The Role of the Library in an Electronic Society

In 1978 the Library Research Center of the University of Illinois Graduate School of Library Science was awarded a grant by the National Science Foundation to investigate the impact of a paperless society on the research library of the future. The basic premise underlying our ongoing research is that many types of publications can be distributed more effectively in electronic form and that, in fact, future economic factors will dictate that they be distributed electronically. Within the long history of human communication, the print-on-paper era will prove to be a short one: a period of little more than 500 years. Clearly, we are evolving out of this paper-based era into one that is electronic. We are presently in a transitional phase in the natural evolution from paper to electronic communication. This transitional phase appears to have three major characteristics: (1) the computer is presently used to print on paper, (2) printed data bases exist side by side with their machine-readable counterparts, and (3) new data bases are emerging only in electronic form. By and large, machine-readable data bases have not yet replaced print-on-paper data bases, but this will undoubtedly occur quite soon.

Full transition will occur when the communication structure is adequate to allow electronic distribution to a large part of the audience that needs to be reached (it has been estimated that there will be around 100 million terminals in the United States by 1995), and when the on-line market is large enough to support the costs of data base construction. It is clear that the market is there. We will soon reach the time when the electronic revenues exceed the revenues derivable from the print market.
Problems of the Present System

To understand the reasons for this evolution we need only look at the problems that exist in the ways and means now used to distribute information.\(^1\) The three most basic problems at present are: (1) the enormous growth of the information produced, (2) the escalating costs, and (3) the general inefficiency of current processes of production and distribution.

Obviously, as knowledge itself grows, the literature of science, social science and the humanities must also grow to keep up with new research and thinking. The real problem in information distribution is one of packaging. How can we “package” and distribute the results of scientific research, for example, in the most effective and efficient way possible? The growth problem in publication is multidimensional: there is continual rapid growth in the number of packages available, in the size of the packages available, and in the diversity of forms in which information is distributed.

The most obvious example of the increase in the number of packages is, of course, the science journal. In the 1660s there were two journals providing information to the scientific community. Now the best available estimate indicates there are 50,000 science journals worldwide, and that this number is increasing at a rate of about 4 percent a year compound growth.

The size of the individual packages is increasing as well. The Physical Review, for example, published less than 2 million words in 1937. By 1968 that same journal was publishing 22 million words a year. Biochimica et Biophysica Acta is now doubling in size in 4.6 years.\(^2\) The body of literature published by the American Institute of Physics doubles every eight years.\(^3\)

Growth is even more dramatic in the secondary literature, which obviously must grow to keep pace with the primary literature. It took Chemical Abstracts thirty-two years to publish its first million abstracts. However, the latest million abstracts, the fifth million, took only 3.3 years to be published. Chemical Abstracts is currently publishing at the rate of approximately 400,000 abstracts per year (i.e., a million abstracts in 2.5 years). It is apparent that soon Chemical Abstracts may be faced with the task of publishing 1 million abstracts a year. When this occurs, very few institutions will be able to afford a version printed on paper. Chemical Abstracts, of course, is not the only secondary publication struggling to make a vast body of literature available.

Publishing costs are skyrocketing. Inflation in the publishing industry is grossly out of step with inflation in the economy as a whole. In a period in which the general rate of inflation (as measured by the Consumer Price Index) was 40 percent, some secondary publications increased 850
percent in price. The cost of the Bibliography of Agriculture has gone from $10 in 1963 to $245 in 1978-79. In the same period, Biological Abstracts rose from $225 to $1300 and Psychological Abstracts from $24 to $315 (a 1475 percent increase in fifteen years)!

These figures illustrate some very cold facts. Unless the average salary paid to a psychologist, biologist or agricultural scientist has increased upwards of 850 percent in the last ten to fifteen years, or unless the budget of a library has increased tenfold in this 15-year span, these publications become increasingly less accessible in printed form. In the extreme example, a subscription to Chemical Abstracts in 1940 cost $12 a year ($6 a year for American Chemical Society members); now in 1979 it costs $4200. The meaning of these figures is clear. These publications began as services to meet the needs of, and be used by, individual subscribers. They were once quite accessible to the individual chemist, psychologist, agriculturist, and so on. But secondary publications have priced themselves out of the individual market and even beyond the resources of many smaller institutions. Not only are they now an "institutional phenomenon," but they tend to be accessible only in the larger and wealthier institutions. This decline in the accessibility of printed secondary literature can only continue. Information will become increasingly less accessible as long as we continue to print, publish and distribute in the same way we have been for the last 300 years.

And it is not just the secondary literature that is doomed to inaccessibility; the same beast preys on the primary literature. The problem is explicit if we look at average subscription costs for libraries. The average subscription price in the United States for a journal in chemistry and physics was approximately $24.48 in 1967-69; the average subscription price for a journal in chemistry and physics in 1978 was $108.22. In education, journal costs rose from $6.34 to $19.49 in the same period, and in business the rise was from $7.54 to $21.09.

Even these average price increases are grossly out of line with the general rate of inflation in the economy. And if we look at extremes (e.g., Inorganica Chimica Acta cost $24 a year in 1970 but now costs approximately $640) the outlook appears more bleak still. Clearly, there is no future in this economic picture, no future in an enterprise whose costs are increasing so much faster than those elsewhere in the economy. But growth and costs are not the only problems. As the literature grows, it becomes increasingly scattered and, consequently, it becomes increasingly hard to find, increasingly hard to keep abreast of, increasingly hard to identify through an indexing or abstracting service in a particular subject field, increasingly difficult to collect in a library specializing in the field... and so on.
The growth in science itself leads to more people having more things to say and therefore writing more. Delays in the distribution of information increase because large numbers of authors are competing for publication space that is limited and costly. Often this limitation is artificial, created by publishers to keep their escalating costs somewhat within bounds. So, a substantial number of papers submitted are rejected, not on grounds of quality, but because the publisher simply cannot afford to print them. Thus, a deserving author may have his article rejected by one or more journals before it is finally accepted and published. This results in considerable delays in publication and distribution, a situation which appears inevitable in our present dissemination system.

What all this portends is that the primary literature of science is headed in the same direction as the secondary literature—becoming more and more a purely institutional phenomenon, with the number of individual subscribers declining relative to the institutional subscribers year by year. In fact, many of the more expensive science journals have not a single individual subscriber.

