SCHOLARSHIP IN THE ELECTRONIC COMMUNITY

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Paper presented at the UCEA Convention '94
Philadelphia, October 29, 1994

ABSTRACT

The technological advances in computing at all levels, but especially in desktop computing and networking, are democratizing the way information is created and distributed. At the same time, any information user on the network can easily become an information provider. To the degree that more and more information providers make their resources available on the Internet they contribute to its growing complexity because of a lack of standards to classify and access all these electronic resources and documents. Problems arise for information seekers when trying to navigate in this seemingly chaotic environment.

The information revolution is affecting the academic workplace at all levels and the new technologies have great application potential in teaching, learning, scholarly activity, and service. Universities enjoy a unique advantage in this revolution because information is the raw material at the core of their mission and because they are a step ahead of other private and public sector organizations in linking their networks to Internet. The combination of high purchasing costs of information resources and easier network access to resources outside an institution's physical walls is forcing a shift with respect to information resources: from ownership to access, wherever they may be and whenever they are needed.

With the proliferation of information resources on the Internet, the academic and research communities have created new tools for searching, accessing, and retrieving information resources. User studies are needed to provide a basis for the next generation of this type of information handling software.

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The advances in computing at all levels, but especially in desktop computing and networking, are democratizing the way information is created and distributed and adding new meanings to the concept of community. The Internet, a global network linking thousands of smaller networks and millions of computers (Quarterman, 1993), is bringing universal connectivity closer to reality. Any computer can establish a link with any other computer to send and receive information on Internet almost instantly. Users can communicate directly with each other regardless of geographic location. Many computers have a *server* function which enables them to provide information on the network for others to retrieve.

New forms of scholarly communication have developed, such as electronic discussion lists (Kovacs, 1994), electronic scholarly journals (Langshied, 1994), computer models and simulations, real-time presentations, and multimedia creations (Brett, 1993). At the same time, new ways of sharing information with constituencies have emerged, such as Gopher and World Wide Web (Kappe, Pani, and Schnabel, 1993). Universities are using these software tools to make information available to their own users —students, faculty, staff, and administration, as well as to the global Internet community. Beyond traditional forms of distance education and beyond the walls of academia a new worldwide electronic university is emerging (Rossman, 1992). As Pool (1990) emphasizes, "a revolution in communication technology is taking place today, a revolution as profound as the invention of printing. Communication is becoming electronic" (p. 7).

A. The Problem: Organizing Information for Better Access for Scholars

As with any revolution, unforeseen problems accompany the breathtaking opportunities that arise. To the degree that more and more providers make their resources available on the Internet they contribute to its growing complexity because there is yet no "industry standard" to classify electronic resources and documents. As Sutton (1992) puts it: "The lack of standardized operating commands makes the network a hazardous environment for the inexperienced user, who must make do without comprehensive training materials or even simple documentation" (p. 10).

Smith (1990) studies the role of the scholar and the librarian in a future research library and predicts that "whether the transition [from print to electronic mode] is brief or prolonged, extensive or relatively limited, the result will be an increase in the amount and complexity of information available to the scholar." He clearly states that "the ready availability of vast amounts of unorganized information is not what scholars want; nor do they want to organize this information" (p. 60).

The problem is that the academic community must determine the most effective way to organize electronic information to maximize use of this powerful resource to carry out its mission of research, teaching and learning, and service. Gregorian's (1993) advice to universities is clear:

> *We must rise above the obsession with quantity of information and speed of transmission, and recognize that the key issue for us is to organize this information once it has been amassed—to assimilate it, find meaning in it, and assure its survival for use by generations to come.* (p. 5)

What is the best pattern of organization for electronic information so that it maximizes its usefulness to the consumers of information resources?

To be able to answer this question one must know more about users' need for information, how they search for and retrieve it, and what they do with it once they have it.

B. Solutions in Progress: New Electronic Tools

A 1992 survey done by the Association of Research Libraries finds that a significant number of academic institutions are making commitments to electronic services: "85 percent of the responding libraries are using or developing electronic document delivery services" (ARL, p. 3).

