

3-1-1984

Electronic Publishing, Libraries, and the Survival of Information

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Recommended Citation

Neavill, G. B. (1984). Electronic publishing, libraries, and the survival of information. *Library Resources & Technical Services*, 28(1), 76-89.

Available at: <http://digitalcommons.wayne.edu/slisfrp/47>

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CONTENTS

	<i>Page</i>
From the Editor's Desk . . .	3
An Analysis of Reviews and Library Holdings of Small Publishers' Books. <i>Judith Serebnick and John Cullars</i>	4
Book Production Quality: A Librarian's View; or, The Self-Destructing Library. <i>Paul H. Mosher</i>	15
<i>The Indian National Bibliography</i> —Its Present State and Future Prospects. <i>Joel C. Downing</i>	20
Considerations in the Creation of a Holdings Record Structure for an Online Catalog. <i>Arnold Hirshon</i>	25
Electronic Publishing and Its Impact on Libraries: A Literature Review. <i>Meredith Butler</i>	41
Technical Services in the Age of Electronic Publishing. <i>Edwin Brownrigg, Clifford Lynch, and Mary Engle</i>	59
Electronic Publishing and Library Technical Services. <i>Brian Aveney</i>	68
Electronic Publishing, Libraries, and the Survival of Information. <i>Gordon B. Neavill</i>	76
In Memoriam: John W. Cronin	90
Instructions to Authors	91
Index to Advertisers	92

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Library Resources & Technical Services (ISSN 0024-2527), the quarterly official publication of the Resources and Technical Services Division of the American Library Association, is published at ALA Headquarters, 50 E. Huron St., Chicago, IL 60611. *Business Manager:* William Bunnell, Executive Director, Resources and Technical Services Division of the American Library Association. *Advertising Sales Manager:* Mary E. Swenson, ALA Headquarters. *Editorial Office:* 11415 Farmland Drive, Rockville, MD 20852. *Advertising Traffic Coordinator:* Leona Swiech, Central Production Unit/Journals, ALA Headquarters. *Subscription Price:* to members of the ALA Resources and Technical Services Division, \$10 per year, included in the membership dues; to nonmembers, \$20 per year; single copies \$5.

Second-class postage paid at Chicago, Illinois, and at additional mailing offices. POSTMASTER: Send address changes to *Library Resources & Technical Services*, 50 E. Huron St., Chicago, IL 60611.

Library Resources & Technical Services is indexed in *Library Literature*, *Library & Information Science Abstracts*, *Current Index to Journals in Education*, *Science Citation Index*, and *Hospital Literature Index*. Contents are listed in *CALL* (*Current Awareness—Library Literature*). Its reviews are included in *Book Review Digest*, *Book Review Index*, and *Review of Reviews*.

Instructions for authors appear on p.91-92 of the January/March 1984 issue of *Library Resources & Technical Services*. Copies of books for review should be addressed to Arnold Hirshon, Editor, *RTSD Newsletter*, Cabell Library, Virginia Commonwealth University, 901 Park Ave., Richmond, VA 23284. Do not send journal issues or journal articles for review.

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Electronic Publishing, Libraries, and the Survival of Information

Gordon B. Neavill

This paper explores some of the problems that will confront librarians and scholars in a paperless society. Researchers have long been able to advance knowledge because of the stability of information preserved in the printed word. They will be denied this legacy with paperless information systems because data banks, stored in computers under the control of the commercial sector, can easily disappear or be significantly changed. An unplanned transition to electronic communication systems can seriously undermine scientific and scholarly communication and alter the role of libraries.

THE COMPUTER MAKES possible a fundamental change in the way recorded information is disseminated. For the first time in human history, it is possible to disseminate written messages to a scattered audience without reproducing the messages in multiple copies and distributing the copies across geographical space. In a computer-based, electronic information system, recorded information is stored in the memory of a central computer to which users with their own video display terminals have electronic access. Users of an electronic system who wish to retain a message have the option of transferring it electronically into their personal computer-based files. This is what F. W. Lancaster calls a "paperless information system."¹ The possibility of recording and disseminating written messages electronically, without having to rely on tangible physical objects as the medium of communication, is a revolutionary innovation with profound intellectual implications, not all of them salutary.

