Computer Networking, Communication, and Scholarship

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It has taken an unexpectedly long time for the academic world to be transformed by the computer, although there have always been great expectations about the dramatic changes that the computer would introduce in education and research. It was anticipated, for example, that the computer would revolutionize teaching, enabling students to learn at their own pace and freeing teachers for more personalized activities with students; some even feared that computers would make teachers obsolete (Roszak 1994). Higher education has not given up on the promise of computing technology to change the process and outcomes of teaching, but, in the face of decades of failure to realize this vision, there has been a significant effort to reevaluate precisely what its impact might be (Jacobson 1993).

No one has ever questioned the usefulness of the computer for scholarly research. The computer's ability to quickly process large amounts of information, easily perform complex and extensive calculations, and effortlessly manipulate text and graphics enables scholars in many disciplines to pursue research programs that would not have been feasible without the power and flexibility afforded by the computer. But neither have these capabilities had the effect of transforming on a wholesale level the process or products of scholarship. Computers have surely changed much about the way that research is done, but the social organization of academic disciplines, the forms taken by knowledge products, and the processes of knowledge dissemination and archiving have all so far remained relatively untouched.

Given this history, it may seem foolhardy to advance yet another prediction about computing and the academy. Nevertheless, we contend that our age will witness the reconfiguration of the academic world and, again, we see the computer as a central player in this

revolution. But it is not the computer alone to which we now attribute these dramatic effects upon the character and substance of the academic world. Instead, the technology that will be responsible for this largely unforeseen revolution in the practices, the structure, and the products of scholarship is the computer network.

The fact that computers can be connected physically to each other—through telephone, cable, satellite links, or radio links—means that they can be used to exchange information and ideas in a variety of ways. Individuals linked through computers can share data files, use computer systems and data resources that are geographically distant, send mail to others, converse in real time, and participate in conferences on topics of mutual interest. This set of interactional capabilities is made possible by what is no less than an entirely new medium for communication. The introduction of computer networking is changing the way that scholars communicate, creating novel practices as well as novel genres of discourse. The net impact of this will be to stimulate a vast array of changes in the conduct of scholarship.

As yet, there is no definitive history of computer networking; but Rheingold (1993) describes some of the impetus, motives, and visions of the individuals and institutions involved in the creation of the computer network now known as the Internet. The precursor to the Internet, a project of the Department of Defense's Advanced Research Projects Agency known as ARPAnet, was a network of military computers, originally interconnected in order to establish a communications system that could survive a disastrous nuclear attack. ARPAnet developers soon recognized that their network could also be used for resource sharing and other exchanges of information, and they realized further that enabling systems operators to communicate with each other facilitated these applications. Thus, ARPAnet was programmed with electronic mail facilities and, over time, communication applications began quickly to rival other uses of the mainframe machines involved.

But, as Rheingold (1993) points out, even before ARPAnet went online, a few of those responsible for developing this system had already grasped the implications of the new technology and were writing about them. These individuals were no doubt among the first to see that computer networking constituted a new medium for communication—one that could "change the nature and value of communication even more profoundly than did the printing press and the picture tube. . . ." (Licklider, Taylor, and Herbert, 1968, 22). This would happen, they claimed, through the creation of online communities of individuals with common interests, whose interaction was made possible through computer networks. And they foresaw that

> when people do their informational work "at the console" and "through the network," telecommunication will be as natural an extension of individual work as face-to-face communication is now. The impact of that fact, and of the marked facilitation of the communication process, will be very great—both on the individual and on society. (31)

Although computers have always provided their users with *access* to information, the major innovation in the development of computer networking is the ability to *share* on a widespread and nearly instantaneous basis both information and ideas in a variety of symbolic forms (text, numbers, images, sound, color, etc.). The sharing or communication of information and ideas is the foundational activity of scholars working within a discipline. Whether conversing, collaborating, presenting papers, teaching, or writing scholarly articles, scholars are exchanging information and ideas of some kind with each other. Scholarship is at root a social activity; research products become knowledge only when ratified by the disciplinary community. Scholars obviously engage in many activities in addition to communication (like analyzing, observing, conducting experiments, and synthesizing), but the products of those activities are not regarded as knowledge until they enter into the stream of disciplinary discourse through which knowledge is created, justified, disseminated, and archived.

Various forms of technology for computer-mediated communication have been available for several decades. Some of the first experiments using such technologies for scholarship were conducted in the 1970s, on systems in which geographically separated users accessed a common host mainframe through commercial data carriers (see, for example, Hiltz 1984; Hiltz and Turoff 1993). However, two more recent technological developments have fueled the explosive growth in scholarly applications of networking that has taken place in the late 1980s and early 1990s. The first was the development of increasingly inexpensive personal computers, which made computing both affordable and convenient for many students and faculty. The second was the development of free-access, global area networks of computing facilities in academic institutions (e.g., Bitnet, JANET, and the Internet), which provided students and faculty at connected institutions with a virtually no-cost medium for interaction. Personal computers equipped with modems could function as terminals interacting with mainframe machines, placing the resources of wide area academic computer networks at the fingertips of a large audience within North American higher education systems.

