr>
<tr>
<td>Indexing</td>
<td>1</td>
</tr>
<tr>
<td>Information Industry</td>
<td>1</td>
</tr>
<tr>
<td>Information Policy</td>
<td>1</td>
</tr>
<tr>
<td>Issues in Information</td>
<td>1</td>
</tr>
<tr>
<td>Serials Management</td>
<td>1</td>
</tr>
<tr>
<td>Systems Analysis and Design</td>
<td>1</td>
</tr>
</tbody>
</table>
topics listed by one or two respondents included policy and legislation, organization of networked information, and personal information management. One respondent summarized frustration with the increase in available resources by stating: "It's expanding too rapidly to limit...."

**Table 3.**
**NETWORKING CONCEPTS/TOOLS THAT SHOULD BE TAUGHT**

<table>
<thead>
<tr>
<th>Networking Concepts/Tools</th>
<th>Respondents (n = 43)</th>
</tr>
</thead>
<tbody>
<tr>
<td>Topics already mentioned in the questionnaire</td>
<td>17</td>
</tr>
<tr>
<td>Library uses, applications, and issues</td>
<td>8</td>
</tr>
<tr>
<td>Access, social, and ethical issues</td>
<td>8</td>
</tr>
<tr>
<td>Navigation, location, evaluation, retrieval issues</td>
<td>6</td>
</tr>
<tr>
<td>Telecommunication principles</td>
<td>5</td>
</tr>
<tr>
<td>Creation and design of network resources</td>
<td>4</td>
</tr>
<tr>
<td>Administration and management issues</td>
<td>4</td>
</tr>
</tbody>
</table>

*Where in the curriculum should networking concepts be taught* (forty-seven respondents)?

Respondents generally agreed that networking concepts are too broad to be limited to a single course. Fifty-one percent (twenty-four of forty-seven) felt networking resources should be included throughout the curriculum. Sentiments toward their inclusion across the curriculum are echoed in responses such as "A separate course treats it like a new discipline—it isn't..." and "It's another tool and should be included in all areas." Other respondents listed specific courses they considered to be most appropriate for networking topics. The most frequently mentioned courses are listed in Table 4.

**Table 4.**
**SUGGESTED CURRICULUM AREAS FOR NETWORKING COVERAGE**

<table>
<thead>
<tr>
<th>Area</th>
<th>Respondents (n = 47)</th>
</tr>
</thead>
<tbody>
<tr>
<td>Throughout the curriculum</td>
<td>24</td>
</tr>
<tr>
<td>Information sources and services/reference</td>
<td>12</td>
</tr>
<tr>
<td>Telecommunications/networking</td>
<td>9</td>
</tr>
<tr>
<td>Computer-applications/information technology courses</td>
<td>8</td>
</tr>
<tr>
<td>Information science</td>
<td>6</td>
</tr>
<tr>
<td>Library automation</td>
<td>6</td>
</tr>
<tr>
<td>Cataloguing/bibliographic control</td>
<td>5</td>
</tr>
<tr>
<td>Online information retrieval</td>
<td>5</td>
</tr>
</tbody>
</table>
—*What teaching approaches should be used* (fifty-one respondents)?

Faculty were also asked what approaches should be used in teaching networking concepts—e.g., theory versus practice. Seventy-one percent of the respondents (thirty-six of fifty-one) felt that a balance of theory and practice should be presented, with hands-on training being a vital component. Sixteen percent (eight of fifty-one) felt that emphasis should be given to practical training with only some theory or general concepts. One individual felt that only practical aspects should be taught. One respondent thought the approach used depended on the environment.

—*What is the future impact on education* (forty-three respondents)?

Respondents generally agreed that the impact of networking technology on library and information science education would play an important role. Forty percent (seventeen of forty-three) used terms such as "crucial," "significant," or "very large" when describing the impact. Two respondents likened the level of significance as being similar to that of the introduction of online databases in the late 1960s and 1970s.

Responses revealed a variety of perceived impacts both short term and long term. However, there were few overlaps in perceived impacts where even two or three respondents listed similar conclusions. Areas of concern or impact listed by two or three respondents included greater access capabilities to information resources, difficulties in keeping up with rapidly developing and changing technologies and its integration into the curriculum, education of professionals, course delivery and teaching methods, and funding issues for access.

Several respondents indicated that networking concepts should be of great concern and urgency within LIS education, as revealed in such remarks as, "If we don't respond, our position will erode" and "We must deal with it and be involved in shaping its policies." Another respondent noted that, "We currently learn from others. Libraries should be active rather than passive participants." More strongly, another respondent lamented, "We're losing it to every little VAX administrator reinventing...subject access every day!"

**DISCUSSION**

Based on the range of questionnaire responses, it can be concluded that library and information science schools are keeping up with the rapid changes that are taking place in information and communication technology. Networking concepts and resources have already found their way into many courses throughout library schools in North America. Several schools have even reported developing
specializations in networking. The rapidness of developments in networking is evident even in the short span between the development of the questionnaire for this study and the time of the writing of this article. In that time, the utility, Veronica, then only available for several months, has since become a standard feature on Internet gophers and a new search tool; Jughead has been made available and is also quickly becoming a standard feature on Internet gophers.

Most respondents felt that the coverage of networking technology defies any well-defined course boundaries since the applications and concepts span numerous areas of LIS. However, specific aspects could be contained within selected courses with standards, protocols, and technical topics being left to specialized courses in telecommunications. The majority of respondents felt that a balance of theory and practice should be included in the class, indicating that networking concepts, tools, and resources are not just a skill to be mastered by students.

The lack of any general consensus on specific future impacts of the technology on education underscores the rapidness of change within the education system. Respondents agreed that the impact will be significant but could not agree on short- and long-term impacts. The technologies are still too new, and change is occurring too rapidly to determine ultimate impacts. One aspect of these developing services that respondents felt quite strongly about is the crucial role of information professionals in shaping future policies and development of access tools to ensure effective design. This is also echoed in the literature by McClure, Ryan, and Moen (1993) among others.

Despite the quickly growing number of information resources and the rapid development of access tools in this decade, the questionnaire results indicate that the responding schools have been keeping abreast of changes in the area of networking education and diffusing this knowledge to students. The wide range of courses in which these resources are being taught indicates that a large group of educators teaching in information technology-oriented courses are diffusing these ideas throughout the curriculum.

CONCLUSIONS

The development of greater accessibility to networks, navigation, and access tools has undoubtedly led to a shift in library and information science education. In this study, the authors have attempted to determine if and how library schools have kept pace with these rapid developments. Based on the questionnaire responses to closed-ended questions on networked resources and access tools, it can be concluded that responding schools are indeed keeping up with these changes. Even tools and resources available for only a few months
at the time of the development of the questionnaire have already found their way into LIS courses.

Respondents overwhelmingly agreed on the importance of integrating networking concepts into the LIS curriculum. However, there was less agreement about the most appropriate locations in the curriculum for these topics. Approximately half of the respondents agreed that, while these developments should be covered throughout the curriculum and should not be isolated in specialized courses, the more technical issues and topics might lend themselves to specialized coursework. Although there is general agreement that the impact of these developments on library and information science education will be profound, there is little consensus on the specifics of that impact.

ACKNOWLEDGMENTS
The authors would like to thank Virgil Diodato for his comments throughout the study.

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A Model for Planning and Providing Reference Services Using Internet Resources

DIANE K. KOVACS, BARBARA F. SCHLOMAN AND JULIE A. McDANIEL

ABSTRACT
Internet resources are similar in function to many print and electronic resources with which library users are familiar. Despite this similarity in function, and sometimes in form, between network resources and traditional information sources, users are often intimidated by this network medium: What is available? Where is it? How do I get to it? Once obtained, the sheer quantity of information that can and is stored in electronic form confronts users with the need to filter and organize it for personal use. Librarians, based on their training and experience, are the most appropriate intermediaries to assist in connecting to and understanding these network resources. This article discusses the development of practical strategies for mediation between Internet resources and potential users.

INTRODUCTION
The dream of the "electronic library" is coming closer to reality because of the capabilities for information access that electronic networks present. Already the Internet and BITNET encompass a vast array of information resources that are increasingly being used both by librarians and the users they serve. The passage of the National Research and Education Network (NREN) bill ensures development of a national infrastructure that will provide increased access to national computer networks by both academic and public institutions. BITNET is being absorbed into the Internet. The phrase "Internet
resources” used in this article refers to the Internet and BITNET resources. Libraries have been identified as a key location for public access to these networks.

More users are finding that network resources complement their traditional information-seeking behavior. The networks allow them to communicate with their colleagues in ways that supplement paper correspondence, telephone conversations, and professional conferences. As the potential of the Internet as a publishing medium begins to be developed, electronic journals (e-journals) are gaining legitimacy as conveyors of the scholarly record.

In a recent study, a group of experts—moderators/editors of scholarly electronic conferences (e-conferences) and e-journals—observed the active use of e-conferences to establish collaborative research and publishing efforts and to exchange information crucial to research projects. Most importantly, a trend was identified of users using electronic communication to replace traditional communication via telephone and postal services (Kovacs & Kovacs, 1991).

Many network resources are similar to traditional sources and services with which librarians and researchers have familiarity. For example, data files, electronic texts (e-texts), and e-conference archives are comparable to online full-text databases. E-conferences—which include discussion lists, electronic newsletters, mailing lists, electronic forums, interest groups, and so on—parallel professional conferences and their activities and proceedings. Electronic journals are equivalent to print journals in terms of format and content. Library catalogs and other bibliographically oriented databases mirror the print and locally based systems with which users are familiar.

Despite this similarity in function and sometimes in form among network resources and traditional information sources, users are often intimidated by this network medium. What is available? Where is it? How do I get to it? Once obtained, the sheer quantity of information that can be, and is, stored in electronic form confronts users with the need to filter and organize it for personal use.

**Librarians’ Role**

Librarians, based on their training and experience, are the most appropriate intermediaries to assist in connecting users with these network resources. Librarians have been at the forefront of using the Internet to provide useful resources to their own discipline. A recent study also shows that a significant number of reference librarians have begun to use the Internet resources in providing reference services to users.¹

It is most appropriate that librarians mediate between the user and information resources in a network environment just as within
a print environment. Our professional role has traditionally been to identify resources, enhance modes of access to them, and enable users to connect with, and use, appropriate sources. Network resources provide an opportunity for us to extend ourselves professionally within this new medium to provide meaningful service to our users.

**Hierarchy of Information Skills**

A hierarchical model of information skills is offered as a framework by which librarians can design services to mediate use of network information sources by their users (see Figure). The model suggested was initially proposed by Mulder and Campbell (1991) for developing a user instruction program. However, it has also been used in the broader context of strategic planning of information services by a reference department (Schloman, 1993).

![Hierarchy of Information Skills Diagram](image)

The specific application of the hierarchy presented here is for the planning and provision of information services using the Internet resources. The hierarchy is particularly useful because it delineates the types of information needs users have and suggests the skills and services necessary to satisfy those needs. In the network environment, users face the tremendous diversity and disorganization of network resources plus the need to learn new protocols for access. Librarians' professional training and experience uniquely prepares them to perform a mediating role between users and network information resources. The following is a discussion of the levels of the hierarchy and how these relate to users' needs for network resources and the librarian's role.
Awareness of Information Services and Resources

Knowing what is available on the networks probably poses one of the biggest challenges for librarians and users alike. In order to serve users at this level, librarians need to familiarize themselves with the types of network resources available and decide for what these might be used. As indicated earlier, the types of available electronic resources parallel what is known in the print world. Full-text resources include data files, journals, electronic texts, and electronic conference archives. Interactive access to experts is provided through electronic conferences and their various forms (e.g., electronic conferences, newsletters, mailing lists, interest groups). Bibliographic sources are identified through library catalogs and various types of indexes to the literature.

As in the print world, a given information resource can often serve different information needs. Sometimes a user will be well served to be made aware of and directed to an existing source. At other times, the librarian may be aware that the resource can be tapped to obtain specific information. For example, a graduate student in English literature might be looking for information on current research on *Finnegan's Wake*, artificial intelligence, AIDS, or the works of Jane Austen. The reference librarian might provide this student the best service by informing him or her of the existence of an electronic conference on any of those subjects.

E-conferences are a great way to "connect" with current thinking in the field by identifying experts and those with related interests. However, when that same librarian is asked if an audiotape for Gaelic language training exists, she or he might search the archives of that e-conference to provide the needed information. In this actual case, a nearby library held the material but locating it was made difficult by not having the actual title of the audio tapes, which were in Gaelic. A search of the Gaelic-L@IRLEARN e-conference archives retrieved several titles.

In providing service at this level, librarians will need to promote the existence of network resources to their users. This may be handled through established library communication channels (e.g., library newsletters, library guides, reference desk service, individual consultation, and bibliographic instruction). The library's existing electronic connectivity with users provides another valuable communication link. The library might promote the availability of network resources through an electronic newsletter or campuswide information server. Specialized messages might be sent to appropriate departments for distribution through their local area network. A type of "reader's advisory role" is possible for librarians who work with a specific clientele. As those librarians find potentially useful new
resources through their own electronic conferences or explorations, they can notify individuals who might be interested. The “forward” function available in most e-mail software makes these alerts very easy to pass on to selected faculty or students.

Understanding the Information Structure of a Discipline

Just as the structure of the print literature within a given discipline differs from that in another, electronic resources can have a different flavor as well. Librarians working with users in specific disciplines will need to gain an understanding of the forms of network resources that are developing in those areas. For example, in the humanities, significant efforts are being made to make literary texts available through the Internet. For example, the works of Shakespeare are being put into electronic form by scholars participating in SHAKSPER@utoronto. The works of Dante and other literature are also available from a variety of Internet sites. In the social sciences, data files, such as the Institute for Research in Social Science’s Public Opinion Item Index, are being made available on the Internet. In biology, the data files of the Human Genome Mapping project are made available to participating scholars. These are just a few examples of information and data that are being made available through the Internet.

In addition to the types of resources that support work within a discipline, access to communication among colleagues within a specialized field reveals characteristics of that area as well. Historically, librarians have been well aware of the role of the “invisible college” in the development of a discipline. It is now possible to introduce students and researchers to “electronic invisible colleges” and for them to observe the development of an idea via an electronic medium.

Librarians will want to integrate these electronic resources into their own understanding of a discipline’s information structure in order to be able to convey it to others. Traditionally, librarians have used such frameworks to provide the proper perspective to work with a particular user group and to design services for them. Often these frameworks are presented to students in bibliographic instruction sessions for courses within their majors or through individual consultation. Given the rapidity of change in network resources, attention also needs to be paid to faculty who are interested in updating their understanding of available resources within their own discipline or for interdisciplinary or multidisciplinary areas in which they are interested. This might take the form of workshops for faculty in given departments or disciplines.
Analysis of Information Problems/Needs

An analysis of a user's information need is the central objective of the reference interview, regardless of the setting. In dealing with network resources, reference consultation by appointment is the ideal situation in which to analyze a user's need and the possible resources that might be useful. In addition to a basic understanding of the Internet and its resources, a librarian will draw upon the "tools" that aid in identifying resources. The finding tools include directory resources, such as HYTELNET and LIBS, through which users can identify resources and finding services, such as Archie and WAIS. Archie servers can assist users in locating electronic texts, and WAIS servers can assist in locating and searching or browsing electronic texts.

Retrieval of Information

Once librarians and library users are aware of Internet resources, the next step is to learn how to retrieve them. Ideally, they will have an opportunity to receive training in retrieval of information from the Internet. This should include an introduction to what the Internet is, how to gain access, and basic protocols for connecting to remote resources and obtaining files. Such instruction may be available through academic computing services or through departmental programs. Librarians may, however, determine that it is necessary to incorporate this basic content into their instructional efforts—in addition to providing information on specific Internet resources and their use. This instruction may take place as part of reference desk service, although the complexity of the Internet retrieval methods may require a significant investment of time with a neophyte user. One-on-one consultation with users is an ideal forum, albeit a costly one.

Group instruction is the most efficient means to teach access and retrieval from the Internet. Clearly, the sessions are more meaningful to users if hands-on experience can be offered as well. Instruction on specific resources may include developing search strategies and using system-specific commands.

End-user aids may also be useful instructional devices to nurture the self-sufficient or remote user. Users can be directed to front-end programs (already presented in this discussion) such as HYTELNET or LIBS. The Gopher front-end software can be used to provide user-friendly menu access to Internet resources for users on local library computer networks. The librarians can configure the Gopher front end to provide access to selected Internet resources to users, including information intended specifically for local use.
Electronic conference and electronic journal information requests can be referred to the *Directory of Electronic Journals, Newsletters and Academic Discussion Lists* (Strangelove & Kovacs, 1993), which combines the *Directory of Scholarly Electronic Conferences* (Kovacs et al., 1990) and the *Directory of Electronic Journals* (Strangelove & Kovacs, 1993). These provide directions for subscribing and for archive searching.

Once useful material is identified, users need to know the next step to obtain it—whether it is through electronic file transfer protocol (FTP), traditional interlibrary loan, or commercial document delivery.

The understanding gained from the first three levels of the hierarchy, in combination with the retrieval skill at this level, provide the very essence of the skills necessary to capitalize on Internet resources. Some of the most accomplished faculty on a campus may not have acquired networking skills. Many are aware of the electronic world "out there" and welcome assistance in being brought up to speed in this area so that they can incorporate network resources into their information seeking. Because faculty have the greatest influence on what their students are exposed to and learn, there is added benefit for the library in developing programs that address faculty skill needs.

As one example of an ongoing program, the Kent State University Libraries' "60 Minute Seminar" series for faculty, highlights a wide range of electronic information sources, including those available through the Internet. Some sessions are team taught with a representative from academic computing services. Most seminars offer hands-on experience. The response has been very positive and has built strong rapport with individual faculty and departments on campus. Additionally, working with faculty, libraries have begun to integrate Internet resources into lectures for graduate students in art, English, ethnomusicology, history, nursing, romance languages, and literature.

**Evaluation of Information**

One role that librarians play in the use of print resources is to assist users in developing criteria for evaluating the information that they find. The key issues in an electronic environment are:

1. Don't believe everything you read.
2. Who is the author?
3. Is the source credible?

Students, in particular, have a tendency to believe that everything they read on a computer must be "true," and that information
obtained via a computer represents all that is needed (Estabrook, 1983). Library instructional efforts need to address these misconceptions.

Some Internet resources do not offer useful scope notes up front, nor do they acknowledge the credentials of the producers. We can expect that continuing efforts to describe and classify Internet resources will at least partially address these deficiencies. Instruction or caveats to individuals are called for. Librarians can point out, for example, that many e-conferences and e-journals have no established editing or reviewing process. There is also the possibility that writers simply provide "data" or "facts" based on what they remember while responding to a message rather than consulting other sources for exact information. Most e-conferences are conversational. When asked, most writers will locate an authoritative source to support their statements. The possibility of typos is also a potential hazard for readers who may want to believe everything they see on an e-conference. Conversely, many new e-journals are taking particular pains to ensure that a peer review process is in place.

Management of Information

Librarians are increasingly familiar with aiding users in developing techniques to manage bibliographic information. Working with computer services personnel, a more comprehensive instructional program for managing network information could also be provided. Key skills in information management include:

1. moving information from a remote Internet location to a local computer;
2. online file/directory management; and
3. database and bibliographic software use (e.g., d-Base, Pro-Cite, Reference Manager).

This area presents an opportunity for librarians to cooperate with computer services personnel. Librarians can provide users with some assistance but should also be able to refer them to computer services for more in-depth technical assistance. Likewise, computer services personnel should be able to refer users to librarians for research assistance. Librarians need to be able to inform users about telecommunications software—such as Kermit and Procomm—and how to download files from mainframe computers to microcomputers. These skills are often included in instruction for CD-ROM databases and can be incorporated for network resources in a similar manner. Librarians must also be minimally familiar with the operating systems available on campus mainframes in order to help remote users access
the Internet and other electronic services—e.g., electronic mail account, public Internet accessible terminal, and so on.

Database and bibliographic softwares present a complex issue. The librarian's role can be as simple as making users aware of their existence and value or as complex as helping them to build their own databases. Future developments in software for the scholar's workstation will have a profound impact on how network information can be managed.

**Contribution to the Knowledge Store**

Finally, librarians will support users as they interact with the electronic medium by contributing to the knowledge base of their discipline. This may be when they are preparing a submission to an electronic journal for which the contributors need to obtain the "instructions for authors," or the users may need to know how to cite an electronic resource for a submission to a conventional print publication. This is an area where librarians will be able to provide assistance.

**Conclusion**

As Internet resources continue to proliferate and connectivity is extended to an ever-widening user group, it is incumbent upon libraries to incorporate awareness of these resources and the means of accessing them into their reference services and instructional programs. The nature of the Internet and the variability of its resources requires time devoted to training of staff and for planning. The hierarchy of information skills is proposed as a framework for identifying the skills needs by staff and users alike and for planning how Internet resources might be integrated into services offered. As users begin incorporating electronic resources into their information frameworks, librarians must be prepared to assist them with traditional information-seeking skills and behaviors—i.e., awareness of what is needed and available, evaluation and management of information, and information regarding additions to the knowledge store. Librarians are familiar with these concepts but need to become familiar with Internet resources and identify ways to incorporate these resources into library services.