The fact is that the science journal, in its present form, is an inefficient dissemination mechanism. As Herschman has pointed out, the science journal tries to serve three distinct purposes:

1. **social function**: It is an effective way for authors to earn academic “brownie” points.
2. **archival function**: Libraries collect issues, bind them and preserve them, thus providing a good archival record of the history of science.
3. **dissemination function**: It is an inefficient way of packaging and distributing information.\(^5\)

The science journal seems to serve the author better than it serves the reader because much of what a subscriber pays for is often irrelevant to his interest, the distribution mechanism is costly and wasteful, and the printed journal lags far behind the “cutting edge” of science research.

The journal is inefficient because much of its contents are irrelevant to any one user or reader and because much of what the reader pays for he or she already knows about! Typically, a published paper reports results of research completed eighteen months to two years prior to publication, and that research was probably begun three to four years prior to publication. Most probably the author whose work is described in a current journal has moved on to another, new research project. In no way can the science journal be considered a reflection of what is happening in science today. At best, it is reporting on what happened in science in the immediate past. The science journal is more archival than current, and of course the secondary services that index and abstract these journals are even more archival.
Looking further into the economic picture, we see that libraries are in a very bad economic situation because they represent labor-intensive activities heavily dependent on other labor-intensive activities (publishing) for their resources and raw materials. Neither libraries nor publishers, up to the present, have benefited significantly from automation in the way that certain other industries (e.g., the rubber and plastics industries) have. Data from Purdue University on sixty-two major U.S. research libraries show that these libraries' budgets increased 133 percent during 1966-75, but the money they had available for materials purchases only increased by 89.7 percent, the difference being largely accounted for by the increase in personnel costs. These libraries actually purchased only 35 percent more materials in 1975 than in 1966; the difference between the 35 percent and the 89.7 percent due to the sharp increase in the cost of materials.\(^6\)

There is no future in this economic situation either, in which budgets are doubling approximately every seven years, but purchasing power in terms of new materials is increasing by only 35 percent. The future lies, quite clearly, in increasing automation; and not only increasing automation of certain selected processes. We have that already. It doesn't simply mean automation of circulation procedures in the library. It means automation throughout the entire communications cycle by which the results of research in science, social science and the humanities are distributed. In the next decade, manual processing costs are expected to increase by a minimum of 6 percent per year, whereas communications costs are expected to decline at an annual rate of 11 percent, computer logic costs at approximately 25 percent per year and, most dramatically, computer memory costs at 40 percent per year. Even if it were not economically feasible to distribute information electronically at present (in fact, one can show that it is already economically attractive to replace print-on-paper with electronic distribution\(^7\)), it is clear that the future lies with electronic distribution.

**Advantages of Electronic Distribution**

The advantages of electronic distribution of information are obvious and some have already been achieved through machine-readable data bases and on-line access. These advantages are:

1. *increasing accessibility:* It is probably true that just as information is getting less accessible and more costly in printed paper copy, it is getting more accessible and less expensive in on-line, machine-readable form.
2. *decreasing cost:* The cost of access to information in electronic form is rapidly decreasing.
3. transformed economic picture: New alternatives arise with electronic information distribution. Before on-line access became a reality, a large capital investment was required to make a data base accessible. To make Chemical Abstracts available in printed form requires a capital investment of $4200, excluding costs of storage and handling. Clearly, if only forty-two searches a year are performed in Chemical Abstracts the cost in data base access alone is $100 per search. But with electronic distribution the economic picture is completely changed. Printed materials need no longer sit on library shelves to be accessible. We can access them when we want them, on demand. In other words, information distribution is changing to an on-demand, pay-as-you-go situation. A client can access when he or she needs to and pay for only as much as he or she uses. This completely transforms the economic picture of information distribution and operation of information services.

4. emergence of new forms: Electronic forms not dreamed of ten years ago have been developed. One such form is the “electrobook,” a hand-held microprocessor closely resembling a pocket calculator.

5. more rapid dissemination: Information is more quickly disseminated when the print phase is skipped entirely.

6. more effective access: We can afford many more access points and use more complex search patterns and strategies than with print-on-paper formats.

7. new capabilities: Electronic publishing can incorporate analog models, three-dimensional representations, and other “razzle-dazzle” features impossible in printed forms. Electronic publishing can be dynamic whereas print on paper is static.

The Role of the Library

The purpose of our present National Science Foundation study is to investigate, at least in a preliminary way, what may be the effects on libraries and librarians of the predicted transition from a print-on-paper to a paperless society. The investigation is being conducted by means of: (1) a detailed review of the relevant literature, (2) a Delphi study in which forecasts relating to the future of publishing are being collected, and (3) the development of a scenario to depict what libraries and librarians may be doing in 2001.

The Delphi study, in two rounds, is being conducted with representative samples of librarians, publishers and “technologists.” The questionnaire (see Appendix I for a specimen page) seeks the informed opinion of this group on the probability that selected events relating to
electronic publishing will be technologically and economically feasible, and will actually have occurred by certain dates. Also, opinions on the desirability of the events were solicited. The first round of the study has been completed and the results tabulated. In the second round, the group forecasts for each event (see Figure 1) were sent back to each participant, with an indication of his or her position relative to the group as a whole. In addition, comments of participants in the first round (see Appendix II) were sent out to all participants. We hope, of course, that the results of the second round will produce a greater consensus of opinion than those of the first. The results of the Delphi study, the scenario, and our interpretation of both will form the backbone of our report to the National Science Foundation.

The scenario was developed and refined as follows:

1. Group or individual interviews were conducted with senior staff members of the University of Illinois Library at Urbana-Champaign. The interviews were largely unstructured and were designed to determine what changes would be likely to occur in the functions/responsibilities of these librarians if certain predicted changes in the publication/distribution of information come to pass. Discussions were stimulated by such questions as, "If x were to occur, what effect would this have on your own professional activities?"

2. A first draft of a scenario was developed as a result of these interviews.

3. The first draft was circulated, for review and criticism, to the deans and directors of all accredited library schools, to one-half of the directors of the member libraries of the Association of Research Libraries (the other half was invited to participate in the Delphi study), and to selected librarians in industry. On the basis of feedback from this group, a second draft was prepared.

4. The second draft scenario was distributed to all participants at the 1979 Clinic on Library Applications of Data Processing, and was also published in the journal Collection Management, with a request for input from the profession at large.8

Presented here is the second-draft scenario. It is set in the year 2001 and looks back at the developments of the preceding twenty-five years.

