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ABSTRACT

This monograph is an overview of the present and possible future trends in networking, the use of computer communications technology to facilitate the sharing of information and computer resources over great distances. The text reviews networks already being used by universities to share instructional resources and computing ability, and by libraries to facilitate systematic acquisition, serial control, and retrospective bibliographic searches. Networking implies problems of uniformity of users, unused capacity, fee sharing, and financial support; each problem is discussed in depth. With an awareness of possible budgetary and political constraints, the present state of network technology is discussed and predictions are made for the future. (EMH)

Computerized Networks among Libraries and Universities·

An Administrator's Overview

by Lewis B. Mayhew

November 1975

ERIC Clearinghouse on Information Resources
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PREFACE

This monograph, with accompanying support materials, describes computerized library and academic resource-sharing networks in non-technical terms and introduces the novice to their actual and potential uses. The subject is approached from the point-of-view of the uninitiated educator, librarian or administrator--competent in his or her own field, but unaware of the role or possibilities of computerized networking and resource-sharing. In much of the paper, an administrator's eye has looked at the cost-effectiveness and realities of such networking. The paper has been written and compiled by staff members of the ERIC Clearinghouse on Information Resources, with assistance from knowledgeable persons at the University of California at Berkeley, the Stanford Libraries, and others.

The paper takes the position that computerized networking is technically well-developed and possesses considerable potential for education, if political, administrative, and economic problems can be overcome. Evidence is presented of actual uses of computerized networking which can be used as a basis for application elsewhere.

The examples and ideas presented here are intended to serve as a tool and springboard for educational administrators, librarians, instructors, and others to further explore networking, perhaps by referring to relevant items listed in the bibliography, or by contacting networks listed in the publication Initialisms and Acronyms of Library Networks, published by ERIC at Stanford.

The organization of facts and their interpretation is the responsibility of the ERIC Clearinghouse staff and not of the individuals consulted in preparing this paper.

After an introduction which defines terms, this paper contains four sections. First, it presents examples of computerized networks, and then analyzes factors in the field's development. Current issues are highlighted in the third section, and the future of networking is explored in the concluding pages.

Busy educators and administrators with backgrounds in networking may wish to turn immediately to sections three and four, while those unfamiliar with the field may wish to read the paper in its entirety.

INTRODUCTION

The term networking, currently in high vogue, can be applied to so many different activities that it has been difficult to bring into focus this monograph dealing with the subject. Further, the language of networking is recently-created and often esoteric--almost incomprehensible to the uninitiated. These difficulties have been intensified by strong feelings people have about networking, ranging on the negative side from a luddite point of view which sees networks eliminating jobs for librarians, to the more paranoic vision of networks listing so much information about each individual that they facilitate the advent of George Orwell's 1984. At the other positive extreme are those who see networking as the only logical, rational way for a super-abundance of information to be recorded in a reasonable, retrievable fashion.

In between these extremes are several more moderate positions. One recognizes that networking is technically possible and can provide important services, but that it will likely be cost ineffective for educational institutions, and will require special funding--probably from the federal government. Another position, somewhat more optimistic, believes that after start-up costs and initial preparation of people to use networks, their value will be so clear that institutions will include necessary costs in their ongoing budgets.

In yet another view of computerized networks, they can be teamed with telecommunications to economically move and process information:

> ...rapid advances in telecommunications capabilities come at a time when present science communication services are threatened by continued exponential growth and rising costs but relatively static markets. In this situation, managers of services are urgently seeking means to lower unit costs for information processing. Combined with computer capabilities, telecommunication technologies promise to improve both the efficiency and effectiveness of scientific and technical communications.
>
> These capabilities allow large-scale storage of machine-readable...information in central facilities for instantaneous presentation wherever there are computer terminals. Computer communication networks ...are a reality today and are growing in numbers, size, complexity, and comprehensiveness. In some cases, linkages are established among institutions to share a common resource, as in the case of cooperative library cataloging; in other cases, interconnections are used to move information from a set of processors, like abstracting and indexing services, to a functionally different set of organizations, such as libraries and information centers.[1]

A Non-Academic Model

Very likely, those who see great relevance and use of large-scale computerized networks in education draw inspiration from successful commercial models. One such commercial model which has led colleges and universities to consider networking seriously has been the airline reservations and ticketing network.

Another working commercial network which can be an example for education was set up by the General Electric Company to link one centralized facility in the Cleveland area to sites throughout the United States, Canada, Alaska, Japan, Latin America, and most countries in Western Europe. The network operates through several levels of concentration, with some 2100 locations where people can place and retrieve business-related information. The 2100 outlets are each linked to one of 16 regional centers called concentrators, which, while they cannot interact with each other, can move information quickly out to the 2100 local stations or back to the centralized computer facility. The central facility consists of several sub-units, each of which can handle eight of the regional centers and, in addition, can interact with each other. In all, there are about a thousand people associated with the network, half of whom are connected with sales and half connected with technical maintenance. General Electric is a worldwide enterprise, and can operate its Cleveland facility 24 hours a day and be available for servicing to all of its outlying offices and agencies during their peak needs.

General Electric chose a centralized network for a number of reasons which should be of interest to academic and library administrators. The network conformed to people's work habits and provided for greater ease of management. In addition, a centralized facility created a critical mass of talent, and a sufficiently interesting set of problems to enable GE to recruit the best people to work with the system. When the corporation elected to use a centralized facility there was some fear that local feelings and morale would be jeopardized. That apparently has not happened.[2]

Definitions

A number of definitions of networking are available today. A brief one says networking is the use of a communications system to share resources among different users. But that definition could include a small telephone system, an open- or closed-circuit television network, a complex single-campus system of computers, or a national computerized bibliographic resource on a particular health problem. A more elaborate definition says networking is "...the use of computer-communications technology to facilitate the sharing of information and computer resources over great distances. Networking provides an opportunity to increase communication and intellectual commerce among computer users and to expand the size of the market for local computer products and services."[3]

This monograph is limited to discussing computerized networks which facilitate the storage, manipulation, and retrieval of information for the benefit of individuals and institutions (academic and library), oftentimes widely separated geographically.