**Notes**

1 Diane K. Kovacs and Kara Robinson, Kent State University, and Jeanne Dixon, College Center for Library Automation, surveyed fifty-eight library and information science electronic conferences in Spring 1992. The data show that 37.5 percent of those surveyed have used Internet resources in providing reference services (Kovacs, et al., In press).

2 Billy Barron, University of North Texas, compiles a directory of Internet accessible resources which Peter Scott and Earl Fogel, University of Ottawa, make available
via the HYTELNET hypertext front end software for DOS, Macintosh, UNIX, and Vax VMS systems (more information can be obtained by addressing an e-mail message to: <scott@sask.usask.ca>.

3 Art St. George, University of New Mexico, compiles a directory of Internet accessible resources which Mark Resmer, Sonoma State University, makes available via L, the LIBS front-end software.

4 Gopher was developed at the University of Minnesota. It is an interface for a network-distributed database. More information can be obtained by anonymous FTP message to: <boombox.micro.umn.edu>

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From Smart Guesser to Smart Navigator: 
Changes in Collection Development 
for Research Libraries in a 
Network Environment

**YUAN ZHOU**

**ABSTRACT**

*Network technology, electronic publishing, and Internet communication are changing the practice of collection development in research libraries. The proliferation of both commercialized electronic information products and the electronic resources available over the Internet require selectors to extend their traditional expertise to include knowledge of various electronic resources and acquisitions skills using computer-facilitated tools and procedures. The techniques will enhance both the selectors' capability in coping with changes and their performance in information selection, but the selectors must take the initiative to explore these possibilities.*

**A TECHNOLOGICAL ENVIRONMENT**

The current trend of dramatic advances in computer network connections suggests that research libraries have been moving into a new technological environment. In this environment, computers are networked locally and connected to each other through "information highways." Many databases and other electronic resources previously available only locally are now accessible to anyone with network connections. Geographical distance, once a seemingly insurmountable barrier to the instantaneous demands of remote users, has become much less relevant in the quest for information. Institution-based differences between the "fortunate" and the "less fortunate" research communities regarding accessibility to information resources are starting to blur and will be redefined by increased connectivity.

Yuan Zhou, East Asian Library, S-75 Wilson Library, University of Minnesota, 309 19th Avenue South, Minneapolis, MN 55455

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The changes occurring in this new environment for research libraries are both visible and profound. Reference service, once constrained to locally created databases, now extends to a host of electronic resources ranging from locally licensed or mounted commercial databases to online public access catalogs (OPACs) of distant collections available for searching through the Internet. This extension has enhanced both the quality of reference services and user satisfaction. The most visible beneficiaries of network connections within the library are perhaps interlibrary loans and document delivery services. For interlibrary loans, access to remote OPACs enables a borrowing institution to confirm holdings, ascertain circulation status, and check bibliographical information before registering a request with a potential lender. It may also aid in determining a preferred lender in cases where several institutions own the item in question. For document delivery services, networks are beginning to demonstrate their potential for instant delivery through the growing number of items stored in digital format. Electronic mail, listservs, and discussion forums on the Internet offer librarians an interactive channel through which they can communicate with colleagues on issues of mutual concern. Such a powerful communications system not only enables librarians to share their thoughts with colleagues across the country and throughout the world, but also significantly improves local organizational communications, particularly to those libraries with branch locations. Indeed, the potential benefits of network communications for professional development, problem solving, and organizational efficiency can hardly be overestimated.

Changes in Collection Development

Less visible, but by no means less important, are changes about to occur in collection development. Compared with other library functions—i.e., cataloging, circulation, reference, and interlibrary loans—collection development has hitherto experienced, in general, fewer changes through technology with the exception of acquisitions processing. While many librarians in other positions experienced increased need for computer skills, these skills were generally less important for bibliographers. Even after CD-ROM products became popular in libraries, their selection and acquisition tended to be handled by systems librarians or online coordinators (Beaubien, 1991, p. 43). Although many bibliographers have acquired high levels of computer proficiency, these skills still tend to be emphasized far less in position descriptions for bibliographers than for other librarians. However, this disparity will not last for long.
Once again, information technology acts as the agent of change. Networks have created new potentials for improving many aspects of collection development such as selection, acquisition, evaluation, and interinstitutional cooperation. Electronic publishing is another technological aspect that will help shape the future of collection development. Librarians have closely monitored the development of electronic publishing—from commercial bibliographic databases; full-text databases; and CD-ROM products to electronic journals and monographs; and full-image and multimedia resources. While rapid advances in computer storage capabilities, information storage and retrieval techniques (including image scanning), and audiovisual technology have surely provided the impetus for this progress, it is network technology and the Internet that have brought about the recent proliferation of formal and informal electronic resources. Without the Internet, many of the new electronic journals would not have been created, nor would a large body of literature from numerous online forums, listservs, and conferences. The informal online literature may be less rigorous, but it is widely consumed and seems likely to play a role in the future of scholarly communication, education, and lifelong learning. The convenience of delivering an electronic text via the Internet, the predictably explosive growth in network subscribers, and the significant improvements in traffic control and navigation to be brought by further development of the National Research and Education Network (NREN), have encouraged—if not actually provoked—electronic storage and preservation of esteemed texts. Those projects are being done by the Center for Electronic Texts in the Humanities (CETH), Project Enlighten, and Project Gutenberg. The advantages apparent in digital scanning over microfilming in preserving, reproducing, and disseminating paper-based images support the prediction that this new technology is well on its way to replacing microforms (Billings, 1991, p. 411).

Change in the research library environment is multidimensional. If the recent advances in information technology represent the high points of this change, the deterioration of funding and the rising costs of operation clearly represent the low points. It is this combination of positive and negative in the present climate of change that compels research libraries to study the challenges and opportunities presented by interior and exterior forces and to explore strategies to cope with them (Gardner, 1991, pp. 18-22). One philosophical change appearing repeatedly in the library literature is the shift in emphasis from ownership to access. Mitchell and Saunders (1991) pointed out that the concept of the "virtual library," which eliminates the distinction between local and remote users, created
a dilemma for libraries whose allocations were based on in-house services. Rooted in the conflict between ownership and access, this problem will intensify with the growth of networks (pp. 8-9). In an article entitled, "From Ownership to Access: A Dilemma for Library Managers," Shaughnessy (1991) claimed that: "The concept of a library as a warehouse of information, if it ever was entirely valid, is certainly losing validity today" (p. 1). He called for libraries to test potential combinations of traditional supply-oriented library philosophy with relatively new demand-driven ideas, predicting that libraries will discontinue ownership-based performance measures in the foreseeable future (pp. 4-6). When discussing the financial difficulties libraries face today, Johnson (1992) strongly advocated that research libraries should reevaluate some of their traditional assumptions, such as large collections equal better libraries, or that ownership is the cost-effective ideal and access to off-site resources is a poor second. She urged research libraries to put the concept of cooperative collection development into daily activities and to concentrate resources on providing "just in time" services and on materials that provide the maximum benefit to the greatest number of users (pp. 4-6). In a more recent article, Smith and Johnson (1993) further suggested that research libraries abandon the traditional practice of developing largely redundant comprehensive collections and "implement a genuine and substantial cooperative collection-development program at the national level" (pp. 391-92). They recommended that research libraries begin purchasing only those materials subject to intense use, those likely to be difficult to acquire or borrow later on, and those for local special collections, predicting that, as scholarly publications are increasingly created and distributed in electronic format, large local collections will become financial burdens in the future (pp. 391-92).

There seems to be little doubt that radical changes will take place in research libraries' collection-development activities if scholarly communication becomes largely electronic, as the consensus of visionaries seems to indicate. However, the migration of this literature from print format to largely electronic media will not occur overnight; rather, it may require several decades (Smith & Johnson, 1993, p. 389).

What should collection-development librarians do in the meantime? One thing seems clear. Changes in collection development will occur even as the migration of the literature proceeds. Thus, a realistic proactive approach may be to evolve with the environmental changes while remaining prepared to take larger and quicker steps as the process unfolds. This article posits a model of three interrelated phases to delineate this approach.
PHASE ONE: A FAMILIAR SCENE

The basic scenario of phase one is that scholarly communications are created and distributed in traditional formats and acquired by libraries through traditional means. These traditional formats include paper-based and nonpaper-based resources. Paper-based resources include published materials such as books, periodicals, reports, patents, specifications, maps, and newspapers, as well as unpublished materials such as letters, diaries, and research notes. Nonpaper-based resources include films, slides, and sound and video recordings. In short, every medium currently collected by libraries, except for computer-based items, falls into this broad definition of traditional formats. The acquisition of these materials does not refer solely to their purchase but to the full range of collection-development activities—i.e., identification, evaluation, selection, and verification—that results in a library adding new material. Traditionally, these activities involve publishers, vendors, and librarians and have been based largely on paper files and manual processes.

In this phase, a well-developed research collection should strive to respond satisfactorily to both the present and future needs of the local user community. This duality requires the selectors to be well-educated guessers. By definition, the competent selector should possess solid knowledge of the publishing industry and book trade market, full comprehension of the institution's short- and long-term commitments, awareness of the core and peripheral user groups' profiles, skill with languages, and expertise in at least one subject area. In practice, selectors in American research libraries are required to hold a graduate degree in library studies and frequently an advanced degree in an academic discipline as well, with the addition of proficiency in foreign languages. Selectors examine lists and reviews regularly. They monitor approval plans, check catalogs and prospectuses from publishers and others, and search standard references and bibliographies. Additionally, selectors maintain close contact with schools, departments, and individual faculty and researchers. Of course, good selectors also require proficient social skills, but it is particularly the other skills mentioned earlier that enable them to make productive educated guesses.

This scene is extremely familiar—the phase one scenario has been the common practice of research libraries for many years and is still valid. Indeed, some portions of this scenario will remain valid for a long time, while others will be replaced as phase two and phase three emerge. In fact, some replacement has already occurred.

PHASE TWO: A BETTER WAY OF DOING OLD BUSINESS

A major distinction between phase one and phase two lies in the different means of acquiring materials. In phase one, the entire
procedure may be based on paper files and manual processes, while in phase two the procedure is facilitated by computers. It is not surprising that automation first was applied to the last link of collection-development's procedural chain—identification, evaluation, selection, and acquisition. The repetitive, labor-intensive, and inventory-oriented nature of this work makes it ideal for the application of automated processes. During the last decade, libraries developed several strategies to automate this process including developing in-house acquisitions programs, purchasing acquisitions software or single-function acquisitions systems, subscribing to time-sharing acquisitions services from a bibliographic utility or vendor, or installing an acquisitions module in an integrated system (Saffady, 1989, p. 269). Before long, it became clear that an integrated system with an acquisitions module was the best solution available.

Automating collection-development procedures will not stop at merely computerizing the acquisitions process. Advances in information technology strongly indicate that solutions to facilitate other parts of collection development are at hand. In a 1989 article, Welsch presented a "selector's workstation" scenario, an idea similar to the concept of the "scholar's workstation." Welsch described such a workstation as "a microcomputer linked with a local computer center and external databases through telecommunications networks," that would provide "a resourceful means for coping with the challenges of new information needs" (p. 29). He listed all the components of this "resourceful means" that would help selectors work more effectively. These components included links with local, regional, national, and international online library catalogs and bibliographic databases, online access to selection tools, an interactive system for faculty consultation on selection decisions, and a sophisticated data analysis system that would provide information on collection use, course offerings, enrollment, and budget expenditures as well as basic information on the collections of the institution's cooperative partners (pp. 32-33). It is exciting to see that a large part of this concept has already been realized. In many research libraries the basic component of the selector's workstation—a microcomputer with network connections—is already on many selectors' desks. What remains to be done is to place the information and data files at selectors' fingertips to aid them in the processes of identification, evaluation, and selection.

Making publication information readily available to selectors' workstations requires active involvement and close cooperation with publishers and vendors. Vendors who maintain current publishing information drawn from a variety of publishers are in the best position to develop such databases. One early example was Faxon's INFOSERV
online service, an interactive purchasing system for serials. With current information on thousands of serial titles on the market, the system allowed librarians to search by publisher, subject, keyword, editor, affiliation, and date of first issue. In the event bibliographic records, order information, or other descriptions were not sufficient to facilitate a decision, the user could instantly request a sample copy, a publisher's catalog, or a visit from a representative. The system also allowed direct input of updated information from publishers, and direct order, inquiry, and confirmation from libraries (Brown, 1984). Similar systems were developed elsewhere. The Southwest Missouri State University Libraries reported their success in adding an online approval subsystem, developed cooperatively by Blackwell's and NOTIS, to their integrated library system. Newly available titles could be searched by author, title, LC class number, and departmental profile. Library liaisons from academic departments could accept or reject titles in their areas of responsibility without going to the library. The appropriate acquisitions process was carried out online once the selection decision was made (Cline, 1992, pp. 164-66). A more general approach has recently been seen in the release of version 2.0 of YBP Folio, Yankee Book Peddler's online approval service. Serving several dozen large academic libraries' approval plans, the system can be accessed through the Internet or direct dialing by customers and noncustomers alike. The system offers standard search capabilities on titles, acquisitions and shipping verification, and electronic ordering interfaces capable of converting orders generated by a number of standard turnkey library systems into the YBP Folio system (Yankee Book Peddler, 1993, pp. 2-4).

While publishing information can be supplied by publishers' or vendors' databases, standard selection tools can be loaded to a local or regional system with licensed linkage to each member location. The same is true for those bibliographies and other reference works which are often used by selectors. It seems likely that efforts in mounting publishing information and selection tools online will increase with time.

To facilitate evaluation, selectors also need access to reviews at their workstations. With the intent of facilitating member libraries' collection-development activities, the Colorado Alliance of Research Libraries (CARL), one of the nation's most successful wide-area library computer networks, loaded CHOICE, a popular book review journal, on their system four years ago. A database or databases containing full-text book reviews in every academic field should be developed and be easily accessible to selectors and to library patrons.

As research libraries' collections become increasingly interdependent within the network environment, information on other
libraries—particularly those of cooperative partners—becomes more important to selectors. The online catalogs of regional library networks, such as MELVYL in California, the State University System (SUS) in Florida, Ohiolink, and CARL, function as union catalogs for all members of the network. These catalogs could be powerful tools in cooperative collection development. For example, an online union catalog containing serials holding records of each member library could aid participating libraries in making critical canceling decisions cooperatively (Lenzini & Koppel, 1990, pp. 15-16). However, unless a system is also equipped with sophisticated data analysis functions so that information such as collection distribution; use; fund allocation; and average price by subject, language, or publisher can be easily obtained and compared with data from other libraries where applicable, the usefulness of the network catalog for cooperative collection development is quite limited. Thus, system upgrading and timely data input and maintenance from each member library are the key issues that need to be addressed. The Internet offers selectors access to the OPACs of many other research collections, which may help them compare the strengths and weaknesses of their collection with others. However, such obstacles as system drops, slow response time, and differences in indexing structures, interfaces, search protocols, level of on-screen instruction, display limitations, and so forth can seriously restrict the usefulness of these resources. As open systems and standardized interfaces become more common, some of these obstacles will be overcome.

Network environments create the potential for useful interactive systems to involve patrons in the selection process. A locally controlled online bulletin board with forms for patron requests linked to the databases of selection tools and reviews could benefit libraries and their users in many ways, including improvements in user relations. Such a system could also help subject specialists develop interactive relationships with a broad patron base while also enhancing their role as academic liaisons.

It is not difficult to realize that no matter how powerful the selector's workstation may become, the ultimate power for change resides in human beings. The real challenge in migrating from traditional modes of acquisition to computer-facilitated modes lies in training the work force to develop its skills as information technology develops. The time has come to automate many collection-development procedures. Thus, this is the time for selectors to add computer skills to their knowledge base and to learn new computer functions as they are developing. The rationale is not that traditional methods will be completely replaced soon, but that integrated components of the selector's workstation will offer a better way of
accomplishing the task. Moreover, developing skills in keeping with the changes in the environment are the best ways to position oneself to accommodate potential radical change in the future.

**Phase Three: A Radical Change?**

The major difference between phase two and phase three are the formats of the resources libraries will acquire. In phase three, the formats are electronic, and the acquisitions process is facilitated by computers. In this case, electronic formats mean materials that can be viewed at a computer terminal—such as software, CD-ROM products, online bibliographical databases, full-text databases, electronic journals and monographs, and some multimedia products. No doubt this list will grow as the market itself grows. For convenience, these products may be classified into three groups: off-line products, such as software and CD-ROMs; online products, such as those available through DIALOG and BRS; and in-between products, such as locally mounted commercial databases. Libraries actually own the off-line products they acquire, while they purchase only certain rights to online products. The third group includes products that may license copyright to a library, a consortium, or a regional network, products that libraries may acquire online and then store for later use, and products acquired intermittently on demand from a central service without local ownership or retention.

Rapid expansion of electronic resources is an accepted fact, yet some figures drawn from Chemical Abstracts Services (CAS) provide some sense of magnitude and impact. In 1980, 99 percent of CAS's annual income came from printed sources. A decade later, in 1990, a little more than 40 percent was derived from electronic services. Between 1985 and 1990, CAS lost one-third of its printed format subscribers (Kaser, 1990, p. 38). At the same time, more than thirty primary chemistry journals developed electronic full-text access (p. 41). While CAS may represent something of a special case because of its primary indexing and abstracting functions, indications are that widespread full-text full-image electronic publication of primary resources is well underway. Elsevier, one of the world's largest purveyors of scholarly publications, recently announced its "University Licensing Project." This experiment will distribute about forty engineering and materials sciences journals over the Internet to a number of university networks where faculty and students will have electronic access to them in full-image (Messmer, 1993, p. 29).

Acquiring electronic resources will become an increasingly complex task as the number and variety of these publications increase. Each product may carry a hardware capability aspect, a technical support consideration, and a public services and user training
commitment. Moreover, overlap will become a greater concern as many products already exist simultaneously in online, offline, and print formats. It is not uncommon today to find the same title—especially a reference work—duplicated in two or more formats within the same library. Some overlap may be unavoidable or even desirable, but, as electronic publications proliferate and competition among producers escalates, excessive overlap may become a financial burden.

It is in this area that selectors should start to accumulate their new expertise in selecting various commercialized electronic resources. As stated earlier, the decision to acquire these resources has more often been the responsibility of systems librarians, committees, or task forces than the responsibility of selectors. The committee or task force approach that is currently employed in many research libraries draws expertise and interested parties together to cope with the complexity of the task. Selectors should empower themselves with the knowledge of acquiring electronic resources by actively participating in these committees and through other means of learning, because a predicted significant growth in commercialized electronic resources will require them to play a more active and important role in assisting libraries to make intelligent selection decisions. This requirement naturally brings up the issue of integrating selectors' traditional expertise in information resources with new knowledge of electronic resources, particularly those related to their subject specialties.

The network connection also creates a favorable climate for the proliferation of electronic resources on the Internet. It was estimated that in 1993 there were approximately 50,000 databases available through the Internet (Pool, 1993, p. 841). While the richness of these resources is astounding, so is the difficulty of keeping track of them. Though navigation aids like Gopher, Wide Area Information Servers, World Wide Web, and Archie offer some traveling guidance and searching tools, knowing what resources are available on the Internet and how to locate them remain formidable tasks. Subject specialists with collection-development responsibilities need to learn how to operate within the Internet environment in order to extend their expertise to include relevant resources located there. As great as this challenge is, so will its reward be, as expert selectors will become increasingly vital to the academic research community.

CONCLUSION

The developments of computer technology, networks, and electronic publishing are changing the mode of scholarly communication. These changes will in turn affect the future of collection development in research libraries. The traditional paper-based
manual selection and acquisition processes will largely be replaced by selectors' workstations and automated procedures. Computer applications will continue to improve and thus become increasingly sophisticated. At the same time, scholarly communication will migrate from mainly print-based systems to a system integrating print and electronic formats. As a result, selectors in research libraries will be responsible for acquiring materials in both formats.

The model proposed in this article (see Figure) suggests that none of these three phases will entirely replace the other two. Rather, they will co-exist for a long time, each in turn serving as the principal pattern at a given period. For instance, when phase three becomes the dominant pattern in collection development, paper catalogs and related material may continue to be used in certain areas, such as foreign language publications. Phase one will be largely pushed off the stage by the impetus of phase two and phase three. Likewise, phase two will be forced toward the current position of phase one, and phase one toward phase three. Eventually, phase three will move to center stage, and phase one and two will be largely off the stage. When this occurs, all phases will cease moving because a particular phase's impetus serves as the force to place it at center stage. Once this placement is attained, the phase's impetus is spent and it is moved thereafter only by newly introduced forces coming from behind. Will the phase three pattern remain unmoved forever? Probably not, nor will collection-development activities remain static as they are currently defined. If the information base becomes largely electronic in format, acquisitions and collection-development activities will decline substantially as Lancaster (1982) predicted. Selection will occur at the moment the decision is made to access a particular resource in response to a particular demand (p. 67). Librarians may become information brokers or consultants, and selecting what to access will become only a portion of their extended responsibilities.