The Scenario

Looking back from the vantage point of this, the first year of the twenty-first century, it is clear that the library profession has not escaped the upheaval that has beset all segments of society in the past twenty-five years. Indeed, it has undergone changes that, in their own way, are as
FOR THE FIRST TIME THE PUBLISHER OF AN EXISTING REFERENCE BOOK DISCONTINUES ITS PUBLICATION AS PRINT ON PAPER AND REPLACES IT WITH A MACHINE-READABLE FILE OF COMPARABLE SCOPE
dramatic as those encountered in education, in medicine, in banking, in transportation, and in many other branches of commerce and industry. It would have been impossible for the profession to resist this change, even had it wanted to, in the face of the rapid developments that have affected the publishing industry and transformed the entire process by which information products are created, distributed and paid for. It is in special libraries, particularly those in industry, that the change has been most pronounced, but academic libraries also look much different than they did in the 1970s, and even public libraries have not escaped the process of change.

While developments affecting the information professions have been numerous and diverse in the last three decades, two major trends can be recognized as predominating. The first is simply the rapid decline of the artifact—particularly the printed book—as the primary device for storage and transmittal of recorded knowledge, and the replacement of these artifacts with data, derived from many sources and presented in many different formats, virtually all of these data now being accessible electronically.9

The second trend, a natural concomitant of the first, has been increasing diversification in the profession. This diversification can be thought of in terms of the “deinstitutionalization” or, perhaps more accurately, the “reinstitutionalization” of many information professionals. It seems undeniable to claim that, while the library as a collection of artifacts has declined substantially in importance in the past twenty years, the information specialist has grown considerably in stature, in recognition and in rate of compensation. This development has occurred primarily as a result of the deinstitutionalization/reinstitutionalization process. Although firms of “information consultants” and even “freelance librarians” existed much earlier, it was the 1980s before it became widely recognized and accepted that information specialists no longer needed to function within the four walls of a library—that computer terminals, in effect, gave these professionals access to vast electronic “libraries,” whether they chose to work within a formal institutional environment, a private office, or from their homes. In the 1980s, then, we witnessed a veritable boom in employment opportunities for qualified information specialists outside the traditional library setting: as members of health care teams; in legal practices; as resource personnel at various levels of national, state and local government; as members of research and development teams in academia and in industry, and so on. At the same time, the rapidly increasing demand for information services led to the formation, throughout North America and Western Europe, of many new companies of information consultants. In the years since 1980 the composition of the information profession has
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gradually changed to the present point at which the number of individuals providing information service who are not library-affiliated exceeds the number who are so affiliated.

To understand the differences between librarians and other information specialists today and those of, say, 1975, it is necessary to look at the changes that have taken place in the publishing industry, in the way in which information products are distributed and used, and in libraries themselves within the last quarter of the twentieth century.

The Publishing Industry Since 1975

The roots of what has become known as the "electronic age" in publishing can be traced back to the early 1960s when computers were first used to drive photocomposition devices. This led to a period of transition in which computers were essentially used as devices to print indexing and abstracting publications, magazines and journals, certain types of reference books, catalog cards, and so on.

The so-called secondary publications, especially those in the sciences, were at the forefront of this development. It was not long before the machine-readable data bases generated through this publishing operation were used in computerized literature searching activities, both retrospective searching on demand and selective dissemination of information (SDI). In the 1960s such services were largely performed by using computers in an off-line, batch-processing mode. Search strategies for many different information needs were put into machine-readable form and matched against data bases in a complete batch, the results being printed out and delivered to the requesters. So-called scientific information dissemination centers emerged in this period. Through licensing agreements with data base producers, such centers were able to offer SDI and retrospective search services from many different data bases, and the volume of use generated by these centers kept cost per search or per user interest profile down to acceptable levels. SDI service, in particular, was an economical application of computers even in the 1960s, though retrospective searching was still quite expensive. In fact, a retrospective search over five years of some data bases could cost as much as a whole year of SDI service from the same data bases.

It was not until the 1970s that a significant switch from off-line to on-line access occurred. The on-line retailers of information, such an integral part of information provision today, emerged in the 1970s, although in those days there were only three or four major centers of this kind. The move to on-line processing greatly increased the accessibility of data bases and substantially decreased the cost of searching them. Cost reduction was dramatic in this period. In the early 1960s a realistic cost for
the conduct of a single retrospective search by computer (if the full costs of data base preparation were distributed over the various services provided) was several hundred dollars. Through on-line access the cost for the same search in 1978 had dropped to perhaps $10.

It was in the 1970s too that telecommunications networks, to support data processing activities, emerged. The early networks were those of the Tymshare Corporation and the Telenet Corporation. Before the end of the 1970s these networks, which were based on analog communication (voice-grade telephone lines), had spread to Canada, Central America and Western Europe. It was not until the 1980s that the worldwide satellite networks, based on digital transmission, emerged. In the 1970s it was an extremely expensive proposition to search a data base located on a computer in, for instance, Los Angeles, from Rio de Janeiro or Sydney, for this required a voice-grade telephone connection for the duration of the search. Now, of course, the cost of the link between Sydney and Los Angeles is only marginally greater than the cost of the digital link between New York and Los Angeles.

The period 1960-80 can be regarded as one of transition from print-on-paper to electronic publication. This transitional period had three major characteristics:

1. computers were used to print on paper and the resulting product was distributed, in a completely conventional manner, through the mail;
2. printed data bases and their machine-readable equivalents existed side by side but, by and large, the former had not been replaced by the latter (before the end of the 1970s, however, a handful of secondary data bases had completely converted from printed to electronic form); and
3. new data bases emerged in machine-readable form only, without ever existing in paper form. (The majority of these were actually data banks—files of numerical, statistical, physical, chemical and commercial data—which essentially could be regarded as types of "reference books" that emerged in the electronic era. Some, however, were data bases of bibliographic references such as the Information Bank of the New York Times and ABI/INFORM, a data base of business information.)

Up until the end of the 1970s, on-line access was very largely restricted to secondary data bases. Reference retrieval had greatly outstripped document delivery, which was still based almost entirely on paper and microform copy distributed through the mail. While some journals were photocomposed in the 1970s, thus leading to the creation of machine-readable files of complete text, very little use was made of these primary data bases in machine-readable form and none could be accessed on-line. A
notable exception to this general pattern was the field of law, for the full text of substantial bodies of legal material was accessible on-line as early as the late 1960s.

