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The Electronic Library in Higher Education: An Overview and Status Report

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INTRODUCTION

F. W. Lancaster (1978) predicted that electronic information systems would replace paper-based systems in the sciences by the year 2000. The role of the library and librarian would radically change. To what extent is the prediction valid for non-scientific disciplines? What are the motivating factors for such a claim? With the year 2000 quickly approaching, what is the status of this prediction? To what extent would the accuracy of this prediction threaten the future of library operating budgets and building programs? How is the electronic age affecting library and information services on college and university campuses?

Publications are at the very heart of scholarship. Faculty require publications as sources for research and as vehicles for communicating results. Migration to electronic publication will have substantial impact on faculty and scholarship. Increased use of electronic technology will also affect college and university publication policy, infrastructure, and organization. Understanding the trend toward electronic publications is therefore important not only for librarians, but for faculty and administrators as well.

This study will show that there has been a steady march toward the effective use of electronic technologies in publication. Some shortcomings of traditional media will be described. This will be followed by a "Vision" of research and publication in the 21st century which exploits electronic communication. Aspects of the "Vision" will be analyzed to see what shortcomings of traditional media are remedied. Then, social and technical obstacles to electronic publication will be explored. A few case sketches will be presented of universities particularly active in electronic communication and publication. Finally, there will be some fearless predictions for the future.

WHAT'S WRONG WITH TRADITIONAL MEDIA IN LIBRARIES?

There are a number of factors which motivate the use of electronic media. The amount of scientific literature is growing exponentially with a doubling about every 15 years since the advent of the journal in the late 1600's. In 1930, there were 36,000 journal titles, but by 1960, the number of journal titles had grown to 60,000. The number of papers indexed in Chemical Abstracts, Engineering Index, Index Medicus, and Physics Abstracts grew from approximately 200,000 in 1950 to approximately one million in 1988 (Convey, 1989). With this tremendous volume of literature, it is difficult for the average scholar to select the appropriate material to read, no less read it. There is a fragmentation of the literature; information is spread out over a larger number of journals. While the number of journals and articles has increased, the amount of time devoted to studying those articles by a scholar has not increased (Lancaster, 1978). In short, journals target individual researchers poorly.

As the amount of information increases, secondary access points such as indexes and abstracts increase in importance. Their volume is growing as well. Subject headings in these indexes are not determined by the researcher and finding relevant citations is time consuming and not always intuitive. For example, to find sources for this paper, the author reviewed the paper index, Index to Library Literature, under the topics "Library Automation" and "Information Retrieval, Higher Ed." Although these were the "standard" Library of Congress headings pertaining to the topic, neither was a particularly good fit and yielded many articles with no relevance to the paper. Furthermore, searching multiple volumes was necessary for the investigation over the required period of time. Using a paper index, one could do no better.

From the perspective of a research university, the growth in the literature and the number of titles available has led to soaring budgets. Scholars do not know in advance what literature they will require, and pressure their libraries to purchase all journals which may be of interest. The periodicals budget has not only grown because of the number of subscriptions, but also because the average growth in the subscription price of a journal has historically exceeded the inflation rate by a factor of 4 to 5. Ironically, the raw material for scholarly publications comes gratis from the scholars themselves, who transfer copyright to the publishers. Universities then buy back the works of their scholars and provide access to them for free (Battin, 1984; Byrd, 1990).

Another problem with the current system of publication is timeliness (Lancaster, 1978). By the early 1970's, the time from submission to publication averaged nearly 18 months. Delays in publication could cause unnecessary duplication of research by others who could otherwise avoid performing work which may have been already completed. The situation is to the point where no self-respecting scholar

depends on journal publication as a primary means of staying current. Preprints and working papers have become a way of life, and formal journal publication is more for posterity and tenure committees than communicating with colleagues (Lewis, 1988, p. 294).
An "invisible college" of collaborators who keep in touch through less formal channels has developed. However, there is evidence that younger scholars are excluded from these cliques (Lancaster & Smith, 1978). Journals, then, are no longer the principal means for scholars to keep current.