The paper explores in non-technical terms the nature and some of the ranges of computerized networks currently or soon to be in operation. In addition, this paper raises in a neutral fashion some critical administrative issues which must be resolved before the future of networking can be clearly perceived.

EXAMPLES OF NETWORKS

Computer--College and University

To begin, non-technical descriptions of a number of different examples may reveal some commonalities which can help the reader understand the subject.

One rather advanced example of a type of network is the ARPANET (Advanced Research Projects Agency), a computer communications system supported by the Department of Defense. It began in September 1969 by linking the computers of four western universities (University of California at Los Angeles, Stanford University, University of California at Santa Barbara, and the University of Utah) so that packets of information could be transmitted almost error-free from one computer to another. The system originally was created to avoid the considerable redundancy of equipment and approach which had developed during the time the four universities were receiving support from the Advanced Research Projects Agency. When the network was first created, the amount of real use (contrasted with experimental or developmental use) was relatively light, in large measure because the mechanisms connecting different computers which enable reliable exchange of information had simply not been perfected. Those technical problems gradually were overcome and the number of computers linked into the system has advanced from the original four in 1969 to 50 in 1972 on to about 125 in 1975. The network now links different types and capacities of computers and allows the user to select the sort of computing service most appropriate for a particular need. In theory, appropriate charges could be passed on to users according to the level of service received. In practice, however, the entire network is still partly subsidized.

A related example is Triangle University's Computation Center which provides computer capacity to the University of North Carolina at Chapel Hill, North Carolina State University and Duke University. The Center was established as a not-for-profit organization by the three universities in 1965 to give each institution access to more computing power at less cost than each could obtain individually. The initial funding for the project was provided by the National Science Foundation and the North Carolina Board of Science and Technology. The facility is located in the Research Triangle Park which provides easy access to all three owners. As of 1975, the Center is deeply involved in research and some educational activities and, to a lesser extent, in the ongoing administrative activities of the three owner universities, e.g. admissions at Duke. In addition, it provides some services to about 50 smaller institutions in the state. The facility in 1974 operated on a budget of about 1 1/2 million dollars a year. Thus far, the Center has been able to provide sophisticated computer services to the institutions more cheaply than each institution could itself provide the services. In addition, each institution has access to a greater variety of programs and to more highly qualified people than they could afford if operating independently.[4] The level of success of the Center is judged quite high, partly because the technical quality of the operations has been outstanding, and partly because the Center has never lost sight of the interests of its owning institutions and has never been viewed by them as a threat.

As to the future, the Center hopes to provide instructional and administrative computer services elsewhere in the state. It hopes to facilitate administrative economies in the three institutions and, through advances in technology, it hopes to reduce operating costs. However, it has experienced some reluctance on the part of owning institutions to entrust their administrative records and processing to the central facility. Duke University has been willing to use it in connection with its rather sophisticated systems analysis process of admissions and prediction of course needs. Other institutions have been less ready to sacrifice their autonomy.

A similar but less formal and advanced example of networking is that of UNI-COLL, which is a modified computer network serving institutions in the Delaware Valley. UNI-COLL evolved from the computer center of the University of Pennsylvania which, after purchasing larger and larger capacity equipment, found it had the capacity to serve not only the University of Pennsylvania, but other institutions as well. By serving other institutions and charging them the same rates as University of Pennsylvania users, UNI-COLL could extend services further and could obtain incremental funds to expand the quality and capacity of its work. The prime motivation seems to have been to obtain cost-effectiveness by using the large University of Pennsylvania facility to serve many more uses. Generally, the new organization has contributed to increased professionalism in the administration of some of the institutions, and has made accounting procedures, for example, much more precise.

However, UNI-COLL has encountered difficulties, few of which have been completely resolved. The first of these is sheerly orchestrating the activities of a number of diverse institutions, each of which has its own goals and expectations which may or may not be compatible with the goals and expectations of others. User institutions wish to get high quality service at low price, while the network organization itself needs to maintain financial stability and, indeed, increase revenues. A second problem involves pricing policy. As the organization has added to the sophistication of its equipment, it has been able to reduce direct costs of rendering service. However, to ensure the financial stability of the organization, prices have been maintained as though those improvements had not taken place.[5]

A third problem, as with all large computer centers, is one of unused capacity. With its most recent addition of advanced equipment, the facility has increased capacity by a factor of three, while demand has not grown nearly to that extent. In part, this may be because participating institutions still are unwilling to commit themselves wholly to a network computer system. From the standpoint of the facility, it would be desirable that each member funnel most of its computing funds into the single large facility. But at the same time, individual schools or faculties may find it more convenient, aesthetic or efficient to meet their particular needs with their own or other equipment. Although the institutions in the Delaware Valley are experiencing increasing needs for computer utilization, the largest single user is still the University of Pennsylvania. This fact alone gives that institution a disproportionate influence on critical decisions. Lastly, at least in the short run, it appears that UNI-COLL has increased computer capacity greatly in anticipation of fairly rapid growth of use--a growth which did not take place. Costs have been considerably higher than justified by revenues. Hence, there has been a slowdown in the technological development of the facility.[6]

