Copyright Impacts of Future Technology†

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Dynamic developments in computer and communication technologies, and in reprography and micrographics, are yielding systems and equipment that render better and faster access to information that has been copyrighted in traditional formats. Procedures and mechanisms must be worked out to permit us to take advantage of these technologies without destroying our basic systems of information dissemination.

Scientific information services and systems today, including chemical information systems, are characterized by developing network capabilities and cooperative activities aimed at improving resource sharing. Many of the administrative and economic considerations underlying these developments have been described in the earlier papers in this symposium: the greater volume of papers offered for publication in primary journals, the increasing numbers of specialized journals, the spiraling costs of publication which contribute to increased subscription charges, and the development of efficient but relatively expensive computer-based information searching services and of services offering on-line access to a number of data bases.

Mention has also been made that tight budgets for library and information centers, coupled with inflationary costs, are forcing the search for alternative ways to maintain service to users in providing access to as many needed books and journals as possible, and as quickly, efficiently, and cheaply as possible. The obvious way for users and their intermediaries is through resource sharing and cooperative activities. For many years, libraries and (more recently) some information services have been cooperating on formal grounds and through informal agreements. Particular success has been achieved in the areas of interlibrary lending, bibliographical access (union lists of holdings), agreements for specialization in collection development, and cooperative technical processing of materials.

These cooperative activities and interlibrary network developments have been accelerated by recent technological advances. For example, interlibrary loan is facilitated by improved photocopying techniques, union lists are maintained in current and easily accessible form in computer files, specialized collections are shared by several cooperating libraries via on-line catalogs and photocopied exchanges, and cooperative processing has become more attractive with on-line access to computer files of cataloging data.

Such advances in the technologies of computers, communications, and reprography have had fundamental impacts on scientific and technical information services. Trends in these technologies will affect even more the patterns of user access to information resources. These patterns include even greater reliance on the services of the libraries or information centers for subscriptions to primary journals and secondary journals, for access to data bases, for photocopies, and for computer-produced bibliographies. Improvements in computer hardware and software, reduced operating costs, and increased use of newer recording media for space and cost savings will contribute to more efficient and effective applications in networking.

The impacts of these trends on copyright protection, already touched upon by previous speakers, bear further careful consideration.

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TRENDS IN TECHNOLOGICAL DEVELOPMENTS

Computer Technology. Advances in computer technology have resulted in dramatic reductions in hardware costs. Thus, economical quantity production of computer hardware is enhanced by developments in solid-state technologies. This is supplanting the economies of scale that had been the dominant factor for large centralized computer systems. Cost benefits resulting from such quantity production will cause computer architects and designers to promote configurations involving distributed computing. This trend to dispersing computing power from a central processor out to peripheral devices began in the 1960's and is accelerating.

Processing costs have also decreased; indeed, the trend in reduction of such costs is expected to continue into the 1990's. Developments in basic central processors have resulted in far more computing power than is necessary for ordinary information-handling applications. But as machine processes are applied more and more to content analysis and the automatic organization of information, this cheap processing power will be even more important.

Another important development trend is the increasing power, decreasing cost, and reduced size of minicomputers. These are important in computer networks and for low-cost local handling of small files or small portions of large files. The price-performance ratio of minis has been improving steadily since they were first introduced in 1963. This trend is expected to continue and will have considerable impact on intelligent terminals and for decentralizing many functions. Recently, much more improvement in performance has been achieved in small computers than in large ones. This suggests again that the more attractive configuration is going to be the combination of a large centralized facility for common functions, coupled to smaller computers for support of local operations.

It has long been recognized that the speeds of available storage devices are not adequately matched to the logic circuitry used for computations. Many of the applications in scientific information handling make computation practically incidental to the storing, retrieving, and manipulating of data. Great effort and ingenuity have been devoted to the question of improved storage devices, resulting in an extensive hierachy of devices and technologies. This is still an extremely active field, one in which developments are proceeding on many fronts. The evolution of solid-state components fabricated in extremely dense form, requiring exceedingly low power per storage element, has resulted in the broad-scale replacement of traditional core memories with active storage devices. The elements used for these devices are typically able to be turned on and off at speeds comparable to the speed of the logic circuitry used elsewhere in the computer. Core memories eventually reached speeds in the hundreds of nanoseconds; solid-state memories now can operate in tens of nanoseconds.

In addition, numerous large-scale information-storage media are being developed and will enter the systems marketplace in the next few years. The basic physical properties of such

materials, which utilize magnetic phenomena, conventional or new photographic processes, or laser-actuated storage mechanisms, will provide for very much higher densities than now employed. These mass-memory storage techniques allow greater packing densities, which in turn promise more rapid retrieval and display of selected data elements or whole pages of information.