The archival qualities of paper are problematic. Acid content papers, in use for over one hundred years, lead to disintegration as do insects and other environmental factors. Paper based scholarship requires large, expensive buildings to which scholars must have physical access.

In summary, publications are too numerous, too difficult to search, too expensive, too late, too fragile, and too inaccessible. How does increased use of technology address these problems?

THE VISION

Imagine a hypothetical Scholar of the 21st century. A technologist's scenario for our Scholar might look something like the following. The Scholar accesses the computer wherever the Scholar is comfortable doing research. Physical location is of little importance, since whether the Scholar is at home, at the university, or visiting, the Scholar and computer will join the electronic community of scholars over a high speed computer network.

First, the Scholar checks for electronic mail from a colleague who is working in a similar area of research. The colleague has sent both textual descriptions and graphic three dimensional models. Both are displayed on our Scholar's workstation, which is capable of displaying high resolution text and graphics. The Scholar rotates the graphic in space to understand its structure.

The Scholar is notified on another area of the screen, a message window, that new research is available from a colleague at another university. Our Scholar has previously completed an electronic profile of his/her research interest, and is notified whenever there is an article available which matches that profile. The Scholar clicks on the message window and an abstract of the research appears. The new research is from a refereed electronic journal published by University X. University X has become a locus for research in this area. It publishes several electronic journals and also provides an electronic bulletin board service where researchers might share their ideas more informally. Bulletin boards are organized by affinity group. Our Scholar regularly reads and posts notes to one such bulletin board. The bulletin board has wide readership among our Scholar's colleagues and is available free of charge. The electronic journals require subscription, but the subscription prices are based on the number of retrievals of particular articles.

The Scholar accesses the article and brings it down into a personal database on his/her computer, where it is automatically indexed for searching at a later time. The Scholar reads the article on the computer screen and is prompted to look for related material. The Scholar starts at his/her own university library with a general search of a database which contains abstracts, citations, and some full text of research. The library subscribes to this information on optical disk and receives updates once each quarter. The optical disk can hold approximately 200,000 pages of information, including graphics and photographs. After receipt, the library downloads the disk to faster magnetic media for network access. Using this network access, the Scholar finds several additional relevant citations and articles. The citations lead to another retrieval of specific articles at University X. Some articles are also accessed from University Y.

The Scholar searches a commercial online database for additional articles. Searches of this database are charged on a per retrieval basis. The Scholar has a grant from his/her university for a certain number of searches each year. Any excess will be paid by the Scholar.

Two of the citations from these sources lead to publications which are available only in paper media; one is a book and one is a journal article. The Scholar searches the online catalog of his/her own university library only to discover that the desired sources are not held locally. The catalog informs the Scholar that they are available from a number of other universities. Not surprisingly, University X has both. The Scholar requests the university catalog system to order a fax of the article from University X. Before the Scholar orders the book through inter- library loan, he/she decides to look at the table of contents. The Scholar connects directly to University X's online catalog and brings up the entry of the desired book. The table of contents, which is contained in the online catalog entry, confirms the desirability of the book, and the Scholar requests the inter-library loan while connected.

One of the electronically retrieved online articles has a three dimensional model similar to the one the Scholar had received earlier in the morning. The Scholar displays them side by side on the computer's monitor and magnifies certain key sections while rotating them. The Scholar realizes that there is something important in both these models. From the message window he/she posts a note to the electronic bulletin board at University X asking if anyone else had noticed this important observation. By the next day there are several responses to the query posted on the bulletin board. One of these convinces the Scholar that a particular colleague at University Z would make an excellent co-author of a publication. They both agree to work together on an article and will share a common copy of the manuscript on our Scholar's computer. During the development of the article, they give each other electronic access to their personal databases and notes on the areas of common interest. Of course, they both protect confidential information.