Before the end of the 1970s, however, new forms of publications began to emerge. In 1978, for example, the first periodical commencing publication in cassette form. This was a popular "magazine" of instructional and recreational materials designed to be used with an early version of a home computer. In the same year the first self-contained electronic "book" appeared. The forefather of our present electrobooks, this was a bilingual dictionary, in the form of a hand-held minicomputer, with interchangeable modules covering various pairs of languages. In 1978, however, an electrobook cost considerably more than an equivalent book in print-on-paper form. The first one, in fact, cost over $200, which, at the present time, has the equivalent purchasing power of about $1500!

In the 1970s there were no real on-line journals apart from one or two experimental and rather informal journals existing within computer conferencing and other types of networks.

Electronic publication of primary literature lagged some years behind electronic publication of secondary literature and followed the same general pattern of development. The text of several primary journals, all in the sciences, became accessible through on-line service centers early in the 1980s. By the end of this decade, a majority of the North American journals of a research nature in the sciences and social sciences could be accessed on-line. A substantial level of on-line access to humanities journals and to journals produced outside of North America did not occur until the 1990s.

The 1980s was a decade of remarkable progress in publishing; it was also a period of great turmoil for the publishing industry and for the library profession at large. Secondary publications began to disappear in printed form as terminals became commonplace and storage and access costs continued to decline. New "reference books" emerged, both in the form of electrobooks and data banks accessible on-line. Many existing reference books were converted from print-on-paper to electronic form in the 1980s, including data handbooks, dictionaries, directories, bibliographies and concordances—a development that continued throughout the 1990s.

By the late 1980s, some printed journals began to disappear, to be replaced by on-line access to text and by journals issued on tape cassettes, videodisks and other electronic forms. This transformation, substantially achieved for the sciences and social sciences by 1995, was forced on the publishing industry by several factors:

1. costs of print-on-paper publication that continued to escalate at rates far beyond general inflation in the economy: All but the largest circulation
journals in the sciences had begun to price themselves beyond the resources of the individual subscriber by 1980. By 1985 they had substantially priced themselves out of the individual subscriber market entirely and many had priced themselves beyond the resources of the smaller institutions.

2. competition from newer journals that began their existence in electronic form: These journals, which were becoming economically viable by the mid-1980s, were beginning to reveal signs of social acceptance, and were offering modes of presenting information (e.g., electronic analogs of equipment and dynamic displays of research data) that were completely impractical in the print-on-paper journals. Only in the handling of high-quality photographic material could the print-on-paper journals offer substantial advantages over the electronic journals, a situation that had altered radically by 1990.

3. the emergence, by 1985, of a pay-as-you-go, on-demand society: The market for information products had begun to change dramatically. The market for many types of printed products was declining rapidly but, to compensate, a vast market was emerging—one of individuals and institutions willing to pay for on-line access to the electronic equivalents of these publications when the need arose. Publishers of data bases in dual (printed and machine-readable) form were deriving less than 20 percent of their income from on-line access royalties in 1978. Some of these publishers had reached the 50 percent level by 1985. By the end of the 1980s the market for secondary publications in printed form had dwindled to an insignificant level in the developed world and only the developing countries, still lagging technologically despite great progress, were expressing need for printed formats. By this time, however, the great cost of the printed versions was making this mode of distribution completely unprofitable and on-line access was subsidizing the printed forms. The same phenomenon, delayed by some years, was beginning to be felt by primary publishers before the end of the 1980s. By 1995, of course, print on paper had virtually disappeared for all secondary publications, for much of the primary literature of the sciences and social sciences, and for many types of reference works.

4. developments in other segments of society which created demand for access to literature through on-line facilities or in other electronic forms: In the 1970s there occurred many developments that were to become essential components of present electronic communication systems. Computer conferencing, the paperless office and electronic transmission of mail were all in their infancy in the 1970s. By the late 1980s, these various separate developments had been brought together into integrated systems. When scientists, attorneys, physicians and other profes-
sionals began to receive much of their mail at terminals, and also to communicate with colleagues through the same networks, demand for access to literature in the electronic mode increased considerably.

It was in the 1980s that on-line access to the text of technical reports, patents, standards and specifications first occurred.

The Publication Situation Today

In 2001, of course, publication in print-on-paper forms is the exception rather than the rule. While a few high-circulation journals have been able to retain their printed form, most of the research literature (whether in the sciences, social sciences or humanities) exists only in electronic versions. Some journals are issued on electronic media for use with domestic television receivers or home computers; these journals can also be accessed through the network of on-line service centers. There is little doubt that the explosive growth of the home computer market has made a significant contribution to the social acceptance of electronic publication. Most journals, together with files of technical reports, patents, standards and specifications, can only be accessed on-line. Patents, standards and specifications can still be obtained in paper or microform, but most of the use is now on-line. Technical reports are available in microform but rarely in paper form; again most of the use is through on-line access. All secondary data bases (including the national bibliographies of all the developed countries) exist only in machine-readable form, accessible through on-line terminals.

For popular magazines, fiction, other works of imagination, and recreational materials in general, print on paper has been replaced much less extensively. While attempts have been made to publish such literature in electronic form, no significant market has yet developed. The great cost of publication on paper, however, including the escalating costs of distribution through "conventional" mail service, has caused a very drastic reduction in the number of magazines available and new titles of fiction and other recreational works are now published in numbers that are only a fraction of those released annually some twenty years ago. It is just not economically feasible to sustain a print-on-paper publication unless an extremely large market can be reasonably assured; thus, the present situation of few new titles but massive print runs on each. The recent emergence of completely portable electronic readers may stimulate the market for popular reading in electronic form. The market for fiction and other imaginative works in audio form is also growing.

The substantial move toward electronic media in education has virtually eliminated the "textbook," even at the elementary level, and the on-demand news services offered through television and through several of
the on-line networks have decimated the ranks of printed newspapers. A few regional papers remain but increasing production costs and declining sales put the future of these in grave doubt.

"Reference books" are rapidly disappearing in print-on-paper form. The last English language encyclopedia to be published in paper form appeared some eight years ago and it is very unlikely that we will see another such publication. Many "pocket" reference books, such as monolingual and bilingual dictionaries and handbooks of engineering and scientific data, have been replaced by electrobooks. More extensive data bases—full-scale dictionaries, encyclopedias, directories, concordances, biographical dictionaries and similar tools—are available on-line. The contents of most of the electrobooks can also be accessed on-line.