The advantages of computer-based, electronic information systems for certain purposes are compelling and real. One advantage is intellectual. Whereas print-based systems freeze data in a particular configuration, computer-based systems enhance the malleability of recorded information. Data stored in a computer memory can be updated, corrected, rearranged, or otherwise altered practically at will, and new data are easily interpolated into existing data. Users of such systems can manipulate and interact with recorded data, arranging the data to suit their individual needs. These features give computer-based, electronic

This article is based in part on a research report presented at a meeting of the Association of American Library Schools on January 7, 1983, by Gordon B. Neavill, Assistant Professor, Graduate School of Library Service, University of Alabama.

information systems powerful capabilities that print-based systems can never hope to match.

TECHNOLOGICAL DETERMINANTS OF INFORMATION SURVIVAL

Computer-based, electronic information systems appear to be a convenient and potentially economical means of distributing recorded information. Moreover, capabilities inherent in their technology enable computer-based electronic systems to meet information needs that print-based systems cannot satisfy. But a complete information system must do more than distribute information efficiently. Many kinds of communication require a system that also ensures the survival of recorded information. The malleability of information that is one of the major advantages of computer-based electronic systems has as its corollary the potential transience of information. Nothing inherent in the technology of computer-based electronic systems ensures that information in the system will survive.

In an electronic environment as described by Lancaster, recorded information may not exist in tangible form outside the memory of central computers. When information is freed from the confines of a physical container it is rendered vulnerable. It can be altered or revised without any indication that a change has been made. It can be purged from the system altogether. Information without a physical container cannot survive on its own. When information is purged from a computer-based electronic system, it is lost.

For ensuring that a recorded message will survive, the technology of printing has strong inherent advantages. Printed books, journals, and other artifacts in which information is recorded are physical objects. From the standpoint of the distribution of information, this is a disadvantage. You have to cope with all those physical objects to get at the information they contain. Printed books and journals have to be shipped from publishers' warehouses to wherever potential users happen to be. They have to be acquired, organized so users can find them, and stored. Exigencies of storage occasionally require that they be shifted from one location to another. Before they can be used, someone has to go to the storage area, remove them from the shelves, and carry them someplace else. Much time and effort are spent trying to keep track of their whereabouts; even so, they are frequently misplaced or lost. Only one user at a time has access to the intellectual content of a copy of a printed book or journal. Often when they are needed they are unavailable.

Yet the simple fact that recorded information in a print-based system exists in tangible form is a matter of considerable intellectual significance. The very characteristics that make printed books and journals cumbersome for the distribution of information are a positive advantage when it comes to ensuring the survival of information. The intellectual content of a printed book or journal cannot be erased or altered. It is likely to survive as long as the book or journal itself survives as a physical object. And because print technology involves the reproduction of texts in multiple copies that are then geographically dispersed, there is a high

probability that at least some of the copies will survive.

So far as I am aware, proponents of computer-based electronic systems have not addressed the issue of the long-term survival of information. Perhaps they are anchored intellectually in the world of print more than they realize. In our familiar print-based environment, the distribution and the survival of recorded information are so closely linked by the physical object in which information is recorded that we ordinarily don't think of them as separate issues. The distribution of recorded information necessarily involves the acquisition of the physical objects in which information is recorded. With the acquisition of these objects, the survival of information follows automatically, as long as the objects are retained. In an environment in which recorded information is distributed without a physical container, the link between distribution and survival is broken. The survival of information in an electronic environment becomes an intellectual and technological problem in its own right.

If computer-based, electronic information systems are to become complete information systems, not just handy devices for quick reference, personal or corporate record keeping, and short-term storage of current materials, it will be necessary consciously to design and build into them mechanisms to ensure the long-term survival of information. It is especially important that this be done if such systems are to play a role in formal scholarly communication.