The ability to share data files or use the capacities of very large and powerful ("super") computers from remote sites has been a major impetus for investment in the development of computer networks in the last decade, as government and educational institutions sought to create an infrastructure that would provide the United States with a scientific, technical and, ultimately, commercial edge over other countries (Bloch 1988; Poore 1988). However, personal computing power combined with access to networks has also made it possible to integrate networking into the more mundane daily research activities of practicing scholars across many disciplines.

Through the use of relatively simple technology such as electronic mail, scholars can replicate, on a dyadic basis, many of the informal communication activities that sustain "invisible colleges" (Crane 1972) of research interests, such as exchanging manuscripts, seeking advice or support, and even conducting group discussions on topics of mutual interest. Beyond electronic mail, numerous other applications for group or public information sharing and interaction have since been developed with more sophisticated and powerful communication capabilities that can be used to further the development and dissemination of knowledge within a discipline.

In this book, we present a broad overview of the ways that faculty, students, researchers, librarians, and professional organizations across the academic spectrum are using computer networking. We do not intend to be exhaustive, for this would hardly be possible. New applications of networking within academic disciplines germinate on a daily basis; it is impossible for anyone to keep up with them. We have chosen not to treat any particular discipline in great depth, although some have clearly become more heavily involved in computer networking than others. And we will not focus on any particular aspect of scholarship, preferring to range over the substantial terrain demarcated by Boyer (1990), which included discovery, integration, application, and teaching, and even beyond to encompass issues related to the storing and dissemination of scholarly products.

Instead, we are concerned with how networking is being used in the service of any activity in which knowledge is created, made meaningful to others through teaching and application, and rendered available to others through formal scholarly channels of communication or knowledge repositories. We sample a diverse number of disciplines with the goal of identifying trends, tendencies, minor perturbations, and even only marginal possibilities introduced by networking that may grow to fruition to constitute the academic world in the twenty-first century.

It is too soon to make any definitive statements about how computer networking will ultimately recast the shape and structure of academic life. As many of the essays in this volume make clear, computer networking threatens to disrupt existing disciplinary social structures based on print technology, restructure traditional student-teacher relationships, and destabilize longstanding economic, legal, and professional interdependencies in the dissemination of academic research. If we are in fact poised on the threshold of a dramatic and far-reaching transformation of the world of scholarship, then the time it will take for such changes and their outcomes to be fully manifested will surely eclipse our lives. But it is not too soon to attempt to catch a glimpse of the futures made possible through networking, and to cultivate some preferences among those possibilities. Indeed, it is only in undertaking such explorations that we can begin actively to build the twenty-first century university.

In the remainder of this essay, we address two tasks central to such explorations. First, we sketch a general framework for understanding the relationship between technological change and social change. More specifically, we argue against a simple technological determinism in which computer networking is viewed as the unproblematic cause of a set of changes in the organization of the academic world that can be expected to unfold naturally in the coming years. We suggest instead that the effects of innovative material capabilities afforded by the network will be negotiated within the social, professional, political, and economic contexts of the academic fields in which they are introduced. Second, we introduce readers to five major applications of academic computer networking, as well as some of the issues that such applications engender. Within the context of this discussion, we also introduce readers to the individual essays in this collection.

The Adoption of Computer Networking by Academic Disciplines

As the essays in this book make clear, there are marked differences in the extent to which computer networking has been adopted and used for scholarly purposes, as well as differences in the sophistication of the network tools that are employed within academic disciplines. Some fields, such as ornithology, which is described by *Jack Hailman* in this volume, rely principally upon electronic mail applications of networking (such as "Listserv"-based communication forums), with apparently

little investment in more sophisticated tools. In other fields, such as medieval studies, described in the chapter by *Deborah Everhart*, scholars have moved relatively quickly to adapt the technology of the World Wide Web, through which users are offered a wide range of scholarly resources. In still other fields, such as high energy physics, individuals *have invented* new network tools such as the World Wide Web (Hughes 1994), presumably in an effort to respond to their own particular research exigencies. Thus, the pattern of adoption and use of computer networking has not been uniform across the disciplines and may appear at first glance to be nothing less than a crazy-quilt, with no apparent rationality or consistency informing or explaining deviations between the disciplines.