The shift from phase one to phase three as the dominant practice is not merely a matter of technological progress. It also represents a long journey undertaken by research libraries to move from the traditions of ownership to a philosophy of access. In the course of this migration, changes in organizational structure, budget and staff allocations, and individual librarians' roles and responsibilities will undoubtedly occur as well. Librarians currently working in collection development must acquire new skills in the electronic environment and integrate them with their traditional strengths of subject expertise and their ability to function as user liaisons. They must understand that this change will not eliminate their role as information selectors but rather empower them to navigate an ocean of information.
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Equalizing Access to Electronic Networked Resources: A Model for Rural Libraries in the United States

JUDITH J. SENKEVITCH AND DIETMAR WOLFRAM

ABSTRACT

RURAL LIBRARIES AND PATRONS have always suffered more because of limited access to information than their metropolitan counterparts. Libraries in rural settings have had to deal with the difficulties of working with more limited budgets and smaller collections serving populations distributed over larger areas. With the rapid development of networked resources and access tools available over the Internet, which are most easily accessible in metropolitan areas, disparities in access to information are growing even larger. Instead of widening the rift between metropolitan and rural library users, the new telecommunications technologies could bridge the distance, providing more equalized access to the wealth of human knowledge to rural library communities. This article provides an overview of the current state of networking technology in rural libraries and describes a model for educating rural librarians in the new technologies that will enhance library service to rural communities.

INTRODUCTION

The recent explosive increase in the development and availability of information resources and access tools over the worldwide network of networks known as the Internet promises to bring great change in the way individuals search for, and are able to access, remote information resources. This accessibility, however, is currently limited to perhaps 10 million users worldwide who are largely associated...
with academic, research, government, and commercial institutions in urban areas. These enhancements in library service are already evident in many academic libraries which have been early adopters of this technology due to easy access through campus computing services. Special libraries have also enjoyed similar privileged access (Tillman & Ladner, 1992). Rural libraries, however, have always been disadvantaged in the number and types of services they are able to provide to their patrons. Serving relatively small populations over large geographic areas, rural libraries must contend with limited resources and access to services taken for granted by urban library users. Economics dictates the size of the collections of the libraries based on the size of the population served. For this reason, rural libraries are traditionally smaller than urban counterparts. Access to larger libraries by rural librarians and patrons is often not feasible due to large distances.

Computer networks provide access to thousands of resources distributed among numerous sites. The availability of these resources via current telecommunication technologies could be the "great equalizer" that would allow rural libraries to access the same online resources available to the largest urban libraries and would enhance the type of services they provide. Access to electronic networks for rural libraries and their communities can help address the growing trend cited in the library literature (e.g., Doctor, 1992; Marien, 1991; Dougherty, 1991; Scheppke, 1990), that is, toward a nation divided between information "haves" and "have-nots"—with attendant disparities in education, income potential, and opportunities. Rural residents, like urban dwellers, need timely access to an array of information in order to make decisions that affect their lives and work and in order to compete successfully in a global marketplace. Although both opinion and research reported in the literature occasionally convey conflicting views on the status of rural libraries and their communities, a careful review of the literature shows reason to be concerned. This conclusion is supported by Doctor's (1992) broader overview of the role of information technology in social equity in the United States which demonstrates that, "existing data provide warning signals about significant disparities in the distribution and use of information resources" (p. 80).

This article provides an overview of issues in rural librarianship concerned with implementing advanced telecommunications technologies in order to enhance library services. It also presents a model for educating rural librarians in accessing electronic networks and outlines how the model may be implemented in rural settings.

RURAL LIBRARIES AND INFORMATION NEEDS

Rural communities (those with fewer than 25,000 inhabitants), and the libraries which serve them, are diverse; they are frequently
in geographically remote and sparsely settled areas, in economically declining towns, as well as in bedroom or commuter communities. In a broad overview of the problems and nature of rural communities, a 1991 study commissioned by the U.S. Congress Office of Technology Assessment reports that, despite their diversity, many rural areas share declining income levels, high unemployment, and population loss. In the past, rural areas have tended to be slower to adopt innovations than more urban communities (Dillman, 1991, p. 32), an additional problem in a time of rapid economic and social change. Being rural "implies [having] low population density and uneven access" to opportunities available in more densely populated areas (Heasley, 1992, p. 8). Wilkinson (1991) notes that ruralness not only impedes access which is essential for well-being, but also, in more recent times, has come to be associated with social isolation, a factor cited in a range of social ills (pp. 54-55).

Recent literature strongly suggests that the varying information needs of rural communities are not adequately met and that rural libraries have an important role in addressing those needs. These are recurring themes in the published papers from two conferences focusing on small and rural public libraries: the 1990 H. W. Wilson Symposium on the Future of Public Libraries (Wilson Library Bulletin, 65[9]) and a conference jointly sponsored by the Center for the Study of Regional Librarianship, the National Agricultural Library, and the Northeast Regional Center for Rural Development, in cooperation with the Department of Library Science at Clarion University of Pennsylvania and the State Library of Maine (Rural Libraries, 12[2], 1992). Dillman (1991), for example, asserts that, "rural communities have some very serious information needs quite different from those of the past, and no one is meeting them..." (p. 31); Heasley (1991, 1992) also describes unmet information needs and the role of rural libraries in meeting them. Consumers, including rural residents, are becoming both more demanding and more sophisticated in their expectations of information service (Vavrek, 1991, p. 26).

Vavrek, in national studies of the information needs of rural Americans (1990) and of the role of the rural public library (1993), found a troubling disparity between identified information needs of rural residents and the capacity of the local library in addressing those needs. Vavrek's (1990) studies found that libraries were not regarded as resources for timely information, leading him to speculate that, "rural library staff continue to be in a book oriented world while the multiplicity of resources has grown because of the information explosion" (pp. 27-28). This problem is compounded by the fact that the great majority of personnel in libraries serving fewer than 25,000
people (80 percent of all public libraries) do not have an M.L.S. degree. Vavrek's findings (1990, 1993) point to a critical need to provide specialized training to rural librarians in order to bring rural libraries into the electronic age.

A recent report by McClure, Ryan, Lauterbach, and Moen (1992), examining the present and future of public libraries and the Internet/NREN (National Research and Education Network), recommends that public libraries play a vital role in providing access for the public to networked information resources. The study identified a pressing need, not only for programs to increase librarians' awareness and understanding of the Internet, but also for a massive effort to provide educational opportunities for public librarians related to the Internet/NREN (pp. 22-23). Again, as Vavrek (1990, 1993) has pointed out, this need is particularly acute for rural librarians who have little formal training and very limited access to continuing education. McClure also found that public librarians, including rural librarians, were less likely than others to be aware of the Internet and its potential uses. Other recent works (McClure et al., 1993; McCook, 1993) also call for leadership and a strong role for libraries, including both public and school, in the development and implementation of future electronic network resources, and cite the need for training in the use of electronic resources for public and school librarians. McCook (1993) posits the idea that the service ideal of the library profession makes it the most viable group to ensure the provision of equal access to information for all (pp. 9, 14).

A number of writers describe the rural library as a potentially key point of access to remote information for rural residents and envision the librarian as serving as an effective change agent in the rural community (Parker, 1991; Heasley, 1991, 1992; Godwin, 1991; Wilkinson, 1991). For example, Heasley (1991) recommends that the librarian actively help the rural community cope with change in adopting new technologies by playing one or more "change agent" roles—e.g., resource linker, process helper, solution giver, and catalyst (p. 34). Heasley sees all of these roles as natural to the library profession.

**Telecommunications Technology Access in Rural Areas**

Studies suggest telecommunications technology use and policy in rural areas may have profound effects on the ways in which rural libraries will be able to implement information technology and provide services. Residents of rural areas traditionally have not adopted innovations in information technologies as quickly as urban dwellers (LaRose & Mettler, 1989, pp. 48-49). However, this does not mean that rural residents do not have access to telecommunications. The
existing telephone network, designed to handle primarily analog voice
communication, represents a readily available data highway for
gaining access to networked information resources by means of
microcomputers, modems, and communication software. However,
limitations in the transmission medium (usually consisting of twisted
pair wires), particularly at the local loop level (the wiring that extends
from the user's residence to the central telephone office that connects
users to the rest of the world), restrict users to low bandwidth
capabilities. Access difficulties for rural users then may not be due
primarily to lack of physical access to data communication networks;
the difficulties may exist because available linkages are underpowered
with low bandwidth. Current telephone lines will support a maximum
of 9.6 Kbps to 14.4 Kbps, whereas direct network users typically will
have at least 64Kbps. Reliability of data transmission also may be
problematic, particularly in rural areas (Hudson & Parker, 1990, p.
200; Egan, 1992, p. 32). Another important factor that has restricted
rural access to networks is economics. Because network access is rarely
available locally through a network node, rural users must also absorb
long-distance telephone charges.

As noted earlier, the research literature provides conflicting
evidence as to the plight of rural residents. In a study of information
technology use, LaRose and Mettler (1989) examined use of a variety
of information technologies in seven rural counties in the United
States and residents' willingness to adopt these technologies. The study
found no significant differences between rural residents' and nonrural
residents' willingness to use information technologies, including
networking technologies (electronic mail, online databases, computer
modems, private computer networks). It is interesting to note that
there were also no significant differences observed in use between
rural and nonrural counterparts. The authors also suggest that rural
residents are not technologically disadvantaged members of the
information society. However, the study's nonrural segment used for
comparison represented regions bordering rural areas and was not
truly urban.

Another study, specifically of rural libraries, by Mumma (1991)
concludes that most rural libraries do not have the same technological
advances as urban libraries. Of the ninety-seven respondents in the
study of a random sample of rural libraries throughout the United
States (except Hawaii), only ten libraries had an automated catalog
while twenty reported an automated circulation system and thirty-
three reported using some type of computer program to assist in
cataloging. Twenty-one of the respondents offered online database
searches, either in house or elsewhere, and eight libraries offered CD-
ROM searches (pp. 8-10). Mumma (1991) found that most rural
librarians would like to offer these services and cite lack of funds as the key deterrent (p. 12). Vavrek (1993) found that while 55 percent of rural adults were interested or somewhat interested in "computerized information" as a library service, fewer than 6 percent of the libraries surveyed had computerized information (pp. 25-26). A new survey on the use of Internet technology in public libraries begun in Fall 1993 by McClure and Zweizig for the U. S. National Commission on Libraries and Information Science (NCLIS News Release, November 17, 1993) will yield additional insights on this topic.

A 1990 national poll by the Louis Harris organization (Westin & Finger, 1991) found a high level of interest among the U. S. public (two-thirds of those adults polled, including low-income and minority individuals) in using computers for online information from public libraries or other nonprofit services (p. 4). Westin and Finger, in summarizing the key implications of the study's findings for the future of publicly funded libraries, urge the use of electronic resources to enhance library services in order to narrow the gap in access to information (pp. 4-6).

The 1991 U.S. Congress Office of Technology Assessment (OTA) study assesses the information technology needs of rural residents across the United States and explores the positive role that communication technologies can play in the future of rural development. It also touches on the challenges, political as well as logistical, of linking diverse remote areas to the National Information Infrastructure. Based on an examination of many rural areas and current technology availability, the investigators conclude that rural areas share many common problems, but local resources to help solve these problems can be very different. They believe that education of rural users is important for efficient use of available technologies and that it prepares them for future information technologies. Rural areas must have access to the necessary information infrastructure to inhibit further economic decline of these regions.

A range of technologies exists to facilitate network access to rural areas. Telephone access represents the most readily available technology, but limitations in bandwidth and lack of broadband capability make it undesirable for electronic networking. Current economic constraints prevent enclosed media with high bandwidth capability (such as fiber optics) to be readily available in most rural areas. Broadcast media in the form of microwave and satellite transmission could represent an economical way of reaching isolated communities because costs are less distance dependent than for enclosed media. These broadcast technologies have already been used to support communication and educational and entertainment needs in many areas of the world.
The OTA study (1991) proposes the development of Rural Area Networks (RANs) configured around geographic, rather than functional, boundaries and needs of communities—a ring architecture linking many types of users, ultimately connected statewide using government or education networks (p. 9). The investigators make a case for deploying broadband networks rather than taking a more cautious evolutionary approach on the basis that broadband technology facilitates sharing and will ultimately be more cost effective than upgrading narrowband technology. In addition to access, the OTA study outlines other problems facing rural communities in implementing new technologies. These include a lack of local expertise and experience, lack of attention from communication vendors (p. 11), and competition for turf and control that can hinder necessary cooperation (p. 17).

Telecommunications policy for rural areas has been an active area of investigation, focusing on the socioeconomic benefits associated with greater telecommunications access. Warnings have already been issued stating that, if rural America does not learn to use telecommunications technology, its decline will continue because it will not be able to compete with urban economies. Information-based industries in rural areas could help rural communities compete with urban counterparts since geographic proximity to urban centers becomes unnecessary once appropriate telecommunication connections have been established.

Hudson and Parker (1990) examine the changes in the telecommunications environment based on economic changes in rural areas sparked by the growth of public and private services. The authors develop a list of indirect socioeconomic benefits of telecommunications, some of which, by implication, also will benefit libraries. These include improving the quality and accessibility of education and other social services; improving productivity, efficiency, and quality of services and a reduction of costs; and fostering of a sense of community and strengthening of cultural identity (p. 196). Specific goals the authors recommend cover both voice and data communications including “telephone facilities of sufficient quality to allow reliable transmission of facsimile documents...” and providing “rural telephone users with local access to value-added data networks” (p. 201). These ideas are expanded in a book compiled by the authors (Parker & Hudson, 1992).

Egan (1992) investigates factors influencing advanced voice and data telecommunications development in rural areas of the United States, technical difficulties associated with their implementation, current options, and costs of various technologies. Before advanced data communications services will be possible, upgraded digital services
will be necessary for rural subscribers. Egan provides estimates of costs for upgrading rural connections for baseband and broadband services. From Egan's comment that, "[t]oday's rural telecommunications infrastructure is a patchwork quilt of subnetworks with many owners and operators..." (p. 37), it is clear that network infrastructure for rural environments is largely lacking. He recommends that the best way to achieve rural objectives for a network infrastructure is to proceed at the state level.

**SAMPLE SERVICES TO ENHANCE INFORMATION ACCESS**

Rural environments have already begun to take advantage of advanced computing and telecommunication technologies. Libraries have played an important role in many of these projects.

Facsimile technology represents a readily available technology using standard telephone access for enhancing document request and delivery. The use of this technology in rural areas has been implemented in some settings (Nichols, 1990).

The Blacksburg Electronic Village in southwest Virginia represents a locally focused networking project using high-level information technology. The project was established as a partnership of a regional telecommunications company, Virginia Polytechnic Institute and State University, and local government to provide Blacksburg with a twenty-first century telecommunications infrastructure. The project, a prototype to test the success of a variety of information services, encompasses a range of applications for data access and transfer including video transmission. The network will allow students at all levels and teachers to communicate with one another and will permit access to the wider NREN. Business and professional uses will allow professional services to be offered to local clients. In addition to providing recreational and social services, the network is envisioned as an electronic town hall to facilitate discussion on a variety of local issues (Wiencko, 1993).

If proven viable, the Blacksburg model could be implemented in other communities. However, it must be noted that the project is being developed in a specialized environment with a large university to help establish and support the network and a technologically literate community. The community also has the support of its high-profile U. S. Congressman, Rick Boucher.

While the Blacksburg Electronic Village employs high technology for community-based information services, the Big Sky Telegraph project in Montana represents a successful rural community-based information system using lower level technology (Odasz, 1994). Based in western Montana, it is now accessible in several northern mountain states. This bulletin board service, established in the late 1980s with
the cooperation of Western Montana College, allows users to interact with resource people and librarians. Big Sky uses a variety of approaches to promote the adoption of this technology, including "circuit riders" or change agents who visit local communities to offer demonstrations and training (Odasz, 1993). The project offers a regional model for access to a wide variety of users across many towns using community bulletin board systems.

Project GAIN (Global Access Information Network), based in upstate New York, is examining the value of Internet connectivity for rural public libraries. The project will evaluate the effectiveness and tangible benefits of providing rural communities and libraries with access to electronic resources. The project takes a novel approach to supporting network access in rural areas. Network accessibility to rural areas is often viewed as a one-way benefit in which the rural areas are seen to profit from access to urban resources but provide no resources in return to the wider Internet. Project GAIN is also investigating how rural connections can provide access to local resources such as genealogical information, regional history, and recreational information for travel and tourism (Polly, 1994. See also Project GAIN press release on NYSERNet gopher at nysernet.org).

Regional and statewide projects have likewise been implemented in other parts of the country. In West Texas, an interactive telecommunications network called MEDNET has been established to provide physicians in remote areas with a variety of services to maintain contact with peers for consultation, diagnostic services, and continuing education (Moore & Hartman, 1992). Librarians act as information intermediaries in the preparation of information packets as well as in the support of educational programming.

North Carolina has established the North Carolina Information Network that relies on electronic mail and bulletin board services to act as gateways to a range of electronic information resources. The project is a good example of the use of available technologies and planning for advanced technologies. It is based on a philosophy of building on past investments in materials and technologies rather than one of beginning with costly new technology investments. Rural libraries are gaining access to the Internet through the statewide LINCNET System, which links the state universities, several private colleges, and the state's fifty-eight community colleges, thus making available packet switching in every geographic region of the state. The author points out that this will affect rural library acquisition budgets where money traditionally used for print resources will have to be shifted toward electronic resources. The State Library has played a pivotal role in the development and promotion of the network and has become the chief provider and marketing agency of the state's
information products and services. The North Carolina Network effort demonstrates the success of a model with the state library agency in a leading role.

While the vision of libraries with limited resources taking an active role in providing their rural publics access to electronic resources may be a challenging one (McClure et al., 1993, pp. 37-39; Vavrek, 1993, pp. 10-12), the array of regional, state, and local networking activities described earlier illustrates that libraries have been and can be viable players in this effort.

**Educating and Empowering Rural Librarians**

Because current costs for telecommunications technology can be very high, publicly funded rural libraries offer logical and potentially cost-effective sites for extending community access to electronic networked resources. They are open to all and are mandated to provide information services to their communities. However, because many rural librarians may have had little previous training in electronic networking, a large-scale effort is needed to educate librarians in using these resources.

Any effort to extend full access for rural communities to electronic networks, including the Internet, will benefit from clear national vision and leadership. Linking rural areas into the National Information Infrastructure will require cooperation from a number of sectors and at many levels, but a strong national commitment to this end, including funding, is nonetheless essential. In addition, models developed for assisting rural libraries in this endeavor need to be flexible and adaptable to differing local circumstances and needs. There are key elements or characteristics generalized from the literature and research discussed earlier which should be included in any effort to disseminate information technology to rural communities and libraries. These include:

- **Community leadership.** Effective dissemination requires a visionary, knowledgeable, energetic leader in the community. Flexibility and creative thinking are also extremely important.

- **Cooperation between public and private sectors at all levels.** Cooperation, particularly among key parties, is essential. Sharing and cross fertilization is critical in order to take maximum advantage of scarce resources in rural communities. A holistic approach, linking the deployment of communication technology to broader issues of community economic and social development (not simply in response to market demand), is needed.

- **Technology transfer/education component.** The use of a technology transfer change agent model for dissemination of technological
innovation will help rural communities implement electronic technologies more quickly and learn to use them more effectively. Research on the diffusion of innovation in rural settings suggests that the role of change agent is critical to successful adoption of a new technology (Rogers, 1983). In the classic model based on rural agricultural extension agencies, the change agent serves as an intermediary between technical experts and the field practitioner. The change agent helps practitioners understand and implement useful new technologies and programs to improve practice. At the same time, the change agent also provides the technical experts with insights and feedback on needs and problems of practitioners. Librarians have been proposed as logical agents of change in disseminating information technologies and services in rural areas.

A Model for Educating Rural Librarians

A model for educating public and school librarians in using and promoting electronic network resources to rural communities is being developed and tested at the School of Library and Information Science, University of Wisconsin—Milwaukee, with a grant from the U.S. Department of Education, Library Education and Human Resources Development Program. The model will be implemented and tested during a one-week institute held at the university in May 1994 and will target potential rural library change agents. It features an intensive training approach which combines informative sessions with experts in electronic networking and rural issues and hands-on computer laboratory instruction in using networked resources, particularly the Internet. In addition to specialized training in electronic internetworking, the institute will also teach participants the skills needed to act as change agents in disseminating the knowledge gained to other library personnel in rural areas.

The institute will train thirty rural library professionals selected from two key groups: school library media coordinators based in cooperative education agencies or combined districts and regional public library systems or network specialists. To support the "training the trainers" approach of the model, the institute will target librarians who are in positions with responsibilities for training and providing technical assistance to rural public or school library personnel. Participants will be selected for their potential to serve as change agents within their library systems and communities and to provide leadership in promoting electronic networking literacy in rural areas. Because of their common mandates to provide technical assistance to member libraries, public library systems professionals and regional school media specialists are ideally positioned to carry out this role.
Using lectures, discussion sessions, and computer laboratory instruction, the training model will provide to participants an opportunity to acquire the following competencies:

- knowledge of, and skills in using, currently available internetworked services and resources, particularly through the Internet;
- an understanding of how these resources can benefit rural library personnel and patrons;
- an understanding of accessibility and cost issues associated with electronic internetworking in a rural setting; and
- skills in disseminating information about, and promoting networking literacy to, other rural library personnel and patrons.