With examples of successful commercial networks in mind, such as those discussed in the introduction, colleges and universities have organized cooperative networking arrangements which are expected to increase their computer capacity at substantially reduced costs. For instance, over a five year period, beginning in 1967, the Harvard University Computing Center (operating on a fee-for-service basis) accumulated a 1.6 million dollar deficit. The progression of that deficit underscored one of the critical points facing all not-for-profit, large-scale computer operations in the mid-1970's. During that five year period, income from federal grants and contracts declined steadily, while charges made by the Center to Harvard University itself increased steadily. Thus, there was a net outflow from the university and its affiliates. To solve that fiscal problem and to maintain service to the various components of Harvard University, the institution divested itself of its major on-campus computer facility and entered into a partnership with the Massachusetts Institute of Technology (MIT). When it was discovered that Harvard used the facility only 35% of the time, while MIT used it 65% of the time, the arrangement was changed so that Harvard became a customer of MIT rather than a partner. As of the mid-70's, Harvard seems quite committed to the philosophy of using off-campus facilities, including networks, to satisfy most of its needs. Some smaller systems continue to operate on the Harvard campus for specific uses, but these are linked to the larger MIT facility.

A somewhat different solution was attempted in the state of Michigan with the creation of MERIT, which links by telephone lines the computing facilities of the University of Michigan, Michigan State University and Wayne State University. A user can submit at a local terminal anywhere in the state a task intended for any one of the three computers. Gradually, at all three institutions, various aggregations of data are added to and stored in computers and these in turn become available for use throughout the state. The technology of the MERIT system is quite sophisticated; the different computers are able to communicate with any one of the other two and each is able to initiate tasks.[7] However, the dream of the system's originators, which was to have the appropriate hard- and software on the campuses of all or most of the four-year and two-year colleges in the state, linking the entire state educational network, has not yet been realized.

The MERIT system faces a rather acute problem which seems generic to not-for-profit installations; the three-way linkup's tremendous capacity is being seriously underused. The capacity was created with the expectation of a steady, if not exponential, increase in research and development activities throughout the 70's. That expectation clearly has not been realized and the network suffers a continuous deficit situation.

One small example may illustrate other problems. Individuals in the University of Michigan Center for the Improvement of Instruction have been interested in the concepts and practice of computer-assisted instruction and would like to see a spread of interest in such activities throughout the state. They have seen junior colleges as fertile fields for expansion of computer-assisted instruction, yet junior and liberal arts colleges do not have computer capacity, nor are their faculties oftentimes knowledgeable about operating computer arrangements. The MERIT system seemed an ideal solution, if terminals or telephone connections could be established on junior and liberal arts college campuses throughout the state and if instructors could be trained to use the system and to develop computer-assisted modules for their classes. After several years of continuous effort, a few people on a few nearby junior college campuses did develop instructional units and were experimenting with them in their classes. However, the dream of such activity greatly increasing the use of MERIT proved to be illusory.

Still a different sort of network is maintained at the University of Texas at Austin to support computer based or assisted instruction.

> Academic computing has been centralized at UT Austin for many years. We have a seven-year old Control Data 6600 and a younger 6400 which are connected through a large core memory and through a large mass storage system. The computers operate independently but share a common file system. They are used exclusively for academic purposes with all data processing being handled in a separate business office computer. The 6400 is serving the interactive users through 128 timesharing ports, and the 6600 is handling the batch load through 16 remote batch entry terminals. There are also computers serving special academic needs on the campus, but nearly all are interconnected with the 6600, forming a campus computer network. Like most institutions with large computer facilities, Texas has used its computers primarily for support of large research projects, particularly in the natural sciences. Things have changed, however, and we have seen a substantial upswing in the use of computers in instruction.
>
> Texas served as the host or supplier institution in one of the National Science

Foundation regional computer networks during the three academic years 1969-1972. We had nine other colleges and universities engaged in that experiment, and it proved to be a successful one. Today we have 23 institutions in our educational network, which is operating without any NSF support.

The success of the southwest regional network was similar to that of other regional networks. That is, we succeeded in the technical aspects of getting terminals and communication lines installed and checked out, and interactive and remote batch services were brought to a stable, reliable state. Unfortunately, however, most of the network projects were too short to do much more than get themselves under way, and even then a number of them faltered and disappeared.[8]

In an effort to determine possible limits to a large-scale computer based instructional network, the National Science Foundation has joined with the University of Texas in the large-scale Computer-Based Instruction Project (C-BE). It has four primary goals:

1. To identify the common concepts among disciplines, 2. To develop evaluation schema, 3. To develop transferability criteria, and 4. To develop an implementation model.

Ultimately, the project will involve 75 professors and over 4,000 students in 44 different curriculum development and demonstration projects. The project is entering its third year and its impact is readily apparent. For example, this semester, 25 of the sub-projects will be testing computer-based instructional modules with 1,200 students averaging 2,000 console hours per week. A wide spectrum of disciplines is represented, including physics, chemistry, psychology, engineering, statistics, biometrics, linguistics and home economics.