A number of independent, loosely coordinated efforts have been made to give structure to electronic information resources on the Internet. One of the widely used tools is Gopher (Quarterman, 1993), developed at the University of Minnesota in 1991 (Alberti, Anklesaria, Lindner, McCahill, and Torrey, 1992; McCahill, 1993; Roca, 1993; Wiggins, 1993). The software is available free of charge to educational and non-profit entities. Universities and other educational institutions, government agencies, and numerous other organizations and individuals are making use of Gopher and becoming both providers and consumers of electronic information. The flexibility of the software does not impose any rules other than that information must be presented in hierarchical menus, much like the table of contents for a research paper.

The explosion of information on the Internet places the burden on the end users of this information now that the use of tools like Gopher, Wais, and World Wide Web has spread rapidly. In the same way that numerous user studies helped answer questions about the users of online catalogs (Council of Library Resources, 1983; Lewis, 1987; Markey, 1983; Peters, 1991)

and facilitated their evolution, it is important to learn how new tools such as Gopher are being used to assess their effectiveness in information delivery.

How are information seekers finding it in today's environment? What processes are followed in the search and retrieval of network information on Internet? Who is using these new Internet tools? Do they make sense to them? While there are numerous books and articles focusing on how to use these tools, no user studies have been found in the current literature. Studies identifying and evaluating how information is searched for, retrieved, and used with the Internet tools are needed to fill this gap.

C. The Evolution of Information Classification

Information must be well organized to be useful, no matter which medium contains it: paper, video, compact disk, film, computer disk, or others. Organizing information has been a human endeavor for centuries. Although we know little about libraries during the first ten centuries of the Christian era, Alcuin's "metrical catalogue", dating back to the eighth century, provides an insight on how the early medieval library at the monastery of York was organized. According to Norris (1969) this catalogue "enjoys the unique position of being the only catalogue, in the whole history of cataloguing, which has been compiled without any reference whatever to the books themselves" (p. 8). Here is a sample of Alcuin's catalogue in a loose translation provided by Norris that references classic authors in the order and arrangement they would be located on the shelves:

> *Wise Aristotle looks on Tully near.*
> *Sedulius and Juvencus next appear.*
> *Then come Albinus, Clement, Prosper too,*
> *Paulinus and Arator. Next we view*
> *Lactantius, Fortunatus. Ranged in line*
> *Virgilius Maro, Statius, Lucan, shine.*
> *Donatus, Priscian, Probus, Phocas start*
> *The roll of masters in grammatic art.*
> *Eutychius, Servius, Pompey each extend*
> *The list. Comminian brings it to an end.* (p. 10)

As Norris recounts, libraries through the medieval ages settled on cataloguing books in some subject order, although monks were more concerned about having an inventory of property than a key to the library; it was not until the seventeenth century, with the closing of monastic libraries and the appearance of university libraries, that the users of the library were considered. Organization by author was introduced, marking the beginning of modern cataloguing. A plethora of author and subject classifications appeared during the eighteenth and nineteenth centuries.

The introduction of the Dewey Decimal Classification by Melville Dewey in 1876 divided the field of knowledge into ten classes. Kossuth (1966) emphasizes that "Dewey was concerned with the classification of books, as distinguished from the classification of knowledge as such" (p. 81) and praises Dewey for being the first "with a simple, generally acceptable, system of library classification." This is how Dewey (1966), using his simpler English spelling, describes the reasoning behind his classification:

> *It was chiefly necesary to find a method that wud clas, arranje and index books and pamflets on shelvs, cards of a catalog, clippings and notes in scrapbooks and index rerums, references to all these items, and indeed any literary material in any form, as redily as an ordinary index gyds to proper paje of a bound book.* [sic] (p. 86)

As technology provides the means to deal with the increasing demands for information in electronic form, the quest for simple, easy to use methods

of classification echoes Dewey's concerns. How or where information is stored is not as relevant today as how users will be able to find it in a manner that makes sense to them.