Electronic reference tools offer many advantages over the print-on-paper tools. Many are updated on a continuous basis, which is especially valuable for directory-type information. The search capabilities are also very much greater because many more access points can be provided economically. To quote but one example, biographical files can be searched not only on names or parts of names but on biographical details of the subjects covered, such as profession, education, dates of birth and death, place of birth, titles of works written, and so on. It is a simple matter to identify, for example, the names of novelists born in Stoke on Trent, or born in September 1933.

Electronic publishing has produced reference works that would not have been economically viable in print-on-paper form. A good example can be seen in the concordances that now cover complete groups of poets. It has also allowed the publication of reference tools with capabilities far beyond those possible with print on paper. In particular, electronic analog models of equipment and other devices are now commonplace in encyclopedia-type data bases.

A potential obstacle to the transition from print-on-paper to electronic publication, stressed by many early skeptics, actually proved to work in favor of the electronic medium rather than against it. Communications networks, especially those providing "on-demand" services to the home, proved to be extremely effective channels for the advertising of many types of products and services. Loss of advertising revenue to the publishers of printed journals, as advertisers switched to electronic media, was an additional incentive to these publishers to convert to an electronic mode of distribution.

Influence on Information-Seeking Behavior

Computer-based information systems were well received in the 1960s and 1970s by many scientists and social scientists and by the legal and
medical professions. They were also well accepted by the majority of librarians. In the 1970s most on-line searches were mediated searches conducted by librarians or other information specialists on behalf of the ultimate users. By 1985, however, the wider accessibility of terminals, together with the greatly increased demand for on-line searches, which was beginning to exceed the capacities of libraries and information centers, had produced a change in this pattern of use—more and more scientists, social scientists and other professionals were using on-line systems directly. At least, they were conducting their own searches in those data bases they had most need for and had become most familiar with. They still tended, as they do today, to go to the information specialists for searches in less familiar areas or in less familiar data bases. Unmediated on-line searches, of course, became increasingly feasible with the emergence of more user-oriented searching software, especially those software packages permitting interrogation of data bases in sentence form.

Data banks and electrobooks, when these began to replace printed reference books, were well received. Even in the humanities the reception was more cordial than might have been expected. One reason was simply the realization that computer facilities made possible the production of reference aids (e.g., rather comprehensive concordances and detailed indexes to older historical and literary materials) that would not have been economically viable in print-on-paper versions. Also, the great power of the computer in linguistic studies and in textual analysis had become widely recognized. Scholars in the humanities recognized the benefits that could be derived from computer processing facilities and, in general, were quite receptive to new bibliographic and other tools as they became accessible on-line.

On-line journals were received cautiously. The first successful electronic journals were those introduced to serve communities that were considered most likely to be receptive to this medium. These communities included computer programmers and other segments of the computer industry, information science, medical electronics and electronics in general. Electronic journals also emerged rapidly in highly specialized fields, especially interdisciplinary research areas, where the community to be reached was too small to support a journal in printed form. Many of these electronic journals arose out of specialized conferences set up within computer conferencing networks. The majority of these journals, from the beginning, imposed editorial and refereeing standards roughly comparable to those of reputable journals in the print medium. After an initial "teething" period they were well accepted, becoming cited in other journals (both electronic and paper) and, somewhat later, indexed by the major services. As acceptance occurred, and it was recognized that a paper pub-
lished in a machine data base having a high standard of peer review carried as much "weight" (for purposes of promotion, tenure and salary review) as one accepted by a "conventional" journal, it became increasingly easy to attract high-quality contributions. The speed with which contributions could be reviewed and published, and the new reporting capabilities afforded by the electronic medium, were major factors leading to a switch of allegiance from paper to electronics on the part of many authors.

The first electronic journals were introduced by new publishing entities. The traditional publishing industry was (predictably) antagonistic to the newer competitors and was itself reluctant to change. Conversion of existing journals to electronic formats was forced on the industry, however, as the electronic journals gained in strength and acceptance. Not only were the conventional journals losing authors to their electronic competitors, they were also losing subscribers through their own escalating costs. The most expensive of the science journals were the first to convert but a more widespread and rapid conversion began toward the end of the 1980s.

Paradoxically, although the research community was quite willing to accept new journals and new tools in electronic form, it was highly resistant to the disappearance of the familiar printed journals. It was only in the past decade that the inevitability of this conversion process was accepted. A major reason for the change in attitude has simply been the emergence of a new generation of scientists and professionals in other fields, a generation that has grown up with on-line systems, especially as a result of the widespread use of such systems in education.

The completely integrated approach to information handling that we now know, while it had its origin in the 1970s, has really only reached full implementation in the last ten years. In science, commerce and most other fields, professionals now receive much of their mail electronically. SDI services direct to their attention citations or abstracts of new publications (articles, reports, patents). Such notifications form one category of message that is awaiting the user when he or she logs onto a network, the other major category being notifications of mail. The text of the majority of sources referred to by the SDI services can be directly accessed on-line. Although some individuals still insist on making hard-copy prints, personal electronic files have virtually replaced paper document files. Almost all commercial and professional correspondence is now handled through on-line processing and the majority of offices are now paperless. Computer conferencing is widely accepted and more and more individuals find it convenient to work from their homes, only visiting their parent offices at irregular intervals.

A major use of on-line systems is simply to provide an electronic "work-space" which can be used as an informal notebook and for the
composition of reports. The versatility and simplicity of current text-editing systems has made on-line composition of reports virtually universal. Communication among authors, editors and referees is handled entirely in an on-line mode. Publications are more "dynamic" now than they were in the past. The speed with which research results can be reported has led to the wide recognition and acceptance of the "transience" of publications. It has become very common for investigators to publish the results of a research project as a series of progress reports, each one essentially replacing its predecessor. This trend has been facilitated by the changes in reporting itself brought about by the electronic medium, which places much greater emphasis on tabular, diagrammatic and other concise representations than on narrative text. The typical electronic journal most closely resembles the "brief communication" or "letters" journal of the print-on-paper environment.

Terminals in offices and homes are used to search for information as well as to receive information, compose reports, build and index files, and communicate with other individuals. Searches extend from personal files to files of parent institutions and out into the universe of available resources in machine-readable form. On-line directories and referral centers identify sources (personal as well as database sources) having the greatest likelihood of satisfying particular information needs.