Without any question, Project C-BE is helping to bring about changes in the educational policies of the university, including a change in the university attitude toward the allocation of computer resources.[9]

A related project, also sponsored by the National Science Foundation, links five regional computer networks, each using a different type of computer system. Collectively, they serve almost 275,000 students in 100 institutions of higher education. The project, named CONDUIT, was designed to improve undergraduate education in a cost-effective way, through the exchange of computer-related instructional materials. But before that purpose could be achieved, more had to be known as to how curriculum material did function in actual use and how it was disseminated. Then the task was to determine the requisites for transferability of materials, by looking at different methods of transfer. This task breaks down into 10 sub-objectives which illustrate not only the project's complexity, but also many issues and perplexities facing networking generally:

1. Create dissemination strategies which differ in the manner in which they perform their various functions.
2. Obtain quantitative measures of "success" of dissemination.
3. Determine subjective aspects of computer-based materials dissemination such as acceptance and attitudes.
4. Determine guidelines for technical transport.
5. Establish a small high-quality reservoir of materials based on experimentation with disciplinary review and technical verification of the materials.
6. Publicize the availability of materials.
7. Obtain cost-effectiveness data.
8. Determine the irreducible minimum of procedures for dissemination.
9. Provide insight into the human inter-relationships that must necessarily accompany distribution activities on a national scale.
10. Determine which CONDUIT services could be

made wholly or part self-supporting and what the long-range role of CONDUIT should be in the dissemination of computer-related curriculum materials.[10]

In approximately two years, CONDUIT has selected, produced and installed 87 program modules arranged selectively, which have been used by 60 professors with 7,600 students. However, such use is still highly experimental. What has yet to be proven is whether such a complex system can be made operational. The administration of the University of Texas believes it can, as do those directly involved with the project. But the real testing here, as with similar projects, still lies in the future.[11]

Bibliographic

The networks thus far sketched for the most part assist academic institutions in sharing instructional resources and computing capability. A significantly different kind of network focuses upon stored information--bibliographic or substantive--which is made easily accessible to network participants. One of these is an on-line information retrieval system for toxicology, operating under the title TOXLINE. Toxicology--concerned with the effects of chemicals on living organisms and their component sub-systems--plays an important role in attempts to protect man from adverse effects of the natural environment, as well as the man-modified environment. However, toxicology is a multi-disciplinary topic, cutting across such fields as biology, analytic chemistry, biochemistry, pharmacology, medicine and so on. By 1966 a need became apparent for some systematic filing of toxicological information which would obviate users having to search relevant files in all of the component fields. Thus, in 1967 the National Institutes of Health established a toxicology information program with the objectives of creating automated data banks and disseminating toxicology information throughout the medical and scientific communities. TOXLINE, since its founding, has maintained query-response activities, the publication of journals and monographs and, of course, the on-line retrieval system. Essentially, the system scrutinizes such sources of information as MEDLINE, which covers and abstracts 2,200 journals, chemical abstracts, biological abstracts and fugitive literature.

The initial identification of the TOXLINE collection and the abstracting and placement of data in a computer were accomplished under a contract with the National Library of Medicine. The file now is lodged in an IBM 360 series computer which in turn is linked to the national communications network of Tyme-Share, Inc. In 1972 the project was sufficiently advanced that services could be offered at a rate of $45 per terminal hour, which represented a partial cost recovery. By 1974 the system was processing about 24,000 searches per year and had some 300,000 citations recorded in its data bank. A preliminary impression of this system is that it may be encouraging direct users of information to do their own searches. In days before computers, practitioners and researchers would generally have to search for information themselves. The computer proved to be a rather formidable element which researchers, unless technically precocious, were reluctant to face directly. This led to on-line interactive searches being carried out by people who were not directly or creatively involved in research. Experience with TOXLINE reveals that the essential elements of interaction can be inculcated, and that researchers can once again deal directly with sources of information. The TOXLINE also seems to have established a rather clear conclusion: With enough financial support and diligence, essential elements from several disciplines can be extracted and put together in a new information system. This accomplishment suggests that a similar approach could be used to build on-line interactive retrieval systems for most interdisciplinary specialty areas in science and technology, when external agents provide the funding.

Beyond question, the most widely publicized network for bibliographic purposes is the Ohio College Library Center (OCLC), created as a not-for-profit corporation in order to provide greater cooperation among Ohio libraries and library systems outside of Ohio. Approximately 50 academic institutions and public libraries in Ohio make up the essential cadre of system users. Cooperative ventures on the part of Ohio libraries date back to the 1950's. However, it was not until the latter part of the 1960's that serious efforts were made to develop a computer-based system which would assist library personnel in carrying on the classical library services of ordering, acquiring and cataloging.

The essential OCLC goals were envisioned as shared cataloging, remote catalog access and circulation control, serials control, a technical processing system and retrieval of information by subject. Once the mission was decided upon, developers made an exhaustive and exhausting search for appropriate equipment. The final decision came after a number of competing systems were tested through simulation. The Xerox Sigma-5 computer emerged as the most versatile piece of equipment for accomodating all needs.

By the summer of 1970 over one-third of the 50 members were situated so as to link into the catalog production system. In that system, MARC (Machine Readable Cataloging) tapes were searched and appropriate bibliographic information recorded. It was then possible to derive information from the system to print on cards which could be shipped to member institutions for inclusion in their individual card catalogs. It should be pointed out that this simple sounding act required considerable technical sophistication and modification of equipment so that the ideosyncratic needs of all users could be accomodated. As the system became more fully operational in the early 1970's, other modifications were accomplished so that the catalog production system could accomodate 8,000 combinations of printing options available for user library catalogs. Then came a training period for catalogers. By February 1972, the OCLC system allowed smooth meshing of member-created records and Library of Congress records which could facilitate accurate location of titles and the preparation of almost any catalog card needed. The original system dealt with book titles, and in 1973 a parallel system went into operation dealing with journals and other serial publications. By 1975 the OCLC had expanded its linkages to almost 1,200 libraries and emerged as the largest of a growing number of networks designed for facilitating, locating, ordering and cataloging library materials. In the near future, the OCLC will embark on a procedure for the retrieval of information, procedures to facilitate interlibrary loans and then into other information services needed by the Center.