In addition, by bringing together rural public and school library personnel, the model is designed to promote linkages and cooperation in order to make more effective use of limited resources in rural areas.

Participants will attend expert seminars on various aspects of internetworking, available services and resources, and access costs and availability. Prior to arriving for the institute, participants will be sent a packet of key papers and materials relating to electronic networking. This will allow participants to prepare for the training program and will permit a more effective interaction with speakers and other participants. Panel reaction sessions will follow lectures to promote dialogue between speakers and participants, and coordinated small-group discussion sessions will be held to promote additional exchange of information and ideas among participants. In addition, the expert papers presented at the model institute will be published to provide a foundation for future training sessions.

Computer laboratory sessions will require participants to tackle various information-seeking tasks using network services. Participants will first receive demonstrations of various information resources and access tools. Then they will be assigned information-retrieval tasks requiring navigation of the Internet to the appropriate sources to fill the information need. Participant success rate at resolving these information requests will be monitored by institute instructors to ensure that participants are absorbing basic knowledge and concepts from the speaker sessions. These hands-on sessions will be useful in allowing the participants to explore first-hand the capabilities of the different resources currently available. Commentary sessions will also follow the labs to allow participants to express their reactions to the networked services and to permit a second opportunity for questions that may arise from using the electronic services.

In order to help ensure that the training will carry over into practice, institute participants will be expected to develop a plan for promoting networking literacy among rural librarians in their service
areas. They must also agree to disseminate knowledge gained from the program to rural librarians and residents in their service areas by providing workshops, training sessions, and technical assistance. Participant success in implementing their new skills will be monitored by the institute directors with follow-up evaluations at six months and at one year after the institute session in May 1994.

CONCLUSIONS

The literature reviewed earlier provides an overview of issues and trends—including technological developments—in extending access for rural residents to information resources available through electronic networks. The availability of network access could provide rural areas with benefits that will stimulate economic growth, particularly for information-based industries and services, and could encourage them to compete more effectively with urban areas and in a global market. Examples of current network projects underway in rural areas illustrate both the variety and potential of electronic resources to address rural information needs and offer an array of potential approaches—at the state, regional, and local level—to ensuring that rural residents will have equitable access to information.

It is crucial that rural librarians learn about electronic network resources. The authors propose a model for educating and empowering rural librarians through a funded institute that will bring systems-level rural library professionals together with noted experts in networking and information technology to permit first-hand knowledge transfer. The model discussed earlier represents an innovative approach to training potential leaders and change agents to promote the use of electronic network resources by rural librarians and the communities they serve. Skilled use of these resources can enhance rural library services and enable rural libraries to address more fully the range of information needs of rural residents. Thus will rural librarians be better prepared to take advantage of the information technologies and resources of the twenty-first century on an equal footing with their urban counterparts.

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Evaluating Electronic Texts in the Humanities

Susan Hockey

Abstract

The number of electronic texts in the humanities is growing fast and many libraries are seeking to acquire them from various sources or to provide access to them. Building, in part, on the experience of those scholars who work with electronic texts in literary and linguistic computing, this article surveys some issues which libraries may need to consider as they begin to establish collection-development policies for electronic texts. An overview of existing texts and applications is given, which leads to a discussion of markup schemes. The Text Encoding Initiative's proposals for documenting electronic texts are surveyed, and the article concludes with a discussion of software and access tools.

Introduction

Electronic texts have been used for scholarly research in the humanities for the past forty years or so ever since Roberto Busa began work on his Index Thomisticus in 1949. However, it is only in the last three to four years, and particularly with the advent of the Internet, that humanities electronic texts have moved into the center of the scholarly arena as libraries begin to collect them and provide access to them. In the humanities, as in other disciplines, electronic textual resources offer many more possibilities than print, but, in general, libraries do not yet have any well-established practices for collecting and handling electronic texts as they have with print material. Shreeves (1992) discusses some of these questions from the
perspective of the librarian, but there is a need also to look at what humanities scholars might want to do with the texts.

Electronic text is used here to mean primary source material in the humanities rather than journals and reference works. Such texts may be literary works (prose, verse, drama), historical papers, letters and memoranda, charters, papyri, inscriptions, and the like. The source material may be in any natural language and may be in print or manuscript form. The focus of this article is also on transcripts of text rather than digitized page or manuscript images. Images provide an exact reproduction of the original so that marginalia, annotations, parallel texts, illustrations, and the like are readily available. They can be used for access and preservation but the text cannot be searched or otherwise manipulated. A transcript of a text allows many more novel possibilities for research and teaching and exploits more fully the capabilities of electronic materials. In the future, a combination of image and text may well form the basis of the electronic library, where it will be possible to search the text and retrieve the image.

THE PRESENT SITUATION

The picture in the early 1990s is one of many humanities texts in many different places and in many different formats. The Georgetown Catalog of Projects in Electronic Texts lists over 300 institutions which hold electronic texts but not the texts themselves. From sources such as The Humanities Computing Yearbook 1989-90: A comprehensive guide to software and other resources (Lancashire, 1991), journals, and proceedings of annual conferences on humanities computing, the number of existing electronic texts in the humanities can be estimated at many thousands. The Internet gives access to a fraction of these, and the existence of most of the others is only known from articles which describe their use in specific projects.

Most of these texts are held by individuals or by research institutes (mainly in Europe) which have compiled them for their own research purposes. Examples include the Istituto di Linguistica Computazionale in Pisa, and the Institut für Deutsche Sprache, Mannheim. For a variety of reasons, most of the collections of these institutes are not available for others to use. The few exceptions include many of the texts which were compiled for the Trésor de la Langue Française at Nancy, which are now available from ARTFL (American Research on the Treasury of the French Language) in Chicago. The texts compiled for the Responsa Project at Bar-Ilan University are now available on CD-ROM as the Global Jewish Database, and the collection of Early Christian Latin at Louvain-la-Neuve has now been published as the CETEDOC CD-ROM.
The Thesaurus Linguae Graecae (TLG) was the earliest systematic attempt to create electronic versions of the complete literature of one language (Ancient Greek) and its 60 million word task is now almost finished after twenty years of work. The Packard Humanities Institute (PHI) has completed a complementary collection of Classical Latin which is about 8 million words. Both of these are distributed on CD-ROM.

The largest general purpose collection of electronic texts is the Oxford Text Archive (OTA), which was established at Oxford University Computing Services in 1976 in order to prevent texts from becoming "lost" once their compilers had finished with them. The bulk of its collection comes from donations from individual scholars. It is committed to maintaining any text which is deposited in it but does not actively pursue material to be added or correct errors within the texts. It now has some 1,200 texts in about thirty languages and makes these available at nominal cost provided that the compiler has given the appropriate permissions. Little information is known about the source of some OTA texts, and the OTA takes no responsibility for the accuracy of the texts. Some texts are available by FTP from <black.ox.ac.uk>.

It is estimated that about 95 percent of existing texts are plain text files—that is, ASCII files which are not indexed for any specific software. Those who use them must acquire or develop suitable software programs, depending on the nature of their application. Various software programs for humanities electronic texts are in widespread use, notably the Oxford Concordance Program (OCP), Micro-OCP (a PC version); TACT and WordCruncher (interactive text retrieval programs) which all provide some basic facilities as well as more sophisticated tools tailored to the specific needs of the humanities.

The remaining 5 percent of texts are what can be called packaged products, where the text has been indexed for use with specific, often proprietary, software and cannot be used for any other purpose. Most of these products, at present, are on CD-ROM (e.g., the CETEDOC library of Christian Latin Texts, the WordCruncher Disc of American and English literature, the New Oxford English Dictionary on CD-ROM, and the Global Jewish Database). Libraries which provide these packaged resources will generally find that the support costs are not insignificant. Almost all use their own query language which in most cases is not intuitive. It takes some time to gain a good understanding of the full potential of many of them. They provide complex search facilities because the texts themselves are complex and scholars want to study them in many different ways. However, most of these products do have manuals which document the source
of the text as well as how to use the programs, which is more than can be said for some texts.

The Internet gives access to ARTFL and to the Dartmouth Dante Project (DDP), which includes the text of *The Divine Comedy* and major commentaries. ARTFL uses software developed by its own team, the second version of which is based on UNIX utilities and is not particularly easy to use for those not familiar with UNIX. The DDP uses BRS-Search with a user-friendly interface. It can perform flexible searches, but scholars who use it extensively will begin to see the limitations of applying a commercial text-retrieval system, which is document-oriented, to complex humanities texts, where it is not clear what constitutes a single document.

At present, it is rare for several different electronic versions of a work to exist. The Bible and Shakespeare are the exceptions. Comparisons of these can help in establishing design principles for better electronic texts. Bolton (1990) reviews three electronic versions of Shakespeare and tools to access them and gives a detailed evaluation from the perspective of a scholar in English studies. This essay highlights the relevance of complex tools for what are complex texts and the need to provide good documentation for them. Most of the current electronic versions of the Bible seem to be intended more for the popular market and only one or two would be really suitable for scholars and students in religious studies. As yet, there are few comparative reviews similar to Bolton's, but soon there will be more versions of electronic texts to choose from and more evaluations are sorely needed. Likely candidates might include a comparison of the texts of J. P. Migne's *Patrologia Latina* published by Chadwyck-Healey.

Given the present situation, how can a library evaluate electronic texts now? What makes a good electronic text that a research library would want to acquire or access? The popular market for electronic texts is growing fast. We are already witnessing different collections of electronic texts which are intended for popular, rather than scholarly, consumption. How can a research library ensure that a text is suitable for its collection? What do libraries need to know to make decisions on what to collect and how to provide access to their collections?

Some very basic questions which should be asked include: How are patrons going to use the text? Is it a text which requires software from elsewhere, or is it a complete package? If it requires software, what is the best program? What facilities does it provide? Are these facilities suitable for scholarly applications? What source text was used? What guarantee is there that the text is accurate? What markup scheme does it use? How will the electronic text be supported in
the library? What can the text do for patrons that print materials cannot do? Some understanding of what is involved in creating an electronic text and of basic techniques and applications in literary computing is helpful in order to begin to answer these questions.

CREATING ELECTRONIC TEXTS

Most existing texts have been created by keyboarding in one way or another. Ones which were created many years ago, including the TLG as it is stored on the CD-ROM, are entirely in uppercase letters. Some of these have been converted to upper- and lowercase by software and thus often do not begin sentences with uppercase letters. Much keyboarding has been done by individuals who needed to create an electronic text for their own research purposes. They may have consciously or unconsciously edited the text to suit their own needs and understanding and have possibly not documented these changes. They may also genuinely have made mistakes which went unnoticed in proofreading. If the text has been keyboarded professionally, it may be less likely to contain mistakes, as in the case of the TLG where very few errors exist. However, if significant cost has been incurred in creating the text, it is perhaps less likely that the text is widely available for others to use. At present, the texts which are most widely available are often those that have been created by individuals. Experience has shown that accuracy must not be assumed.

Optical character reading (OCR) has been used to input a variety of humanities texts. The capability of OCR software has improved somewhat, but OCR is not yet able to handle early printed books, manuscripts, some types of newspapers, and other material printed on poor quality paper. A text which has been input by OCR will need thorough proofreading even if the initial scanning appears to be very good. Claims of accuracy rates of 99.9 percent in effect mean two or three errors per page, which is far more than one would expect to find in a printed book. Many existing texts which have been input via OCR have not been proofread well. Typical errors include confusion of e and c, h, and b and the number 1 and letter l, as well as words run together or spaces inserted in the middle of words. Extraneous matter on the page—such as blotches on a photocopy—will be read as apostrophes or commas. But, even if the letters have been recognized accurately, it is becoming increasingly clear that optical scanning yields only part of what is needed to create a useful electronic text. It gives a physical representation of the text, which can be ambiguous without additional information. For example, a word which is in italic could be a foreign word, part of a title, or an emphasized word. These distinctions need to be made for a retrieval program to be useful, but they can only be done by adding information
to a text after it has been scanned. When a text is keyboarded, this information can be embedded in the text at the time of capture in the form of encoding or markup tags.

As with print materials, the choice of source edition is important for the academic acceptability of a text. Many existing texts have been created from out-of-copyright editions because their compilers have not been able to obtain copyright permissions for newer editions or have not wanted to ask permission for fear of becoming embroiled in legal issues. It is often the case that more recent editions have greater scholarly value and would be more appropriate for research use. It is to be hoped that these copyright issues will be tackled and resolved in the future rather than being avoided, which seems to be the case at present. Another factor which has determined the choice of source edition is its suitability for scanning. Again, the text which can be read best on the scanner may not necessarily be the edition with the best scholarly value. Good intentions to edit the text so that it conforms to a better edition are sometimes not carried out. When shown electronic texts, scholars who are skeptical about their value often voice their concern by criticizing the choice of source edition, which is, after all, something they understand from traditional scholarship. The lack of good scholarly texts in electronic form has seriously hampered the development and acceptability of full-text applications in humanities research and teaching. This situation is not being helped by various projects which use the Internet to announce, and make freely available, texts which do not appear to have any particular scholarly value.

USES OF ELECTRONIC TEXTS IN THE HUMANITIES

Certain methodologies and techniques for literary and linguistic computing have been well understood for some time. Hockey (1980) gives an overview of applications, many of which are still current. Butler's (1992) collection of essays is also a useful source. The journals Literary and Linguistic Computing and Computers and the Humanities and the proceedings of various literary and linguistic and humanities computing conferences also give some background (Miall, 1990; Hockey & Ide, 1991).

Concordances and text retrieval have formed the major application areas in literary and linguistic computing. A concordance is an alphabetical list of words which shows all the instances of a particular form, allowing the scholar to examine them in fine detail. Text retrieval gives instant access to occurrences. The first and most obvious application of these is as a reference tool. In the humanities, questions such as, Does this word ever occur in this text? are as common as, Find a text about this topic. For the former, the text
must be absolutely accurate otherwise the user cannot be sure whether the word exists or not.

Concordances have been used as a basis for stylistic analyses and even for studies of disputed authorship. It has been shown that the style of an author, or even a genre, can be characterized by the use of function words, that is, words which authors share in common with their contemporaries. In their study of the Federalist Papers, Mosteller and Wallace (1964) showed that the use of words such as “whilst” or “while,” “enough,” and “upon” in the disputed papers followed that of Madison rather than Hamilton. Burrows (1987) used a concordance program and some simple statistics to show that the thirty most common words in the novels of Jane Austen can distinguish the “idiolects” of the different characters in her novels. Kenny’s (1978) work on the Aristotelian Ethics is another classic example of traditional literary and linguistic computing techniques where a study of particles and other common words in Greek shows that the three books which appear in both the Nicomachean Ethics and Eudemian Ethics of Aristotle are more like the Eudemian Ethics. There are many other similar studies, all of which are based on common words which therefore need to be indexed.

Other computer-aided research has concentrated on the production of new critical editions in print form and now also in electronic form. Collation, concordance, and statistical tools can help the scholar establish the text and provide information for the commentary and other annotations (Robinson, in press). Other studies have included programs to analyze sound patterns and correlate these with the sense as, for example, in the Divine Comedy (Robey, 1987) and in Homer (Packard, 1974). Most kinds of research, which are based on lexical analysis, are suitable for computational techniques, provided that it is understood that the text is viewed as a sequence of graphic forms. Programs for automatic lemmatization (putting words under their dictionary headings), syntax, and morphological analysis are not yet widely available, and, in any case, those that do exist are never completely accurate and require manual verification of the results.

Hypertext applications have also become popular in the humanities (Delany & Landow, 1991). Images and sound can be linked to texts. More importantly, hypertext does not require the text and ancillary material to be constrained into a rigid structure such as a relational database. The data can be as flexible and extensible as needed, thus allowing the scholar to add more information or reorganize existing material as he or she learns more from working with an electronic version of it. The best known humanities hypertext is Perseus, which was developed by a consortium of institutions based
at Harvard (Mylonas, 1992). Perseus goes far beyond the text. It is a multimedia encyclopedia of Ancient Greek literature, archaeology, geography, history, and culture. Besides the works of major authors in Greek and English, it contains photographs of vases, sculptures, coins, buildings, and archaeological sites as well as an encyclopedia, historical overview, and Greek/English dictionary. Although Perseus is currently available on CD-ROM, the Perseus team sees the network as the future means of accessing the database and have designed it so that the individual components can easily be imported into other systems.

Retrieval and other applications on humanities texts can be complex simply because of the nature of the texts and the fine detail in which they are normally studied. A text may contain several different natural languages, some of which may be in different scripts or use different alphabets for sorting words. Examples include parallel texts of the Bible or Middle English texts which contain sections in Latin with citations of Greek or Hebrew words. Users of the texts must be able to identify which sections are in each language and to index them separately. Variant readings or spellings may be indexed. Quotations from other texts may need separate treatment. Punctuation is important in early printed books and may also need to be searchable. Studies of morphology in inflected languages or of rhyme can benefit from a reverse index where words are alphabetized according to their endings.

The canonical referencing scheme or logical structure of many humanities texts is complex, yet it needs to be represented in an electronic version. Depending on the type of literature, there are many different subdivisions of verse texts (stanzas, verses, books, quatrains, and so on). In simple terms, a play is divided into acts which are themselves divided into scenes and speeches. It also has a cast list and stage directions. However, a play may also have another referencing scheme which is based on pages within a printed edition. Line numbering may be in relation to the pages or sequential throughout the text. Printed editions of early manuscripts may also have two parallel referencing schemes—pages and lines in the print version as well as folios and lines in the original. All of these should be accessible to the scholar working on the text and therefore need to be identified or encoded within the text. An overview of some of these issues and the need for encoding to handle them is in Sperberg-McQueen (1991).

**MARKUP**

Markup or encoding makes explicit for computer processing those features of a text which are implicit for the reader. A text without
Markup is like a bibliographic record which is not divided into fields. Markup is needed to identify the different elements of the referencing scheme as well as to distinguish among features which would otherwise be ambiguous and to encode features of interest. The period (full stop) is also used in abbreviations or as a decimal point in numbers. Some programs delimit concordance citations by orthographic sentences—i.e., by all the text up to a period—and so, without additional markup, abbreviations and decimal points would be erroneously considered as sentence boundaries. Quotations from another author or text need to be identified by their source. For studies such as the Burrows's work on Jane Austen cited earlier, markup is needed to separate the dialogue from the narrative in the text and to identify the speaker for each section of dialogue. In a play, markup could encode the change of speakers and stage directions as well as the logical structure. For further discussions on markup and scholarly text processing, see Coombs et al. (1987) and Renear et al. (1992).

A text without markup can only be used for very simple applications. One analogy is trying to perform functions such as sorting and searching on a bibliographic record which does not have field divisions. For textual analysis, this amounts to making a simple alphabetical list of words, counting the word frequencies, and performing very simple searches. None of these will be completely accurate for detailed analyses. A look at various versions of Shakespeare which are available over the Internet will immediately show the problems. Act and scene numbers are not marked up in any way and so will lead to word counts which include all the incidences of the word “Act” as the act number within those of “act” as a verb or noun used in the normal way. Roman numerals used as act and scene numbers are more problematic. Act I will be assumed to be an occurrence of the personal pronoun I. Even the WordCruncher CD-ROM suffers from this problem. The simple searches will retrieve one or more surrounding lines of context. With a prose text, the reader may want to reformat the lines as on a word processor when the margins are changed. In verse, the lineation is fixed and must not be reformatted. When a text is entirely in verse, one can allow for this, but texts which are mixed verse and prose need to have markup to show the difference. Words which are not in the main language of the text also need to be encoded so that they can be distinguished. Examples include English “vale” and Latin “vale” (farewell), English “pain” and French “pain” (bread).

Many different markup schemes have been developed for humanities electronic texts over the last forty years. Of these, the most notable are COCOA and its variants. COCOA was first devised for an Archive of Old Scots Texts in Edinburgh in the early 1960s.
(Aitken & Bratley, 1967) and is described fully in the Micro-OCP manual. It provides a way of encoding the canonical referencing structure of a text including parallel referencing schemes and can also be used for other features such as stage directions, editorial comment, and so on. It is used by most of the major text-analysis programs in current use in the humanities, notably the Oxford Concordance Program (OCP) and (in extended form) TACT. The Thesaurus Linguae Graecae developed its own markup scheme, called beta code, which has also been used by other projects in classics and religious studies. The retrieval program WordCruncher also has its own markup scheme. Many existing humanities electronic texts are encoded for use by these programs.

Typographic markup is also needed to print or display a text so that it is more easily readable. Even simple word processing programs include features such as italic, bold, and so on to highlight sections of a text to draw the reader’s eye to them. A parallel set of markup schemes was thus developed for printing and formatting, most notably TeX, TROFF, and later various word processors, such as WordPerfect, where the markup is exposed by the Reveal Codes function.