THE LIBRARY'S INSTITUTIONAL ROLE

In the print-based environment, the library is involved in both the distribution and the survival of recorded information. Although one function may be emphasized over the other, they remain closely connected. As long as books were scarce and readers constituted an elite, libraries tended to be viewed as storehouses whose primary function was to ensure the survival of the society's cultural heritage. The old-fashioned librarian was first of all a collection builder who sometimes seemed to care more about protecting the books than encouraging and facilitating their use. Yet even in the most old-fashioned of libraries, underlying the acquisition of any book was always the idea—however vague—that it had potential value to someone.

As books became cheaper and more plentiful and literacy the norm instead of the exception, the emphasis shifted to the distribution function. New kinds of libraries came into existence, such as school libraries, many smaller public libraries, and some special libraries, that were concerned mainly with the distribution of current information. These libraries made little attempt to retain materials that were no longer in great demand. Research libraries of all kinds continued to contribute to the survival of recorded information, but this aspect of their role was less emphasized. Today, few librarians outside of national libraries, a small number of other research libraries of international significance, and special collections departments devote much conscious attention to the library's function of ensuring the survival of recorded information. Attention is focused instead on the information needs of users and how those needs can best be met. This is as it should be. In an environment

where information is recorded in physical form, librarians don't need to think much about the survival function. Apart from questions relating to the physical preservation of printed materials, one can say that if librarians take care of distribution, survival for the most part takes care of itself.

In an electronic environment, paying conscious attention to the survival of recorded information will be an urgent necessity. With this goes a renewed emphasis on the library's role as a social institution.

The survival of information in an electronic environment becomes an intellectual and technological problem in its own right.

The old debate over whether the library should be regarded as a social institution or a social agency was, in large part, a debate about which of the library's dual functions should receive primary emphasis. When Lowell Martin in 1937 defined the library as "an institution for the transmission of group culture and knowledge as recorded in printed materials," he acknowledged the importance of the survival function.² Twelve years later, Jesse Shera stated the case for viewing the library not as a social institution but as a social agency. "The distinction," he wrote, "is fundamental to complete understanding of the relation between the library and its social environment. Whereas the social institution is primary and basic, the social agency is secondary and derived. The family and the state are institutions; the school, the library, and the museum are agencies. The one determines the pattern of society, and the other is determined by that pattern."³

Shera's view lent theoretical support to the modern emphasis on the library as an agency through which recorded information and knowledge are distributed, and most librarians during the past thirty-five years have endorsed his position. On the whole, the view of the library as a social agency has been valuable and rewarding. It has focused attention on the importance of the social setting in shaping the development of libraries and the services they provide, and it has encouraged investigation into the information needs of various users and the kinds of services that best meet those needs. Its chief theoretical shortcoming is that it does not adequately account for the library's role in ensuring the survival of recorded information.

In an electronic environment, the view of the library as a social agency has dangerous policy implications. If the library is regarded merely as a social agency, one can argue that, if conditions change and other agencies come into existence that are able to distribute recorded information and knowledge more efficiently, then libraries could be supplanted and "wither away, their historic duty done," as one observer has expressed it.⁴

We need to begin thinking of the library as both a social agency and a

social institution. As a social agency the library is involved in the distribution of recorded information and knowledge. It is not the only agency with this function, but it has been and so far continues to be the most important. In its institutional role the library has no serious competition. The library is the primary social institution by means of which a society remains in contact with and in possession of its accumulated stock of recorded knowledge.

The library has served its institutional role in all literate societies, whatever their particular social environments have been. In this role the library is as basic to the fabric of society as are institutions like the family and the state. Remaining in contact with its stock of knowledge is a matter of fundamental importance to any society. Indeed, a society can be well defined in terms of its stock of knowledge and how that knowledge is distributed among its members.

THE STOCK OF KNOWLEDGE

The stock of knowledge of a nonliterate society cannot exceed that which can be held in the minds of its members. Since this knowledge remains available to the society only so long as it is transmitted directly from one mind to another, its long-term survival is never certain. With the advent of literacy, constructs of words and ideas can be recorded in physical form, and the potential stock of knowledge expands to include not only knowledge actively possessed in the minds of living human beings but also knowledge recorded in physical objects that remain available to the society.