Somewhat more functionally elaborate than the Ohio system is the BALLOTS (Bibliographic Automation of Large Library Operations Using a Time-Sharing System) system at Stanford University.[12] BALLOTS was designed originally to facilitate bibliographic automation for large research libraries. With funds from the United States Office of Education and the National Science Foundation, Stanford University Libraries have developed a computer-based system for acquiring and processing library materials. Development began in 1967 and, after careful evaluation and significant modification, the system entered continuous production in 1972. With it, the library acquisition department at Stanford now can order books and periodicals, with the computer placing the order, recording the document arrival and tracing its progress until it has been shelved in the stacks and a record of it placed in the card catalog. The system operates through terminals connected to an IBM-360 Model 67 computer located a mile away from the main Stanford Library.

BALLOTS maintains a Library of Congress MARC file and three additional files. The MARC file is updated once a week with Library of Congress records on magnetic tape. The information thus received is classified under four elements: Personal names, corporate or conference names, title words and Library of Congress card number.

The in-process file contains information about documents ordered or being processed. When a document is ordered, it is done in the language of the MARC file, the Stanford card catalog or the most precise bibliographic information available to the acquisition department. The file contains information on each step of the acquisition process taken by each document ordered. Once the document reaches its final destination in the library system, the temporary process information is deleted from the file and only catalog data remain. The file may be reached with the four MARC elements or with the BALLOTS identification number.

The catalog data file contains complete bibliographic data on all materials acquired and uses the same indexes as does the in-process file along with the Library of Congress subject heading and call number.

The reference file contains the information needed to locate a title in the catalog data file. It operates when a user at a terminal keyboard asks the computer to find all records which contain certain specified words. Thus a search in the personal name index of the name "White" would generate all versions of the name contained in the file. The system is sufficiently sensitive that it will produce information even when fragmentary or truncated words, phrases or numbers are used. The system even will decide which files should be searched if the user does not indicate this information.

The total BALLOTS system involves nine computerized functions: Ordering, receiving, non-purchase order material receipt, claiming and cancelling, cataloging, in-process material distribution, catalog records maintenance, reference input and maintenance, and standing search removal. The user is led through these functions by a protocol indicating the relevant commands to operate the system. The resultant information is projected on a screen, and the user is then stimulated to issue the next relevant command. If the user does not, the system issues the next appropriate command to itself. When the screen finally portrays a full bibliographic profile of a document and places an order for it, the information is recorded in the appropriate files.

BALLOTS has implications for several library departments. It has made acquisitions more efficient and error-free. It has, for example, saved six positions, or one-third of the order division. It also has increased the range of words which can be used in various combinations to search the files. While this is a complex matter, the staff has been trained to use the system. Because BALLOTS is used regularly, the previous endemic backlog of orders and documents received has been eliminated.[13]

The catalog department also has been improved. Even with a reduced staff, the amount of cataloged material has increased and cataloging delays reduced. As of November 1974, 80% of all titles were cataloged through BALLOTS. Especially significant has been the preparation of cards for the card catalog. When done manually, this was a tedious process. BALLOTS potentially can be linked to other systems in California or the nation.

Others

Thus far, the networks described in this paper have been reasonably well-publicized, and elaborate descriptions of them appear in a variety of sources. A number of lesser known examples, however, can suggest both the potentialities and the limitations of networking. One example is the Cooperative Information Network (CIN) in Santa Clara County, California, begun in 1972 and headquartered in the library of Stanford University.[14] CIN's principal purpose was to respond to the informational needs of individuals, governmental units and businesses located in Santa Clara County. Its first project was to survey the various library collections within the County and to record the details of the nature of those collections so that they could be retrieved via TWX (Teletypewriter Exchange) equipment. By the end of the first year, the adjacent San Mateo County had joined the organization, followed by Santa Cruz and Monterey Counties.

The organization is non-intrusive, imposing no rules on member libraries, which continue their own processes as they see fit. The one condition for membership is that each library respond to requests for information regarding its collection within 24 hours. In addition to the principal mission of reference referral via TWX equipment, a number of workshops or roundtable discussions were held on how to accept queries through network channels. These small workshops proved to be substantially more effective than large conference-style modes of dissemination. A series of internships were developed which enabled librarians from one organization to serve in other types of libraries in the four-county area. Saturday seminars were organized, based on subjects requested by the membership, with expertise provided by participating institutions.

The next logical step was to use computerized retrieval of information. Four libraries were involved in the initial experiment funded by the National Science Foundation. Today, CIN can offer the general public immediate access to four million references and abstracts through computerized retrieval by Lockheed.

A major concern throughout all activities has been that the system be fully utilized. Thus, CIN has worked diligently at distributing brochures and publications lists to encourage greater use.

> Two of the major problems that CIN faces are promoting awareness and use of the network and evaluating the results. Apathy or indifference remains a major hurdle in promoting the dynamics of usage. There is a wide band of apathy which cuts across through the professional library cadre and out to the general public and to the government units and businesses who could benefit from the

> information now so much more readily available. Overcoming that apathy required professional promotion. It cannot be left as the short straw selected by an unwilling librarian.[15]

The second problem, that of evaluation, is exemplified through a series of questions:

> How does one judge the usefulness of a library network? Is the value of a credit or insurance plan based only on the number of times you use it, or on the comforting knowledge that it exists if you need it? Can a network be evaluated statistically? What are network statistics anyway? Is it all the little pencil scratches made by reference librarians of member libraries each time they are asked a question? Only those questions which require a library to transcend its own collection for an answer? Or only those questions which transcend the collections of an existing library system? Must the questions have fishtailed their way through multitype libraries to qualify as network statistics? Are normal transactions between member libraries disqualified because such transactions existed before the network came into being? What of the strengthening and reaffirmation of transactions between libraries as the result of their mutual participation in a larger reference umbrella which enabled them to become more familiar with each other and each other's collections?[16]

Representing a different kind of network is Washington University's Periodical Holdings in the Library of the School of Medicine (PHILSOM). It began in 1963 and now is used as a serials control mechanism for eight medical libraries throughout the country. The system deals with approximately 11,000 periodicals; however, almost half of them are not being received by any system library. Each library is provided with a list of holdings of the serials in all libraries, annotated according to the desires of the individual librarians. This list is rather simple, intended for users. A second, more elaborate listing with precise bibliographical details is supplied for serial librarians. In addition, each library receives binding slips for journals, lists of journals which should be re-ordered, and IBM cards indicating the journals to be published the following month. A library wishing to enter the network first must supply enough information on its own journal holdings and management to indicate whether it can be served. Once a library has joined, it records and updates its own holdings with the system.