When their research has progressed far enough, they post a note to the bulletin board which describes the research in general terms and summarizes preliminary findings. They decide to publish in one of University X's electronic journals. When the article is ready, it is electronically submitted to University X's editorial board. The referees have several suggestions, which are inserted into the appropriate places in the text, and returned electronically to the authors. These comments display as a different color on the Scholar's workstation. The authors make modifications to the text, and resubmit the article.

University X notifies the authors via electronic mail that it has accepted the article, and asks the authors to complete a release. The release gives University X distribution rights for the authoritative source of the new article, but the copyright privileges are shared between the authors and the University. This sharing arrangement will enable the Scholar to release copies under specific conditions to other colleagues. University X librarians catalog and index the new article and publish it to the network computers which keep track of scholars' interest profiles.

Our Scholar is notified that a new publication is available in his/her area of interest....

IS THE VISION THE ANSWER?

How well does the "Vision" address the problems cited in the earlier section? This section will show that electronic technology can lower costs while increasing the utility of publications. Researchers may more easily find source material. The journals themselves are more timely and accessible. The necessary desktop technology empowers faculty in other areas, as well.

Cost and Selectivity

Using the above "Vision" as a model, cost is contained in several ways. Publications which are utilized tend to be available and paid for as individual articles. Articles, instead of journals, are targeted for access. "Scholars don't read journals, they read articles (Yavarkovsky, 1990, p. 15)." Access to only articles of interest, instead of voluminous paper journals which are targeted poorly toward particular scholarly interests, should lead to reduced costs at individual institutions.

The frequent use of technology in production, from the scholar, to the ultimate "publication," is another possible source of savings. Although the fixed costs of publication are similar for electronic and paper journals, there are fewer variable costs in electronic publications such as paper and postage. After a modest subscription level is reached, additional subscribers will result in profits (Wilson, 1991b). This could be an important source of auxiliary income for research universities in their roles as electronic publishers.

Libraries have always been proponents of sharing to reduce costs. The OCLC system is an example of libraries sharing their cataloging information to reduce costs for all (McGill & Racine, 1990). The wide availability of specialized university electronic collections over a national network should greatly facilitate sharing. University electronic publishing and common university interests will likely lead to a different notion of copyright which promotes the distribution of research at reduced costs.

Ease of Searching

Few would argue that electronic indexes and databases are easier to search than their paper counterparts. Not only are traditional search terms, such as title, author, and Library of Congress subject classification available, but often any word or term in the entire machine readable record can be used in boolean combinations for searching. As the content of the machine readable records expands to accommodate tables of contents, abstracts, and even full text of articles, searching will facilitate more precise results than is possible using today's paper indexes. Furthermore, with electronic profiling of scholar interest, and automatic retrieval of sources, active searching may be less frequent thereby increasing researcher productivity.

Timeliness

The use of technology will shorten the time to publication from research. There is an opportunity to publicize results informally, through electronic bulletin boards. This will decrease duplication of effort. Also, there will be less time involved in physical transfer of paper media from scholar to referee to scholar. Scholars will find it easier to collaborate. Finally, there is little delay due to physical production and distribution of paper journals.

Accessibility

Properly equipped scholars have great accessibility to information in this model. One of the virtues of magnetic media is that is usable by many at the same time. Also, notice that in this model, the need for physical access to the library is greatly reduced. This does not necessarily mean that libraries will be superfluous. Existing paper volumes abound, and no doubt there will be many future paper publications whatever the course of technology. Furthermore, some undergraduates and researchers will still prefer the social experience of going to a library (Moran, Surprenant, & Taylor 1987). Nevertheless, the library must adapt itself to operate "without walls."

Other Improvements

The "Vision" offers a number of other useful features. The intelligent workstation and high speed networks could make graphics, sound, and other media available at the desktop which would otherwise be difficult to obtain. For example, the three dimensional graphics described in the "Vision" section could not be published using traditional media.