The result of this plethora of markup schemes has been described as chaos (Burnard, 1988). By the mid-1980s, experience showed clearly that markup is essential for good quality texts, but no scheme had wide acceptance. Each scheme was designed for a specific project or application. Most schemes were poorly documented and had no provision for extension or were not otherwise sufficiently flexible. Much time was wasted on converting from one format to another. None of the existing markup schemes was suitable for adoption as a standard.

In 1986, the Standard Generalized Markup Language (SGML) became an international standard (van Herwijnen, 1990). SGML is not, in itself, an encoding scheme. It provides a syntactic framework within which descriptive information about an electronic text can be encoded. The principle of SGML is descriptive, not prescriptive—that is, it describes the structure of a text. It enables the word which is seen to be in italic to be described as part of a title, or a foreign word, or an emphasized word, or whatever the encoder wishes. At a very basic level, SGML views a text as being a collection of objects called elements. These may be chapters, pages, words, lines, stanzas, or whatever the user wishes. The set of elements for a particular text or group of texts and the relationship among them is defined in a document type definition (DTD). The DTD has a formal structure. It can be read by a computer program called an SGML parser which validates the markup in a text or by other SGML-based software.
which operates on the text. SGML provides a method of encoding which addresses many of the intellectual issues which previously used encoding schemes have not. A further advantage is that it also provides links to material which is not ASCII text—e.g., sound and images—which are likely to become increasingly important. Its one disadvantage is that it views a document as a single hierarchic structure and has no easy way of dealing with the multiple parallel referencing schemes which appear in many humanities texts.

Sets of encoding or markup tags which conform to the SGML syntax are known as SGML applications. When a text is said to be in SGML, it is important to know which SGML application and to have access to the DTD. True SGML must conform to a DTD. There are many electronic texts now in existence which claim to be SGML which do not appear to have DTDs. Others, most notably the New Oxford English Dictionary, are described as SGML-like and may not necessarily be processable by all SGML software. In some cases this may not be a problem now, but it may become so in the future as SGML becomes more widely used.

The need for standardization of markup in the humanities led to the establishment of the Text Encoding Initiative (TEI) in 1987. The TEI is sponsored by the three major text analysis computing organizations: the Association for Literary and Linguistic Computing, the Association for Computers and the Humanities, and the Association for Computational Linguistics. It has become a major international project with funding of over $1 million from North America and from the Commission of the European Communities beginning in 1988. Its objectives are to define a common encoding format for electronic texts and to provide guidelines for the interchange of electronic texts. Further information about the TEI project is available from the fileserver of the listserv <tei-l@uicvm>.

The TEI immediately made a commitment to SGML and set up four main committees to deal with different aspects of encoding electronic texts. The documentation committee defined a method of documenting electronic texts which is stored within the text as a header. This is described in more detail in the next section. The text representation committee first looked at ways of encoding the physical description and logical structure of text and identified the components and core features of basic text types. It then set up a number of work groups to look in more detail at specific areas and text types. These included character sets, hypermedia, textual criticism, language corpora, formulae and tables, verse, performance texts, and literary prose. A third committee on analysis and interpretation first devised general purpose mechanisms for encoding linguistic and other analytic interpretations which are comprehensive
enough to allow several different interpretations to be placed on a word or section of text. It then set up work groups to look at electronic dictionaries, spoken texts, and terminological data as well as the interpretation of historical material and further linguistic analysis. A fourth committee defined how best the TEI might use SGML. It prepared a kind of "house-style" for the TEI's use of SGML and proposed methods for dealing with multiple hierarchies.

The TEI Guidelines have been developed following a set of principles established at the planning meeting in 1987. The guidelines are intended for text in any kind of written or spoken language. They are intended for both scholars and librarians. The guidelines give recommendations both on what features to encode and how to encode them. The features discussed in the guidelines include both those which are explicitly marked and those which are the result of analyzing and interpreting the text. Although the TEI Guidelines include some 400 different encoding tags, very few indeed are absolutely required. The basic philosophy is "if you want to encode this feature, do it this way." Sufficient information is provided for the TEI DTDs to be extended by users if necessary.

The TEI Guidelines are built on the assumption that virtually all texts share a common core of features, to which can be added tags for a specific discipline, text type, or application. The encoding process is seen as incremental, so that additional tags may be inserted in a text as new researchers work on the text. Almost all encoding implies some interpretation of a text and so the guidelines provide for multiple views of a text and multiple encodings for individual phenomena within a text. They also provide a means of documenting any interpretation so that a new user of the text can know why that interpretation is there.

A TEI conformant text consists of a TEI header followed by the text itself. The text has optional front and back matter. The body of a text is divided into units which, for convenience, the TEI has chosen to call divisions using the tag <div>. SGML attributes are used to identify the type of division—e.g., "chapter," "stanza," "act." Within the smallest division, the basic element is a paragraph which can contain many other elements such as lists, names, dates, abbreviations, and so on.

The first draft version of the TEI Guidelines (Sperberg-McQueen & Burnard, 1990) has been distributed extensively for comment. The second draft is being made available electronically in fascicles from the listserv <tei-l@uicvm> as new chapters have been completed for publication. A cumulative print version is in preparation (Sperberg-McQueen & Burnard, 1990).
DOCUMENTING ELECTRONIC TEXTS

The source from which an electronic text has been compiled is sometimes not known or is unclear. One of the major reasons for this is that, until recently, there has been no standard way of providing this information in such a way that it does not get detached from the text or lost. Most of the large text archives held in research institutes use databases which they have developed themselves for recording information about the texts. These databases often consist of limited information of value only to themselves. Individuals who have created texts have not often even provided this information, most obviously because they themselves were fully aware of it and thus did not feel the need to record it. Many existing texts have encoding within them which is not documented and, if the exact source is not known, it may be impossible to identify, for example, what a group of percent signs in the middle of a text may mean.

One of the TEI's major contributions is a set of proposals for documenting electronic texts so that users may know what they have and librarians will have the information they need to catalog the texts. The TEI header is believed to be the first systematic attempt to provide in-file documentation of an electronic text which conforms to the same syntax as the markup within the text. It consists of four major sections or SGML elements each of which contains further elements or subdivisions. The file description element is the most important. It contains a full bibliographic description of the electronic file which can be used for creating catalog entries or bibliographic citations. It must include a file statement which gives the title of the work and those responsible for its intellectual content, a publication statement which identifies the publication or distribution of an electronic text, and a source description, which is a bibliographic description of the source from which the electronic text was derived. Additional optional elements give information relating to one edition of a text, the approximate size of the text in whatever units are convenient, the series, if any, to which a publication belongs, and notes which provide additional descriptive information not contained in other elements.

The encoding description element provides information which the user of a text needs to know. It documents the methods and editorial principles that governed the transcription of the text, also giving the intellectual rationale for any analytic or interpretive information. Additional information which characterizes a text but does not fit easily into the other header sections is given in the profile description. This includes information about the participants in a conversation if the text is a transcript of speech as well as details
of the natural languages used in the text. The fourth section, the revision history, documents any changes made to the text and provides information which is critical for working with electronic texts in which changes are made over time and where there is a need to ensure that a particular version of a text was used.

The file description contains sufficient information for a librarian to catalog the text, with indications of its source. The encoding description contains information which anyone who uses the text needs to have. The revision history provides a means of recording updates to the text. The TEI header does not yet have elements which specifically address authentication, but it would be a simple matter to define extra elements which would contain a time stamp or other authentication codes. These may further be extended to apply to only certain SGML elements within the text, leaving the others to be modified as users exploit the text for their own purposes.

**CATALOGING ELECTRONIC TEXTS**

The only attempt to create a systematic catalog of electronic texts in the humanities using standard bibliographic procedures is the Rutgers Inventory of Machine-Readable Texts in the Humanities, which began in 1983 in response to a growing number of enquiries about the availability of electronic texts. Responsibility for the inventory was assumed by the Center for Electronic Texts in the Humanities (CETH) when it was established in the second half of 1991 at Rutgers and Princeton universities. The inventory is available now on the Research Libraries Information Network (RLIN) and should be accessible soon in other ways as well.

Research done at CETH indicates that there is little expertise in the specific problems of cataloging electronic texts. CETH has found that most of the expertise in cataloging computer files is derived from experience with either software or social science numeric data files. There seems to have been very little emphasis specifically on electronic text files in the humanities where it is necessary to know whether the text requires specific software in order to use it, or what encoding scheme it uses. The rules in Chapter 9 of the Anglo-American Cataloging Rules, second edition, 1988 Revision (AACR2R) (ALA, 1988), cover all kinds of computer files (programs, numeric data files, and so on) but are not especially suitable for electronic texts. CETH has now developed comprehensive guidelines for cataloging electronic texts in the humanities which ensure that sufficient information is provided in the catalog record to enable librarians to provide access to the text in a meaningful way (Hoogcarpspel, 1993, 1994).
At present, the main source of information for updating the inventory is a survey which began in 1990 with funding from the Commission of the European Communities. A first questionnaire was distributed to some 5,000 people who were on the mailing lists of the Association for Literary and Linguistic Computing, the Association for Computers and the Humanities, the Association for Computational Linguistics, and twelve other sponsoring organizations. Recipients were asked to note which of the following types of data they hold: (1) speech (tape recordings), (2) single (individual) texts, (3) collections of texts, (4) corpora (collections of texts which have been put together on a principled basis as samples which represent a specific population—e.g., the Brown Corpus), (5) machine-readable dictionaries, and (6) computational lexica. The intention was to send a different follow-up questionnaire depending on the type of data held. CETH took over responsibility for doing the follow-up for single texts, collections of texts, and corpora.

The questionnaire reflected input from a large number of people in the field and was intended to be comprehensive in its coverage with regard to written language, spoken language, and dictionary and other lexical information. In redesigning the questionnaire, CETH took great care to ensure that bibliographic records could easily be created from the data. Examples were provided together with simple explanation. The responses have come from a variety of individuals and institutes, all of whom appear to have different procedures for documenting and cataloging their texts. None found it particularly easy to describe their material in such a way that catalog records could easily be created from it, and CETH is often finding it necessary to go back to the respondent for further information. Cataloging the backlog of existing collections is not going to be an easy task. Future material will be much easier to catalog once standard procedures for documenting the texts are adopted.

Software Issues

Software issues are also central to the evaluation of electronic texts, the key question being how to provide access to the texts. An ASCII file with markup offers the most possibilities in that it is not restricted to any particular program. Scholars and libraries can use it for whatever purposes they like. However, they need to acquire software from somewhere else or write their own programs. Writing their own software gives the most flexibility, but in reality very few people are going to do that. The time investment is large and it is obviously not efficient for the person who just wants to look up a few words. It pays off only for the scholar who has very specific individual requirements.
Texts which are pre-indexed for some specific software are easier to begin with and can satisfy a good many purposes, but it is important then to look at the facilities provided by the software. Browsing normally is easy, but the real issue is how to find exactly what is wanted. The response to any search request is only as good as what is indexed. Most commonly used index-based retrieval programs cannot really handle many of the complex features of scholarly texts such as marginalia, the critical apparatus and parallel texts which were discussed earlier in this article. They work with document structures which are too simple. Accented characters and diacritics also pose problems as decisions need to be made at the time of building the index as to whether these are to be specified in a search query. Once scholars begin to use these programs seriously and gain an understanding of basic techniques, more often than not they will want to ask questions which cannot be answered by a package, even though it is technically feasible to do so. They will find that much existing software becomes limiting in terms of what it can do. There are instances where the capability of the software is driving the kinds of research which can be done and, in some cases, restricting it. Electronic texts can transform scholarship, but the needs and requirements of scholars ought to be paramount in the design and development of new software which effects these transformations.

Traditional humanities computing software, such as Micro-OCP and TACT, leaves these decisions entirely in the hands of the scholar. He or she has specific areas of research and can work with that in mind, but as more people want to work on the same texts, it makes sense not to duplicate effort and to provide these centrally. Libraries are now beginning to index texts for many different people to use, most notably with the PAT software, a retrieval program developed by Open Text Systems of Waterloo, Canada. In effect, in some ways, they are taking on responsibility for the intellectual content of the text since they have to decide what is indexed and how it can be accessed. The Text Encoding Initiative has laid the groundwork for multipurpose text after over four years of research. It is debatable whether existing software provides the capability of building indexes which can satisfy many different purposes. A good deal more research may be needed in this area, particularly in the exploitation of SGML.

CONCLUSION
What can a library do now? Setting up an electronic text center with adequate support is a considerable investment. The greater part of the cost will involve staff who support the facility. Ensuring that staff have adequate training in the relevant tools and techniques is essential so that they can make informed judgments. Discussion
groups, such as <etextctr@rutvm1>, are intended to help librarians enter this new world. Consultation with potential users is important at all stages. Experimenting with some CD-ROM-based resources would be a good first step as well as looking at some widely available software tools. These should help libraries decide how to handle texts over the network which is so obviously the long-term future. More than anything, widespread consultation and collaboration in research will be needed in order to determine the principles and procedures for providing access to the multipurpose high-quality electronic text which will serve the needs of humanities scholarship in the next century.

REFERENCES


The Role of Computer Networks in Aerospace Engineering

ANN PETERSON BISHOP

ABSTRACT

This article presents selected results from an empirical investigation into the use of computer networks in aerospace engineering. Such networks allow aerospace engineers to communicate with people and access remote resources through electronic mail, file transfer, and remote log-in. The study drew its subjects from private sector, government, and academic organizations in the U.S. aerospace industry. Data presented here were gathered in a national mail survey, conducted in Spring 1993, that was distributed to aerospace engineers performing a wide variety of jobs. Results from the mail survey provide an overview of the current use of computer networks in the aerospace industry, suggest factors associated with the use of networks, and identify perceived impacts of networks on aerospace engineering work and communication. Such data are important in planning for the development of policies and features of the National Research and Education Network (NREN) if it is to meet the needs of its intended users.

INTRODUCTION: THE NEED FOR USER-BASED STUDIES OF ELECTRONIC NETWORKING

Both individual engineering organizations and the federal government in the United States are making large investments in computer networks (i.e., telecommunications links that connect computers to each other or to other devices) in order to, among other things, increase research and development (R&D) productivity, facilitate technology transfer, and improve industrial competitiveness. Federal policy-makers, network system designers and service...
providers, and workplace managers are struggling to implement effective systems and to develop appropriate policies to govern network implementation and use. The success of institutional networking endeavors—and national efforts, such as those associated with the National Research and Education Network or, more broadly, the National Information Infrastructure (NII)—will depend on the development of network features, policies, and support programs that are based on a solid knowledge of users' needs and habits and substantiated links between network use and engineering outcomes. But little empirical information has been gathered that can be used to help in understanding the impact of networking investments, designs, and policies on engineering work. And little is known about the extent of computer network use across different types of engineering organizations. Thus, many major investment, design, and policy decisions are being made solely on the basis of educated guesses about the current use of networks and the assumed contribution of networking to scientific and technical enterprises.

In order to help remedy this situation, the author undertook an empirical investigation of computer networking in engineering that collected data from the network user's point of view. The study's aim was to describe and explore the use of electronic networks by one particular group—aerospace engineers. It focused on the way that networks are currently used by aerospace engineers to facilitate communication and otherwise assist in the performance of work tasks. The study was guided by the following research questions:

1. What types of computer networks and network applications are currently used by aerospace engineers?
2. What work tasks and communication activities do aerospace engineers use computer networks to support?
3. What work-related factors are associated with the use of computer networks by aerospace engineers?
4. What are the impacts of network use on aerospace engineering work and communication?

In order to include subjects representing a wide range of work and communication activities and to look at as many aspects of the aerospace industry as possible, "aerospace engineer" was interpreted very broadly. It included people engaged in all phases of the development and production of military and commercial aeronautical or aerospace equipment and processes.

**Background: Computer Networking in Engineering Settings**

Engineers are employed to research, develop, design, test, and manufacture technology, which may exist in the form of either
materials, products, systems, or processes. Engineering is a complex, information- and communication-intensive activity that involves invention, problem-solving, and coordination of many independent efforts (for interesting discussions of the nature of engineering work and communication, see Adams, 1991; Allen, 1977; Constant, 1984; Ferguson, 1992; Layton, 1974; Pinelli et al., 1993; and Vincenti, 1990). "Concurrent engineering," a notion that is currently popular in engineering management circles, focuses on the perceived need for better and faster communication, coordination, and integration of the work and information contributed by all of the people involved in the development, production, and marketing of a particular technology. Many engineering organizations are exploring the ability of computers and electronic networks to facilitate concurrent engineering and improve the performance of engineers and the technical quality of their work (see, for example, Dirr & Stockdale, 1989; Heiler & Rosenthal, 1989; Keen, 1986; Mishkoff, 1986; Rachowicz et al., 1991; Schatz, 1988). Industrial organizations hope that, by facilitating communication and improving coordination, electronic networks will decrease both the costs and time needed to bring products to market. Due to proprietary and security concerns, many engineering organizations have implemented their own private high-speed networks that are used only by their employees and affiliates. The need for the completely reliable electronic transfer of very large amounts of data also makes the use of most commercial networks inadequate for some industries and applications.

Today engineers use computers to perform calculations; to produce and evaluate drawings, designs, and prototypes (CAD/CAM); to maintain and archive the "corporate memory"—i.e., all the contracts, designs, schedules, assumptions, constraints, procedures, data, and so on, associated with each particular project; to write and edit documents and prepare presentations; to run project management software; and to control equipment. Computer networks are also playing an increasingly important role in engineering work. For example, engineers use networks to receive data collected by remote instruments. Networks facilitate the transfer of documents and designs and are used to automate the manufacturing process. Electronic data interchange (EDI) is used to exchange orders and invoices with vendors and suppliers, and contracts with clients and customers. Networks are also used for information retrieval in connection with both in-house and commercial databases (Gould & Pearce, 1991; Mailloux, 1989).

Finally, engineers also use computer networks for a variety of communication purposes (Beckert, 1990; Borchardt, 1990; DeMeyer, 1991; Stevens, 1987; Perry, 1992). For instance, they can exploit
computer-based message systems to call on the expertise, ideas, and advice of other members of their community and to locate resources. Electronic mail and various computer conferencing applications are also used to schedule and coordinate work or even conduct meetings, since they can be used to contact project team members, managers, people in other departments or divisions, and consultants in outside organizations. Electronic mail and bulletin boards are sometimes used to facilitate communication with customers and funders as well.

There is a growing body of empirical research that examines the characteristics, use, and effects of computer-mediated communication (Bikson & Eveland, 1990; Hiltz, 1988; Rice, 1980; Steinfeld, 1986a, 1986b; Sproull & Kiesler, 1991). Few studies attempt to describe these variables in terms of particular kinds of work, except by comparing broad job categories—for example, managers, professionals, and clerical workers (Rice & Shook, 1990). With the recent proliferation of electronic networks, a number of empirical efforts dedicated to exploring the use of electronic networks for communication by scientists and engineers have been undertaken (Bizot et al., 1991; Eveland & Bikson, 1987; Feldman, 1987; Gerola & Gomory, 1984; Hesse et al., 1993; Hiltz, 1984; McClure et al., 1991; Schatz, 1992; Sproull & Kiesler, 1986; Foulger, 1990). There seems to be agreement that electronic communication is used for administrative, technical, and social purposes. Much of this work seems compatible with findings about the nature of engineering communication and its relationship to engineering work and productivity, although virtually no studies have dealt exclusively or extensively with engineers. The capabilities and characteristics of electronic communication, in other words, seem to "match," to some extent, the nature and requirements of engineering work, knowledge, and communication. But new questions and issues have been raised and a number of conflicting findings have been presented. All in all, very little is known about the characteristics, use, and impact of electronic communication from the engineer's point of view.

The aerospace industry possesses a number of characteristics that make it a natural environment for the implementation of electronic networks. It is a high technology industry, already highly computerized. It involves significant R&D, which is an especially communication-intensive activity. Further, its end products are highly complex, calling for a great deal of work task coordination and the integration of information created by diverse people. In describing the business and technology strategy in place at British Aerospace, Hall (1990) emphasized the need for increased computing and communications capabilities in aerospace firms aiming to design, develop, make, and market complex systems while maintaining a
technical competitive edge and reducing unit costs. He noted that a number of typical information technology opportunities were particularly relevant to the aerospace industry, such as "improved productivity, better competitive edge, reduced timescales, closer collaboration, more streamlined management, better commonality of standards across sites, more operational flexibility, [and] constructive change of workforce skill levels..." (pp. 16-30).

Rachowitz et al. (1991) describe efforts at Grumman Aerospace Corporation to realize a fully distributed computing environment. Grumman's goal is to implement a system of networked workstations in order to "cost-effectively optimize the computing tools available to the engineers, while promoting the systematic implementation of concurrent engineering among project teams" (p. 38). The network includes personal computers and software to be used for communication. Grumman assumes that their computer/information integrated environment (CIE) will result in "product optimization—quality products manufactured with fewer errors in shorter time and at a lower cost" (p. 66).