The majority of individuals in all fields now conduct their own searches, at least in those data bases that are most familiar to them. The low cost of on-line access to many data bases, coupled with the emergence of an international standard query language and the capability for natural language interrogation in sentence form in most networks, makes direct, unmediated searching the mode of access preferred by the majority. For the less familiar data bases, on the other hand, there is a strong tendency to delegate the search to an information specialist. Directories of these, indexed by subject or data base expertise, can be accessed on-line through several of the existing networks. Communication between information specialist and customer is generally on-line, the results of the searcher's efforts being transmitted directly to the customer's terminal. The work of these information specialists, both those with library affiliations and those without, is discussed in the next two sections of this report.

The Role of the Research Library

The decades from 1980 to the present have been decades of remarkable change in libraries. The period of transition from a largely paper-based society to a largely paperless one was also one of considerable trauma in the profession. The rapid emergence of more and more machine-readable data bases (both primary and secondary) in the 1980s coincided with a period of
wholesale conversion from card catalogs to on-line catalogs, especially in academic libraries. Gradually it became recognized that the catalog of a library could no longer be restricted to coverage of items physically present within the walls of the institution. Since an increasing number of sources were not purchased outright, but were accessed on-line as the need arose, it no longer made sense to retain this artificial distinction. By the middle of the 1980s, several of the on-line catalogs were including entries for data bases frequently accessed on behalf of users. The justification was simply that if a data base was readily accessible to users, it was quite immaterial whether it was physically present in the library (as paper, microform, disk, tape, electrobook or some other electronic form) or accessible through on-line connection.

The inclusion of entries for data bases not actually "owned" paved the way for the development of our present multisource catalogs. These catalogs, now virtually universal in academic, special and all but the smallest of public libraries, include entries for all materials held by the network or networks that a particular library belongs to. In addition, they include entries for all externally accessible data bases, primary and secondary, that any member library chooses to include. While entries for "physically owned" items still exceed entries for externally accessible sources, especially in those networks incorporating large academic libraries (which still have substantial quantities of older printed materials), the ratio is gradually changing as more and more sources become accessible only through on-line connection.

The emphasis in cataloging has changed in the electronic medium. The concept of a "main entry" has disappeared, since an entry can be accessed by many different approaches, including complete or partial names of authors (personal or corporate), editors and publishers, complete or partial titles, or any combination of these. Descriptive cataloging of North American materials is now entirely centralized, through cooperation between the Library of Congress and the publishing industry, and descriptive entries become available for network use at the same time that a data base becomes accessible to on-line users or at the time that a printed, tape, disk, microform, electrobook or other publication is released for sale.

Subject cataloging has increased in importance since electronic catalogs make it economically feasible to provide multiple access points. While library networks maintain cataloging staff to augment the limited subject access approaches provided by the Library of Congress, and to catalog materials added by network members that have not been covered by the Library of Congress, catalog departments have disappeared in all but the larger academic and public libraries. Even in the very large libraries these departments have rapidly dwindled in size in the past twenty years. The
principal functions performed by these staffs are cataloging of local interest materials, cataloging of printed materials from foreign sources, and augmentation of subject access points for materials of special interest.

On-line catalogs, of course, include entries for materials in all forms: printed, microform, tape, disk, electrobook, on-line data bases and other electronic forms.

The dwindling of cataloging in individual libraries is part of the larger dwindling away of technical services in general. Since libraries are now acquiring much less material of their own, the acquisition activity is of much smaller volume than it was twenty years ago, and binding in academic libraries is now mostly restricted to older materials of historical interest.

While libraries have declined as institutions, and library technical services in particular have dwindled, remaining library activities are highly service-oriented. A better understanding of the present situation in libraries can be gained from a brief review of developments since 1980.

Academic and special libraries were generally highly receptive to on-line services providing access to secondary data bases when these were introduced in the 1970s, but it was not until the 1980s that the on-line services began to impact seriously the sales of their printed equivalents, and libraries began widespread cancellation of printed subscriptions in favor of on-line access on demand. This, of course, was a major contributor to the market shift from printed to machine-readable forms.

Library attitudes toward other data bases and electronic forms were mixed. Electrobooks were ignored at first, or looked at with considerable suspicion. When it became evident that these forms were "here to stay" and that they are in fact a legitimate and useful form of publication, libraries began to acquire them along with other forms.

Because libraries in the 1980s were already using on-line secondary data bases extensively, they were not slow to make use of other on-line data bases as they became available, including the data banks that began to replace conventional printed reference books; data bases of patents, laws, standards and specifications; data bases of technical reports; new electronic journals; and the on-line versions of these journals still available in paper form. Again, it was the widespread shift from printed journal subscriptions to on-line access to equivalent data bases that led to the subsequent demise of the printed versions of many titles. By the beginning of the 1990s, the wide accessibility of text on-line had caused a very considerable reduction in interlibrary loan traffic. Now interlibrary lending is largely restricted to the older books and journals.

Libraries were slower in adopting journals released in the form of tape cassettes, videodisk and other electronic forms largely because of the capi-
tal investment required in providing an adequate number of minicomputers to make these accessible to library users. Those libraries that did make substantial investments in equipment of this kind came to regret their haste as an increasing number of the journals released in these forms became accessible on-line through the various on-line retailers.

Beginning in the early 1980s, academic and many special libraries have followed a familiar pattern of development:

1. **an increasing portion of the budget allocated to purchase of on-line access to information sources when needed, at the expense of outright purchase:** This move to on-demand, pay-as-you-go operation in libraries has had important cost-effectiveness advantages. It is no longer necessary to "second-guess" demand; libraries now avoid investing substantial sums in materials that are rarely if ever used. This is in direct contrast to the situation some twenty years ago when it was estimated at the University of Pittsburgh, for example, that about 40 percent of the materials acquired by its library received no use.

2. **drastic curtailment of physical growth:** As many fewer materials are acquired, special libraries and smaller academic libraries with active weeding programs have tended to shrink considerably.

3. **staff reduction accompanied by reductions in the size of the library:** Technical services have been practically eliminated but public service staffs have also dwindled as many of the more specialized information services have passed out of the hands of the library.

4. **departmental libraries in academic institutions begin to disappear:** As printed materials have declined in value, and become important mostly in various types of historical research, materials held in departmental libraries are being consolidated with the other collections of older materials.

5. **a partial dichotomy between those librarians that handle electronic information sources and those dealing with print and microform materials:** Most of the information service function has passed to the former although the latter group also perform reference activities on a lesser scale, especially in the humanities and in support of historical research.