The ability to store knowledge outside the human brain makes possible the cumulative growth of knowledge characteristic of literate societies. Our own stock of knowledge consists of the contributions of many previous generations together with what we have added. Some of the contributions of earlier writers continue to be widely read and cited. Other works are kept alive by relatively few readers. Many more slip from active possession altogether and survive only as physical objects on library shelves, awaiting the arrival of some Prince Charming (often in the guise of a doctoral student) to bestow a fleeting kiss of life. As Michael Polanyi has written, "Only a small fragment of his own culture is directly visible to any of its adherents. Large parts of it are altogether buried in books, paintings, musical scores, etc., which remain mostly unread, unseen, unperformed. The messages of these records live, even in the minds best informed about them, only in their awareness of having access to them and of being able to evoke their voices and understand them."⁵

Access to the accumulated stock of recorded knowledge, especially to that part of it which is no longer commercially available, is provided chiefly by libraries. This stock of knowledge is not a miscellaneous accumulation. So long as intellectual works are recorded in tangible form, the primary responsibility for defining and shaping a society's stock of recorded knowledge rests with its librarians. Private correspondence, corporate records, and other unpublished documents generally remain in the private possession of their creators or owners, outside the stock of

public knowledge. They enter the stock of public knowledge only if they are published or if they are acquired by libraries for their potential research value. Although the greater part of the stock of knowledge preserved in libraries consists of published works, publication alone does not ensure that a work will be acquired, cataloged, and retained. Some published works are thought by librarians to have insufficient value to justify their inclusion in library collections. If the place of a work in the stock of knowledge is not secured by bibliographic control in the broadest sense, it is relegated to a kind of limbo when it ceases to be commercially available. Yet as long as physical copies of the work survive, there is always the possibility that its place in the publicly available stock of knowledge can be secured retrospectively.

ELECTRONIC PUBLISHING AND THE STOCK OF KNOWLEDGE

The question facing us now is this: Would an electronic society, relying primarily on computer-based electronic systems for the storage and distribution of recorded information, be able to retain contact with its accumulated stock of recorded knowledge? Since information in a computer-based electronic system is not recorded in physical objects that have an independent existence of their own, it will survive only so long as it is retained in the system. Commercial vendors of such systems are concerned with the distribution of information in the marketplace. They may assume part of the library's role as an agency involved in the distribution of recorded information, but they are not likely to share the library's institutional commitment to the survival of information.

Three categories of information could be in danger. Formal contributions to scientific or scholarly literature for which there is little or no apparent demand might eventually be purged from the system. Nonscholarly writings that have served the primary purpose for which they were created and are no longer in demand would in all probability be purged, precluding their later use by scholars for secondary purposes. Finally, the continual updating of electronic reference works could mean the loss of noncurrent information.

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The role of the information vendor in an electronic society is comparable to that of a publisher. Publishers in the print-based environment do not keep books or other documents available forever. When the demand falls off, they are allowed to go out of print. There is no reason to assume that commercial vendors of computer-based, electronic information systems will behave differently from their counterparts in the print-based media. If retention of information in a computer-based system can no longer be justified in economic terms, it may be purged from the system. The problem is that these similar, perfectly rational deci-

sions on the part of the print publisher and the electronic information vendor have radically different implications for the stock of knowledge. Out-of-print books, to the extent that copies have been acquired, cataloged, and retained in libraries, continue to be available to scholars and anyone else who wishes to consult them. In an electronic environment, information no longer retained in a computer memory ceases to exist.

Of course, many of the circumstances that contribute to books or other information-bearing physical objects being declared out of print would not affect vendors of computer-based electronic systems. Print publishers have high warehousing costs to consider. Current tax laws in the United States discourage commercial publishers from carrying large inventories of backlist titles. Even if all copies of a printed book sell out, the level of continuing demand may be too low to justify a new printing. Vendors of computer-based, electronic information systems would face none of these problems. In an electronic environment, recorded information with a low but steady level of demand could remain commercially available indefinitely.