Black (1990) presents a brief overview of the uses and advantages of computer conferencing systems, noting that computer conferencing "can be a very powerful tool for the transfer of information in all areas of research and development" and "a 'natural' for use by the AGARD [Advisory Group for Aerospace Research and Development] community..." (pp. 13-14). Molholm (1990) describes the application of the Department of Defense's Computer-Aided Acquisition and Logistics Support (CALS) initiative to the aerospace community. CALS mandates the use of specific standards for the electronic creation and transmission of technical information associated with weapons systems development. Eventually all Department of Defense contractors and subcontractors will be required to create and distribute in digital form all the drawings, specifications, technical data, documents, and support information required over the entire life cycle of a military project. The CALS system may be a significant impetus to networking for aerospace firms.

Few empirical studies of computer networking in the aerospace industry have been conducted, although a number of the surveys conducted as part of the NASA/DoD Aerospace Knowledge Diffusion Project have included small components assessing the use of computing and communications technologies by aerospace students, faculty, researchers, and engineers. Beuschel and Kling (1993) conducted a case study of computer-integrated manufacturing (CIM) in an aerospace firm and found that effective technological integration was limited by complex social requirements for group coordination processes, such as negotiation and interpretation.
These reports reveal that a number of engineering organizations, including those in aerospace, are using electronic networks for a variety of communication activities, distributed computing, and shared access to information resources. Networks are being implemented to serve organizational goals and business strategies—i.e., to achieve impacts in terms of better and faster product development and cost savings. The motivations for network investments noted in these reports suggest factors that may encourage network use in particular engineering organizations and obviate the need for them in others. These reports also point to a number of factors that may hinder network use, such as security and proprietary concerns, the inability of networks to accommodate the negotiation and interpretation aspects of communication, and the substantial financial outlays required to implement networked systems.

A USER-BASED STUDY OF COMPUTER NETWORKING IN THE AEROSPACE INDUSTRY: METHOD

This section describes briefly the method of the study whose results are reported here. As noted earlier, data to answer the study's research questions were gathered from a wide variety of aerospace engineers, and the study sought specifically to collect data that reported network use: (1) from the user's point of view, and (2) from within the context of aerospace engineering work and communication. The study drew upon methodological approaches and techniques that have evolved in the fields of library and information science, communications, management, computer science, and sociology (e.g., Bizot et al., 1991; Feldman, 1987; Hiltz, 1984; McClure et al., 1991; Dervin & Nilan, 1986; Wilson et al., 1989; Wixon et al., 1990; Gould et al., 1991; Murotate, 1990). Because it is user-based, the study aimed to collect data directly from individual aerospace engineers on networking topics and issues that were specifically related to their personal experiences and concerns. Understanding relationships among network use, work, and communication will be useful to those people and organizations trying to estimate the potential impact of electronic networks on aerospace engineers, on their organizations, and on national productivity and competitiveness in the aerospace industry. Further, the results should be suggestive of the potential impact of global networks on other kinds of work, based on the degree to which they resemble aerospace engineering work. It was the aim of this research to identify work characteristics and needs that underlie the use of networks. This type of user-based research on information and communication technology is important
because it not only evaluates the status quo, it points to networking system features, implementation strategies, and use policies that could improve the effectiveness of the next generation of networked systems.

The primary mechanism for gathering data was a national mail survey conducted in Spring 1993. The mail survey was preceded by site visits and in-depth interviews and a national telephone survey. These preliminary activities were used to refine the mail survey instrument, to supply anecdotal and interpretive data not easily gathered in a mail survey, and to triangulate study results. This article will present results from the mail survey only.

The mail survey's respondents came from a stratified random sample of 2,000 U.S. subscribers to Aerospace Engineering, a weekly trade magazine published by the Society of Automotive Engineers (SAE), whose membership includes both automotive and aerospace engineers. The database containing records for the 54,600 journal subscribers is maintained by SAE, but subscribers are not required to be SAE members. The database includes practicing aerospace engineers working on a broad range of aerospace products, in a wide variety of organizations and subfields, and with a variety of professional duties. The SAE sample possesses characteristics in proportions that are similar to those reported in NSF employment data on the aerospace industry as a whole. The final unadjusted response rate for the mail survey was about 48 percent with 950 usable surveys returned.

The mail survey consisted of a ten-page booklet containing items on network availability and use, work and communication characteristics and activities, perceived network impacts, and demographic and employment characteristics of respondents (the questionnaire is reproduced in the Appendix). Most questions required respondents to circle the number of their selected answer or to fill in a matrix by placing check marks in cells corresponding to their answers. Several questions called for respondents to supply numerical answers or open-ended textual replies.

**STUDY RESULTS**

The mail survey's results are presented here with simple descriptive summaries. Most survey respondents were engaged primarily in design or product engineering (23 percent), advanced or applied development (14 percent), or research (13 percent); the majority were employed in industry (54 percent) or government (30 percent) settings. Other characteristics of survey respondents appear below (figures represent percentage of respondents):
### Gender
- Male: 97
- Female: 3

### Age
- 20-29 yrs.: 3
- 30-39: 24
- 40-49: 24
- 50-59: 32
- 60+: 17

### Size of Parent Organization (if private sector business)
- 1-4 employees: 10
- 50-99: 3
- 100-499: 13
- 500-999: 6
- 1000-4999: 21
- 5000-9999: 10
- 9996+: 37

### Job Type (self-identified)
- Engineer: 46
- Manager: 39
- Scientist: 5
- Other: 10

### Branch of Aerospace (self-identified)
- Aerodynamics: 6
- Structures: 12
- Propulsion: 9
- Flight Dynamics & Control: 5
- Avionics: 12
- Materials & Processes: 14
- Other: 42

### Primary Job Function (self-identified)
- Administration: 10
- Research: 13
- Advanced or Applied Development: 14
- Design or Product Engineering: 23
- Industrial Engineering: 6
- Quality Control: 6
- Production: 1
- Sales or Service: 7
- Information Processing: 3
- Teaching: 5
- Other: 12
In general, survey results paint a picture of widespread use of electronic networks. The majority of respondents (74 percent) reported that they personally used networks, while 11 percent used networks through some kind of intermediary, such as a secretary or a librarian. Only 15 percent declared that they never used any kind of computer network (from linked workstations within an organization, to a personal computer connected to a printer down the hall or a supercomputer across the country, to a dial-up link to the Internet) in their work. In interpreting these figures, however, it should probably be assumed that results are biased in favor of network use (i.e., because of the length and topic of the survey, it is likely that potential respondents who did not use computer networks at all would be less inclined to complete and return the questionnaire even though the cover letter emphasized the importance of the responses of nonusers). One survey question attempted to put this potential bias in perspective by asking respondents to describe not their personal use, but the general use of computer networks in their workplace. These results suggest, in fact, a similar high level of use. In describing the extent of computer networking at their workplace, 40 percent of respondents reported that: "Networks are used by most people; many tools are available on networks; most computer systems are linked together by a network; and network use is required or strongly encouraged." A slightly higher proportion (48 percent) characterized the extent of networking at their workplace as use by "some" people, and only 7 percent reported use by "few" people with "little" organizational encouragement or even discouragement of network use.

Respondents also reported on availability and use of different types of networks (see Table 1). It appears as if those networks providing access to the broadest range of other people are least likely to be available at the aerospace engineering workplace. Computers connected to commercial networks that link users to people, tools, or information outside of their own organization—such as CompuServe—were available to the smallest percentage of respondents (about 30 percent); 50 percent had access to an external research network such as the Internet; 74 percent reported that they were connected to an organizational network that linked them to resources beyond one workplace building; and 85 percent reported access to a local area network. On the other hand, respondents were about equally likely to use any type of network available to them. Between 85 percent and 91 percent of respondents reportedly used each type of available network. As Table 2 indicates, the overwhelming majority of respondents used computer networks at work as opposed to at home or at some other location; of the various types of networks,
external/commercial networks were, not surprisingly, most likely to be used at home.

The mail questionnaire also asked respondents to describe the availability, use, and perceived value of various types of computer network applications (see Table 3). File transfer was the computer network application reportedly available to the greatest percentage of respondents (85 percent), followed by electronic mail (82 percent), accessing remote data files (82 percent), remote log-in to run a computer program (80 percent), and electronic bulletin boards or conferencing systems (77 percent). These applications were also the network features most likely to be used. Less available were applications that supported access to published literature, such as electronic journals or newsletters (61 percent) or online library catalog searching (62 percent). It should be noted that these responses indicate a lack of perceived availability; some aerospace engineers may simply not be aware that certain applications are available to them. As a point of general comparison, 94 percent of respondents indicated that fax was available in their workplace, and 77 percent reported the availability of telephone voice mail. The percentage of respondents considering the value of each computer network application
application to be "great" or "some" varied from a high of 83 percent for electronic mail to a low of 41 percent for computer-integrated manufacturing.

Throughout the survey, value judgments were made by all respondents, whether or not they currently had access to or used the network feature in question. Overall value judgments, in this particular instance, may be colored by whether or not a specific application is used by a large number of respondents, even though respondents were also given the answer option of "Application is NOT APPLICABLE to My Work." For example, CIM may be assessed by a smaller percentage of respondents as valuable to their work because it is directly applicable to the work of a relatively smaller number of the aerospace engineers who completed this survey.

Tables 4-5 report the availability, use, and value of network access to various work resources in aerospace engineering. In describing network access to human resources (Table 4), more respondents (about 85 percent) were able to communicate electronically with people within their own organization more so than with people in other

<table>
<thead>
<tr>
<th>APPLICATIONS</th>
<th>% Who say that application is AVAILABLE</th>
<th>% USING application (if available)</th>
<th>% Who consider VALUE of application as &quot;great&quot; or &quot;some&quot;</th>
</tr>
</thead>
<tbody>
<tr>
<td>E-mail</td>
<td>82</td>
<td>84</td>
<td>88</td>
</tr>
<tr>
<td>BBs, mail lists, conferencing</td>
<td>77</td>
<td>70</td>
<td>67</td>
</tr>
<tr>
<td>Real-time interactive messag-</td>
<td>70</td>
<td>51</td>
<td>54</td>
</tr>
<tr>
<td>ing</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Videoconferencing</td>
<td>66</td>
<td>44</td>
<td>58</td>
</tr>
<tr>
<td>Voice mail</td>
<td>77</td>
<td>78</td>
<td>76</td>
</tr>
<tr>
<td>Fax</td>
<td>94</td>
<td>96</td>
<td>94</td>
</tr>
<tr>
<td>Electronic journals</td>
<td>61</td>
<td>41</td>
<td>50</td>
</tr>
<tr>
<td>EDI</td>
<td>61</td>
<td>23</td>
<td>42</td>
</tr>
<tr>
<td>Run program on remote</td>
<td>80</td>
<td>71</td>
<td>73</td>
</tr>
<tr>
<td>computer</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Access data on remote computer</td>
<td>82</td>
<td>72</td>
<td>75</td>
</tr>
<tr>
<td>Search government, commercial</td>
<td>66</td>
<td>49</td>
<td>59</td>
</tr>
<tr>
<td>database</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Card catalog search</td>
<td>62</td>
<td>57</td>
<td>62</td>
</tr>
<tr>
<td>Operate remote devices</td>
<td>62</td>
<td>27</td>
<td>43</td>
</tr>
<tr>
<td>CIM</td>
<td>63</td>
<td>24</td>
<td>41</td>
</tr>
<tr>
<td>Transfer data between</td>
<td>85</td>
<td>81</td>
<td>81</td>
</tr>
<tr>
<td>computers</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Access images</td>
<td>74</td>
<td>56</td>
<td>69</td>
</tr>
<tr>
<td>Other</td>
<td>69</td>
<td>50</td>
<td>52</td>
</tr>
</tbody>
</table>
organizations, which coincides with the greater availability of local and organizational networks reported earlier. Private sector colleagues or associates were least likely to be accessible over the network, with between 61 percent and 66 percent of respondents reporting such access. Network access to people in other departments of one's own organization was judged valuable by the greatest number of respondents (81 percent), while access to external colleagues, customers, vendors, and so on was apparently considered slightly less important. This may reflect the feeling—accepted as common knowledge by observers of the engineering enterprise—that internal communication of any kind is generally more critical in engineering work than is external communication. On the other hand, the number of aerospace engineers who do use networks to communicate with various kinds of people outside their own organizations (between 52 percent and 72 percent) may surprise those who thought that such links, at least in the private sector, were still largely prohibited due to proprietary and security concerns.

Network access to information resources (Table 5) ranged from a low of 50 percent for lab notebooks to a high of 77 percent for computer code and programs. Other information resources to which at least 70 percent of respondents reportedly had electronic access were company newsletters or bulletins, directories of people, internal financial data, production control data, and drawings or designs. Those resources actually accessed via networks by at least 70 percent of the respondents with network access were document citations and abstracts, internal technical reports, company newsletters and

---

Table 4. Work Resources and Network Use: People

<table>
<thead>
<tr>
<th>WORK RESOURCES USED</th>
<th>% With Net ACCESS to Resource</th>
<th>% USING Net Access</th>
<th>% Who consider VALUE of access as “great” or “some”</th>
</tr>
</thead>
<tbody>
<tr>
<td>People in your workgroup or department</td>
<td>85</td>
<td>88</td>
<td>78</td>
</tr>
<tr>
<td>Other people in your organization</td>
<td>86</td>
<td>89</td>
<td>81</td>
</tr>
<tr>
<td>Colleagues in academia, government</td>
<td>70</td>
<td>72</td>
<td>66</td>
</tr>
<tr>
<td>Colleagues in private industry</td>
<td>66</td>
<td>62</td>
<td>62</td>
</tr>
<tr>
<td>External clients, customers, sponsors</td>
<td>62</td>
<td>58</td>
<td>66</td>
</tr>
<tr>
<td>External vendors, suppliers</td>
<td>61</td>
<td>52</td>
<td>63</td>
</tr>
<tr>
<td>Other</td>
<td>46</td>
<td>22</td>
<td>42</td>
</tr>
</tbody>
</table>
### Table 5.
**Work Resources and Network Use: Information**

<table>
<thead>
<tr>
<th>WORK RESOURCES USED</th>
<th>% With Net ACCESS to Resource</th>
<th>% USING Net Access</th>
<th>% Who consider VALUE of access as &quot;great&quot; or &quot;some&quot;</th>
</tr>
</thead>
<tbody>
<tr>
<td>Document citations, abstracts</td>
<td>69</td>
<td>76</td>
<td>74</td>
</tr>
<tr>
<td>Journal, trade magazine articles</td>
<td>55</td>
<td>50</td>
<td>63</td>
</tr>
<tr>
<td>Equipment/procedures manuals</td>
<td>59</td>
<td>57</td>
<td>62</td>
</tr>
<tr>
<td>Internal technical reports</td>
<td>66</td>
<td>71</td>
<td>72</td>
</tr>
<tr>
<td>Company newsletters, bulletins</td>
<td>70</td>
<td>75</td>
<td>61</td>
</tr>
<tr>
<td>Suppliers' catalogs</td>
<td>52</td>
<td>34</td>
<td>61</td>
</tr>
<tr>
<td>Codes of standards &amp; practices</td>
<td>58</td>
<td>57</td>
<td>63</td>
</tr>
<tr>
<td>Directories of people</td>
<td>73</td>
<td>79</td>
<td>72</td>
</tr>
<tr>
<td>Training material, tools, programs</td>
<td>67</td>
<td>67</td>
<td>69</td>
</tr>
<tr>
<td>Internal financial data</td>
<td>71</td>
<td>73</td>
<td>70</td>
</tr>
<tr>
<td>Production control data</td>
<td>70</td>
<td>69</td>
<td>64</td>
</tr>
<tr>
<td>Experimental data</td>
<td>66</td>
<td>73</td>
<td>76</td>
</tr>
<tr>
<td>Product, material characteristics</td>
<td>60</td>
<td>61</td>
<td>71</td>
</tr>
<tr>
<td>Technical specifications</td>
<td>62</td>
<td>69</td>
<td>79</td>
</tr>
<tr>
<td>Design change forms</td>
<td>61</td>
<td>58</td>
<td>61</td>
</tr>
<tr>
<td>Lab notebooks</td>
<td>50</td>
<td>33</td>
<td>47</td>
</tr>
<tr>
<td>Drawings and designs</td>
<td>71</td>
<td>74</td>
<td>79</td>
</tr>
<tr>
<td>Computer code/programs</td>
<td>77</td>
<td>82</td>
<td>79</td>
</tr>
<tr>
<td>Other</td>
<td>61</td>
<td>56</td>
<td>78</td>
</tr>
</tbody>
</table>

Bulletins, directories of people, internal financial data, experimental data, drawings and designs, and computer code and programs. The range of resources here suggests that network access to information supports a broad array of specific engineering tasks. Network access to those resources most crucial to the actual design and production of technologies—such as technical specifications and designs—was considered of "great" or "some" value by the greatest number of respondents.

Respondents were also asked to report the two most significant communication channels they used to perform an important work task. They could either choose one of the twenty-one work tasks presented in the questionnaire list or supply a task not listed. The tasks selected by the greatest number of respondents were:

- identify requirements;
- conduct experiment or run test;
- interpret results of experiments, tests;
- produce drawings, designs;
- assure conformance with requirements;
- plan tasks, projects, programs, and so on;
- coordinate work;
- negotiate with coworkers, clients, vendors, students, and so on;
- solve technical problem;
- write proposal, report, paper, and so on.

Figure 1 portrays the extent to which different communication channels were used in task performance regardless of which task was performed. Face to face communication was used by a clear majority of respondents (69 percent), followed by the examination of printed material (37 percent), and use of the telephone (36 percent). Use of a computer network link to people, information, or a computer was greater than the reported use of either voice mail or U.S. or internal mail service. In examining other survey data to explore the use of network channels for specific tasks, “Learning how to do something” was found to be the one task that accounted for substantial use of all three kinds of network channels. Network links to information were also used most heavily for producing drawings or designs and identifying problems. Network links to people were also used most extensively to support work coordination and for writing proposals and reports. Finally, network links to computers were also used most often to develop theories and concepts or produce drawings or designs.

Survey results discussed so far address extent of network use in the aerospace industry and the use of networks to support aerospace engineering work and communication tasks. Another aim of the study was to explore factors that might be associated with network use. One questionnaire matrix asked respondents to report the extent to which they agreed or disagreed with a number of statements describing their work and networking environments. Comparing the responses of network users to nonusers reveals possible relationships among network use and various factors (see Table 6). For example, a greater percentage of network users, compared to nonusers, agreed that their work is integrated with the work of others, that the people they need to communicate with are all in their building, that they require a diverse range of information from a wide variety of sources, and that time pressures in their work are tremendous. A greater percentage of network nonusers, as opposed to users, agreed that they spent their day working independently. The accessibility of a networked computer is strongly associated with network use, as is work output that is stored in computerized form; these are frequently cited in the literature as factors that encourage network use, but they may
also, of course, be effects of extensive network use as opposed to causes. Organizational reward and external demand seem to be significant factors in encouraging network use among this survey's respondents. Interestingly, more network users agreed that networking is not seamless, and that many incompatible systems exist; nonusers, perhaps, are simply more optimistic about network capabilities.