6. **members of the professional staff of academic (as well as public and school) libraries tend to be generalists rather than specialists:** In contrast, the staff of industrial and governmental libraries, as well as information professionals not affiliated with libraries, tend to be subject specialists. The latter are likely to have master's degrees in a subject field, as well as a master's degree in information science, while the former are much less likely to have an advanced degree except in librarianship or information science.
ROLE OF THE LIBRARY

It is the special libraries, especially those serving government agencies and industry, that differ most from those of 1980. These libraries now maintain only very small collections of print and microform materials, almost all of their activities being concerned with information service from data bases in electronic form. Librarians in industry have increased considerably in importance since they are likely to have control over indexing and retrieval operations involving the company's electronic mail and its own machine-readable files of technical reports, as well as providing information services from external sources.

The librarian of today has become essentially an information consultant. In the 1970s librarians were intermediaries between those needing information and the electronic files. In the 1980s, with the rapidly increasing availability of on-line terminals, many professionals began to conduct their own searches. They found themselves successful, however, only in those data bases that they used regularly. The explosion in the number and diversity of electronic data bases led to increased reliance on librarians as guides to what is available in machine-readable form and as exploiters of data bases and data banks unfamiliar to the scientist or other professional having need for information. When an individual needs information that cannot readily be found in his own files or other sources he is familiar with, he will frequently consult with an information specialist. This professional recommends appropriate information sources for the requester's own use or conducts a search on the requester's behalf.

In the academic environment, subject-oriented information specialists perform this function. In some academic organizations these specialists are members of the staff of the academic library, even though they may be permanently assigned to a particular academic department. In other institutions, however, these specialists are completely divorced from the library as an institution. In these cases, the staff of the library itself is composed of information generalists rather than specialists and it is more oriented toward serving the needs of the undergraduate curriculum (both student and faculty needs) and of the administrative staff than it is to serving the needs of advanced teaching and research programs. Information professionals in academic institutions are primarily information consultants to faculty, staff and students. The same function is performed by information staff in industry and in government agencies. The information professional plays an important role in "interdisciplinary linking" by searching data bases in areas that are unfamiliar to users. Another important activity is to keep up to date with new data bases and to inform potential users of the existence of these tools.

The larger public libraries now provide similar services to those members of the community that have no access to academic or special
libraries. In addition, they provide adequate terminal facilities to allow requesters to access data bases from the library itself, if they choose to do so. Besides providing books and other materials for recreation and study purposes, many public libraries have raised the level of their information service activities in the last decade. The ability of a public library to provide general question-answering service of a high quality has been considerably enhanced by the wide range of reliable and constantly updated electronic sources accessible to them and by the fact that most such libraries belong to reference service networks in which cooperating libraries maintain an on-line data base of answers and sources for “difficult” questions. A number of such networks are now linked so that a vast “growing encyclopedia” is accessible to even the smallest of institutions.

Many of the large and medium-sized public libraries have taken on important community information services, including the compilation and maintenance of community resource directories that can be accessed through domestic television receivers, as well as other terminal devices, and the organization and control of municipal or county records of all types. Some public libraries are also active in the provision of information service to small businesses in the community, although much of this type of service is now handled by information consulting companies, especially in the larger cities.

School libraries have been widely expanded into learning resource centers, providing access to a wide range of computer-aided instruction facilities and other learning materials in all formats. As in other types of libraries, the professional on the staff of a school library is an information consultant to the teaching staff and to students, and plays an important role in instructing students in the use of information resources. School libraries also provide extensive recreational materials in printed, audio and electronic forms.

Closely related to their role as information consultants is the function that professional librarians now perform in “user education.” Beginning in the 1980s, librarians in academic and special libraries have been extremely active in instructing members of their user communities in how to exploit on-line resources effectively. The scope of the instruction encompasses search strategy, use of query languages, use of on-line resource directories, and general surveys of resources available. The instruction may be conducted on a one-to-one basis or through more formal workshops for groups. In the academic world it is now common for information professionals (on the staff of the academic library or school of information science) to present courses on information services and their exploitation within the various academic departments: physics resources for physicists, economics resources for economists, and so on.
The wide move to electronic communication has served to narrow the gap between the "information rich" and the "information poor" countries rather than widening it, as many were predicting a decade or so ago. Just as many developing countries moved rapidly from the age of the oxcart to that of jet aircraft, virtually skipping all the intermediate steps that occurred in the developed world, so many have moved smoothly into electronic information networks without having gone through a stage of well-developed traditional libraries. Satellite communication has served to make information sources more internationally accessible than ever before. The North American networks can communicate, and exchange information, with Euronet, Afronet and similar enterprises in other parts of the world, and international information programs organized by various agencies of the United Nations provide for free interchange of information between the developed and the developing worlds.

Information Professionals Outside the Library

As mentioned earlier, the most spectacular growth in the information profession has been the rapid increase in numbers of information professionals who are not affiliated with any library. This has led to some diversity in terminology. The term librarian has clung to those professionals who are clearly affiliated with a library, while those without such affiliation are more likely to be referred to as "information officers," "information consultants," or simply, "information specialists."

In the 1980s there was a short-lived boom in completely freelance information specialists, many working from their homes, but almost all of these have now been absorbed into information consulting companies or into "private practices" closely resembling the group practices that are also common in the health care and legal fields.  

While a few freelance librarians could be found in the 1970s (mostly in the large cities) the growth of private information practices has been phenomenal in the last fifteen years. It came about, of course, with the realization that a good reference librarian in the electronic age does not need to operate from a library. Indeed, the needs are not for extensive physical facilities but for a detailed knowledge of electronic information resources together with the terminals and expertise needed to exploit these resources effectively.

These professionals perform in much the same way as their counterparts in academic and special libraries. Although not so much concerned with education and training, they act as information consultants, helping to put those with information needs in touch with data bases or individuals likely to be able to satisfy these needs. Alternatively, they provide a complete service, searching available sources and delivering information, text
or source references directly to requesters. These specialists also assist customers in developing suitable interest profiles for use with on-line SDI services.

Their customers are drawn mostly from small businesses and other institutions that lack their own information professionals. As well as providing information services, these information specialists will also consult with these organizations on their internal information problems, including the organization of internal files and the indexing of electronic mail.

Many such information specialists who restrict their activities to particular subject areas—medicine, engineering, economics, and so on—are generally well qualified in those areas, and command high rates of compensation. That information specialists tend now to have a higher level of subject expertise than their predecessors is due largely to the fact that their customers frequently expect them to deliver a precise answer to a research problem rather than merely point them to possible sources that might contain the answer to their question. As mentioned earlier, the information world is much less artifact-oriented and much more data-oriented than it was twenty years ago.