The Subject Classification at the Library of Congress also sought to group books by subject conveniently. In introducing the Library of Congress Subject Classification in 1912, Hulme (1966) argues that the object of any classification of books is that it will be easier and faster to find them:

> *We now beg leave to introduce a brief outline of the theory of book classification with the following definition: viz. that book classification is a mechanical time-saving operation for the discovery of knowledge in the literature. Books are our theme: and the discovery of knowledge in books by the shortest route our aim and object.* (p. 110)

Not many years later, in 1931, Ranganathan (1964) makes "save the time of the reader" his fourth law of library science. He elaborates on how to put that law into practice:

> *Perhaps the most convenient method of studying the consequences of this law will be to follow a reader from the moment he enters the library to the moment he leaves it, critically examining each process, which he has to go through, with an eye to the economy of time that can be effected at each stage.* (p. 288)

Again the importance of the end user cannot be stressed enough. In order to improve the delivery of information we must gain an understanding of how end users look at information and how they utilize the available search and retrieval tools.

D. Impact of Electronic Information

Duncan (1993) concludes his study of the implications for change due to the implementation of electronic information systems in universities by

saying that "information technology will change the nature of academic work; exactly what those changes are to be is yet to be known." Studies of users of such information systems will help unveil the true nature of these changes.

The application of computers to information has added time saving benefits by making it possible to retrieve any information almost instantly. Early online catalogs with limited search capabilities were replaced by newer systems that included features such as keyword searching and online browsing (Hildreth, 1985). Today's online systems have added access to journal citation databases and some of these provide easy access to the full text of the articles (Mintz, 1993; Orenstein, 1993). Many of these online catalogs are now linked to each other and accessible to the public through Internet (Scott, 1992).

However, as more and more of the information resources —not just library catalogs— are available online, they may become too much of a good thing. Brett (1993) labels this situation "the inverse of the tragedy of the commons": instead of the commons failing to support a medieval community due to depletion of resources, today "we are increasing the volume to a dangerously high level" (p. 26). He then proceeds to present the networked information retrieval tools created by the computing community as an answer to deal with this deluge of information: electronic mail, file transfer, telnet and remote login, menu-based systems, hypertext navigation systems or browsing tools —such as World Wide Web and Gopher, Wide Area Information Servers, and knowbots and intelligent agents. As for answering the question "how do we get there from here?" he advocates a solution integrating the human centered approaches used by libraries and the machine centered approaches used by computer centers: "Communication

will happen at least at three levels: human to human, human to computer, and computer to computer" (p. 34).

Cochenour (1993) concludes that "people are more important than technology" and maintains that "the most difficult aspect of the development of the virtual library will be interactions with people" (p. 158). Similarly, Branin, D'Elia, and Lund (1993) report that in implementing the Integrated Information Center (at the University of Minnesota) the planners found that "organizational integration is a much more problematic undertaking than technological integration" (p. 76).

1. The Information Revolution

Changes in the world of information cannot be looked at in isolation. They are all part of a radical transformation taking place at the end of the twentieth century, as the global economy is forcing businesses here and abroad to downsize, retool, restructure, with no alternative but to do it or perish. All kinds of organizations are in the process of *reengineering* their operations. Drucker (1993) analyzes these global changes in the context of the transition from the industrial revolution, through the productivity and management revolutions, and to the *knowledge society*. He puts knowledge at the center and predicts that "the greatest change will be in the form and content of knowledge . . . and what it means to be an educated person."

