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ARCHIVING ELECTRONIC JOURNALS

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Abstract

Libraries must take an active role in collecting and archiving electronic journals to ensure that their contents remain accessible to users as far into the future as possible. The CICNet electronic journals project represents a promising example of cooperative network-based archiving undertaken by the library community, but at the present stage of development the most reliable archiving option is for individual libraries or library consortia to obtain electronic journals directly from the network and establish their own access and archiving procedures. Problems involving in long-term electronic archiving include the short life expectancies of digital storage media, hardware and software dependency, and the need for authentication devices to distinguish between versions of electronic records and ensure that there are no unidentified changes in content.

[p. 13]

Journals in the paper-based environment serve many functions, but two are fundamental: the transmission of information through space and the transmission of information through time. The electronic journal enhances the transmission of information through space and may make information available more quickly, but it raises serious questions about the long-term transmission of information through time. For the electronic journal to gain widespread acceptance within the scholarly community as a medium of record for the formal publication of original scientific and scholarly research, archival issues concerning the preservation and authentication of digitally encoded information will have to be resolved. As long as these issues remain unresolved, electronic journals serving the scholarly community are likely to be limited primarily to current awareness services, informal communication, and the circulation of work in progress for criticism and discussion.

This paper discusses problems related to preserving and authenticating the contents of electronic journals so that they will remain accessible to scholars and usable by them as far into the future as possible. Our concern is with archival retention in the sense of permanent or very long-term storage. Our primary focus is not on futuristic scenarios for archiving electronic journals in a mature and stable network environment but on

[p. 14]

what can be done in the transitional environment to ensure continuing access to the contents of electronic journals being published today.

Network-based electronic journals are a relatively new phenomenon, but journals in machine-readable form are not. Full-text electronic versions of printed journals have been available in libraries for a number of years. Libraries have been able to provide electronic access to these journals without incurring the responsibilities and costs traditionally associated with ownership. Vendors like Dialog charge on a pay-per-use basis, and CD-ROM databases are typically licensed rather than sold. Most research libraries have used electronic services to enhance current access to journal literature while continuing to acquire a core collection of printed journals. Continuing access over long periods of time has been assured by print and microform versions owned by and preserved in libraries.

The advent of network-based electronic journals without print counterparts changes everything. Publication patterns of network-based journals are still evolving. The network itself and the technologies that support it are also evolving rapidly. The primary emphasis of network-based communication to date has been the transmission of information through space, not the long-term transmission of information through time. Libraries that wish to ensure continuing access to network-based journals have limited options. The development by the library community of reliable network-based archiving with sufficient built-in redundancy to guard against catastrophic losses of information is the logical long-term solution. At the present stage of development the most reliable option is probably for individual libraries or library consortia to obtain electronic journals directly from the network and establish their own access and archiving procedures.

Archiving options

When a library decides to provide access to a journal, it usually does so with the expectation that current issues will be retained and that eventually the library will have backfiles dating from the time the subscription began. The information content of each issue is expected to be available in the library indefinitely. Continuing availability of this kind is especially important for journals that publish formal contributions to the scholarly literature of a given field. It is less important for newsletters and current awareness services, although retention of these serials can provide useful documentation for scholars interested in a field's historical development.

Libraries can provide continuing access to electronic journals in several ways. Back issues of several network-based journals such as Postmodern Culture are available as offline products (usually floppy disks or microfiche) that can be acquired from the publisher. However, back issues of many network journals are not available as offline products. Libraries that rely solely on such products can provide continuing access only to a subset of electronic journals.

Many publishers of electronic journals maintain archives of backfiles at network sites, but there is little assurance that these files will be available permanently. Publishers may discontinue individual titles or go out of business altogether. Cochenour and Moothart write, "The majority of electronic journals are currently produced by not-for-profit organizations, which means the permanent archives will be affected by both the direction of the organization and the whim of the publisher. . . . Permanent archives will also be a problem in the future for publications from smaller scholarly societies and professional organizations where the editorship and publishing responsibilities seem to be passed around regularly."[1] Any publisher's archive must be regarded as potentially unstable.