Is there a way to explain differences in the rate of adoption and kinds of applications that various disciplines are pursuing? Before attempting to answer this question, it is important to stress that it would be a mistake to think of networking projects in terms of a single institution, such as *a* discipline or *a* research field, moving as a unit to adopt the new technology. Although this is a convenient way to write about what is happening within academic fields, it is misleading. In most cases, specific individuals have acted initially to make computer networking technology available to others within their fields—by informing them about the existence of the technology, by adapting the technology to uses perhaps somewhat idiosyncratic to their fields, or by writing entirely new software to create technologies that are relevant to their fields. These individuals work within the contexts of their disciplinary communities; they have been trained within the discipline, understand the needs and exigencies of disciplinary inquiry, and have the technical background to be able to imagine how networking technologies might be used in the service of the field. Such innovators have designed resources and undertaken projects related to the interests of those within their disciplines, and, frequently without financial support, taken the initiative to make these services available to their audiences.

It is also a mistake to think of computer networking as one technology. It is instead a cluster of technologies involving a variety of hardware configurations (e.g., personal computers, workstations, mainframes, network connection technology) and software tools. Each hardware and software configuration can provide a wide but delimited array of functionalities, with somewhat different advantages and disadvantages. Readers unacquainted with network infrastructures and their software resources will benefit from reading the essay by *John December* in this volume, which provides an introduction to the vocabulary and resources of network navigation.

And it is a mistake to think in terms of coherent and unitary disciplines responding in some uniform way to the potentials of computer networking. Instead, different fields of inquiry within a discipline or across disciplines may react quite differently to various network capabilities, depending upon the tempo, the levels of interdependence and ongoing communication, and the rate of change within these research areas.

To advance any broad generalizations regarding the brief history of network use by academic disciplines at this point would imply the existence of a relatively well elaborated theoretical framework that could lend itself to the formulation of *a priori* predictions about the diffusion of new communication technologies across social contexts. While some things are known about the diffusion of innovations (see, for example, Rogers 1984), such a framework simply does not exist. Instead, we can make some sense out of this ongoing evolution by examining briefly how communication theorists and historians have explained the deployment of new technologies of the past and the changes these technologies are credited with stimulating. The outcome of this examination will be to suggest that changes within academic disciplines associated with computer networking will have as much to do with prevailing patterns of media use, more or less idiosyncratic demands for communication, and existing social organization within a research field as they do with new capabilities afforded by the technology.

The introduction of any new technology in a social context takes place within an ongoing set of social tensions among competing, cooperating, and coexisting social groups. Initially, technologies must perform some service regarded as valuable, frequently just enabling individuals to do something they have always done, but more quickly, more efficiently, or obtaining some other advantage hitherto not achievable. As with any new communication technology, the introduction of computer networking within a social context threatens to disrupt prevailing patterns of media use and, in turn, to destablize the social interdependencies within communities that are predicated upon them. Marvin (1988), who has studied the history of the electric light and telephony, observes that "[e]arly uses of technological innovations are essentially conservative because their capacity to create social disequilibrium is intuitively recognized amidst declarations of progress and enthusiasm for the new" (235).

Thus, networking technology alone will not *determine* particular changes in the academic world. The transformations that we casually attribute to new technologies are more accurately viewed as the emergent products of negotiations among social actors and groups over

time, through which questions such as *how* the technology will be used, *who* will use it, and *what groups* will benefit eventually get answered. These negotiations involve strategic maneuvering to realize opportunities and achieve objectives through the rearrangement of previous social interdependencies, the creation of new groups and organizations, as well as social conflict and its resolution. But they also encompass consequences of individual actions, which, despite their best efforts, individuals are unable to control or influence completely. Although we assume that people use technology intentionally to achieve their goals, unintended consequences arise simply through the effects that the technology may have upon the attitudes, beliefs, and values of users.

This brings us to the question of what role technology *does* play in social transformations, and, more specifically, the role that we expect it to play in transforming the academic world. While, as we have argued, technology does not determine social change, technology does offer material capabilities for new kinds of action. In Cherry's (1985) words, new technology presents certain "liberties of action" (74), making it physically possible for individuals to organize and behave in new ways. The presence of such capabilities does not guarantee that they will be used or that these uses will ever gain widespread significance, but they do provide for certain kinds of potentials that can be manipulated and exploited.

Innovative material capabilities of new technologies also threaten existing social orders, as they present advantages or disadvantages that are biased in ways that benefit some individuals or groups at the expense of others. As Winner (1986) has pointed out, whether or not a technology is developed at all and what specific features are included in the design of a technology are decisions whose answers favor the political, economic, or social positions of some individuals or groups and distress others. Further, choices to use or develop a technology "tend to become strongly fixed in material equipment, economic investment, and social habit" and "[i]n that sense technological innovations are similar to legislative acts or political foundings that establish a framework for public order that will endure over many generations" (Winner 1986, 29).