But many contributions to the stock of knowledge do not have a level of use that can be characterized as "low but steady." Highly specialized articles in scholarly journals may be read by a tiny handful of people when they first appear and referred to with extreme infrequency thereafter. Because of the cumulative nature of scientific knowledge, older contributions to scientific literature are hardly read at all. How often are nonclassic scientific articles published twenty, forty, or eighty years ago referred to today? A large part of the stock of knowledge preserved in libraries is dead or dormant knowledge retained for its archival value.

In a computer-based, electronic information system with full-text capacity, infrequently requested works would probably be stored offline in a kind of archival memory. Even though storage costs in such a memory would be very low, it would still cost something to retain works in the system. I have no idea what rate of demand would be necessary to justify retention in economic terms, and it may well be that inertia would militate against the selective purging of archival files. Nonetheless, I would be surprised if commercial vendors retained works indefinitely for which there was no apparent demand. Certainly the possibility exists that rarely or never requested works would be purged.

Would it matter if they were? A specialized article in an obscure sub-discipline may be of great significance to the handful of subsequent scholars whose work leads them into that area. Rarely consulted publications that are outdated or superseded continue to be significant to anyone interested in examining the development of a scholarly discipline. Older contributions to the scientific literature have obvious value to the historian and sociologist of science.

But it is also important to the practicing scientist that earlier contributions remain available. New knowledge occasionally leads to a reopening of old channels of inquiry that seemed to have been worked out, or were merely abandoned, or were rejected as invalid. The theory of continental drift put forth by the meteorologist Alfred Wegener in 1912 was rejected and even ridiculed until geophysical discoveries in the 1950s

lent it new credibility. Michael Polanyi has noted how his theory of the adsorption of gases, first published in 1914, was disregarded for nearly half a century until changing views about the nature of intermolecular forces permitted scientists to accept its validity.⁶ Precisely because of the cumulative and intricately interrelated structure of our scientific knowledge, with everything that we think we know, as Karl Popper has argued,⁷ being considered conjecture subject to criticism and refutation, and with earlier contributions being built on and superseded by later contributions, it is essential that the whole fabric be preserved. Only in this way can earlier work—and later contributions based on it—be reexamined in the light of current knowledge. Since we cannot predict where new discoveries will lead us, it is impossible to know which earlier contributions may eventually be subject to renewed scrutiny. All must be retained.

In an electronic environment, vendors of computer-based information systems would have to be strictly regulated to guard against any possibility that formal contributions to scientific and scholarly knowledge, however rarely used, might be purged. But many nonscholarly electronic texts probably would not be protected. The real problem in an electronic environment would be distinguishing between messages that are truly ephemeral and those that might later turn out to have value as source material for scholarly research.

In a completely paperless society in which all recorded messages were disseminated electronically, there is a high probability that many kinds of apparently ephemeral writings would be purged after they had served their primary purpose and ceased to be in demand. Literary and other works that failed to find or retain an audience might also be purged after a time. It would be undesirable and probably impossible to retain everything. Yet an ongoing electronic holocaust of this sort would be a disaster both for scholarship and for cultural life in general.

Many documents used by historians and other scholars are used for purposes quite different from those for which the documents were originally created. For example, to the extent that seventeenth-century sermons are read today, they are read primarily not for spiritual edification but in order to penetrate the mental world of human beings who lived three centuries ago. Reformation pamphlets, eighteenth-century chapbooks, nineteenth-century economic tracts, literature generated by social movements, such as the civil rights movement of the 1950s and 1960s or the women's movement of today, constitute the essential raw material of history. These documents survive for retrospective use by scholars primarily because they have survived as physical objects long after the primary purposes for which they were created are met. They survive long after their authors and publishers lose interest in them. And, having survived, they can then be used for secondary purposes never imagined by those who created them.

Vendors of computer-based, electronic information systems are not likely to retain information that has served its primary purpose and is no longer in demand just because some scholar sometime in the future might want to use it for some secondary purpose. I don't know what the

solution to this problem might be. Short of requiring that all messages entered into computer-based electronic systems be retained permanently, it would be necessary for libraries (which I assume would still exist) to transfer electronic texts of potential value to scholars into local archival memories while they were still current. The difficulty here is that the scholarly value of many documents does not become apparent until after their primary purpose has been served. How many people in the eighteenth century would have predicted that chapbooks and other ephemeral literature of the time would interest scholars two centuries later? How many people in December 1955 would have guessed that a local bus boycott in Montgomery, Alabama, marked the beginning of a movement that was to shake and transform the American social order and that the documents it generated would have great historical value?