This network has encountered a number of problems. A generic problem is that the system was designed for one library and then adapted to a number of others, requiring standardization of bibliographic listing, binding slips and cross-referencing. Then, too, the matter of cooperation among libraries requires some continuity of personnel, a continuity which does not seem to be characteristic of serials librarians or cle[illegible] This has resulted in the need to constantly prepare manuals and news bulletins to educate new personnel. As with other networks, the increased volume of periodical material poses problems, such as the increased size of printouts which computing facilities must produce each month. The computing capacity now used proves adequate only when the work is done at extremely asymmetrical times.[17] PHILSOM has just begun producing its union list on microfiche, and is adding a minicomputer to provide for more individualized on-line service.

Reasonably well-developed networks have been examined up to this point. To gain some understanding of the problems and issues involved during the developmental stages of networks, one emerging system now will be described--the Northeast Academic Science Information Center, sponsored by the New England Board of Higher Education and financed by the National Science Foundation.[18] Its aim is to produce machine-readable bibliographic information resources to support academic research in the northeast. Through its program, efficient and effective links are made between academic libraries and commercial suppliers of computerized literature searching. It also wishes to link the enormous library resources of such institutions as Harvard and MIT (Massachusetts Institute of Technology) in order to serve researchers throughout the region.

The first tasks were to examine available computerized literature searching services for relevance, persuade potential users of anticipated values from the system, train potential users, and create an effective management system. There was some degree of urgency in creating a useful system because, simultaneously with the creation of the Center, two major commercial suppliers of bibliographic services were persuading institutions to make individual arrangements. This urgency forced the Center staff to forego broad comprehensive planning and to develop and advertise various ad hoc techniques and services. Thus the preparation of user manuals was delayed and the kind of data collected and made available through the system was severely limited. In their place, such activities as marketing potential services and training librarians occupied a great deal of time--matters which were originally planned for later concentrated effort.

By the end of the second year, plans had been completed to link participating libraries with 14 existing bibliographic data bases such as the Educational Resources Information Center (ERIC) and Psychological Abstracts. The staff, although expanded, had been unable to complete a comprehensive user manual. The choice between contracting an external agency to prepare the manual or further expanding the Center staff to do the work was resolved in favor of staff expansion. Meetings of library directors from participating institutions were held to develop administrative guidelines and criteria for equipment acquisition. And, of course, a great deal of time was spent interesting other libraries in the system. Underlying all these activities was the intent to create a system which would be financially self-sustaining. Considerable external funding was needed to create the network, but such resources would eventually end. Three alternative financial arrangements have been considered: (1) Institutional subscription; (2) rebates from commercial vendors in return for increased use of those services; or (3) external support or finances gained from selling special services. None of these has proven successful elsewhere, but Center officials believe that in the future, vendors of computer services can be convinced to help support the activity.[19]

FACTORS IN THE DEVELOPMENT OF NETWORKING

The rather explosive interest and activity in networking seems to be attributable to a number of factors, forces and conditions. Among these factors are sophisticated technology, growth of multi-campus educational systems, expansion of available information to be stored, and the presence of developmental funding.

One of the most obvious factors is the sheer existence of sophisticated equipment needed to link and interface people and organizations with different kinds of computer technology and data bases. While eventually rather complex networks such as MERIT will be used to capacity, one has the distinct impression when visiting the three Michigan campuses that, in large part, the initiative to produce the network came from computer scientists and technologists who wanted to use new generations of computers as they became available.

In recent years some universities have experimented with structures other than a single university-wide computer center. While there are some operational reasons for this, at least part of the motivation is simply that new technology is available. Many computers selling for twelve to twenty thousand dollars have been developed which can meet the needs of departments and researchers. A typical scenario is for a department of statistics, for example, which includes funds for the payment of computer charges on all of its research grants, to use the budgeted funds to purchase a small computer rather than pay fees to use the university's central computer.

A second technological development is the capacity to use computers remotely, either in a time-sharing or remote job entry mode. This development allows people to look to a much larger market for needed services and to find the particular piece of equipment most ideally suited to a set of specific needs. It is this particular development that makes the ARPANET network possible, since it links different kinds and sizes of computers and gives the user a choice of which to adopt. Relatedly, there are "improvements in computer communications technology and in data transmission and switching procedures which make it easier and less costly to have connections between unlike computers running under unlike operating systems across great distances. The resulting networks are spreading and are beginning to provide what could become an important new mode, called networking."[20] Networking is also facilitated through the development of larger and less expensive memory cores which make feasible the amassing of more and bigger data banks.

Another contributing development is simply the professional, technical and creative motivations and interests of people who have entered the new fields of computer or information science. It would appear that the sophistication of networks far exceeds the skills of potential users, even though such networks should be designed simply, with the unsophisticated user in mind. The reason for the excessive complexity seems to be the satisfaction of those who design and program the equipment. It is said, for example, that the ARPANET network, which is a highly sophisticated linking of different computers, is of major value because it interests creative computer scientists.