Thus, the introduction of any new communication technology always takes place, as Marvin (1988) notes, within a tension created "by the coexistence of the old and the new . . " (8). Existing social orders and new communication capabilities are mutually accommodated and, in the process, social change takes place, for "[n]o matter how firmly custom or instrumentality may appear to organize and contain it," new communication technology carries the seeds that

subvert existing social orders (Marvin 1988, 8). It is important to recognize that the processes of change just described are essentially indeterminate, and that it will be

> difficult, if not well-nigh impossible, to guess what will be the future uses, significance, and values of radically new inventions of our own day—especially those pertaining to human communication. The reasons are . . . namely, that we do not know what will be the social conditions of the future, what will be the new customs and habits, the new institutions, the political and economic changes. (Cherry 1985, 59)

But this is not to suggest that we should allow change to unfold unmonitored and without critique. Simply because these processes are indeterminate does not mean that we should abandon attempts to influence and control them. In fact, quite the opposite. It is because the process of change is a negotiated one, and because actors can exercise influence over these negotiations, that these processes are indeterminate. The history of new technology is one in which social actors—scientists, researchers, engineers, industrialists, policymakers, humanists, and educators—have made active choices among technological alternatives, albeit sometimes in favor of development consistent with preexisting distributions of power (Marvin 1988; Noble 1984; Winner 1986), but not exclusively so. As others have pointed out, individuals and groups frequently "appropriate" technical expertise and new communication technologies for their own uses, much to the dismay of some engineers and designers (Giddens 1990; Poole and DeSanctis 1990).

Following Giddens' (1984) more fundamental position regarding human agency and its constraints, we regard human beings as social actors, enmeshed in the business of making choices about future actions, relatively knowledgeable about what they are attempting to accomplish, monitoring in an ongoing and reflexive way the outcomes of their actions and those of others in the environment, and adjusting action in ways consistent with their intentions. Actors are constrained in numerous ways by existing social practices, social norms, and power relations, but their behavior is not predetermined in any necessary way. Further, social actions can produce outcomes that are not predicted or fully understood by the actors who undertake them. Even in the face of new technologies, social action may reproduce existing social conditions, but change is an ever-present potential outcome of any human action. We are convinced that substantial and wide-ranging changes in the social organization of disciplines, in the process and

products of higher education, and in the form, distribution, and storage of scholarly products are now beginning to emerge. But we also acknowledge that, to the extent that these very general predictions are realized, such changes will be the products of incremental social action, practiced by individuals and accumulating over time, and will take particular forms not entirely consistent with our current best guesses.

Thus, the history of the introduction of computer networking technology in the academic world is just beginning to be written. In the maelstrom of innovation stimulated by the development of computer networking, existing requirements for information sharing and communication within fields of inquiry, prevailing patterns of media use, relations of power among ongoing social groups, levels of technical expertise among members of a field, access to hardware and the networks, new methods for engaging in traditional disciplinary activities, and entirely new technological capabilities for exchange and discourse—all these factors and the interdependencies among them will be implicated in the process of change, which, as we have argued, is still essentially open-ended. Since some of the consequences of using new technologies will be unintended and unforeseen by users and designers, it would be reckless indeed to assume that any particular path of evolution has been set irrevocably in motion. But, as we observed earlier, the choices we make today regarding how and whether new technology is used are more likely to become fixed in the world that is constituted tomorrow. Thus, as we explore further in a later chapter (see *Stephen and Harrison* in this volume), it is of immense importance that we think carefully about how computer networking may be used in the service of academic objectives, and that we engage in an ongoing process of critique as these applications emerge.

Major Applications of Academic Computer Networking

In the remainder of this chapter, we shall explore our claim that computer networking is stimulating the development of new research practices, new ways of teaching and learning, and new ways of distributing and archiving scholarship. Some of the changes that we describe as "new" are perhaps more accurately regarded as traditional disciplinary practices that technology now enables us to perform in different, perhaps better, ways. In other cases of change, we can detect

the glimmers of more radical innovation, consisting of potentially new forms of discourse, new forms of knowledge products, new forms of social organization, and perhaps even the emergence of new conceptions of what knowledge is. In partial support for our claim, we turn to particular chapters of this book, which describe applications of computer networking designed to accomplish particular communication objectives within fields of research or teaching, or assess their potential for doing so. Before reading about these applications in greater detail, it may be useful to situate them within a more general and broader view of the uses to which computer networking is being applied within academic fields.

Gaining Access to Computer Networking

Inititially, whether or not computer networking is used by members of a field or discipline appears to depend upon a variety of factors that enable an individual to gain access to the technology, such as obtaining the necessary hardware and software, and gaining affordable access to the network. It is also necessary to master the technical skills required for using network tools and resources. None of these are trivial obstacles, and they have not been completely overcome; but their ability to inhibit the diffusion of networking in institutions of higher education has declined significantly over the last decade.