Another type of information specialist is the one who is a member of a research and development team in industry or academia and the one who, as a member of a health care facility, works directly with physicians in providing information as needed in patient care. These professionals, whose importance has now become widely recognized, are integral components of the teams they support, assuming complete responsibility for providing all information, from whatever source, needed to facilitate the work of the group.

Professional Education

With so many changes taking place in information delivery, it is hardly surprising that education for the profession has also undergone a process of alteration in the last twenty years. All of the major library schools have become schools of information science. Education for professionals in public libraries and in school libraries has changed less than other aspects; it is a separate track in some schools, while others concentrate exclusively on the preparation of students for those branches of the profession. Most professionals working outside of libraries as well as those in academic and special libraries have master’s degree in a subject area as well as one in information science.

The information science curriculum differs considerably from the library science curriculum of twenty years ago. Again, the deinstitutionalization process is very evident. “What goes on in a library” is no longer the
principal focus of study. In leading schools the curriculum is much broader in scope: communication processes (formal and informal) in general, publication and dissemination processes, interpersonal communication, design and management of information services, factors affecting the effectiveness and cost-effectiveness of information services, indexing, vocabulary control, data base management, information resources and how to exploit these resources effectively ("search strategy" in the broadest sense of the term), and the evaluation of information services. The librarian of today needs to be thoroughly familiar with a wide range of communication activities, including electronic mail systems, computer conferencing, communications networks of all types, and word-processing and text-editing systems and equipment.

As previously mentioned, many schools of information science also offer "service" courses for other academic departments, an activity that has become a major function of several of the leading schools.

There is now great diversification in the employment opportunities open to graduates of schools of information science. They can find employment in special, academic, public or school libraries; in the headquarters of library networks; as information specialists in industry, law or health care; in publishing companies (both primary publishers and the publishers of indexing/abstracting services); in the on-line service centers, in information analysis centers, or as information specialists in group practices or the larger consulting companies.

The developments of the past twenty-five years have not, of course, been free of problems. The conversion to electronics created great economic stress in the publishing industry, particularly for publishers of periodicals who were faced not only with capital investment in new equipment but with a completely different income environment—payment on a "use" basis rather than a "front end" subscription income. This led to the demise of some publishers, the amalgamation of others, and many formal cooperative arrangements, especially the use of cooperative editorial processing centers.

The copyright laws were shown to be woefully inadequate in coping with the conversion from print-on-paper to electronic publishing, and it is only since 1993 that the copyright and royalty situations have been settled to the apparent satisfaction of all parties concerned.

A specter raised repeatedly in the 1980s turned out to be less of a danger than predicted. The rapid spread of fee-based information consultants threatened to cause a wide rift between "information rich" and "information poor." It was feared that an "information elite," composed of those members of the community who could afford information services, would emerge. This situation did, in fact, exist for a number of years while the
“fee versus free” controversy raged throughout the profession. This has largely settled itself as costs have declined and as public libraries and academic libraries came to recognize that information service from electronic sources is as legitimate a service to provide to their communities as the provision of printed materials. It is true, as it has always been, that the wealthier organizations and individuals can afford to purchase a higher level of subject expertise or a more rapid response in information services, but virtually no citizen of the United States is deprived of access to needed information through inability to pay for it. Fortunately, the electronic networks developed in the past twenty years have not created an information elite but have improved access to information for all segments of society.

ACKNOWLEDGMENT

This paper is drawn from research supported by the National Science Foundation, Division of Information Science and Technology (DSI-78-04768).

REFERENCES


4. Between 1963 and 1973, a period in which the Consumer Price Index rose about 40 percent, the subscription price of Psychological Abstracts and Bibliography of Agriculture rose 850 percent.


9. We are indebted to Allen Veaner for first characterizing this trend in this particular way.

10. We are indebted to Estelle Brodman for this idea.
APPENDIX I

Specimen Page of Questionnaire

INDEXING AND ABSTRACTING SERVICES

4. 90% of all indexing and abstracting services are published only in electronic form.
   (a) The event could be technologically feasible by:
   (b) The event could be economically feasible by:
   (c) The event will have occurred by:
   (d) This event is:
       very desirable  neither desirable  undesirable  very desirable
       nor undesirable  undesirable
   (e) Comments or justifications:

PERIODICAL LITERATURE

5. The first periodical to begin its life in electronic form will appear. It will not exist in print-on-paper form and it will never have existed earlier in print-on-paper form.
   (a) The event could be technologically feasible by:
   (b) The event could be economically feasible by:
   (c) The event will have occurred by:
   (d) This event is:
       very desirable  neither desirable  undesirable  very desirable
       nor undesirable  undesirable
   (e) Comments or justifications:

SCIENCE AND TECHNOLOGY PERIODICALS

6. For the first time a periodical in science or technology begins to be available in machine-readable form as well as in paper-copy form.
   (a) The event could be technologically feasible by:
   (b) The event could be economically feasible by:
(c) The event will have occurred by:

- 1980
- 1985
- 1990
- 1995
- 2000
- after 2000
- never

(d) This event is:

- very desirable
- neither desirable nor undesirable
- undesirable
- very undesirable

(e) Comments or justifications:

**APPENDIX II**

**Comments or Justifications for Question 5**

1. Periodicals may start on-line but hard-copy derivatives may follow.
2. More inclined to the belief that ongoing periodicals will take the plunge first.
3. See EIES at NJIT. +NEWS is a formal periodical. Difficult to browse at 30 char./sec.
4. Is being done now—if enough publishers did it, it could become feasible soon—but resistance is high! Lots of people will have terminals—will want it!
5. By your own definition (and mine) this type of publication would not be a periodical. May happen but needs new definition and role.
6. Very limited distribution; 100 to 500.
7. I believe conversion from paper to electronic form will be more significant than the indications.
8. CBS Evening News satisfies your definition now. Several in-house periodicals now exist entirely on-line (e.g., NEWS on DIALOG, similar feature on ARPANET). Bowker-Ramo Stock Quotation Service is on-line now and profitable.
9. Postage, paper, printing and labor costs will force things to go this direction.
10. Public libraries must have good terminals.
11. Message network related; could be home-computer related.
12. The convenience of paper form is yet to be challenged.
13. Some computer-related journal (ACM) might, since its users have access to needed technology.