From an information science perspective, Lynch (1992) calls network information a "revolution in progress" and points to the problems arising from the exponential growth in the volume of information:

> *It is true that more information is end-user-accessible and that the access software is becoming easier to use. At the same time, the total amount of information available is growing very rapidly, and some of it is complex and difficult to search and evaluate.* (p. 36)

Gregorian (1993) looks at how these changes affect universities and acknowledges the overwhelming reality:

> *We are unable to use 90 to 95 percent of the information that is currently available, and nowhere is this more apparent than at the university, where the daunting arrival of information in the form of books and journals has been compounded by an accelerating electronic torrent from thousands of databases around the world.* (p. 1)

In spite of this reality, Gregorian believes there is hope because "information technology also presents us with the opportunity and the tools for meeting the challenge of the explosion of information and the fragmentation of knowledge" (p. 6). However, he warns that "the focus is not technology, but information and its associated methodologies of analysis, synthesis, and communication; the real revolution in information technology is about communication, not computation" (p. 9). Gregorian thinks that institutions of higher education are at the core of this revolution and have an opportunity to participate in redefining what it means to be an educated person because communication is at the heart of the research, teaching, learning and service processes.

For Ward (1994) the growing knowledge base presents a real challenge: in the 1960s the printed word could keep pace with the creation of knowledge, but "today we no longer have the means to present it in a timely fashion using the normal print media" (p. 25). Ward recommends that the future of higher education should be connected to information technology in designing a new learning environment.

Smith (1990) echoes the concern about the exponential growth in the volume and complexity of scholarly information (p. 60). Writing later with Johnson (Smith and Johnson, 1993), they see an emerging long-term solution "as the research/higher education community takes advantage of the new information technology, transforming scholarly communication from a print-based to an electronic-based system" (p. 389). Smith and Johnson (p. 390) analyze the report of the American Physical Society (APS) as a "credible snapshot of the future." The APS report (APS, 1991) defines Vision 2020, a World Scientific Information System "where all of the world's formal scientific literature is available, online, to scientific workers throughout the world, from a world scientific database" (APS, p. 1140). Nonetheless, one of the members of the task force that produced the APS report writes: "the current rate of development for hardware, software, and networks suggests that 2020 is most conservative and that 2010 is not unduly optimistic (Schultz, 1992, p. 45).

2. *Change in the Information Paradigm: From Ownership to Access*

Access has become a key concept that is changing how universities look at information (Shaughnessy, 1992; Wegner, 1992). Traditionally, a university's ownership of an item containing information —the book, the journal, the film, the sound recording— was essential to carry out its mission. Academic libraries acquired huge collections of everything within their budgets but never enough to satisfy all faculty. With the explosion in the rate of knowledge creation it is no longer practical, much less economically feasible, to have a link to information based primarily on ownership. Gregorian (1993) puts it simply: "ownership does not matter any more, only

access, because technology has democratized knowledge" (p. 10). Anyone with access to the computer network can become a knowledge generator by publishing his or her own papers, an electronic journal, or adding value to existing information. Within this context, the learning experience itself has the potential for generating knowledge. Never in the past has the learning environment enjoyed such direct access to the pipelines of knowledge.

Maximizing access and minimizing costs is at the core of Baker and Jackson's (1992) report of the Association of Research Libraries. They look at resource sharing among those libraries and report on the volume of inter-library loans: since 1981, lending to users of other libraries has grown 155 percent and borrowing from other libraries by 206 percent. At the same time, while budgets grew 244 percent, collections grew only by 12 percent; the average cost of a book has risen 49 percent, the cost of a journal 105 percent (p. 3). It comes as no surprise that this report recommends that libraries should support resource sharing. In fact, they have no alternative given the rising cost of ownership.

Shifting the focus from ownership to access has forced universities to look at cooperative collection development. According to the report from the Association of Research Libraries, 80 percent of the libraries were implementing policies that emphasize access over ownership and 61 percent were involved in cooperative purchase or development of electronic files or hardware (ARL, 1992, p. 3). The same report mentions how several of the universities in the State University of New York system have developed policies and plans for cooperative collection development and resource sharing. A similar policy has been in force in the MINITEX region in the state of Minnesota, where several consortiums —PALS, CLIC, SELCO— were formed on the basis of resource sharing (Barnett et al., 1994). Thus the

traditional role of the library has evolved from being a place where resources are stored, to being an access ramp to the information highway. Dempsey (1991) and Sloan (1990) describe in detail the progress made by numerous projects linking academic and research networks in North America.