As we noted earlier, decreases in the cost of computers and related peripherals have enabled many faculty members and students to acquire the equipment necessary to use computer networks at their convenience. Owning or having direct and perhaps exclusive access to equipment is important because, as Schaefermeyer and Sewell (1988) point out, those who possess personal computers and modems in their homes and offices are more likely to be heavy users of computer-mediated communication. It is certainly not the case that the average faculty member or student can afford to purchase workstations with sophisticated graphics and multimedia capabilities. But, even in the humanities and social sciences, many faculty members, if not most, can either afford or have obtained institutional access to basic computing equipment that makes network connections possible.

Markus (1987) has argued that universal access is required for the diffusion of an interactive medium with a community. Without such access, the medium threatens to split a research community into "haves" and "have-nots," precluding many of the potential advantages associated with using computer networking to support research or teaching. However, institutional subscriptions to academic computer networks such as the Internet and Bitnet have burgeoned over

the last decade, supplying members of thousands of educational organizations with virtually no-cost (at least at this point in time) access to computer networking. This has enabled an immensely fertile period of experimentation, giving members of academic institutions the time to learn about networking and to launch projects that encompass increasingly larger audiences within their disciplines and fields.

As these technical and financial hurdles were beginning to be overcome for significant numbers of faculty and students, it became increasingly possible, in principle, for a critical mass of users to physically access the network; it therefore became increasingly conceivable to use the network as a tool for scholarship. We first began using electronic mail to exchange drafts of collaborative research papers between Rensselaer Polytechnic Institute and West Virginia University in 1984, but it soon became apparent that the network could be used in the service of broader scholarly objectives. Initially, we surmised that this could be accomplished through the development of software ("file-servers") that would enable individuals to contribute to and draw from an automated repository of files encompassing information of one kind or another that might be useful to those within a disciplinary community. We envisioned that such a resource might deliver bibliographies, syllabi, drafts of research papers, conference announcements, and other useful documents. It also occurred to us that the network might be used to establish online groups of faculty and/or students with similar interests who would be able to exchange documents, as well as conduct ongoing online conversations, in support of their research or teaching interests. We were not the only ones to arrive at these insights.

But a further impediment to diffusion of networking has been the difficulty scholars have experienced in learning how to to use the network. Academic computer networks were not designed originally to be used by those without computer science backgrounds; network vocabulary was and continues to be arcane, and procedures generally non-intuitive; computer center staff were frequently not skilled at communicating with networking novices. Furthermore, documentation for network protocols and procedures was in short supply and, when available, difficult to understand.

In designing our own disciplinary service for communication scholars, we were sensitive to the need to make using the network a relatively painless as well as rewarding experience. Thus we created our own software system called "Comserve" (see *Stephen and Harrison* in this volume and Harrison and Stephen 1992), which required only that users learn how to send and receive electronic mail. Once that

skill was mastered, users could begin immediately to avail themselves of the professional resources offered by Comserve, which, in 1986 when the service was inaugurated, consisted of an online resource library, a self-service professional directory to enable scholars to locate the network addresses of others, and periodic newsletters. Computer conferencing was added one year later, following the development of the "Listserv" software.

Up until the mid-1980s, existing computer conferencing facilities (e.g., Usenet) were relatively inaccessible to unsophisticated users, or required financial resources to install or to become connected. In 1986, the appearance of the Bitnet-based "Listserv" software (available at that time to the higher educational community for free and supported voluntarily by systems operators at colleges and universities across the U.S.) enabled the first wave of network innovators within a wide variety of disciplines to initiate their own online "lists" or electronic conferences organized around particular themes or topics. Listserv (and later Eric Thomas's "revised Listserv") was immensely popular because it was free and, while requiring some network expertise, it was not necessary for an individual to know how to program in order to initiate a conference. The availability of this software meant that, with a little knowledge about how the network operated, virtually anyone could create and operate an electronic conference. Further, Listserv conferences were relatively easy for novice networkers to join and the procedures standard across conferences or "lists." Once a user learned how to join and participate in one conference, that user could join nearly any conference.

Thus, simply by learning how to use the electronic mail facility at their home institutions, most interested individuals could join the vast majority of academic electronic conferences and participate "asynchronously" in professional dialogue using the network. In such conferences, electronic mail to participants can simply be sent to the conference's computer address, where the software then accomplishes distribution to list members; electronic mail from the conference address is sent directly to each participant's computer address where it accumulates in participants' electronic mailboxes to be read at their convenience. All that was then required was the creation of conferences that served one's own interests. Network innovators have moved quickly to meet this need; the number of academically oriented electronic discussion lists now reaches nearly 1800, a dramatic increase from its initial count of 517 in 1991 and a second count of nearly 800 in 1992 (Okerson 1994; Kovacs 1992; Kovacs 1994). It seems unlikely that any field of significant academic inquiry is unrepresented by an electronic conference.