Perhaps the most dramatic developments in computer technology have occurred in terminals, input/output devices, or local processors, man's primary communication links to the computer. The terminal marketplace is dynamic and competitive. For example, CRT-based terminals are already available for $1000; some projections show a cost for a basic terminal of only a few hundred dollars in a very few years. Major cost-performance improvements of digital logic using large-scale integrated circuitry are major factors in bringing down costs for terminals and their related logic.

High-performance terminal devices are becoming available that offer video-screen textual and graphic presentations, on-line correction and data-manipulation capabilities, and final output through printers or data-output stations. Such terminals, for example, can be used very effectively in editorial processing centers to provide reductions in the costs and increases in the efficiency of publication of primary scientific journals.

Minicomputer-based or microcomputer-based terminals have a certain amount of local processing capability and can be adapted to different communication protocols and user requirements. As the cost of microprocessors continues to go down, more and more terminals will incorporate them, leading to a trend toward specialized terminals which will cost little more than today's general-purpose terminals. This is important, because some of the requirements of library and information services exceed those of most scientific and business applications, for example, the need to handle scientific notations and multiple alphabets of non-English characters. The minimum library character set for bibliographic information alone includes 176 different characters, according to the Library of Congress. It is now technically feasible, and it will be increasingly economically viable, to build equipments to handle such a range. This, of course, is of great importance for computerized publishing, which in turn can provide the content of machine-readable publications for storage in information systems.

Communications Technology. Developments in computer networking rely on data-communications technology. Communications links of importance in scientific information systems include links between the individual user and the system, from a centralized distribution point to a particular service center, and among nodes in a store-and-retrieve network. Until recently the system could embody only two choices for these communications links: the telephone network and leased private telephone lines between two points, both designed primarily for voice (not data) transmission. Now, many different services are available, and improvements in both performance and cost of data transmission can be clearly foreseen. Digital transmission services will be used increasingly and will become the prime data communications carrier. These networks will be able to operate in the mode most suitable for the particular terminals or computers involved, that is, either store-and-forward or real-time.

Whereas today the user worries about modulating systems to maximize the number of bits per second that can be transmitted over an analog phone line of fixed bandwidth, in the future the user will be concerned with finding the optimum coding scheme to maximize the number of conversations that can be sent over a digital data channel of fixed transmission rate.

In addition to developments in digital transmission services, facsimile data communications will involve more use of specialized carriers, satellite channels, and packet switching services. For example, satellite links will be used increasingly for textual-information transmission, as is done now by the *Wall Street Journal* in transmitting complete newspaper pages from its main printing plant in Massachusetts to its regional plant in Florida.

These developments in communications technology will not reduce basic costs to any large extent, however. Various changes in tariffs will give the user some price breaks. The cost of logic circuitry will decrease at a faster rate than the cost of basic communications. So developmental efforts today reflect an emphasis on distributed systems having multiple, specialized processors. There will be an incentive to carry out more processing at the local level, or to carry out sufficient preprocessing to reduce the amount of information to be transmitted.

The potential of cable TV is high for local distribution of information of all types. The technical capabilities of new CATV facilities to provide two-way communications to over 50 channels can supply an enormous amount of information. Of course, the legal and regulatory questions involved constitute major concerns in realizing these potentials.

In summary, the components exist for expanding the current skeleton national computer network into a full-fledged computer utility, one which could make possible great gains in service efficiencies at low costs. However, a number of regulatory and policy questions remain to be answered.

Reprographic and Micrographic Technologies. Reprography and micrographics involve technologies of major importance in scientific information systems. New and unusual recording media are being developed which will permit meaningful space and cost savings and will guarantee faster and better copies for the user.

The most popular types of microforms in use today are roll film, microfiche (sheet film containing images in a grid pattern, with reduction ratios of 24 to 48), jackets (plastic carriers holding strips of microfilm, which permits addition or updating of material), and ultrastrips and ultrafiche (with reduction ratios of up to 250 to 1).

The use of micrographics should be encouraged as a means of conserving scarce and expensive paper. However, use patterns today usually result in blowing back the micro-image to full-size copies, resulting, of course, in using paper. In general, today's paper problem will not affect copying operations as much as original publishing; in any case, it will accelerate the development curve of micrographics and reprography.

As regards the role of micrographics in publishing, we see the use of microfilm for micro-republishing, where copyright arrangements or agreements are worked out satisfactorily; for original publishing in micro editions concurrent with traditional editions; and for micro editions as sole outputs because of printing and distribution costs.

Newer microforms include photochromic, photopolymeric, electrostatic, and thermoplastic materials, and holographic techniques.

The distribution or dissemination of information within or between information service centers and networks will be accomplished more economically in the future by facsimile transmission. The technology is already well developed, but commercial scanners and display modules need to be improved. I have mentioned the use of facsimile transmission of page masters for the *Wall Street Journal*; in this the material is scanned with a high-quality scanner, transmitted, and regenerated at the target site with high-quality equipment. One link is by satellite, and ten others are by microwave trans-

missions. It is at present an expensive procedure, owing to the costs of appropriate hardware as well as to data transmission. For ordinary library and information-service users, the expense cannot now be justified in terms of time constraints or requirements. In general, also, image resolution or quality is not good: for office copying or newspaper material the system proves satisfactory, but it might not be for scientific and technical publications containing smaller type sizes and detailed graphical material.