The "invisible college" of collaborating scholars described in the literature (Lancaster & Smith, 1978) would be broadened by electronic bulletin boards such as the one described. Technology could help democratize the sharing of information beyond a few select individuals.

TECHNICAL FEASIBILITY OF THE VISION

Even critics of scenarios like the one presented in the "Vision" section generally concede that it is technically feasible. In fact, most of the scenario is technically feasible today (Arms, 1990b). While inflationary pressures on libraries have been increasing, the cost of computing processing power has been decreasing at the rate of 25 % per year. Changes have been even more dramatic for personal computers. The result has been proliferation of computing power across the campus for both faculty and students. The preponderance of desktop processing power and disk space has also changed the conceptualization of providing information services. The model of the 1970's was a giant computer providing timesharing services to hundreds of users. Computing in the 1990's is evolving to a decentralized scheme with a combination of specialized computers collaborating to provide services over a computer network.

The number of online databases has increased steadily from one in 1965 (Lancaster, 1978) to 7,637 in 1991 (Williams, 1992). Commercial databases are available directly to scholars at reduced costs at off peak hours through services like Dialog's Knowledge Index and BRS's After Dark. OCLC recently introduced a service, First Search, which enables electronic searching directly by library patrons (Wilson, 1991c). Monographs and journal articles are available on a new OCLC network. Once a source is found at a member location, arrangements can be made for interlibrary loan. Journal articles may be transferred by fax. There will be a flat charge for each search. The Colorado Alliance for Research Libraries (CARL) Systems will also fax articles found as a result of an electronic search in its Uncover2 database. Some databases even contain graphical information similar to that described in the "Vision." A database of three dimensional molecular models is stored at Brookhaven National Laboratories and is available for online display. The molecules may be rotated in space (Lyman, 1991).

National networks such as Bitnet and the Internet join many of the nation's colleges and universities. Over one hundred online library catalogs are already available on the Internet. LISTSERVE on BITNET and Anonymous File Transfer Protocol on the Internet have facilitated hundreds of national bulletin boards for common interest groups. Electronic mail is available to thousands of faculty, administrators, and students. About a dozen peer-reviewed electronic journals are available over the Internet as are CARL's Uncover2 and other bibliographic databases. Although image transfer is possible now, the coming National Research and Education Network will expedite graphics based information transfer (Hall, 1991).

Compact disk technology (CD-ROM) is enabling more information to be kept locally. CD's are economical, costing about $3 each to manufacture, and can store the equivalent of 200,000 printed pages (Arms, 1990b). CD-ROM products are beginning to be mass-marketed as consumer items. A number of popular reference titles are now being included in the cost of a CD drive. For example, for less than $500, a CD drive from SONY is available with a robust collection of entertainment and reference works including _The New Grolier Multimedia Encyclopedia_. Apple's new Macintosh IIvx computer is available with built-in CD-ROM drive and is being introduced with 9 CD-ROM disks included in the purchase price. Works published on CD-ROM are very cost competitive with their paper analogs. A discounted copy of _Microsoft Bookshelf_ - which includes the _American Heritage Dictionary_, _Bartlett's Familiar Quotations_, _Concise Columbia Dictionary of Quotations_, _Hammond Atlas of the World_, _Roget's II: The New Thesaurus_, _World Almanac and Book of Facts_, and an encyclopedia - is available for $119. Notebook computers are quickly assuming the profile of a book. If the prices continue to plunge on CD-ROM and computer equipment, and monitors on notebook computers become more readable, then CD's could conceivably move out of the reference collection and into the trade-book area. The _Wall Street Journal_ recently reviewed a recent "trade book" produced on CD-ROM, _From Alice to Ocean_, in glowing terms as "a sign of what can result from the merger of publishing and technology, if the right material is chosen, and handled with care and skill" (Mossberg, 1992). The commercial success of these products will reflect the growing acceptance of digital publications, especially in areas where digital publications are clearly superior: large reference works, multimedia, and interactive applications.