Interacting in a Networked Environment

Although more sophisticated networking technologies may produce more dazzling effects, there seems little doubt that fundamental changes in scholarly practices at a grass roots level received their primary and initial impetus from scholars' participation in electronic conferences. The ability to send electronic mail enables scholars to keep in touch with each other on a dyadic basis; the ability to reach extended groups of recipients in electronic conferences through electronic mail has meant that scholars could participate in dialogue with colleagues who share their research and teaching interests. As Harasim (1993) argues, network conferencing creates a kind of "social space." For academics, this space resembles a perpetual academic conference where scholars gather in virtual hallways, bars, and public presentations to share information about each other's research, offer consultation regarding research problems, debate issues relevant to their fields—in short, to practice the kind of discourse that is the essence of informal communication in scholarly communities (Crane 1972).

As the chapter by *Jack Hailman* illustrates, electronic conferences have permitted members of particular research specialties (in his case a small speciality within the field of ornithology), who are internationally dispersed and who might otherwise meet face-to-face at infrequent conferences, to share an ongoing forum for information exchange. But electronic conferences also enable individuals in interdisciplinary research fields, such as medieval studies, described in the chapter by *Deborah Everhart*, to establish channels for interaction that are easily accessible to all. Such electronic conferences frequently offer services similar to those provided by professional organizations, such as directories of information about members, notices of international meetings, grants, legislation and other news related to the field, and forums for posting article and paper abstracts and reference materials.

Academic electronic conferences vary widely in content, structure, and the extent to which substantial academic work is accomplished. Some conferences are free flowing and general forums, in which any topic may be introduced and pursued if there is sufficient interest. They may exist purely to broadcast or exchange information or for engaging in spontaneous interaction. Some conferences are moderated by individuals, who monitor content more or less loosely for appropriateness and relevance to the audience and objectives of the conference, and who may, at times, stimulate discussion on useful topics (see, for example, Conner 1992; McCarty 1992).

In still other conferences, great pains are taken to insure that the audience can participate or "lurk" in a forum engaged in focused and

directed scholarly discourse. For example, the University of Chicago Philosophy Project offers an array of conferences that are guided by moderators and consist of particular types of discussion relevant to philosophy, such as "(1) comments on and exegesis of sections of a philosophy text, (2) attempts to elucidate difficult arguments in the text, (3) interpretative argument between participants over parts of the text, (4) papers by the participants that are related to the text in some way, and (5) general discussion of the text by participants" (Welcome to The University of Chicago Philosophy Project 1994). *Deborah Everhart's* essay describes the structure of "Interscripta," a medieval studies conference in which discussions are carried out in a "round table" format, addressing particular topics for six weeks at a time, and moderated by an individual who subsequently shapes the content of the discussion into a summarizing article that is distributed to participants for revision before publication in the companion electronic journal.

Although electronic conferences are not likely to supplant the need for face-to-face interaction, their ability to link geographically dispersed scholars in a research field, transcend disciplinary boundaries, and be used in the service of significant scholarly discourse makes them powerful interactional tools. It should not be overlooked that this form of contact has the additional advantage of being more widely inclusive of scholarly populations. While the problem of access to the technology has not disappeared, and is particularly acute in non-Western countries, more and more scholars and students are gaining access. Further, as numerous researchers and commentators have noted, computer-mediated communication minimizes social presence cues (such as physical features, status identifiers, speech disfluencies), thus making it easier for some individuals to interact, disagree with others, or support unpopular positions under these conditions (see Spears and Lea 1992 for a review).

In the best of circumstances, online conferences produce a new and intriguing textual product. In traditional scholarship, a formal, artificial type of dialogue is carried out through a series of extended monological texts, from article or book to article or book, across long expanses of time. In contrast, texts produced through online conferences reflect a more authentic scholarly dialogue: distinctions between authors and readers become blurred as participants function in both roles, their voices represented as distinct even as their particular contributions get woven into synthetic and emergent products (see *Jean-Claude Guédon's* essay in this volume and Harrison and Stephen 1992). In such texts, it may be possible to see the dialogical process of scholarship at work. The fact that substantial scholarly work is

accomplished through network interaction (and that network discussions are the site for other types of significant social action as well) makes them a source of information that scholars increasingly wish to cite within their research. *Laura Gurak's* essay describes the problems she has confronted in using such texts as research information, and explains how she has reasoned through issues of authorship, copyright, and citation conventions to conduct her study of the network-based protest against the development of a marketing software product.