For technical journals, present TV-type display technology is also not satisfactory. There are, for example, an average of 15,000 characters per page of *Index Medicus*, but the usual character generator displays 30 lines of 36 characters each, or 1080 total characters on the CRT screen. However, techniques have been demonstrated for using laser or electron beam scanning to drive another scanner to activate display modules. Material stored on 16-mm microform were regenerated as 35-mm microforms with good success by Project Intrex.

Computer-output-microfilm (COM) is another technology for the production of micrographics of interest to scientific information systems. COM, which first appeared in 1958, offered the promise of being faster than the computer impact printer and more compact than bulky paper reports. Today, technological advances in equipment and supplies have vastly improved reliability, quality, and cost effectiveness. COM recorders have average output capability of 20,000 lines/min, approximately 20 times faster than most computer impact printers. Even the latest innovation in computer in-line printing, a laser printer, operates at 13,000 lines/min.

In addition to savings in storage (270 tab-sized pages of printed data on a microfiche) and handling (4 fiche weigh less than an ounce and can be inserted into a 4 × 6 in. envelope), COM can be economically reproduced and rapidly duplicated: up to 1300 microfiche can be produced in an hour. COM can be considered, then, as a substitute for the line printer, a technique for photocopying for micro editions (mentioned earlier), or a means for photocomposing for subsequent blow-up to produce macro (regular size) publications. Such uses will proliferate in the near future and will contribute to faster and cheaper dissemination and distribution of information throughout library and information-service networks.

IMPACTS ON COPYRIGHT PROTECTION

Concern has been expressed, and properly so, about the use of copyrighted works in traditional formats in computers and computer networks. As has been pointed out, a work stored in a computer network accessible to users all over the country means that one copy could serve needs which previously could be met only by, perhaps, 10,000 copies. Much of the abstracting and indexing material in today's data banks is the result of computer typesetting of conventional secondary publications. There are few real problems in obtaining the copyright owner's permission for their use.

But computers also store raw data which are not copyrighted. So we have two groups of problems.

The first group concerns use of computer files which contain materials that are protected by copyright. What kinds of uses of what sorts of works should require permission of the copyright owners? Should permission be required and royalties paid when the work is input to the computer system? Or when it is displayed or printed out by the system? Should the copyright owner have control over the input of abstracts or digests of his work, or over use of the computer system to index his work? If the digest is so detailed as to constitute a derivative work, it would seem that permission should be required. And if the abstract was prepared by the author himself, it is copyrighted. But if the condensation is so brief that consultation of the original work is not precluded, as in an annotated bibliography or catalog, should permission to use be required?

The arguments for permission at input vs. permission at output revolve around the probable use patterns of such material in computer files. For example, permission and royalty payment at input would cover situations where a particular work might never be printed out in its entirety, or might be used only in fair-use situations. On the other hand, having to pay royalties at the input stage might inhibit computer-file development; material that is judged to be of marginal interest might well be left out.

Of course, permission and payment at input are easier to control than use at the output stage. But does scanning a file to search for material constitute use of the material? If material stored in a computer is used to generate or create a new work, who is the author and copyright owner? To quote, "The distinction between author or producer of stored material and the user of that material tends to be blurred".[1]

The second copyright problem centers on protection in computer banks of raw data and unpublished material. Unpublished material that is the product of "creative and original intellectual endeavor" should have the same copyright protection as published works. Raw data, however, may not involve such intellectual effort, although it may have required large investments in time and funds. So the question centers on how the investment in gathering masses of new data to be stored in a computer can be protected.

Another problem entirely is that of maintaining the integrity of data and information in computer systems and in computer networks. The ready availability of remote terminals connected through convenient communications services, and coupled with sometimes carelessly designed log-in and password schemes, provides ready access to all of the data in many networks with a minimum of effort. Careful attention to the design of individual computer systems, including all of the resources maintained within them, and to their coupling with communications services and terminals, is necessary to establish complete control over data accessibility.

This problem of controlling network access is coupled with one that is almost exactly the opposite. It is essential that those individuals and organizations which need resources know where to find them and be able to access them readily. Here, however, it is nontechnological problems of providing access that are creating our concern. We are all familiar with, and users of, various indexing services that reflect our fields of interest. The growth of information makes the development of even better retrieval tools imperative. Indeed, when we consider this need along with the developments in computer, communications, and reprographic technologies outlined previously, we can see a time in the not-too-distant future when the use of larger retrieval systems available to more users will become more common. We must work to develop procedures and mechanisms to take advantage of all these technologies without destroying our basic systems of information dissemination and exchange.

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