Fortunately, the majority of nonscholarly texts are likely to be disseminated in printed form for many years to come. We may be able to postpone facing this problem until we have more experience in ensuring the survival of other kinds of electronic information. But librarians, scholars, and commercial information vendors should now be searching for a means of ensuring the survival of noncurrent information in online directories and other regularly updated electronic reference works. The printed versions of these works will begin to disappear in the very near future.

Consider a reference work like *Books in Print*. In its printed form, a new edition appears once a year. Because print technology freezes data in a particular configuration and because of the time needed to manufacture and distribute the edition, the information it contains is out of date on the day of publication and becomes increasingly so as the year goes by. Meanwhile, the universe that *Books in Print* aspires to document is changing every day. Prices change, new books are published, old books go out of print. If we rely on the printed version, we may not know about the changes until the next edition appears. The electronic version, on the other hand, can be updated continually. New information can be made available instantaneously. We can always have an up-to-the-minute knowledge of how things stand today.

But would we still be able to know how things stood in the past? When the new edition of a printed reference work like *Books in Print* comes out, we continue to have a record of what books were in print the previous year, and at what prices, because the old edition, being a physical object, does not cease to exist when the new edition replaces it. Back volumes of directories, yearbooks, and other regularly updated reference works provide documentation about the past that is of great value to scholars and generally is available nowhere else. Yet the *raison d'être* of such reference works is solely the provision of current information. They provide a retrospective capability only because the survival of information no longer relevant to the purpose for which it was created is an inherent feature of print technology.

It is this feature of print technology—a by-product, as it were—that makes historical research possible. In an electronic environment, we are likely to lose much of the retrospective documentation we now take for

granted, unless strict standards are promulgated that require that fairly complicated retrospective capabilities be built into online directories and other electronic current information services. This will not be easy. For an electronic information service to provide a retrospective capability comparable to the back volumes of a printed reference work, three distinct features would need to be incorporated. Entries that are no longer current (books that go out of print, members of an organization who die or drop their memberships, etc.) would have to be retained somewhere in the system. Many electronic information services will find it desirable to do this without mandatory standards, but some may not. A more complex problem is posed by the revision of information within fields of an entry. When the price of a book or an address in a biographical entry changes, the old information would have to be retained with an indication of when it was superseded. Finally, for many scholarly purposes something more than a large cumulative file of current and retrospective information is needed. A content analysis of the types of books available at a particular period or a study of how characteristics of the members of a professional organization changed over time would require that the database be designed so it could be reconstructed as it existed at any given time in the past. An electronic information service with these features would provide retrospective information far more efficiently than do back volumes of printed reference works.

In an electronic environment, we are likely to lose much of the retrospective documentation we now take for granted, unless strict standards are promulgated . . .

The difficulty is that a retrospective capability of this sort is irrelevant to the primary purposes for which current information services are created. Vendors may resist standards requiring that a retrospective capability be built into the system. Another difficulty is deciding who would bear the added cost it would entail. Yet the provision of some form of retrospective capability is imperative if the needs of future scholars are to be met. A possible alternative to an electronic retrospective capability would be a requirement that a computer output microform record of the database be generated at established intervals. This record would be comparable to the back volumes of a printed reference work, and its sale to research libraries could be a source of additional income to the vendor. Probably the best way to ensure the survival of noncurrent information in electronic reference works would be to tie the provision of some form of retrospective capability to copyright of the database.