Even when faculty prepare publications for traditional media, many of them use word processing equipment. The work is, in theory, ready for electronic distribution. In fact, if the electronic information revolution is going to happen anywhere, colleges and universities would be a likely place (Eisenberg, 1989). Many faculty already have the requisite equipment and network connections.

PROBLEMS WITH THE VISION

If electronic distribution of information is technically feasible, why are paper systems still dominant? F. W. Lancaster (1978) described several obstacles to achieving his vision of a paperless information system. He expected resistance from publishers. Commercial publishers, in particular, are concerned with the return on their investment.

Certainly the difficulty of reconciling the convenience of electronic distribution of information with copyright law has been a major obstacle. The legal problems of licensing parts of books on an "as used" basis rather than paying for the whole book in advance is something that publishers simply do not know how to handle (Schuman, 1990). Digital works will be more challenging to protect from widespread copying than traditional media (Samuelson, 1991). Copying a computer file is fast and easy. Transmitting it is no more difficult. Files may be transmitted by disk or sent around the world over the Internet. Compared to copying paper media, copying digital media is both less expensive and less time consuming. Furthermore, the copies are perfect replicas of the original. Publishers may be reluctant to join this brave, new, digital world if they can not protect and profit from their investment.

Lancaster (1978) described psychological difficulties; for example, researchers will want to see their name in print in a fine scholarly journal. Researchers not only want to see their own name in print, but evidently so do those making promotion and tenure decisions. So far, electronic journals have not had the prestige of their hard copy counterparts (Wilson, 1991a). This has created vicious cycle. The best publications will go to paper journals because they are more likely to "count" for tenure and promotion. Electronic journals are perceived by some to carry articles of secondary quality. These perceptions reinforce the desire of scholars to publish in traditional journals. There will need to be a cultural shift in attitudes before electronic publications will equal the prestige of their paper counterparts. In the mean time, electronic journals will need to have editorial policies as demanding as their paper analogs.

Mr. Lancaster expected difficulty transmitting graphics electronically, but he thought electronic publication could be supplemented with mailings of graphics. Perhaps it is the lack of graphics which contribute to the scarcity of refereed electronic scientific journals (Wilson, 1991b). Graphics requires a relatively large volume of information transmission. Whereas a page of text might contain a few thousand characters, a page of graphics will require tens of thousands. It may be that fax technology will become more important for document delivery. Fax capability is becoming an inexpensive addition to personal computer equipment. In any event, better compression, faster data communication, and better technical standards will need to be more widespread before graphics is common in electronic journals.

Mr. Lancaster claimed the economics of costly paper publication would provide incentive for electronic publication. There is conflicting information on this. Some say the costs of producing a peer review journal are the same whether electronically published or in the traditional way (Wilson, 1991a). At Virginia Tech, on the other hand, two new scholarly journals have been launched, one electronic and one paper, and the paper journal costs exceed the electronic journal by over 50 percent (Metz &

Gherman, 1991). This issue is complicated by the fact that many publishers price their journals on their perceived value to the academic community rather than on costs of production. The Internet, the distribution channel for most electronic publications, is a government subsidized resource; it is unclear what removal of this subsidy would mean for electronic publications. More experience will be necessary before the cost issues are resolved.

More compelling than any of these reasons, however, is that paper systems have a number of very advantageous attributes. Chief among these is its portability. Scientists may have desktop access to electronic information, but they do not always work at their desks. Although portable CD-ROM units are becoming available, they are few in number and literature titles are very limited. It is not clear whether there will ever be a mass market for CD-ROM books, other than reference works. CD-ROM has so much capacity that it is actually overkill for the typical scholarly work (Eisenberg, 1989).

Paper also enables one to quickly scan different parts of a lengthy document. Traditional media have several points of access: i.e., tables of contents, chapter headings, and indexes. This conceptual framework may not translate easily to electronic media and new delivery systems will be required (Schumann, 1990). One may annotate or highlight paper easily for later use. Paper provides a system of "cues" for scholars; it does not disappear until something is physically done with it (Oakeshott, 1985).