Client/server protocols such as Gopher and the World Wide Web can be used to locate and access current and back issues of electronic serials that individual libraries and library consortia are beginning to collect and organize at a number of network sites.[2] The largest and most comprehensive storage site is the CICNet Electronic Journal Collection, which began in 1992.[3] CICNet is a cooperative archival project of the Committee on Institutional Cooperation (CIC), an academic consortium of major research universities. Thirteen CIC libraries are cooperating to build and maintain an archive of electronic serials for member libraries. Over 700 journals and newsletters are archived at the CICNet site. CICNet currently maintains an open-door policy and allows access to public domain titles in the archives by Gopher servers outside of the consortium, but there is no guarantee that access will continue to be open. Cochenour and Moothart note, "Because of the traffic on the server, CICNet may decide to eliminate access to non-CIC sites. Libraries should not depend on the charity of a few sites such as CICNet to provide universal access to these publications."[4] Moreover, CICNet at this stage of its development is far from perfect. According to MacLennan, "Access to the collection . . . is limited by an alphabetical listing of titles that often

[p. 15]

leaves room for interpretation as to what the 'title proper' actually is. . . . There are currently no index capabilities available, such as WAIS, for keyword searching of the archives. The CICNet archives are not pretty and not always up-to-date."[5] CICNet is an enormously promising development, but much of that promise has yet to be realized.

Local archiving appears to be the most reliable way for libraries in today's transitional environment to ensure that their users will have adequate and continuing access to files of network-based journals. But no library should establish an electronic archive without careful evaluation of the implications for the library and the inherent problems involved. Storage options, preservation requirements of digital storage media, problems related to hardware and software dependency, and the authentication of digital records are among the issues that must be addressed. A local archive established as an interim measure to ensure access to electronic journals until adequate regional or national archiving structures are developed may not have to face all of these issues. They cannot be avoided if the archive is maintained for more than five to ten years.

Storage options

Most libraries that establish local archives of electronic journals download the files to mainframe computers or network servers. Online access can be provided because the number of electronic journals is still relatively small and most began publication within the past few years. But eventually holdings are likely to exceed allocated space and most libraries with local archives will have to consider offline storage options.

Offline storage options include both magnetic media such as data tape, hard disks, and floppy disks, and optical media such as CD-ROMs. Magnetic data tape is an attractive option for archiving electronic journals because of its large storage capacity and its widespread use by computer centers. Its main shortcoming for offline storage is related to current loading procedures. There is no loading system for magnetic tapes equivalent to juke boxes and CD-ROM towers, which allow patrons at a workstation to access different CD-ROMs without physical contact with the disks. Magnetic tapes are loaded by operators at computer centers in response to user prompts; storing journal backfiles on magnetic tape is therefore equivalent to having printed journals in closed stacks. When there are many requests, queues can cause delays. Magnetic tape may be impractical for large collections of backfiles where on-demand access is important.

Preservation of storage media

It is widely recognized that digital storage media present serious preservation challenges.[6] Neither magnetic nor optical media are considered to be of archival quality.[7] The lifetime of digital storage media is measured at best in decades; in contrast, the lifetime of archival-quality paper and photographic film is measured in centuries. Sidney B. Geller has identified two kinds of decay that may affect digital storage media: (1) static decay, the deterioration of the medium over time when it is not in use; and (2) dynamic decay, the deterioration of the medium as a function of use.[8]

Magnetic media are subject to both types of decay.[9] Dynamic decay occurs during read/write procedures when there is contact between the medium and the transport. Static decay results from environmental degradation by hydrolysis, which affects the binder in which the magnetized particles are suspended. The chemical reaction between the binder and atmospheric water vapor is accelerated by high temperatures, humidity, and acidic pollutants in the air. Careful monitoring of storage conditions can extend the life of magnetic media, but some hydrolysis is inevitable even under ideal conditions. A recent study at the National Institute of Standards and Technology concluded that magnetic tape has an expected lifetime of ten to twenty years but cautioned that lifetimes can vary considerably: ". . . we have seen cases of failure after only a few years."[10] Magnetic tapes and other digital storage media have to be monitored to identify degradation, and their information content has to be copied onto new storage media on a regular basis to ensure continuing access over time.