However, beyond their ability to broadcast information, electronic conferences may be more or less useful for various disciplines as forums for scholarly discourse. *David Rodgers, Kevin Curnow, Drury Burton, Greg Ullmann,* and *William Woolf,* who describe experiences of the American Mathematical Society in a chapter in this volume, note that interest in Listserv conferences devoted to mathematics has been limited, while public access to online services that automate the delivery of professional and scholarly information has been quite robust. It is possible that disciplines may differentially value information versus interaction, or certain types of interaction, in the service of their research programs. For example, researchers in some humanities and social science disciplines may rely more heavily upon discourse and interaction for idea generation, while those in scientific fields may value quickly disseminated information about recent research (cf. Cronin 1982). These kinds of distinctions, which would surely affect the way in which different kinds of electronic services are received within scholarly communities, must await empirical verification.

Sharing Resources in a Network Environment

In the meantime, it is clear that computer networking has been used by individuals, universities, professional associations, and educational and research organizations in a wide number of disciplines to offer services that facilitate access to professional and scholarly resources. Space permits only a few illustrations of the burgeoning library of scholarly resources that exist on the network. Chemistry students and researchers, for example, can use the network to explore the Cambridge Structural Database, which contains bibliographic information for organocarbon compounds produced by X-ray or neutron diffraction and is maintained by the Cambridge Crystallographic Data Centre (Cambridge Structural Database 1994). Humanities scholars can conduct online searches of the Catalogue of Projects in Electronic Text maintained by the Center for Text and Technology at Georgetown University. This database documents information about electronic text projects that provide machine-readable files of primary materials from

humanities disciplines (Catalogue of Projects in Electronic Text 1994). Michael Hart's impressive"Project Gutenberg" is one example of an electronic text project that seeks to convert texts of 10,000 enduring works to electronic form to create an electronic library by the year 2001 (Hart 1994). Increasingly, network services offer access to full text materials in the scholarly literature as, for example, the Distance Education Database, maintained by the International Centre for Distance Learning, which supplies online search and retrieval for the full text of over one hundred papers and reports in distance education (Melton 1994).

The latter raises the larger issue of how texts, regardless of disciplinary content or form (article, book, report, etc.) can be distributed in a way that facilitates scholars' ability to analyze them. As *Brian Gaines* points out, electronic publications that do not allow scholars to analyze and restructure text sacrifice part of our ability to organize, index, search, and use knowledge contained within them. However, the development of incompatible text analysis systems is both frustrating and wasteful. This problem is addressed by *Susan Hockey* and her collaborators in the Text Encoding Initiative, an encoding scheme for humanities texts based on the Standard Generalized Markup Language (SGML). The SGML-based system increases the usability of electronic texts by providing descriptive labels for their various parts and by documenting the particular text transcription, both with a common set of conventions that allow electronic texts created anywhere on the network to be used by scholars anywhere on the network.

Unfortunately, such efforts to organize resources for networking are the exception rather than the rule. Until recently, even simple access to most network resources has been technically difficult and haphazard for users, which is the negative side of the unmanaged, sprawling evolution of the network and the voluntaristic ethic that has spawned the creation of network services. The result has been that an enormous number of scholarly and other resources, characterized by one science writer as the "Storehouse of Human Knowledge, Department of Grass Roots" (Gleick 1994), are dispersed across thousands of host computers with varying protocols, producing a situation that has resisted the creation of a systematic method for cataloging or developing collections of services. Only the most intrepid and persistent of users have penetrated cyberspace on behalf of their disciplines to find out what resources exist and what one needs to know to gain access to them. Even now, volunteers circulate a monthly "Internet Hunt" that challenges users' network navigational and detective skills.

However, a set of sophisticated technological tools for using the network (we refer here to Gopher systems, Mosaic, the World Wide Web and other network tools, which are described in the chapter by *John December*) that enable individuals to overcome technical obstacles to locating resources has quite recently come of age. Further, such tools make it possible for scholars or organizations within research fields to construct automated links ("hypertext" links) between network resources, thus facilitating users' ability to identify and gain direct access to those resources related to a field of inquiry, but located at diverse computer sites.

But even with these technological tools, it has become increasingly apparent that efficient and productive use of the network requires the development of forms of social organization that complement and enhance the ability of the medium to serve as a mechanical conduit for information. As guardians of print resources, librarians, who might have headed down a slow but steady path to obsolescence, have instead become champions in the campaign to make their academic constitutencies aware of the revolutionary potential of the Internet, to provide technological and social support in finding valuable network resources, and to call attention to the complex issues that face us in re-structuring the academic world for electronic communication. Librarians have taken on the task of organizing "field guides" to resources that exist on the network, some of which appear in print publications for the purpose of alerting uninitiated users to the value of network (see, for example, Dowling 1994; Fehrmann 1993; Glazier 1994). In this volume, the chapter by *Lyman Ross, Paul Philbin, Merri Beth Lavagnino,* and *Albert Joy* describes one university library's efforts to incorporate network resources into the collections it makes available to patrons.