Cross tabulating various respondent characteristics with network use (see Table 7) revealed, for the most part, only small differences in use due to respondent characteristics. Network use did not vary greatly by age except for those over sixty who were much less likely to be network users. Network use appears to increase with educational level. Network use is more extensive in academia, as opposed to other sectors and is more widespread in very large organizations. Table 8 reports variations in network use according to different work characteristics. Scientists appear to use networks more than engineers. In terms of primary job function, network use is most extensive among those engaged in teaching, research, advanced or applied development, and industrial engineering. Aerospace engineers working in aerodynamics or flight dynamics and control are slightly more likely to use networks than are those in other branches of aerospace.
Table 6.  
Factors Affecting Network Use

<table>
<thead>
<tr>
<th>FACTORS</th>
<th>% of USERS agreeing with statement</th>
<th>% of NON-USERS agreeing with statement</th>
</tr>
</thead>
<tbody>
<tr>
<td>The results of my work are integrated with the work of others</td>
<td>89</td>
<td>77</td>
</tr>
<tr>
<td>I spend my day working independently</td>
<td>42</td>
<td>63</td>
</tr>
<tr>
<td>All the people I need to communicate with are in my building</td>
<td>25-14</td>
<td>26</td>
</tr>
<tr>
<td>I require a diverse range of information from a variety of sources</td>
<td>84</td>
<td>65</td>
</tr>
<tr>
<td>Time pressures are tremendous in my work</td>
<td>76</td>
<td>59</td>
</tr>
<tr>
<td>My work is routine, predictable</td>
<td>7</td>
<td>13</td>
</tr>
<tr>
<td>Work discussions require having documents, devices and drawings in hand</td>
<td>67</td>
<td>66</td>
</tr>
<tr>
<td>I examine physical devices, instruments, materials, processes, etc.</td>
<td>59</td>
<td>62</td>
</tr>
<tr>
<td>The products I design, develop, or produce are highly complex</td>
<td>69</td>
<td>59</td>
</tr>
<tr>
<td>I work in a field that is extremely competitive</td>
<td>69</td>
<td>59</td>
</tr>
<tr>
<td>My organization is hierarchically structured (not project-based)</td>
<td>48</td>
<td>41</td>
</tr>
<tr>
<td>My organizational culture is rigid and authoritative</td>
<td>34</td>
<td>24</td>
</tr>
<tr>
<td>My work is classified</td>
<td>22</td>
<td>21</td>
</tr>
<tr>
<td>Results of my work are proprietary</td>
<td>49</td>
<td>55</td>
</tr>
<tr>
<td>Results of my work are stored in computerized form</td>
<td>67</td>
<td>40</td>
</tr>
<tr>
<td>I started my professional career without networks</td>
<td>88</td>
<td>84</td>
</tr>
<tr>
<td>I like to learn new computer things just for the fun of it</td>
<td>65</td>
<td>56</td>
</tr>
<tr>
<td>Networking requires too much effort to learn and keep up with</td>
<td>23</td>
<td>16</td>
</tr>
<tr>
<td>I know all about networked information services relevant to my work</td>
<td>19</td>
<td>7</td>
</tr>
<tr>
<td>Networking help comes from formal training or support programs</td>
<td>25</td>
<td>16</td>
</tr>
<tr>
<td>Network transmission is unreliable</td>
<td>15</td>
<td>5</td>
</tr>
<tr>
<td>Existing network applications are well-suited to my work</td>
<td>44</td>
<td>16</td>
</tr>
<tr>
<td>All the people, tools, resources I need are on the network</td>
<td>16</td>
<td>4</td>
</tr>
<tr>
<td>Networking is not seamless—many unconnected incompatible systems</td>
<td>61</td>
<td>21</td>
</tr>
<tr>
<td>Networking costs outweigh its benefits</td>
<td>11</td>
<td>12</td>
</tr>
<tr>
<td>Network use is actively encouraged, rewarded by my organization</td>
<td>35</td>
<td>11</td>
</tr>
<tr>
<td>Lack of networking experience makes it hard to predict costs/benefits</td>
<td>45</td>
<td>36</td>
</tr>
<tr>
<td>A networked computer is easily accessible to me</td>
<td>77</td>
<td>15</td>
</tr>
<tr>
<td>Customers, clients, sponsors are demanding that I use networks</td>
<td>20</td>
<td>9</td>
</tr>
</tbody>
</table>
The final aspect of networking considered in this study was its impact on aerospace engineering work and communication. The percentage of respondents selecting various replies to the question "Overall, how would you describe your current reaction to computer networks" is presented below:

- They have revolutionized aerospace work (21%)
- They are very useful in many respects (55%)
- They have certain worthwhile uses (19%)
- I am neutral or indifferent to them (4%)
- I have reservations about their value (1%)
- They have limited value and can cause serious problems (.4%)
- They are worthless and should not be implemented (0%)
Table 8.
WORK CHARACTERISTICS AND NETWORK USE (NETWORK USE IN %)

<table>
<thead>
<tr>
<th>Respondent Characteristics</th>
<th>Use Networks</th>
<th>NEVER USE Networks</th>
</tr>
</thead>
<tbody>
<tr>
<td>Job Title:</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Engineer</td>
<td>84</td>
<td>16</td>
</tr>
<tr>
<td>Manager</td>
<td>87</td>
<td>13</td>
</tr>
<tr>
<td>Scientist</td>
<td>91</td>
<td>9</td>
</tr>
<tr>
<td>Other</td>
<td>84</td>
<td>16</td>
</tr>
<tr>
<td>Job Function:</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Administration</td>
<td>80</td>
<td>20</td>
</tr>
<tr>
<td>Research</td>
<td>94</td>
<td>6</td>
</tr>
<tr>
<td>Advanced/Applied Development</td>
<td>91</td>
<td>9</td>
</tr>
<tr>
<td>Design/Product Engineering</td>
<td>81</td>
<td>19</td>
</tr>
<tr>
<td>Industrial Engineering</td>
<td>91</td>
<td>9</td>
</tr>
<tr>
<td>Quality Control</td>
<td>85</td>
<td>15</td>
</tr>
<tr>
<td>Production</td>
<td>80</td>
<td>20</td>
</tr>
<tr>
<td>Sales or Marketing</td>
<td>73</td>
<td>27</td>
</tr>
<tr>
<td>Service or Maintenance</td>
<td>75</td>
<td>25</td>
</tr>
<tr>
<td>Information Processing</td>
<td>88</td>
<td>12</td>
</tr>
<tr>
<td>Teaching</td>
<td>98</td>
<td>2</td>
</tr>
<tr>
<td>Aerospace Branch:</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Aerodynamics</td>
<td>94</td>
<td>6</td>
</tr>
<tr>
<td>Structures</td>
<td>85</td>
<td>15</td>
</tr>
<tr>
<td>Propulsion</td>
<td>85</td>
<td>15</td>
</tr>
<tr>
<td>Flight Dynamics and Control</td>
<td>90</td>
<td>10</td>
</tr>
<tr>
<td>Avionics</td>
<td>85</td>
<td>15</td>
</tr>
<tr>
<td>Materials</td>
<td>83</td>
<td>17</td>
</tr>
</tbody>
</table>

Thus the overwhelming majority of aerospace engineers surveyed perceived the impact of computer networks on aerospace to be positive.

The survey also solicited aerospace engineers' assessments of specific networking impacts. In one questionnaire matrix, respondents first indicated whether they thought networks decreased greatly, decreased somewhat, had no effect on, increased somewhat, or increased greatly each of the aspects of work and communication listed. They then indicated whether they considered the perceived networking effect to be a major problem, a major benefit, or neither/both. Table 9 presents selected results from this section of the survey. Responses citing some degree of increase or decrease were grouped ("don't know" and "no effect" responses are not reported in the table so percentages do not total 100 percent). Results appear in descending order, with the effects perceived by the greatest percentage of respondents listed first. The table also shows the percentage of respondents who felt that each network effect represented a major problem or benefit in aerospace work ("don't know" and "neither/both"
Table 9. Network Impacts

<table>
<thead>
<tr>
<th>Aspects of Work and Communication</th>
<th>% Reporting Effect is:</th>
<th>% Reporting Effect is:</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>Decrease</td>
<td>Increase</td>
</tr>
<tr>
<td>Amount of information available</td>
<td>2</td>
<td>87</td>
</tr>
<tr>
<td>Exchange of information, ideas across organizational boundaries</td>
<td>3</td>
<td>74</td>
</tr>
<tr>
<td>Efficiency of contacting people</td>
<td>4</td>
<td>70</td>
</tr>
<tr>
<td>Ability to complete projects on schedule</td>
<td>6</td>
<td>65</td>
</tr>
<tr>
<td>Responsiveness to customers, clients, etc.</td>
<td>2</td>
<td>65</td>
</tr>
<tr>
<td>Ability to stay on the cutting edge of new knowledge</td>
<td>2</td>
<td>64</td>
</tr>
<tr>
<td>Documentation, evaluation of work processes</td>
<td>4</td>
<td>64</td>
</tr>
<tr>
<td>Ability to communicate with otherwise inaccessible people</td>
<td>2</td>
<td>68</td>
</tr>
<tr>
<td>Use of expensive computers &amp; devices</td>
<td>11</td>
<td>62</td>
</tr>
<tr>
<td>Ability to express ideas at point of need</td>
<td>5</td>
<td>60</td>
</tr>
<tr>
<td>Need for face-to-face interaction</td>
<td>55</td>
<td>35</td>
</tr>
<tr>
<td>Performance of work at home, on the road, off-site</td>
<td>2</td>
<td>53</td>
</tr>
<tr>
<td>Management control</td>
<td>8</td>
<td>53</td>
</tr>
<tr>
<td>Feasibility, size of collaborative efforts</td>
<td>3</td>
<td>53</td>
</tr>
<tr>
<td>Flexibility in work structures, patterns</td>
<td>3</td>
<td>53</td>
</tr>
<tr>
<td>Coherence with one’s work community</td>
<td>8</td>
<td>52</td>
</tr>
<tr>
<td>Duplication of effort</td>
<td>52</td>
<td>14</td>
</tr>
<tr>
<td>Ability to complete projects within budget</td>
<td>6</td>
<td>47</td>
</tr>
<tr>
<td>Turnaround time on solving problems</td>
<td>29</td>
<td>47</td>
</tr>
<tr>
<td>Major system security problems</td>
<td>4</td>
<td>43</td>
</tr>
<tr>
<td>Amount of time spent fooling around</td>
<td>9</td>
<td>43</td>
</tr>
<tr>
<td>Leaks of proprietary or sensitive information</td>
<td>4</td>
<td>38</td>
</tr>
<tr>
<td>Number of changes required in final products</td>
<td>32</td>
<td>16</td>
</tr>
<tr>
<td>Degree of status among one’s peers</td>
<td>1</td>
<td>30</td>
</tr>
<tr>
<td>Sense of ownership, commitment to work product</td>
<td>7</td>
<td>29</td>
</tr>
<tr>
<td>Rate of career advancement</td>
<td>2</td>
<td>24</td>
</tr>
<tr>
<td>Communication with people NOT on the network</td>
<td>22</td>
<td>14</td>
</tr>
<tr>
<td>Number of staff employed</td>
<td>22</td>
<td>11</td>
</tr>
</tbody>
</table>

responses are not reported). Over half of the respondents felt that major benefits of networks were that they increased:

- the amount of information available;
• the exchange of information and ideas across organizational boundaries;
• the efficiency of contacting people;
• the ability to complete projects on schedule;
• responsiveness to customers, clients, etc.;
• the ability to stay on the cutting edge of new knowledge;
• the documentation, evaluation of work processes;
• the ability to communicate with otherwise inaccessible people;
• the ability to express ideas at point of need;
• the performance of work at home, on the road, off-site;
• the feasibility and size of collaborative efforts;
• the turn-around time on solving problems.

Citing the increased turn-around time in solving problems as a major benefit seems counterintuitive, if one assumes that it is always advantageous to solve problems as quickly as possible. It may be that some respondents had difficulty with the “decrease/increase” scale used in that question, applying it rather as the degree of “bad” to “good” influence of networks. Another possible explanation is that some respondents felt that networks allowed for more input into the problem-solving process, which increased the time required to arrive at a solution but also improved the quality of the solution.

Of the major problems cited, the risk of system security and leaks of proprietary information were perceived by over 40 percent of respondents. Almost one-third of aerospace engineers surveyed felt it was a major problem that networks increased the time that people spent “fooling around,” while about one-fifth cited the problem that communication with nonusers of networks was reduced. A number of these impacts, such as “increases the amount of information available,” are generic in the sense that they may be felt as well by other types of users beyond those in the engineering community. Some of the reported impacts relate directly to efficiency or effectiveness gains. Others, such as the increased “coherence with one’s work community,” describe second order effects, which are also important within the general work context.

CONCLUSIONS

Few studies have appeared that examine networking in engineering, as opposed to scientific or scholarly work, or that relate electronic communication determinants and effects to the situations and environments of particular communities of users. The current study hoped to extend existing knowledge by employing a user-based approach to explore the role of electronic networks in engineering work and communication.
This article has reported selected data from the author's survey on the use of electronic networks in aerospace engineering environments. Networks appear to be used widely for both communication and computation purposes by engineers in the aerospace industry, with interorganizational links available to half of those surveyed. Nonetheless, respondents perceived internal electronic links as being more valuable than external communication capabilities. A significant number of respondents reported that they had network access to a variety of tools and resources and judged network access highly valuable for accessing a variety of resource types, from analytical tools like computer programs, to experimental data, to literature citations and abstracts. While computer networks are apparently not as important as face-to-face, telephone, and print channels in the conduct of aerospace engineering work, they were used more often than voice mail or regular mail services, and almost as often as fax. Electronic mail and file transfer are the applications that are most available, most used, and judged most valuable.

While organizational sector and size—as well as primary job function—appear to influence network use, other demographic characteristics of respondents do not, generally, seem to differentiate network users from nonusers as well as specific job and organizational environment characteristics (e.g., accessibility of networked computers, whether network use is rewarded by one's organization or whether one requires a wide range of information to perform one's job). Lack of network training and awareness were noted by both network users and nonusers; this may be one area that organizations could target if they wish to increase network use by their employees. The impact of computer networks on the aerospace industry has apparently been overwhelmingly positive, with respondents generally reporting gains in areas of work efficiency, effectiveness, and satisfaction. A number of significant problems were also perceived, including lack of ubiquitous connections and inadequate security controls.

In addition to the questionnaire findings, comments made by study respondents in in-depth interviews suggest some of the limitations and advantages of electronic communication in engineering work. Although electronic communication is perceived to contribute to engineering efficiency and effectiveness, its use is limited (at least in terms of today's technology) by engineers' need for immediate highly interactive discussion of complex problems of both a technical and nontechnical nature. Networks do not provide adequate means to convey the multifaceted multimedia information that is typically exchanged in those situations where, for example, engineers discuss issues and negotiate while simultaneously...
consulting drawings, contracts, financial data, test results, and physical devices. Use may also be limited by an organization's lack of experience with electronic communication: while dangers are easy to imagine and costs easy to tally, benefits are harder to predict and quantify.

Research conducted from a user perspective can be utilized by network policy-makers, system designers, and service providers (at both the national and organizational levels) in a number of ways. It can help them:

- anticipate and avoid conflicts by discovering where attitudes and expectations vary among different groups;
- understand and estimate networking impacts and benefits by revealing both direct and second order effects;
- develop products and services well-suited to customer/client needs;
- choose appropriate network designs and features to meet users' real needs;
- devise strategies to promote network use;
- develop appropriate management and use policies;
- implement effective mechanisms for user training and support by finding out who is having what kind of problem;
- prepare appropriate evaluations of network systems and services by identifying a variety of goals and objectives and assessing the degree to which they have been met.

Thus user-based research is important in planning for the NREN and the NII. It offers an important complement to networking investigations that concentrate on technical and financial analyses and can help assure that national networking goals will be optimally met.

**ACKNOWLEDGMENT**

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APPENDIX

QUESTIONNAIRE USED IN THE SURVEY

PHASE 1 OF THE
NASA/DOD AEROSPACE KNOWLEDGE
DIFFUSION RESEARCH PROJECT

The Role of Computer Networks in Aerospace Work and Communication: SAE Study

APPENDIX (Cont.)

QUESTIONNAIRE USED IN THE SURVEY

SURVEY ON THE ROLE OF COMPUTER NETWORKS
IN AEROSPACE WORK AND COMMUNICATION

The purpose of this survey is to learn more about the current and potential impact of computer networks on work and communication in the aerospace industry from the point of view of a wide range of individuals. Your opinions and experiences are important, even (perhaps especially) if you do not use computer networks. So please answer each question as completely as possible.

**PLEASE READ THIS DEFINITION BEFORE BEGINNING THE SURVEY:**

**COMPUTER NETWORKS** are defined as telecommunication links between computers. They take many forms, for example: linked workstations within an organization; a desktop computer or terminal connected to a nearby printer or linked to a central mainframe; a dial-up link between your computer and a supercomputer or database located in some other part of the country or a link through your computer to services on the Internet or CompuServe. With a computer network, you can communicate with other computer users, utilize remote computers or computerized devices, and access information located on systems beyond your own desktop. IN THE CONTEXT OF THIS SURVEY, COMPUTER NETWORKING DOES NOT INCLUDE VOICE MAIL or TELEPHONE TELEFACSIMILE TRANSMISSION (FAX).

1. Overall, how would you describe your current reaction to computer networks? (Circle number of best response)
   - 1 They have revolutionized aerospace work.
   - 2 They are very useful in many respects.
   - 3 They have certain worthwhile uses.
   - 4 I am neutral or indifferent to them.
   - 5 I have reservations about their value.
   - 6 They have limited value and can cause serious problems.
   - 7 They are worthless and should not be implemented.

2. Which description below BEST characterizes the extent of computer networking at your workplace? (Circle number of best response)
   - 1 Networks are used by most people; many tools and resources are available on networks; most computer systems are linked together by a network; network use is required or strongly encouraged.
   - 2 Networks are used by some people; certain tools and resources are available on networks; some computer systems are linked together by a network; network use is encouraged in some cases.
   - 3 Networks are used by few, if any people; few, if any tools and resources are available on networks; few, if any computer systems are linked together by a network; organization does little to encourage, or even discourages network use.
   - 4 Don't know/Not applicable

3. Do you ever use any kind of computer in your work, such as a PC, terminal, mainframe, laptop, handheld computer, etc.? (Circle number of your response) (Circle number of your response)
   - 1 No, I never use computers
   - 2a Yes
   - 2b If yes, approximately what percent of your typical work week is spent using computers? ____ %

4. Do you ever use any kind of computer network in your work? (Circle number of best response)
   - 1 No, I never use computer networks
   - 2a Yes, I personally use computer networks
   - 2b Yes, I use computer networks, but only through an intermediary; e.g., secretary, librarian, computer support staff
   - 2c If yes, approximately what percent of your typical work week is spent using computer networks? ____ %
COMPUTER NETWORK AVAILABILITY, VALUE, AND USE

This section of the survey aims at obtaining a clearer picture of the current availability, perceived value, and use of specific types of computer networks in aerospace.

5. Please complete the chart below by placing check marks in the appropriate cells to describe YOUR access to, assessment, and use of specific types of computer networks.

If you NEVER use networks, please complete COLUMNS I-II. Record in column II your personal assessment of the POTENTIAL VALUE of each type of network listed.

If you DO use some type of network, please complete COLUMNS I-III. Record in column II your personal assessment of the ACTUAL VALUE of each type of network that you use and the POTENTIAL VALUE of each type that you do not use. Record the LOCATION OF YOUR NETWORK USE in column III.

Very often, people cannot say for sure what kinds of computer networks are available to them. That's fine; please place a check mark in the "Not Sure" cell, if this is the most appropriate response.

<table>
<thead>
<tr>
<th>TYPE OF NETWORK</th>
<th>AVAILABILITY, VALUE, AND LOCATION OF USE</th>
<th>I</th>
<th>II</th>
<th>III</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>Availability: Is a computer or terminal connected to such a NETWORK AVAILABLE for your use?</td>
<td>(Check only one)</td>
<td>VALUE of this type of network TO YOUR WORK?</td>
<td>IF YOU USE this type of network, WHERE do you use it?</td>
</tr>
<tr>
<td>LOCAL</td>
<td>Connects you to people, tools, or information within ONE BUILDING AT YOUR WORKPLACE (i.e., Local Area Network or LAN)</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>ORGANIZATIONAL</td>
<td>Connects you BEYOND ONE WORKPLACE BUILDING to people, tools, or information WITHIN YOUR OWN ORGANIZATION (e.g., corporate Wide Area Network or WAN; campus network)</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>EXTERNAL/RESEARCH</td>
<td>Provides a variety of services. Connects you to people, tools, or information OUTSIDE YOUR OWN ORGANIZATION and is INTENDED FOR RESEARCH AND EDUCATIONAL USE (e.g., Internet, BITNET, NSFNet, Usenet)</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>EXTERNAL/COMMERCIAL</td>
<td>Provides a variety of services. Connects you to people, tools, or information OUTSIDE YOUR OWN ORGANIZATION and is OPEN FOR USE BY THE GENERAL PUBLIC (e.g., Prodigy, BIX, CompuServe, GEnie, MC!Mail)</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>OTHER (please describe)</td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
</tbody>
</table>
APPENDIX (Cont.)

QUESTIONNAIRE USED IN THE SURVEY

WORK RESOURCES IN AEROSPACE

This section of the survey asks about the wide variety of resources you use in your work and the extent to which these resources are accessible over any kind of computer network. Please complete the entire chart below FOR ANY WORK RESOURCE YOU USE, even if you don’t use networks.

6. First, CHECK OFF ANY RESOURCE THAT YOU USE in your work. Then, place check marks in each of THOSE ROWS ONLY to describe YOUR use and assessment of computer network access to that work resource. If any resources you use do not appear in the chart, add them in the “Other” rows.

For any resource CURRENTLY ACCESSIBLE TO YOU VIA COMPUTER NETWORK, describe your assessment of the ACTUAL VALUE OF NETWORK ACCESS to that resource, based on your experience.

For any resource NOT CURRENTLY ACCESSIBLE TO YOU VIA COMPUTER NETWORK, describe your assessment of the POTENTIAL VALUE OF NETWORK ACCESS to that resource, based on your opinion.

WAIT! Information resources (e.g., journal articles, internal financial data) should NOT be considered network accessible unless the full text or content of the information—as opposed to just the bibliographic citation or database listing—can be viewed over the network.