Librarians and scholars may not be the only groups concerned about the survival of information in an electronic environment. I don't know to what extent legal scholars have begun thinking about these matters, but it would seem that an electronic environment would also have grave implications for the legal system, especially in terms of standards of evidence. In an electronic environment, legal evidence could easily be al-

tered or destroyed. Suppose, for example, I enter a libelous statement into a computer-based, electronic information system. Suppose then, having allowed the statement to have its effect, I delete it. The fact of my having committed libel remains. The evidence of the crime has vanished. Somewhat less dramatically, information also figures in civil cases of all kinds. Decisions are made, actions are taken, on the basis of information. If there is any legal question about those decisions or actions, it is important that we be able to present as evidence the information on which they were based. In an electronic environment, the ever-present possibility that information might have been altered could raise doubts about evidence submitted in a court of law. The routine updating of information could mean that information subsequently needed as legal evidence might no longer exist.

Even if computer-based electronic systems are designed in such a way as to ensure the survival of information for scholarly and other uses, one problem remains. Not all vendors of computer-based, electronic information systems will be successful. They will be subject to the same forces that affect other enterprises; some of them will go out of business. What happens then to the portion of the stock of knowledge for which they were responsible? When a print publisher goes out of business, the publications issued over the course of its existence continue to be part of the stock of knowledge available in libraries. When an electronic information vendor goes out of business, information in the memory of that vendor's computers could cease to be available, either temporarily or permanently. Some provision will have to be made to counteract this possibility. The establishment of a public corporation to assume the assets of bankrupt information vendors is not an attractive idea, but I don't know what else to propose.

Finally, the fact that a significant portion of the stock of knowledge in an electronic environment would not exist in tangible form outside the memories of central computers raises preservation issues that are even more complex and difficult than those in the print-based environment. In the print-based environment, we have to be concerned about the preservation of the physical objects in which information is recorded, and, if these are beyond saving, with the transfer of their intellectual content to other media such as microforms or optical discs and video-discs. Even though many printed documents are actively disintegrating on library shelves, the fact that most printed documents exist in multiple copies—some of which have deteriorated less than others, depending on the conditions of their storage and use—means that there is a good chance of salvaging the intellectual content of endangered documents, if not the documents themselves.

Although certain forms of computer memory may be superior to paper and print for long-term storage, information in a computer memory remains vulnerable. It remains vulnerable because it may exist in only a single copy or, with backup capability, in a very limited number of copies. In this respect, an electronic environment resembles a nonliterate society, where the society's vital religious myths, literary creations, and genealogical traditions may be preserved in complete form in the minds

of a handful of individuals. Just as a nonliterate society takes great pains to ensure that these individuals survive to pass on their knowledge to the next generation, it will be necessary in an electronic environment to pay special attention to the protection and care of computer memories. Otherwise, a single disaster could decimate a portion of the stock of knowledge.

We'll need to know with precision and certainty how reliable various forms of computer memory are for long-term storage, and we'll need to determine how many backup copies are necessary (and how they should be stored) to have reasonable assurance that information will not be lost through technological mishaps or disasters of other kinds. We can't risk allowing an earthquake or fire to destroy the only copy of scientific or scholarly knowledge. We also need backup copies to guard against the possibility that modern-day Luddites could enter a computer facility and destroy a portion of our scientific knowledge, or that the stock of knowledge itself could be held at ransom by political terrorists.

OTHER ISSUES

The survival of recorded information is not the only issue of intellectual consequence raised by the advent of computer-based electronic information systems. The ease with which messages can be recorded and disseminated in an electronic environment may result in an enormous increase in the amount of low-quality information entering the stock of public knowledge. Certain intellectually important distinctions that are made automatically when works are recorded and disseminated in tangible form could be blurred. Bibliographic control is likely to be a more complex problem than it is now.

The linkage of individual computers in an electronic environment will allow anyone who invests in a small amount of supplementary equipment to become an electronic publisher. Alongside major information vendors are likely to be a large number of individuals disseminating works they have written or compiled themselves. Some of this material will be valuable, as is much self-published work today in areas like jazz discography. Much of it will be garbage. Little of it will have been assessed by editors or referees, or, if it has been so assessed, it may be self-published after having been rejected by the gatekeepers of established publishers. A tidal wave of self-published works of disparate quality, many of which may have a transitory existence, would place great strains on the system of bibliographic control. To distinguish works of value, some kind of qualitative evaluation might have to become part of the bibliographic control process. Because standards and regulations designed for commercial vendors would be difficult to apply to individuals, special steps to ensure the survival of self-published works of lasting value might have to be taken.