Directions are not needed to use a paper publication. All that is required is physical access and the ability to read. In fact, it is not technical issues at all, but human factors which have caused the failure of early experiments with electronic publication (Freeman, 1987; Oakeshott, 1985). In the late 1970's the NSF sponsored an experiment which studied the use of an electronic journal. Work was prepared and submitted electronically for refereeing. Then the work was "published" electronically in a journal, Mental Workload. The system failed because i) it was difficult to use; ii) contributors received no external reward for publishing in this medium; and iii) the distribution was limited. In Great Britain, another attempt at a formal electronic journal failed for similar reasons. The principal of least effort, restated as Mooers' Law, tells us that "an information retrieval system will tend not to be used whenever it is more painful and troublesome for a customer to have information than for him not to have it" (Bierbaum, 1990, p. 18). Human factors will need to play a much greater role if future electronic journals are to succeed.

The networking and computer infrastructure to support activities described in the "Vision," above, are only available at a few prestigious campuses. Even at some of these, there have been dashed expectations. Academics have simply opted for more limited use of technology (Mangrum 1987; Moran, Surprenant, & Taylor 1987).

There are other problems with electronic technology including standardization, rapid obsolescence, and eye fatigue. The relative infancy of the computer has resulted in a lack of standardization. Almost no media commonly in use ten years ago for the storage of computer data is commonly in use today. Nine- track tape, 1600 Byte Per Inch (BPI) tape drives, the standard storage medium for back-up in 1980, has been replaced first by 6400 BPI magnetic tape, and then by a variety of 4 mm and 8 mm optical media. Floppy disks first appeared as 8", then 5.25", then 3.5" media with several recording densities available in each size. Although CD-ROM has received much review, it probably will not be the media of choice in the future, since it is extremely limited in its speed and its ability to store full motion video. Even if one accepts the ability to transfer digital information stored in one media to a different media, an extra burden and expense is placed on the library for the conversion. Magnetic media and optical media may require controlled environmental conditions for long term storage. Magnetic and optical media, then, are hardly ideal for archival purposes.

Although most critics of the "paperless" approach concede the desirability of some of the attributes favoring electronic systems, such as ease of searching, some question the very assumptions underlying electronic system development. Schuman (1990) examines the assumptions behind the use of advanced technology in libraries, and questions their validity. For example, she claims there is no information explosion, only a data explosion; the proportion of "quality" information has decreased. In her view, electronic delivery of information services to the home can not take place when 20 percent of Americans can not read above the fifth grade level and where home computer penetration is less than 13 per cent. Because of its expense, technology could widen the gap between the information rich and poor. Librarians should remember the defunct Automat, which delivered only the food without the "unnecessary" waiters and waitresses (Schuman, 1990, p. 37).

A review of the contemporary literature about the promise of microfilm technology should caution us against making sensationalistic claims for any new technology (Cady, 1990). Microfilm was supposed to lower the cost of publication. There were claims in the 1930's and 1940's that its discovery was as important as the development of the printing press. Vannevar Bush (1945) described a "scholar's workstation" with microfilm as its core technology. But scholars never found the readers very convenient and preferred hard copy, if available. Microfilm has its niche; it is commonly used for preservation and space reduction, but it has not fulfilled the promise of the library literature of the 1930's to 1950's.