3. Distribution of Information: Faster Delivery, Complex Integration

Hirshon (1993) sees electronic information bringing with it "some basic paradigm shifts that will inexorably change the course of both the dissemination of, and access to, information" (p. 2). He thinks the lines between the mechanisms for accessing and for retrieving information are blurring and, in his words, *"publishing* is moving toward *information distribution"* (p. 2).

According to Kountz (1992), the library should become an electronic information distribution center that can support users wherever they are. He suggests that "the alternative to the academic library as we know it will be comprised of two interacting parts: intellectual content in forms that are easily distributed/communicated, and appliances by which to use those communication forms."

Gregorian argues that new technologies must be integrated with each other and with the mission of the university, although, as Graves (1994) points out, this may mean redefining the mission of the public university. Failure to address these issues will weaken the effectiveness of the university as a learning environment for a rapidly changing society. As Jim Neal, dean of University Libraries at Indiana University, summarizes it "from the perspective of the university, the ability to identify, locate, and access new information resources can only enhance research productivity and student

learning" (Heath, 1993). Rossman (1992) warns that the clock is ticking for universities to take a lead in this arena:

> *unless universities can agree upon plans to guide and coordinate these electronic developments, the largest share of higher education in the world may indeed fall into the hands of business corporations or for-profit educational institutions.* (p. 8)

With individual access to the network every student, researcher and scholar is now online with this vast body of knowledge which resides on Internet. Information, and thus the potential for knowledge generation, can travel in all directions from one node to the next and everybody is a beneficiary if, as Branin demands, "libraries, computing centers, and networking and telecommunications units . . . come together to create a logical, effective system of information provision for teaching, research, and service support" (Dougherty and Dougherty, 1993).

4. Gopher and World Wide Web: Two Steps Forward

Widespread use of Gopher and the World Wide Web (WWW) systems is one more step toward an effective use of the new technology in higher education. The first report from the Higher Education Information Resources Alliance (HEIRA, 1992) about information technologies on campus points out that while the main focus for information technology in higher education during the past decade was automating the administrative functions, "the focus for the next decade on many campuses will be on making strategic investments to increase academic productivity and reengineer administrative processes for greater efficiency" (p. 3). The same report continues with a list of suggestions for the successful development and integration of information technology into the campus community, such as:

develop an effective campus-wide network . . .
focus overall coordination of information resources . . .
encourage innovation and exploration . . .
develop a plan to fund the maintenance of desktop, network, and classroom technology . . .
move aggressively toward paperless administration . . . (p. 3-4)

WWW originated at CERN, the European high-energy physics laboratory in Geneva in 1991 although it took the development of Mosaic, a WWW client, before its wide acceptance (Porterfield, 1994). The Internet Gopher was also developed a full year ahead of HEIRA's suggestions yet it seems that it fulfills them all quite well. Through Mosaic and Gopher the end user can get closer to this massive virtual library, with seamless access to a vast amount of resources around the world using a simple menu structure (with Gopher), or through a system of linked documents (with Mosaic).

McCahill, project leader for the Gopher development team at the University of Minnesota, says that "the goal was to find a scheme that was more efficient than one-to-one consulting or conventional handouts and short courses" (Wiggins, 1993, p. 27). As Wiggins reports, at that time the campus was looking for an electronic document delivery system and was considering a mainframe based system. The Gopher group wanted "a simple, network-based scheme that supported browsing of available documents" (p. 27). Anklesaria, also on the Gopher development team, says that when he was designing the Gopher software one of his objectives was "to come up with something my own mother *could* use; to come up with something that my mother *would* use" and, according to him, he succeeded when he saw his mother using Gopher to search for recipes (Anklesaria, 1994). The barriers to searching and retrieving information, whether imposed by gatekeepers or by inconvenience of access, are fast disappearing. Wiggins continues: "by early 1992, Gopher was no longer a prototype but was becoming a tool of choice as

universities sought ways to implement campus-wide information systems" (p. 28). Tomer (1992) examines the most popular approaches to navigating the Internet and considers Gopher a good tool for unsophisticated or nontechnical users because it enables the new or infrequent user to navigate easily.