Floppy disks have an even shorter life expectancy than magnetic tapes. They are sensitive to high temperatures, humidity, and extreme temperature changes. The National Institute of Standards and Technology reports expected lifetimes of ten to fifteen years at most for floppy disks stored under ideal conditions. Archivists have been more cautious and estimate that information recovery from floppy disks should be expected for no more than five years after initial storage."[11]

Optical media have been marketed as a solution for the problems of magnetic carriers. Dynamic decay is not a problem, since optical media are read by a laser and there is no contact between the reading head and the disk surface. But optical media are subject to static decay. The American Physical Society's Task Force on Electronic Information Systems has concluded that the lifetime of current optical media "is finite, on the order of years. This is due to the ingassing, or diffusion into the medium, of atmospheric gasses or contaminants that attack the reflective or transmissive layer used in the optical medium."[12] It is unclear whether this problem is inherent in the medium or due to manufacturing defects. Some laboratory tests using accelerated aging techniques have shown optical media to be durable, and manufacturers have predicted life expectancies of one hundred years or more. However, many users remain cautious and doubt whether lifespans of more than five to ten years can be expected. A major problem with optical media is that they have not passed the test of time; as Helmut Bansa remarks, "Might last does not mean will last."[13]

Hardware and software dependency

The short life-expectancies of digital storage media are not a significant problem in terms of the long-term preservation of digitally encoded information. Little is gained if storage media outlive the hardware and software that are required to provide access to their information content. Most electronic hardware is not expected to function for more than ten to twenty years.

Storage media designed for use with specific hardware may not be usable with later generations of computers. Some mainframe computers, for example, can only accommodate magnetic tapes within a specific density range, with the result that some early tapes cannot be read by currently available hardware. It is not feasible to maintain superseded hardware over long periods of time to provide access to outdated storage media. Continuing access to digitally encoded information can only be provided by copying and reformatting electronic records on a regular basis to ensure that the records remain compatible with current hardware and software.

Software dependency is an even greater problem than hardware dependency. Software tends to change more rapidly than hardware, and generations of software tend to be less compatible than generations of hardware. There are hopes that future software will be less system specific and that translator disks will make possible system-independent software. However, this is an ambitious goal and requires a level of standardization that has yet to be achieved.[14] Emulator programs may provide a partial solution to software obsolescence. These programs allow software for obsolete equipment to be executed on later generations of computers. But emulator programs require the user to enter the parameters of the obsolete system. Unless this information has been accurately recorded, extensive trial and error is necessary.[15]

Electronic journals will have to include graphics, illustrations, and text in non-roman alphabets if they are to gain widespread acceptance. This may exacerbate the software dependency problem. Currently most electronic journals are published in English and are stored as text files in ASCII (American Standard Code for Information Interchange). ASCII represents all characters of the roman alphabet, numerals, and a limited number of other characters using an 8-bit coding scheme. However, ASCII does not accommodate color, graphics, diacritics, or mathematical notation, and most network journals therefore include little non-text information.

Other coding methods provide greater flexibility for electronic publishing, but all formats are software dependent. Illustrations and graphics in network journals are frequently handled through the use of bitmapped images or page-description formats such as PostScript. The World Wide Web and the Mosaic interface make it possible to display graphic, moving, and sound files in an easy-to-use, attractive desktop format.[16] The coding standard for Mosaic applications is Hypertext Markup Language (HTML). HTML supports most multimedia but is of limited use for scientific publishing because it does not support mathematical notation. Scientific notation is often accommodated through the use of typesetting formats such as TeX. Information stored in these formats will only be accessible as long as appropriate software applications remain available.

Nonroman alphabets present additional archiving problems. The inadequacy of the ASCII coding scheme to represent all of the world's languages is widely recognized. The Unicode initiative emerged as an attempt to find a single coding scheme to represent all of the character sets and scripts used around the world. Unicode proposes a 16-bit coding scheme with a capacity to accommodate 65,536 characters.[17] This compares with ASCII's 8-bit coding scheme and 128 character representation. Other initiatives have been directed toward developing character sets to handle Asian scripts such as Apple's two-byte character set to accommodate the Japanese and Chinese languages.

The replacement of ASCII by Unicode or any other character set as a standard for text encoding could lead to problems for information access and retrieval. Text

[p. 17]

encoded in ASCII, Unicode, and other character sets has to be manipulated by data conversion utilities. ASCII, for example, is typically converted to EBCDIC-coded data. Unless text encoding details are accurately recorded and appropriate software is available, information recovery can be difficult.