A description of programming and ARPANET makes the point:

> What makes programming fascinating, of course, is that the programmer finds himself dealing with a fabulous medium in which he can create castles in the air and have his boss call them programs and pay him for them. Anyone who has had the experience of building a computer program model has some feeling for the importance of synthesis in bringing the computer into the scientific process.... ARPANET is a joy to programmers and researchers who know enough about programming to find their way around and to master procedures that have not yet been fully mastered for them. It attracts creative programmers and creative programmers create the kinds of systems and services that they like and need--systems and services that have much in common with those that other creative people, not programmers, like and need.[21]

Another factor is the growing tendency for individual institutions to be linked together in systems of campuses or into multi-campus universities. In 1957 only 10 states had supra-institutional coordinating or controlling agencies. By the early 1970's public institutions in all states were subordinated to some form of these agencies. These coordinating or controlling bodies have come into existence mainly to try to bring under control the burgeoning costs of higher education, and hence they have sought to centralize activities whenever savings seemed plausible. Among the most rigidly centralized are the 19 institutions called the California State Universities and Colleges. Since its creation in 1960, the Chancellor's office has instituted more and more centralized activity on the ground of economy. The Chancellor's office realized the frightening cost of providing uncoordinated computing services to member institutions and produced a plan for a network and centralized capacity which could effect economies. Each campus has some computing capacity and these facilities are linked to each other and to a much larger facility on the campus of the University of California at Los Angeles. The California state system is not totally acceptable to some. It is argued that the network imposes excessive restraints on institutions which retard growth, innovation and independence of investigation. However, the centralized system is supported in Sacramento and by the Chancellor, who feels that a high degree of structure is imperative if the needs of the people are to be served.

During the formative developmental years of computing, campus users were few. There were, of course, the computer scientists and technologists who were developing a new interdisciplinary specialty having great promise. Computers were used by researchers facing large aggregations of data for whom the sheer capacity of computer data processing was a godsend. Administratively, computers were used for payrolls and other financial data, and only gradually graduated to more sophisticated tasks such as maintaining and utilizing personnel records, space data and the like. Relatively little was actually done with respect to instructional or bibliographical problems before the mid-1960's. One primitive exception was the storage in one computer and retrieval and conversion to print by another of the text of portions of Gone With The Wind. However, the number of potential users and uses has grown significantly. Today, we find expanded variety of computer-aided instruction, expanded scope and variety of bibliographies which can be recorded and retrieved, and expanded storage of full texts. The following table indicates potential users, purposes and the real or potential market for services, with approximate costs.[22]

Table 10.1. Matrix of Potential Network Services

Type of Service	Intended Usage	Market Scope and Growth Potential	Access Mode	Prototype Sources	Status and Availability
Computer-aided instruction	Elementary, secondary, and vocational	118,000 schools and 51,000,000 students. Cost, service availability, and availability of quality materials primarily limit growth potential.	Interactive	Stanford University IMSSS PDP-10	Operational to east and west coasts, 25 schools and about 300 terminals
				Mitre TICCIT McLean, Va. Nova 800	Large-scale trials being developed for 1973–74.
Large-scale computing	Scientific research	About 300 organizations, 66,000 academic users, 225,000 federal and related industry users.* Service reliability, user assistance, and applications support limit increased utilization of large remote centers.	Interactive or RJE	UCLA Campus Net IBM 360/91	Operational on ARPANET
				UCLA Health Services IBM 360/91	Operational with dial-up access
				Johns Hopkins University IBM 360/91	Operational with dial-up access
Retrospective bibliographic search	General research	About 300 organizations, 66,000 academic users, 225,000 federal and related industry users.* Cost is primary limit to wider use; service availability may limit interactive usage also.	Interactive RJE	LEADERMART Lehigh University, CDC 6400	Operational with dial-up access, several major data bases
				University of Georgia IBM 360/65	Operational on regional network, many data bases

* Based on "National Patterns of R&D Resources," NSF Report 70-46, December 1970, and "Research and Development in Industry-1969," NSF Report 70-18, January 1970. The table is only an illustration of the form.

Quite obviously, a major factor in the development of bibliographic networks is the tremendous increase in the amount of data in all disciplines and the need to store information so that it can be quickly and efficiently retrieved. As recently as the late 1950's, one could generalize in a number of fields such as psychology or biology that it was probably cheaper to redo an experiment than to search through fugitive and unordered archives to find the results of the same experiment conducted earlier. For all sorts of reasons, including inflation of costs, such a generalization no longer can be made. In general, organizations and institutions should seriously consider network possibilities if they must deal with large amounts of textual or bibliographic data, if a large amount of data must be stored, and if the data must be disseminated over a wide geographic area. On the other hand, not everyone needs to cope with large amounts of data or titles or annotations or texts, and for those people, linking into a complex network is not particularly advisable.

Similar to many other developments in schools and colleges since World War II, networking has been stimulated by the availability of external funding. Not only has the National Science Foundation (NSF) provided direct subsidy for institutions wishing to develop computing capacity, but research supported by a number of federal agencies also has helped to underwrite the expansion of computer use. The NSF supported development of computing facilities on individual campuses and also in regional organizations like the

Triangle University's Computation Center. Foundations such as the Exxon Education Foundation have been particularly interested in the potentiality of computer uses and have supported projects including the linking of ten mid-western liberal arts colleges into a network to facilitate data exchange and to improve management planning. That same foundation contributed to a complex network of large and small computers for instruction in the science and engineering departments at the University of Texas at Austin and to an effort to increase usage of the MERIT network. It seems apparent that without specific external financial support, development of computers at educational institutions probably would have remained at a relatively low and unsophisticated level. Even clearer is the likelihood that networking would not have advanced except under the impetus of external funding. It is possible to argue that, in the long run, computers and networks of computer resources and services should be self-sustaining, at least within the standard "hard money" funding of educational institutions. Whether that goal can ever be reached is highly conjectural.