Publication is the process by which a work passes out of the private possession of its author and is made available to the public at large. In the print-based environment, publication involves reproducing a recorded work in multiple copies and distributing the copies to consumers. In an electronic environment, it involves entering a work into a

computer-based information system to which the public has electronic access. Since the freezing of data in a particular configuration is not inherent in the technology of such systems, publication in an electronic environment will have rather different intellectual implications than it does now, both for bibliographic control and for intellectual life in general.

In the print-based environment, an author may write several drafts of a work, circulate it among friends and colleagues for comment, even deliver it orally at a meeting before publishing a final version. So long as the author controls access to the work, it has not fully been made public. Publication implies that the work has been completed or has evolved to a point at which the author is willing to stop working on it. In an electronic environment, works in progress can be made available to the public at large, either for discussion and comment or to disseminate new information quickly. The publication of such works has disturbing implications for bibliographic control, which in the print-based environment has been concerned primarily with completed works in (or about to enter) the stock of public knowledge. It is difficult enough to organize, describe, and provide appropriate access points to works fixed in tangible media; to extend bibliographic control to works whose content, subject emphasis, and titles may be in a state of flux will be a challenge of staggering proportions.

Distinctions between a work in progress and a completed work, and between the original edition of a published work and revised editions, will be blurred in an environment where content is not frozen and revisions can be made at any time. In the print-based environment, a clear line of demarcation is drawn when a work is set in type. Once corrections are made at the proof stage, the content is fixed in the form in which, for better or worse, it will be released to the public. To revise a work after it has been published, type must be reset and a new printing made, resulting in a separate, clearly defined edition. These characteristics of printed communication are intellectually significant. They make it possible to cite passages in printed works with the assurance that the content of those passages will remain unchanged and accessible to future readers. They make it possible to document the changes made in the content of new editions. To a large extent, they make cumulative scholarship possible. If the intellectual content of scientific and scholarly publications remains potentially in flux and subject to revision at any time, citations to those publications could be rendered meaningless, and it would be perilous to rely on findings or conclusions in those publications as the basis for subsequent investigation.

Although computer-based, electronic information systems may not supersede the printed word as the primary medium for written communication, there is little doubt that they will be an increasingly important part of the information environment. To the extent that they are used for formal scientific and scholarly communication or for the communication of information of potential interest to scholars, the issues raised in this paper will need to be addressed. Otherwise, the tradition of

cumulative scholarship could be undermined, and the continual updating of information could mean an ongoing obliteration of the past.

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Library Resources & Technical Services is published quarterly by the American Library Association, 50 E. Huron St., Chicago, IL 60611. Annual subscription price, \$10. American Library Association, owner; Elizabeth L. Tate, editor. Second-class postage paid at Chicago, Illinois. Printed in U.S.A. As a nonprofit organization authorized to mail at special rates (Section 132.122, *Postal Service Manual*), the purposes, function, and nonprofit status of this organization and the exempt status for federal income tax purposes have not changed during the preceding twelve months.

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("Average" figures denote the number of copies printed each issue during the preceding twelve months: "Actual" figures denote number of copies for single issue published nearest to filing date—the July/September 1983 issue.) *Total number of copies printed:* Average, 9,702; Actual, 9,548. *Paid circulation:* not applicable (i.e., no sales through dealers and carriers, street vendors and counter sales). *Mail subscriptions:* Average, 8,611; Actual, 8,564. *Free distribution by mail, carrier or other means, samples, complimentary, and other free copies:* Average, 867; Actual, 851. *Total distribution:* Average, 9,478; Actual, 9,415. *Copies not distributed:* office use, leftover, unaccounted, spoiled after printing: Average, 224; Actual, 133. *Returns from news agents:* not applicable. *Total (sum previous three entries):* Average, 9,702; Actual, 9,548.

Statement of Ownership, Management and Circulation
(PS form 3526, July 1982) for 1983 filed with the
United States Post Office, Postmaster in Chicago,
September 30, 1983.