However, the simplicity of Gopher may be part of its limitation. Several managers of Gopher systems recognize the need for a more systematic approach to the problem or organizing information in Gopher servers. At sessions on quality control of information during the 1994 Internet Gopher Conference, numerous speakers called for finding a better system to classify the information in Gopher servers.

WWW was also developed with universal readership in mind (Porterfield, 1994), with "the idea that information, once made available, should be accessible through the use of a simple interface on any kind of computer anywhere on the network" (p. 20). Bosley (1994) anticipates that "the proliferation of tools like Mosaic will do for the Internet what Windows did for the PC: make it usable for the average person" and considers it "ideally suited to today's multimedia fascination, namely the ability to display inline graphics in a variety of formats, as well as the ability to play sound-bytes" (p. 3). WWW uses a hypertext system to link documents stored on WWW servers and allows easy traversing between documents, even when they reside on different servers.

Powell (1994) advances that "while the Gopher system is probably at the peak of its popularity, the WWW is now gaining in popularity as a system for publishing electronic information" and adds that "the WWW supports more sources of networked and local electronic information than any other networked information retrieval tool" (p. 59), but cautions that "a hypertext

information system requires more effort by the information provider" (p. 66). Baker (1994) agrees that the WWW "has grown into one of the world's most widely used tools for information publishing, discovery, and retrieval" (p. 47).

E. An Electronic *Invisible College*

Lievrouw (1989) explains that *invisible college* was first used by the Royal Society of London in the seventeenth century and was revived by Price (1963). Price's invisible college means the informal affiliation of scientists with common interests who were already embedded in other institutions. Borrowing from Price, Lievrouw refocuses the concept around communications processes and proposes a revised definition: "an *invisible college* is a set of informal communication relations among scientists or other scholars who share a specific common interest or goal" (p. 622). Lievrouw defines the invisible college in terms of informal communications rather than social structure.

Crane (1972), in her chapter on social organization and the diffusion of ideas, concludes that "a high level of utilization reflects conformity to norms set by the invisible college in the area" (p. 83). She believes in the important role of the interactions between scientific communities: "The exchange of ideas between members of different research areas is important in generating new lines of inquiry and in producing some integration of the findings from diverse areas" (p. 114). In her discussion of the structure of science and its implications for the scientific community, Crane mentions the recent —in 1972— circulation of prepublication papers and other methods of informal communications in order to supplement the formal communication system. Crane's conclusion is that "the enormous growth of new knowledge is necessitating greater flexibility in the formal communication system" (p. 128).

Lievrouw examines relationships of bibliometric techniques (especially citation analysis) to communication theory and research and examines the model of the *invisible college*. She posits that, based on the pioneering bibliometric work of Price, Hagstrom, and Crane, the theoretical construct of the *invisible college* is used because it "has been widely accepted as a description of certain social relationships in science" and "it is possibly the best-known model of scientific communication" (p. 616). For Crane "the real strength of citation analysis in communication research is that clusters or maps of research articles can be interpreted as networks of interpersonal contacts" (p. 617)

The new paradigm created by electronic communication can be approached as an extension of this *invisible college* described by Price and Crane. The wide availability of electronic mail as well as Gopher, World Wide Web, and other resources on the Internet is breaking down the last barriers of communication across departments, campuses, colleges and universities, and research communities in Rossman's (1992) emerging worldwide electronic university.

F. Toward the Emerging Worldwide Electronic University

One of the aspects of electronic communication identified by Pool (1990) in his analysis of the effects of modern telecommunications on society is that "distance is ceasing to be a barrier to communication" (p. 8). The idea of location independence to conduct business has long been a reality in the military establishment and is now becoming feasible in applications like telemedicine or electronic customer support through e-mail or bulletin board systems.