Graham has discussed the implications of migrating non-ASCII information in the face of software obsolescence. "Migrating graphic, image, moving or sound data, or even formatted text, will only work as long as the software application can also be migrated to the next computing platform."[18] This type of migration will require skilled labor, extensive documentation, and record keeping if these materials are to be retrieved at a later time, since full retrieval is dependent on access to appropriate software.

Finally, some obsolescence problems are linked to the fortunes of information technologies in the marketplace. The widespread use of CD-ROMs in the entertainment industry makes possible their economical use in libraries. If new entertainment media supersede CDROMs, it is unlikely that libraries will be able to support the technology on their own.[19]

Libraries that archive electronic journals in machine-readable form must recognize that, in Bansa's words, "Electronic data are not for long-term storage. They are for use.[20] Copying and reformatting electronic records at regular intervals will be necessary to prevent the loss of information due to deterioration of electronic storage media or hardware and software obsolescence. These problems appear to be inherent in electronic technologies and are not limited to the transitional environment. Every library with an electronic archive must be prepared to assume responsibility for perpetual copying and reformatting to ensure that the intellectual content survives and remains accessible to future users.

The flexibility of access and use provided by electronic storage may justify the cost of copying and reformatting and the risk of possible information loss. However, there are strong arguments against relying on long-term electronic storage. A Committee on Preservation established by the National Archives and Records Service to advise on machine-readable records issued a report in 1984 that argued strongly against the preservation of records in machine-readable form. The committee based its opposition to machine-readable archives primarily on problems related to hardware and software dependence and proposed instead a system in which records would be permanently stored in human-readable form on archival-quality microfilm."[21] Graham has also suggested migrating electronic information to paper or microform for long-term storage.[22] This approach precludes keyword searching of text and other forms of machine manipulation, but it is a simple, reliable, and cost-effective option that libraries may wish to consider when preservation of content is the primary objective. Johns Hopkins University Press plans to allow full subscribers to the projected online versions of its journals in the humanities and social sciences to covert them to either film or CD-ROM for purposes of preservation.[23] In the print-based environment we have been accustomed to relying on a single information technology (print) that is well suited to transmission through both space and time. In the electronic environment it may turn out to be advisable to utilize different technologies for different kinds of transmission.

Authentication of records and versions

Archiving electronic journals is complicated by the malleable nature of electronic text. The MIT Electronic Journals Task Force observed, "Electronic journals offer the opportunity for articles to be submitted online, refereed and edited online, and even enhanced later by new data, both by the original authors and by others working in the field."[24] This raises the problem of the authentication of records and the identification of successive versions. Intellectual preservation of electronic media includes identifying versions of documents and keeping track bibliographically of the distinctions between them. Users of electronic documents should be able to identify the version referenced in a bibliography or index and be certain that the content of a document that has been retrieved is the same as the one cited. If a document in hand contains revisions, users should know what changes have been made and be able to cite the revised document so that others may locate and use that version.

Several techniques have been developed for distinguishing, authenticating, and citing versions of electronic documents. The three most important are cryptography, hashing, and time-stamping.[25] Probably the most widely used cryptosystem for the authentication of electronic documents is public-key cryptography. Public-key cryptosystems separate the capacities for encryption and decryption so that either (1) many people can encrypt a message that only one person can read, or (2) one person can encrypt a message that many people can read.[26]

[p. 18]

In a public-key cryptosystem, each user holds a set of corresponding public and private keys; data encoded by the public key can only be decoded by the corresponding private key. Each user places a unique encryption process (public key) in a file. This file becomes a directory of the public encryption processes of many users. Each user keeps secret a corresponding decryption process (private key). When user A wants to send a message to user B, user A encrypts the message using B's public key. Only user B can decrypt A's message because only B has the corresponding private key. Similarly, user A can encrypt a message using his or her private key that anyone can decrypt using A's public key. This message is authenticated, since only A could have created the message using that unique private key. Recipients of A's message can only decode the message; they are not able to modify it since they lack access to A's private key.

Public-key encryption is routinely used in financial transfers, but it is not suited for use in libraries. This type of cryptosystem is impractical for information that is distributed widely and must be made freely accessible over a long period of time.[27] The loss of private keys as information outlives originators would make encrypted documents useless.

A second authentication technique used for electronic documents is hashing. A cryptographic hash creates a unique fingerprint for electronic documents "based on the arrangement of all the letters, numbers, graphics and symbols contained in the item."[28] If even one character of a document is changed, the hash value will differ from the original, indicating that the document has been altered.