But certainly one of the most common forms of social support for the network has consisted of lone individuals or ad hoc groups who have taken the initiative to identify resources related to a field of study and been generous in making their information available to others. For example, Arthur McGee has for several years compiled lists of electronic conferences, online bulletin boards, news services, and other online resources related to African and African-American affairs, international development issues, and indigenous, native, or aboriginal affairs, which are broadcast through relevant electronic conferences. His labor, and that of countless other network volunteers, receives no financial support. The group of scholars collaborating in the design of Labyrinth project discussed by *Deborah Everhart,* present a particularly compelling example of volunteers forming a social structure that complements sophisticated network technology in organiz-

ing access to network resources for their field. This project, like so many others, was undertaken initially without financial support.

It is now becoming more common to see the development of network projects supported by the government, by research centers and universities, and by scholarly societies whose mission is to organize network resources in the service of disciplinary inquiry. For example, the Department of Energy has funded the High Energy Physics Network Resource Center housed at FermiLab, providing physics researchers with a central location for identifying online resources (Welcome to HEPNRC, 1994). Increasingly, research centers and professional societies have become active in facilitating their disciplines' use of the network. For example, the Center for Computing in the Humanities maintains an online archive for syllabi and other course materials in humanities computing (McCarty 1994). As of July 1994, sixty-five professional academic organizations now maintain their own "Gopher" systems, which are used to provide access to professional information and to identify and link relevant resources wherever they may exist on the network (University of Waterloo Library, 1994).

As we have seen, the network is an excellent mechanism for the distribution of information. But this distribution capability is only as good as the information that is transmitted. Thus, a critical issue in using the network for academic research is determining what kind of content is most appropriate to deliver, how to guarantee its quality, and how to ensure that it will be maintained over time. Such decisions can probably best be made by disciplinary insiders who understand what their colleagues will see as valuable and credible. As the social organization supporting the network becomes increasingly elaborated, issues of content, quality, and currency will begin to be confronted directly. For the forseeable future, however, academic networkers need to be somewhat cautious about the resources they obtain from the network, as too many resource sites fail to maintain their materials.

Despite this rationale for a conservative approach to networking, scholars have initiated increasingly bold attempts to exploit the potential of the medium to support research. One of the most dramatic applications of networking is the development and use of systems that automate the distribution and archiving of preprints. In certain rapidly evolving scientific fields, like high energy physics, new information circulates quickly among selected individuals through the exchange of preprints. Traditionally, researchers have maintained their own preprint lists, inevitably leaving some researchers out of the loop. In 1991, Paul Ginsparg of the Los Alamos Research Laboratory developed software that allowed anyone in the high energy physics field (and beyond) to identify, obtain, and archive

papers prior to their publication in print journals, which typically can take months (Broad 1993; Publication by Electronic Mail Takes Physics by Storm 1993). Electronic preprint distribution has been so successful in taking the place of paper preprints, as Okerson (1994) reports, that the Stanford Linear Accelerator Center has recently decided to cease their paper preprint distribution because more than half of them had already circulated widely on the Internet. Such a distribution channel appears to be making print media functionally irrelevant to the process of doing research in high energy physics.

Following this example, individuals in other disciplines are organizing to provide similar electronic preprint distribution services. Individuals in research fields related to physics have tended to use Ginsparg's software to administer their services. Other organizations, both formal and ad hoc, have designed and developed their own software. *Rodgers, Curnow, Burton, Ullmann,* and *Woolf* discuss some of the issues considered by American Mathematical Society in undertaking their preprint distribution service. It will be interesting indeed to see if such services are received as enthusiastically in the humanities and social sciences, as disciplines such as philosophy and economics begin experiments with preprint distribution (International Philosophical Preprint Exchange 1994; Economics WPA World Wide Webb Service 1994).

Collaborating in a Network Environment

These combined interactional and informational resources suggest that the network is a potentially useful site for new types of collaborative research. And it has been the case that scholars, especially in multi-, trans-, or interdisciplinary research projects, have marshalled network capabilities to support their work. This is not to say, however, that the network will prove uniformly useful as an interactional tool across all such projects. *Duncan Sanderson's* carefully drawn distinction between cooperative and collaborative work reminds us that offering opinions, providing information, sharing data, and other activities characteristic of cooperative work is quite different from the commitments of time and energy, the complex coordinated actions, and the development of common understandings that are more characteristic of collaborative work. While networks may be seen as easily supportive of cooperative work, more than just technology is required for genuinely collaborative work. As *Sanderson* further observes, some researchers, such as the atmospheric sciences team he studied, may prefer to use face-to-face meetings instead of the network for their interaction. Whether or not the network can be used successfully to support collaborative work