ORGANIZATIONAL ISSUES

The increasing use of technology in higher education has resulted in some organizational challenges. There has been closer cooperation, and in some cases merger, between libraries and computer centers (Dougherty, 1987; Battin, 1984). The job description of a reference librarian and a computer center user services consultant looks quite similar: help people help themselves using information resource tools. Libraries also have a number of technically oriented functions, for example systems administration, which have analogs in the computer center. However the cultures of the library and the computer center are quite different. Librarianship is a female dominated profession which requires a professional degree, the M.L.S. Computer organizations are male dominated with less emphasis on formal educational achievement. Woodsworth (1991) reveals some preliminary results of her research which show that for functionally equivalent jobs in the library and the computer center, librarians get paid significantly less. It will be interesting to see how some of the universities pioneering in unified organizations are ultimately able to adapt. There will have to be economies someplace for libraries to make the necessary investments in both electronic and traditional collections, and computer center-library reorganization warrants additional examination. Clearly, this is an emerging area of research.

CASE SKETCHES

In spite of the problems with electronic information, many scholars in the field believe that the march toward increased use of technology is not only desirable, but irreversible and inevitable. Arms (1990a) presents a series of case sketches of universities which have been successful in the electronic information realm. Many share a common vision which parallels that in the "Vision" section, above. They believe that technology can ultimately deliver increased utility at decreased costs. Those universities which are most successful have developed the infrastructure to support electronic activities. A high speed network has been deployed, computer access is near universal, and the campus is linked to the Internet. Colleges and universities progress through several stages. The introduction of the online public access catalog (OPAC), CD-ROM, or online searches retrieves bibliographic citations. The hard copy collection which is referenced by these searches becomes more heavily utilized. Patrons ask about retrieving full text in addition to bibliographic citations. Faculty want to access this full text information from their offices.

Electronic sources, when available, are used more frequently than hard copy sources. Nevertheless, research library cancellations of hard-copy sources are very infrequent. Large academic libraries are caught in a double bind; they must provide both traditional and electronic media for information access. Providing electronic access often means large investments in computer hardware and software and building a computer networking infrastructure.

Financial pressures at smaller institutions of higher education are also moving libraries toward increased use of technology. For example, a survey of small college (<10,000 students) liberal arts libraries shows that they are canceling subscriptions to hard copy indexing services. Respondents did not attribute the availability of the same services via online database as the principal reason for the cancellation. Expense and frequency of use were given more often as the reasons, with online availability ranked third. CD-ROM databases may further shift the direction away from hard-copy indexing (Wall, Haney, & Griffin, 1990).

Financial pressures will mount on all institutions. Libraries will simply not be able to afford keeping the sources available in hard copy and electronic format. When forced to choose between media, librarians at academic institutions will choose electronic media (Taylor, Mann, & Munro, 1988).

In some respects, Brown University and Carnegie Mellon University represent the low and high points, respectively, in creating reasonable expectations over the great expansion of technology on campus. In the late 1980's Brown University announced plans to wire the campus and install 10,000 "Scholar's Workstations." These would support teaching and research, in part through access to electronic information. The project was particularly interesting at Brown because of its more traditional liberal arts background when compared to the other "Star Wars" universities which pioneered heavy use of technology. By nearly every measure, the project fell short of expectations. Although the buildings were tied to the network at a service entrance, departments were responsible for picking up the cost to bring the network to the desktop; many had not. The proposed Scholar's Workstation was not a commercial product, and IBM, Brown's partner, delayed its introduction. Costs were higher than expected and less than 500 workstations were acquired. There was a realization that a less sophisticated workstation could satisfy the needs of many clients. Faculty were not included in the planning for this project, and many were reluctant to commit to incorporating the technology into the curriculum. Nevertheless, many academics look forward to increased electronic access to library holdings (Moran, Surprenant, & Taylor, 1990).

Carnegie Mellon University made an early commitment to develop the necessary infrastructure to become an electronic campus. IBM sponsored a major increase in computing and networking equipment in the 1980's to support a distributed environment. Carnegie Mellon provided electronic indexes and abstracts (_Magazine Index_, _National Newspaper Index_, _Computer Database_, _Management Contents_, _Trade and Industry_) and full text reference works (_Grollier Academic American Encyclopedia_ and _American Heritage Dictionary_). Access to electronic index information increased usage of microform articles by over 40 per cent (Arms & Michalak, 1990).