If hashing is to be used in libraries as a technique for document authentication, two conditions must be met. First, creators and users of electronic documents must agree on a hashing algorithm. To ensure routine hashing of all documents, this algorithm must be inexpensive to use and widely available. Graham describes the possible use of hashing in libraries for authenticating documents as follows:

> In this scheme, each time a document or a draft is created or saved the hash is created, saved with it and is separately retrievable. If the document is electronically published, it should be published with its hash; and if the document is cited, the hash should be part of the citation. If a reader using the document then wishes to know if she has the right one, she computes the hash easily on her own computer using the standard algorithm and compares it with the published its hash; and if the document is cited, the hash should be part of the citation. If a reader using the document then wishes to know if she has the right one, she computes the hash easily on her own computer using the standard algorithm and compares it with the published hash. If they are the same, she has confidence she has the correct, untampered version of the document before her.[29]

Time-stamping takes the hash value of a particular document and verifies the time and date of creation in relation to other documents by placing it within a mathematical tree of hash values created within a certain time period. This technique was developed by Stuart Haber and W. Scott Stornetta at Bellcore. Time-stamping is important because it not only proves the authorship of a document but also allows intellectual priority to be established and verified. At Bellcore, the technique is replacing handwritten laboratory notebooks to prove the precedence of scientific findings and engineering designs. This information is crucial in proving originality for patent applications.

The time-stamping program is run on a central computer at Bellcore. As described by Haber and Stornetta, hash values are transferred to the time-stamper via a computer network.[30] The time-stamping program combines each hash value received with the time and date of the request and the hash value of the immediately preceding document that has been authenticated. This new hash value, called a certificate, is returned to the client and can be transmitted with the corresponding document to distinguish it from other versions. The time-stamping program combines each certificate with others issued during the week. Bellcore publishes this information every Sunday as an advertisement in *The New York Times.*

Graham has described how this technique could be used by libraries to verify versions of documents.[31] When librarians wish to verify a document version, they would first compute the hash value through standard microcomputer software. This value would be sent to a time-stamping service via a computer network. The server would report on the validity of the document certificate. Alternatively, librarians could look in past issues of the New *York Times* for the probable date that the certificate was issued. Using the hash value from the New *York*

Times and standard microcomputer software, the certificate could be tested and the authenticity of the document could be determined.

Whether or not hashing and time-stamping techniques will be accepted in libraries is uncertain. Extensive standardization would be necessary to ensure continuity between hashing algorithms for electronic documents. The cost of software, hardware, and staff to compute hashes for on-site document verification would have to be assumed by

[p. 19]

libraries. The costs of time-stamping servers would have to be assumed by someone.

Other problems could occur when electronic documents are migrated from one generation of software and hardware to another. Because hash values are computed on all symbols used in a document, including special characters, reformatting an electronic document may result in an altered hash value. This could invalidate the time-stamp for the reformatted document, although the intellectual content of the document would be unaltered.

While hashing together with time-stamping create designators that identify a document as having been created at a specific time with a specific content, these designators by themselves do not make it easy for users to recognize the relationship of one version to another. It is important for users to be able to establish links between successive versions of a document and to differentiate versions that contain significant revisions or changes in intellectual content from those with insignificant changes resulting from minor corrections or reformatting. In the print-based environment these relationships are generally indicated by edition statements. The labeling of editions or versions is even more important in the electronic environment because revisions are so easy to make. Hashing and time-stamping are useful in authenticating each version and assuring the user that the intellectual content of the version being read has not been altered.

Archiving responsibilities

The library's role in the distribution of recorded information is likely to change as electronic publishing becomes increasingly widespread. Electronic publishing creates expectations for rapid information delivery, and commercial information suppliers are frequently in a better position than libraries to meet these expectations. The growing body of public domain information that can easily be accessed from desktop workstations without the intervention of libraries may further reduce the importance of the library as an information supplier.

But libraries are more than distribution agencies. Libraries are responsible for preserving and providing continuing access to a society's accumulated stock of recorded knowledge. The electronic information industry is concerned primarily with access to current information. The library's emphasis on mediating access to current information as well as the preservation of information is unique, and the library has yet to experience serious competition in this role. We predict little change in the importance of the library for the long-term preservation of information. We believe that libraries will have to take an active role in acquiring and preserving electronic journals even if they do not remain the primary distributor for these publications.