Similarly, as institutions of higher learning continue striving for better information management they are becoming part of a new global university that is gradually taking shape. The global university consists of the hundreds of universities, colleges, research institutions, and government entities, as well as the people they serve. It is worldwide, with English being the dominant language. Rossman (1992) identifies multiple signs of an emerging space age university:

> *We see signs of an international electronic university even before all of its institutional forms exist:*
> *. . . students in one country taking courses in another via computer conferences or television . . . catalogs of courses from many universities and countries are available electronically . . . an international faculty . . . electronic classrooms . . . student activities, coffee houses, clubs, and action projects begin to involve students electronically from and to more than one country . . . provision for guidance and counseling . . . an emerging global electronic university library . . . online electronic bookstores . . . faculty meetings and faculty training can be shared from country to country electronically . . . continuing education conferences and workshops . . . in which participants from more than one country participate electronically.* (p. 3)

Rossman cites many instances of universities developing programs in collaboration with universities in other countries. The widespread use of the Internet around the globe is broadening the meaning of the college campus and blurring it with distance education. For example, Gransden (1994) describes how students in Russia can get a masters degree from the State University of New York without leaving their country, thanks to the combination of computers, electronic mail, video, satellite, and teleconferencing. Acker, Slaa, and Bouwman (1993) describe a joint venture between Ohio State University and University of Amsterdam and argue that the advantages gained —multicultural student body and faculty, specialized expertise available around the world, broader range of courses available to

students— far outweigh challenges such as lack of venture capital and the difficulty of evaluating educational outcomes.

Under the electronic university perspective, international education acquires an enriched meaning. It most certainly meets the definition of international education from the Encyclopedia of Educational Research adopted by Pickert (1992): "a variety of activities and programs designed to encourage the flow of ideas and people across cultural and geographic boundaries" (p. 1). Telecourses, e-mail, sharing information through gopherspace, and video-conferencing contribute to this exchange and flow, to the point that it is now possible to study abroad without leaving one's home town.

Rossman points out that it is not just academic institutions that are taking advantage of the new technologies: major corporations are using them to provide continuing education for their work force; the U.S. armed forces use telecourses routinely; courses are offered on commercial computer networks as well as on cable television. But, in his words, "it is not the technology that transforms education; rather, the technology —and perhaps the shock effect of its potential— opens the minds of educators and many students to various new possibilities" (p. 12).

Technology acts as fertile ground for a new learning environment. It is now within reach to have a learning environment that includes access to the vast amount of information in the Library of Congress, the video libraries of NASA, access to researchers and experts in any imaginable field through e-mail, and multimedia courseware that turns the learning experience into an insatiable desire to learn more.

The question of the economics of the virtual library which will support the virtual university is seldom addressed. White (1993) brings a touch of

reality and warns that implementation of the virtual library will not come without a cost. He advises that institutions must be prepared to "divert funds from purchase of materials to a resource-sharing mechanism . . . or new funds must be added" and immediately cautions that "faculty don't like the first option and university administrators don't like the second" (p. 300).

G. Conclusion

Universities enjoy a unique advantage in the information revolution because information is the raw material at the core of their mission. However, they must leverage their resources so that these new technologies are integrated in the day to day activities of teaching faculty, administrators, staff, and students. As new technologies bring significant changes to this workplace, scholars will need to learn to utilize those technologies to their own advantage when conducting their research, communicating with other scholars, and publishing their studies.

The overwhelming wealth of information available on Internet requires mastery of new tools for access and retrieval, such as electronic mail, Gopher, and Mosaic. Without these —or their successors— it will be virtually impossible to navigate in this seemingly chaotic environment and be a member of the worldwide electronic university community. Studies focusing on the users of these tools are needed in order to understand how information is found and used and to bridge the development of better tools in the future.

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