The success of these projects at Carnegie Mellon led to the design of a second generation information system. The ambitious goal is to build a full fledged electronic library, Library Information System II. There will be a common graphical user interface similar to Macintosh "point and click" which will be available from any campus workstation. The library will become the electronic publisher for Carnegie Mellon. The online catalog will be expanded to include the tables of contents of select volumes in the library. Additional databases will be purchased and made available over the campus network. Full text of many documents will be electronically delivered. Several databases will include graphics which have been stored using a fax compression technique. Two major publishers, Elsevier and IEEE, have granted permission to scan journals in computer science and artificial intelligence. These will be available to all campus workstations (Troll, 1990; Arms, Dopirak, Dousti, Rafail, & Wetzel, 1992).

PROSPECTS & CONCLUSION

The trend in higher education is clearly toward increased use of electronic publications, especially in reference works. Both lower costs and increased utility are possible. Academic institutions are quickly developing the capability to deliver a growing number of electronic documents.

It is difficult to predict the effects of technology on libraries as we approach the year 2000. In the first applications of the printing press, type was used which imitated the hand lettering of scribes. The first automobiles were designed to look like horseless carriages. As the potential of the new technology was exploited, the link to the old technology was soon forgotten. There were a large number of "secondary effects" such as suburbanization in the case of the automobile, or the concept of mass education in the case of the printing press. We must keep an open mind and consider a broad context when evaluating the impact of new technology. F. W. Lancaster writes (1985, p. 554)

As far as I have been able to tell, however, rejection of electronic publishing is more often than not based on the rather vague feeling that the printed book is an indispensable element in our society and that it has been with us too long to be easily displaced. This argument, of course, is complete nonsense. The printed book has lasted for only 500 years, which is a mere dot in the history of human communication, and many of its most common manifestations - the novel and the science journal, for example - have been around for a much shorter time. Some reasons given to me for the preservation of the book have been nothing less than amazing. For example, "I like to read on the beach." How long have people been reading on beaches? I would suspect less than a hundred years. Or, I like to read in the bathroom." How long have we had bathrooms, or bathrooms conducive to reading?

There is already evidence that the use of information technology may best lend itself to new information applications. For instance, the Brookhaven database of three dimensional molecular models is an example of an "interactive" database where the researcher may alter results using private variables. The new media seems to lend itself to shorter, less formal articles. The ideal form of electronic media, whatever it turns out to be, will not be limited by the book's static form (Lancaster, 1985).

Will electronic media replace paper technology completely and relegate the library to a set of disk drives? Probably not. Comparing the new electronic revolution to an older one that never quite materialized, Susan Cady (1990, p. 382) perhaps best summarized the likely effect of the new technology on libraries:

Some tentative comparisons and conclusions can be drawn about the relevance of the history of microfilm in libraries to the planning for and adoption of electronic resources today. First, the microfilm experience in libraries and the experience of our culture in general indicate that new technologies seldom replace old ones. Just as television has not eliminated radio and the microwave oven merely supplements the electric or gas range, so microfilm has not done away with the book and neither will electronic text. Instead there will be expanded opportunities, greater diversity, and a more complex environment.

Still, it will be difficult for the academic library to develop its traditional collection, develop its electronic collection, and build buildings to store ever-expanding collections. Something is going to have to give. At the very least, experts agree that it will be more difficult to justify building expansion given the expected increases in the proportion of the electronic collection (Taylor, Mann, & Munro, 1988).

The library of the future is being developed in academe and is progressing rapidly. Increasing financial pressures will accelerate changes. There will be secondary effects on the organization of information services on campus. By the year 2000, the changes will be extensive, probably more extensive than any of us could guess today, save Mr. Lancaster. Still, the technology will take its place alongside existing forms. It will not displace the book as the printing press replaced the scribe. However, information technology is likely to affect all disciplines. Libraries and librarians, as well as other campus information professionals, must prepare for this new age.

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