Closely tied to the preservation issue is the role that libraries have traditionally played as gatekeepers in legitimizing information produced by scholars. This role may become even more important in the electronic environment where information overload is a serious problem. Not all information acquired by libraries is of enduring value, but it is generally assumed that important scholarly information will be acquired by libraries and that information of enduring value will be retained. Scholars have long relied on libraries to make information produced within their community widely available. Network journals are likely to be fully accepted by the scholarly community only if they make their way into libraries or an equivalent institutional structure.

Libraries are just beginning to assume responsibility for collecting and archiving network journals. The CICNet electronic journal project and similar efforts to archive electronic serials show a growing recognition on the part of the library community of the need to assume this responsibility. As electronic publishing becomes widespread and storage requirements increase, cooperative arrangements to collect and archive electronic media will undoubtedly become more common.

The library community could establish cooperative archiving on a national or international level along the lines of bibliographic utilities used for cooperative cataloging. Using the CICNet electronic journal project as a model, files of electronic journals could be acquired centrally as well as deposited by member libraries. With sufficient computer resources the contents of all journals could be available online; in practice, rarely used journals would probably be stored offline and provided in response to user requests. A major advantage of centralized archiving is that copying and reformatting would be less likely to be neglected or postponed because of local budgetary exigencies. As Clifford Lynch has noted, ensuring the smooth migration of information across generations of technologies is an integral part of the culture of information management in the network environment.[32] Ensuring that information is not lost or garbled in the process of copying and reformatting remains a challenge. But a comprehensive effort to archive electronic journals on the national

[p. 20]

level is a scenario for the future; it is not something that libraries can rely on in today's transitional environment.

Conclusion

Most preservation activities in the paper-based environment are reactive and focus on the identification, evaluation, and treatment of materials that show signs of deterioration. Preservation activities in the electronic environment will have to be predominantly proactive. Preservation implications will have to be considered before materials are acquired. This is especially true for electronic information obtained via distributed computing, which does not arrive from a publisher in a prepackaged format and can be stored in different ways at the discretion of each library.

Most archiving procedures developed by libraries over the next several years to ensure continuing access to network journals will be quickly outdated. Electronic storage media and accompanying software continue to evolve. Access protocols for information stored at network sites are also changing rapidly. Added to this instability are evolving patterns and standards for electronic publication. Until publication patterns stabilize and standards are developed for network publishing, libraries will be dealing with a rapidly changing information environment. Information specialists representing a variety of perspectives foresee the stabilization of electronic journal publishing in the near future, but their predictions show many differences.[33] At this point, libraries cannot develop policies on the basis of a stabilized publishing structure. Any plans for access and archiving will have to be temporary. This does not diminish the importance of the library's role in acquiring and preserving network journals. As stated in the report of the MIT Electronic Journals Task Force, "Non-librarians seem to assume that 'someone' will archive electronic journals and that this 'someone' is the library."[34]

Notes

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2. Birdie MacLennan, "Electronic Serial Sites: Collections, Resources, and Services on the Networks," *Directory of Electronic Journals, Newsletters and Academic Discussion Lists,* 4th ed. (Washington, D.C.: Association of Research Libraries, 1994), 23-24.

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19. Graham, "Intellectual Preservation and the Electronic Environment," p. 78.

20. Bansa, "The New Media, " p. 222.

21. National Archives and Records Service, Committee on Preservation, Subcommittee C, *Strategic Technology Considerations Relative to the Preservation and Storage of Human and Machine Readable Records* (Washington, D.C.: National Archives and Records Service, 1984); see also J. C. Mallinson, "Archiving Human and Machine Records for the Millennia, " in *Second International Symposium: The Stability and Preservation of Photographic Images* (Springfield, Va.: Society of Photographic Scientists and Engineers, 1985), 60-63.

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31. Graham, "Intellectual Preservation and the Electronic Environment," pp. 92-94.

32. Clifford Lynch, "The Future of Networked Information," presentation to the Association for Computers and the Humanities and the Association for Literary and Linguistic Computing, Joint International Conference. Georgetown University, Washington, DC, June 16, 1993.

33. For a review of some of these perspectives see *Serials Review* 18, no. 1/2 (1992).

34. Manoff et al., "Report of the Electronic Journals Task Force," p. 124.