<table>
<thead>
<tr>
<th>WORK RESOURCES</th>
<th>USE AND VALUE OF NETWORK ACCESS</th>
<th>( \text{VALUE of NETWORK ACCESS} )</th>
</tr>
</thead>
<tbody>
<tr>
<td>People in your workgroup or dept.</td>
<td>( \text{Not Applicable-No Network Access} )</td>
<td>( \text{Great} )</td>
</tr>
<tr>
<td>Other people in your organization</td>
<td>( \text{Usually} ) vs. telephone, etc., access</td>
<td>( \text{None} )</td>
</tr>
<tr>
<td>Colleagues in academia, government</td>
<td>( \text{Sometimes} )</td>
<td>( \text{Slight} )</td>
</tr>
<tr>
<td>Colleagues in private industry</td>
<td>( \text{Rarely} )</td>
<td>( \text{None} )</td>
</tr>
<tr>
<td>External clients, customers, sponsors</td>
<td>( \text{Never} )</td>
<td>( \text{Don't know} )</td>
</tr>
<tr>
<td>External vendors, suppliers</td>
<td>( \text{Other} )</td>
<td></td>
</tr>
<tr>
<td>Document citations, abstracts</td>
<td>( \text{Other} )</td>
<td></td>
</tr>
<tr>
<td>Journal, trade magazine articles</td>
<td>( \text{Other} )</td>
<td></td>
</tr>
<tr>
<td>Equipment or procedures manuals</td>
<td>( \text{Other} )</td>
<td></td>
</tr>
<tr>
<td>Internal technical reports</td>
<td>( \text{Other} )</td>
<td></td>
</tr>
<tr>
<td>Company newsletters, bulletins</td>
<td>( \text{Other} )</td>
<td></td>
</tr>
<tr>
<td>Manufacturers or suppliers' catalogs</td>
<td>( \text{Other} )</td>
<td></td>
</tr>
<tr>
<td>Codes of standards and practices</td>
<td>( \text{Other} )</td>
<td></td>
</tr>
<tr>
<td>Directories of people</td>
<td>( \text{Other} )</td>
<td></td>
</tr>
<tr>
<td>Training materials, tools, programs</td>
<td>( \text{Other} )</td>
<td></td>
</tr>
<tr>
<td>Internal financial data</td>
<td>( \text{Other} )</td>
<td></td>
</tr>
<tr>
<td>Production control data</td>
<td>( \text{Other} )</td>
<td></td>
</tr>
<tr>
<td>Experimental or test data</td>
<td>( \text{Other} )</td>
<td></td>
</tr>
<tr>
<td>Product or materials characteristics</td>
<td>( \text{Other} )</td>
<td></td>
</tr>
<tr>
<td>Technical specifications</td>
<td>( \text{Other} )</td>
<td></td>
</tr>
<tr>
<td>Design change forms</td>
<td>( \text{Other} )</td>
<td></td>
</tr>
<tr>
<td>Lab notebooks</td>
<td>( \text{Other} )</td>
<td></td>
</tr>
<tr>
<td>Drawings or designs</td>
<td>( \text{Other} )</td>
<td></td>
</tr>
<tr>
<td>Computer code or programs</td>
<td>( \text{Other} )</td>
<td></td>
</tr>
</tbody>
</table>
NETWORK APPLICATIONS IN AEROSPACE

It's important to gain a fuller picture of the extent to which different network applications (computer AND non-computer) are used in aerospace and which ones are considered the most valuable. Please complete the entire chart below, even if you don't use networks.

7. Place check marks in EACH ROW to describe YOUR use and assessment of each of the specific types of network applications listed.

**For any network application that YOU CURRENTLY USE,** describe your assessment of its ACTUAL VALUE, based on your experience.

**For any network application that YOU DO NOT CURRENTLY USE,** describe your assessment of its POTENTIAL VALUE, based on your opinion.

<table>
<thead>
<tr>
<th>NETWORK APPLICATIONS</th>
<th>AVAILABILITY, USE, AND VALUE</th>
<th>How FREQUENTLY do YOU use this application AT YOUR WORKPLACE? (Check only one)</th>
<th>VALUE of application TO YOUR WORK? (ACTUAL value of application IF USED; otherwise POTENTIAL value) (Check only one)</th>
</tr>
</thead>
<tbody>
<tr>
<td>Electronic mail (sending messages to individuals)</td>
<td>Application NOT AVAILABLE at Workplace</td>
<td>Daily</td>
<td>Weekly</td>
</tr>
<tr>
<td>Electronic bulletin boards, mailing lists, discussion groups or computer conferencing systems (for group messages)</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Real-time, interactive messaging</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Videoconferencing</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Voice mail</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Telefacsimile (Fax)</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Electronic journals or newsletters</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Electronic data interchange (EDI) for exchanging orders, bills, etc.</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Logging into a computer NOT on your desktop or run a program (e.g., CAD/CAM, spreadsheet, modeling)</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Logging into a computer NOT on your desktop to access data or text files (e.g., personnel or project data, reports)</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Online bibliographic searching of commercial or government databases</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Online library and catalog searching</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Operation of computerized experimental, test, or production devices without being physically present</td>
<td></td>
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<tr>
<td>Computer-integrated manufacturing</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Transferring data or text files between computers</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Accessing or transferring images</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Other</td>
<td></td>
<td></td>
<td></td>
</tr>
</tbody>
</table>
AEROSPACE TASKS AND ACTIVITIES

In interviews conducted earlier, people working in aerospace discussed the wide variety of important tasks and activities they perform. This section of the survey asks how YOU performed some particular task that was important to your work.

8. **The one most important work task I performed during my last work week was to** (Circle number of SINGLE BEST response):

1. Come up with new ideas, approaches
2. Keep up with new developments
3. Develop theories, concepts
4. Identify requirements
5. Learn how to do something
6. Select or design methods and procedures
7. Conduct experiment or run test
8. Perform mathematical analysis
9. Interpret results of experiments, tests
10. Produce specifications
11. Produce drawings, designs
12. Identify resources
13. Produce prototypes or products
14. Assure conformance with requirements
15. Troubleshooting, maintenance
16. Plan tasks, projects, programs, etc.
17. Coordinate work
18. Identify problem
19. Negotiate with co-workers, clients, vendors, students, etc.
20. Solve technical problem
21. Write proposal, report, paper, etc.
22. Other: ______________________________________________________________________

9. Please describe the task briefly: ______________________________________________________________________

10. **Approximately how many OTHER people were directly involved in performing this task with you?**

_____ other people (Please supply number from 0 up)

11. **What was the geographic span involved in performing the task, in relation to your primary work location at the time?** (Circle number of best response)

1. Same office/lab
2. Same building
3. Same worksite
4. Same town
5. Same country
6. Across countries
7. Don't know

12. **What was the organizational span involved in performing the task, in relation to your primary work location at the time?** (Circle number of best response)

1. Same workgroup
2. Same department
3. Same division
4. Same organization
5. Across organizations
6. Don't know

13. In performing this task, did you come into contact with any useful people, information sources, or tools not previously known to you? (Circle number of response)

1. Yes
2. No
APPENDIX (Cont.)

QUESTIONNAIRE USED IN THE SURVEY

14. What were the two most important communication channels you used in performing this task? On the lines provided below, please WRITE a "P" in front of the PRIMARY communication channel used. WRITE an "S" in front of the SECONDARY channel used.

  Face-to-face interaction with other person(s) (Mechanism Code: FTF)
  Examining printed material in own office or other location (Mechanism Code: P)
  Own direct examination, testing of physical objects, devices, processes (Mechanism Code: D)
  Use of computer network to communicate with people (Mechanism Code: NP)
  Use of computer network to access information or data (Mechanism Code: NI)
  Use of computer network to operate a computer or other device (Mechanism Code: NC)
  Use of a non-networked computer (Mechanism Code: C)
  Telephone (Mechanism Code: T)
  Voice Mail (Mechanism Code: VM)
  Internal (e.g., company or campus) or U.S. Mail (Mechanism Code: M)
  Fax (Mechanism Code: F)
  Other (please describe): ____________________________

15. What was your MAIN REASON for choosing the PRIMARY channel used? (circle SINGLE BEST response)

1. Preferred mechanism not available: ______ (Supply Mechanism Code from previous question)
2. Tradition demanded it
3. It was quickest way to accomplish the task
4. It required the least effort on my part
5. It was cheapest
6. It was the most reliable
7. It allowed the greatest accuracy of information flow
8. It allowed for the most complete expression, interpretation, or interaction in information flow
9. It allowed for the most presentable expression of information
10. It's what everyone involved was set up for
11. Other (please describe): ____________________________

NATURE OF YOUR WORK ENVIRONMENT

This section seeks information about your work environment in order to explore work-related factors that may be associated with network use.

16. In your present job, do you consider yourself primarily a(n)? (Circle number of SINGLE BEST response):

1. Engineer
2. Manager
3. Scientist
4. Other (please describe): ____________________________

17. In which branch of aerospace do you work? (Circle number of SINGLE BEST response)

1. Aerodynamics
2. Structures
3. Propulsion
4. Flight dynamics and control
5. Avionics
6. Materials and processes
7. Other (please describe): ____________________________

18. What do you think are the biggest barriers to network use that you experience? ____________________________

19. What are the most important factors that encourage your network use or potential use? ____________________________
APPENDIX (Cont.)
QUESTIONNAIRE USED IN THE SURVEY

20. Please complete this chart on YOUR WORK AND NETWORKING ENVIRONMENT by placing a check mark in each row to indicate the extent to which YOU agree or disagree with each of the statements listed. Please complete the entire chart, even if you don’t use networks.

<table>
<thead>
<tr>
<th>EXTENT TO WHICH YOU AGREE?</th>
</tr>
</thead>
<tbody>
<tr>
<td>(Check only one)</td>
</tr>
<tr>
<td>Not applicable/ Don’t know</td>
</tr>
<tr>
<td>Disagree strongly</td>
</tr>
<tr>
<td>Disagree somewhat</td>
</tr>
<tr>
<td>Neither agree nor disagree</td>
</tr>
<tr>
<td>Agree somewhat</td>
</tr>
<tr>
<td>Agree strongly</td>
</tr>
</tbody>
</table>

| STATEMENTS CONCERNING WORK AND NETWORKING ENVIRONMENT | |
|--------------------------------------------------------|
| The results of my work are integrated with the work of others |
| I spend my day working independently                     |
| All the people I need to communicate with are in my building |
| I require a diverse range of information from a wide variety of sources |
| Time pressures are tremendous in my work                  |
| My work is routine, predictable                           |
| Work discussions require having documents, devices, drawings all in hand |
| I often examine physical devices, instruments, materials, processes, etc. |
| The products I design, develop, or produce are highly complex |
| I work in a field that is extremely competitive           |
| My organization is hierarchically structured (as opposed to project-based) |
| My organizational culture is rigid and authoritative      |
| My work is classified                                      |
| Results of my work are proprietary                        |
| Results of my work are stored in computerized form        |
| I started my professional career without networks         |
| I like to learn new computer things just for the fun of it |
| Networking requires too much effort to learn and keep up with |
| I know about all the networked information, services relevant to my work |
| Networking help comes mostly from formal training or support programs |
| Network transmission is unreliable                         |
| Existing network applications are well-suited to my work   |
| All the people, tools, resources I need are on the network |
| Networking is not seamless; still many unconnected, incompatible systems |
| Networking costs outweigh its benefits                     |
| Network use is actively encouraged, rewarded by my organization |
| Lack of experience with networking makes it hard to predict costs, benefits |
| A networked computer is easily accessible to me            |
| Customers, clients, sponsors are demanding that I use networks |
IMPACT OF COMPUTER NETWORKS

In interviews conducted earlier, people involved in the aerospace industry suggested a wide variety of impacts, representing both problems and benefits, that may result from network use. Please complete the entire chart below to share YOUR OWN OPINIONS AND EXPERIENCES, regardless of whether or not you currently use networks.

21. Indicate in COLUMN I the extent to which YOU believe that NETWORKS INCREASE OR DECREASE each work aspect listed. Place a check in COLUMN II IF YOU HAVE PERSONALLY EXPERIENCED that effect. Indicate in COLUMN III whether you believe the effect represents a MAJOR PROBLEM OR BENEFIT in aerospace work.

<table>
<thead>
<tr>
<th>ASPECTS OF WORK</th>
<th>EFFECT OF NETWORKS</th>
<th>COLUMN I</th>
<th>COLUMN II</th>
<th>COLUMN III</th>
</tr>
</thead>
<tbody>
<tr>
<td>Ability to express ideas, problems at point of need</td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Amount of information available</td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Need for face-to-face interaction</td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Coherence with one's work community</td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Communication with people NOT on the network</td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Exchange of information, ideas across organizational boundaries</td>
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<td>Efficiency of contacting people</td>
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<td>Number of changes required in final products</td>
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<td>Use of expensive computers and computerized devices</td>
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<td>Ability to complete projects within budget</td>
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<td>Turnaround time on solving problems</td>
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<td>Ability to complete projects, develop products on schedule</td>
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<td>Duplication of effort</td>
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<td>Ability to stay on the cutting edge of new knowledge</td>
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<td>Sense of ownership, commitment to work product</td>
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<td>Performance of work at home, on the road, off-site</td>
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<td>Rate of career advancement</td>
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<td>Degree of status among one's peers</td>
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<td>Ability to communicate with otherwise inaccessible people</td>
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<td>Documentation, evaluation of work processes</td>
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<td>Feasibility, size of collaborative efforts</td>
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<td>Flexibility in work structures, patterns</td>
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<td>Number of staff employed</td>
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<td>Loss of proprietary or sensitive information</td>
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<td>Major system security problems</td>
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<td>Responsiveness to customers, clients, etc.</td>
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Other (please specify):

Other (please specify):
APPENDIX (Cont.)

QUESTIONNAIRE USED IN THE SURVEY

IMPORTANT BACKGROUND INFORMATION

The information that you provide in this section will be used to help determine whether people with different backgrounds and jobs differ in regard to their network use.

22. Gender (Circle number of your response):

   1 Male
   2 Female

23. Age ___

24. Highest degree obtained (Circle number of the SINGLE BEST response):

   1 High School Diploma
   2 Technical/Vocational Degree
   3 Bachelor’s Degree
   4 Master’s Degree
   5 Doctorate
   6 Post Doctorate
   7 Other (please describe): __________________________

25. Years of professional aerospace work experience: ___ years

26. Type of organization where you work (Circle number of SINGLE BEST response):

   1 Industry/Manufacturing
   2 Government
   3 Academic
   4 Not-for-Profit
   5 Retired or Not Employed
   6 Other (please describe): __________________________

27. If you work in an organization other than an educational institution, what is the approximate number of employees in your organization? (Please supply number of people for each category below that is applicable):

   27a ___ people in parent organization
   27b ___ people in my division
   27c ___ people in my location
   27d ___ people in department (or the equivalent)

28. Which category BEST describes your primary job function? (circle number of SINGLE BEST response)

   1 Administration
   2 Research
   3 Advanced or Applied Development
   4 Design/Product Engineering
   5 Industrial/Manufacturing Engineering
   6 Quality Control/Assurance (testing, inspection, etc.)
   7 Production
   8 Sales/Marketing
   9 Service/Maintenance
   10 Information Processing/Computer Programming/Systems Management
   11 Teaching/Training (may include research)
   12 Other: __________________________

29. What is your current job title? __________________________

30. Does your own work involve, as a primary feature, the development or analysis of computer systems, components, software, or data? (Circle number of your response)

   1 Yes
   2 No
CONCLUDING THE SURVEY

31. What do you most want to convey to network policymakers, service providers, or organizational managers about the impact of computer networks on work and communication in aerospace?

32. Is there anything else you would care to say about the use of computer networks in the aerospace industry? About this study?

33. Would you be interested in participating in follow-up research related to this study, such as a brief telephone interview or a short questionnaire on some specific aspect of network use? (Circle number of your response)

1 Yes
2 No

THANK YOU!

Mail to:
NASA/DoD Aerospace Knowledge Diffusion Research Project
NASA Langley Research Center
Mail Stop 180A
Hampton, VA 23681-0001
REFERENCES


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About the Contributors

Ann Peterson Bishop is a faculty member in the Graduate School of Library and Information Science at the University of Illinois at Urbana-Champaign. Her M.L.S. is from Syracuse University’s School of Information Studies; she is currently working on her Ph.D. at Syracuse. Ms. Bishop’s research interests include information seeking and use behavior, scientific and technical communication, and federal information policy. She is co-founder of Prairienet (a Free-Net in Illinois) and Associate Editor of Internet Research.

Tscheria Harkness Connell received her doctorate from the Graduate School of Library and Information Science at the University of Illinois at Urbana-Champaign. She is currently an assistant professor at the School of Library and Information Science, Kent State University, where she teaches courses in the organization of library materials, cataloging, and technical services. She has authored several articles on subject access in online catalogs. Ms. Connell’s research interests also include evaluating descriptive information for its role in discrimination among records in large online databases. She is a member of several professional library organizations and is currently serving on the executive committee of the Columbus, Ohio, chapter of the American Society for Information Science.

Carl Franklin received his doctorate from the Ohio State University. He is currently an assistant professor at the Kent State University School of Library and Information Science where he teaches courses on advanced information technology, information policy and economics, and online information retrieval. Beginning mid-1994, Mr. Franklin will leave Kent State University to devote full time to his consulting firm, which provides custom research, technology training, and systems integration services.

Susan Hockey is Director of the Center for Electronic Texts in the Humanities, which is sponsored by Rutgers and Princeton.
Universities. She has been active in humanities computing since 1969. She is the author of three books and numerous articles and has lectured widely on various aspects of humanities computing. She is Chair of the Association for Literary and Linguistic Computing and a Member (past Chair) of the Steering Committee of the Text Encoding Initiative.

DIANE K. KOVACS is an instructor and Reference Librarian, at Kent State University Libraries. In addition to an M.S. in Library and Information Science from the University of Illinois at Urbana-Champaign (1989), she has an M.Ed. in Educational Technology from Kent State University (1993). She is the editor-in-chief of the Directory of Scholarly Electronic Conferences published by the Association of Research Libraries, and, with Michael Strangelove, the Directory of Electronic Journals, Newsletters and Academic Discussion Lists, 3d ed. Ms. Kovacs has written and spoken frequently on the topic of scholarly resources on the academic networks. She also has taught workshops on using the Internet Resources for scholarly research. She is editor-in-chief of LIBRES: Library and Information Science Research Electronic Journal (a peer-reviewed electronic journal), co-editor of the Electronic Journal on Virtual Culture, and co-moderator of LIBREF-L—Discussion of Library Reference Issues—and GovDoc-L—Discussion of Government Documents Issues.

CHARLES R. MCCLURE is Professor at the School of Information Studies, Syracuse University, Syracuse, NY 13244. He teaches courses in U.S. Government information management and policies, information resources management, library/information center management, and planning/evaluation of information services. Mr. McClure is the editor of Internet Research, a quarterly journal, and has written extensively on topics related to planning and evaluation of library services, U.S. Government information, and information policy. During Fall 1993, he was selected to serve as Distinguished Researcher at the National Commission on Libraries and Information Science. His most recent book is Libraries and the Internet/NREN: Issues, Perspectives, and Opportunities (Meckler, 1994).

JULIE A. MCDANIEL is currently Coordinator of Online Services at Ohio Wesleyan University Libraries, Delaware, Ohio. She is active in the Academic Library Association of Ohio and is co-author, with Judith K. Ohles, of Training Paraprofessionals for Reference Service (Neal Schuman, 1993).

BARBARA F. SCHLOMAN is Head, Reference and Information Services, and Associate Professor, Libraries and Media Services, at Kent State
University. She is a distinguished member of the Academy of Health Information Professionals of the Medical Library Association. In addition to an M.S.L.S. from the University of Wisconsin—Madison, she has an M.A. in health education and is in a doctoral program in curriculum and instruction. She is interested in the teaching of information skills and the role librarians can play in a networked information environment. Her publications include articles on instructing users in nursing, health education, and the sciences; management of reference services; and information transfer in health education. Along with other members of her department, Ms. Schloman serves as moderator of LIBREF-L and is an Associate Editor of LIBRES: Library and Information Science Research Electronic Journal.

Judith J. Senkevitch is Assistant Professor at the School of Library and Information Science at the University of Wisconsin—Milwaukee, where she teaches, conducts research, and publishes in the areas of library management and organizational processes, and public library issues and services. In May 1994, with Dietmar Wolfram, she will be directing the Internetworking Rural Libraries Institute in Milwaukee.

Thomas D. Walker is Assistant Professor at the School of Library and Information Science at the University of Wisconsin—Milwaukee. With research interests in the history of bibliography and libraries, he has published articles about library historiography, research methods, and the history of scholarship and has contributed entries to encyclopedias of music bibliography and library history. He is currently editing Adalbert Blumenschein's Beschreibung verschiedener Bibliotheken in Europa, an eighteenth-century manuscript account of about 2,500 European libraries.

Constance M. Wittig is the Network Administrator for the School of Library and Information Science at the University of Wisconsin—Milwaukee and teaches introductory courses in microcomputers and local area networking.

Dietmar Wolfram is an Assistant Professor with the School of Library and Information Science at the University of Wisconsin—Milwaukee, where he teaches courses in information and communication technology, database management, and microcomputer applications. He received his Ph.D. in Library and Information Science from the University of Western Ontario. His publication and research areas include applied informetrics and information retrieval.
systems design. With Judith Senkevitch, he has been organizing the Internetworking Rural Libraries Institute, to be held in Milwaukee in May 1994.

**Yuan Zhou** is Head of the East Asian Library at the University of Minnesota Libraries—Twin Cities, Minneapolis, Minnesota. He serves currently on the Automated System Steering Committee of the University of Minnesota Libraries—Twin Cities.
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