In a more speculative vein, one can theorize that some of the incentives to use networks involve lower costs. Networks could result in reduced cost for library clerical work, and other economies could come from the use of computer capacity and from use of a large-scale network. The models for these economies are mainly commercial ones, but the cost benefit factor has been ignored in most literature of networking.

CURRENT ISSUES IN NETWORKING

The examples described in the early section of this monograph and the forces which produced them suggest a number of issues which must be resolved before the true worth of networks can be established and their future comprehended. Essentially, the issues discussed below are: Benefits vs. dangers, questions of productivity and efficiency, economic viability, limits to the amount of information stored and the optimum number of networks that can be formed, and finally, quality filters for information handled by networks.

The first issue involves polar positions with respect to the values and dangers of computer-based networks. At one extreme are the advocates of networks who see in them a revolution, not only in information processing, but also in the quality, intensity and magnitude of actual uses of information. To them the following scenario is an accurate forecast of the future as most people will use it:

> A medical researcher sits at an on-line terminal in Honolulu searching an index to the world's medical literature stored on a computer in Bethesda, Maryland, over 5,000 miles away. His request passes across a radio network of the University of Hawaii. Arriving at a centrally placed message-processing mini-computer, it is operated on, then turned over

> to the Hawaiian telephone company's network for transmittal across the Pacific Ocean via an international satellite. In the continental United States the request is operated on once more by a message processor of a nation-wide research network, then converted and routed to a commercial time-sharing network that moves it along to the medical information system in Bethesda. By mail the request would have taken several days. By computer-communication networks it takes less than five seconds. The response to the request, a set of literature citations, starts printing out at the terminal back in Honolulu within fifteen seconds from the time the request was dispatched.[23]

At the other end of the continuum are those who fear computer aggregates of data as a threat or as an unnecessary dehumanization of administration, teaching or even scholarship. Opponents of networking seem to be of two general sorts: Those who are sure it will work and those who are afraid it will.

As with so many other matters, reality probably rests some place between these extremes. The specific value of networking will depend to some extent on how other contributing issues are resolved.

One of these issues is obvious: Do networks increase productivity and efficiency? If they do, then other issues arise, such as: Does the existence of a complex network actually result in more extensive, effective or efficient actual behavior? Does an instructional network lead to more efficient undergraduate teaching which produces the same or better results than more conventional methods? Does easy access to enormous amounts of bibliographic data result in any greater use of such data or better and more balance of scholarship? Does the MERIT system result in more, or more significant, research in the three Michigan institutions than before the network? Do networks of management information result in more detailed planning, and does that planning produce any difference in the educational outcomes sought by the institution?

The existing literature is for the most part silent regarding such matters. Several of the bibliographic networks such as OCLC or BALLOTS have evidence regarding some economies and librarian satisfaction. But there is no evidence as to whether requisitions for literature on the part of professors is greater or whether the libraries are more frequently used because of the increased potential resources.

To some, this may seem an irrelevant matter on the assumption that the improved acquisitions function is a sufficient end, and that as libraries develop access to a larger pool of potential parts of a collection, greater student and faculty use will likely occur. This may be true, but eventually the cost of complex installations must be measured against results, especially once external funding ends and the system must maintain itself. Greater precision in the preparation of cards for a catalog, or greater speed in ordering books and periodicals may well be worth the effort, but that fact should be either established or warranted.

A logical next issue is whether non-commercial networks can be made economically viable. Most of the more prominent networks have been started with external financial assistance from the federal government, foundations, or state appropriations. Now, such funding support for a potentially significant tool seems warranted. However, long-term financing would seem to require different methods, so that something comparable to self-sustaining financing results. Thus, payment for regular services should be built into appropriations for public institutions or libraries and should be included in the "hard money" budget of private institutions. If a network of games and computer simulation programs available in all eight general campuses of the University of California is to be orchestrated into a major resource, then funds for such services should be incorporated into budgets of individual campuses or the University system, with services then provided free to member campuses. If junior colleges and liberal arts colleges in Michigan are to use the MERIT system as a regular and major instructional device, then at some point the institutions must become convinced that the services are worthwhile and build payment into their regular budgets.

Viable sustaining systems of financing have not yet been found except for a few networks like OCLC which provide a valued service for a sufficiently large clientele. Whether some of the desired future developments of OCLC, such as a major retrieval of information effort, can be self-sustaining, or can be supported by the card production function, is another question.

To dramatize one aspect of this funding issue, assume for the moment that 20 or 30 disciplinary fields, through their associations, each had developed a bibliographic data base to serve scholars in its field. Would institutions appropriate funds which would allow libraries to subscribe to all bases or individual departments to build subscription costs into their budgets? Or in the CONDUIT program cited earlier, assuming an adequate library of modules, would a small institution pay enough for course materials to provide the overhead for CONDUIT to sustain itself? Evidence from other innovations calls this possibility into question. For example, a small institution in the Northwest was willing to offer a completely video-taped course in advanced chemistry as long as a foundation underwrote all expenses, but it was unwilling to use its own resources to continue the program.

Another issue involves the limits of information which can be economically stored in a network. As computer capacity enlarges, and especially as new kinds of memory such as holograms are developed, it will be technically possible to store not just bibliographic data and reasonably brief annotations, but complete texts as well. However, the manpower to place such textual materials into computers is enormously expensive, making that level of storage unlikely in the foreseeable future. In the meantime, restricting networks to bibliographic materials alone tends to limit their full utility. Long lists of titles are not often useful to the scholar, simply because of the time and money needed to locate and read each of the cited documents.

Another issue concerns how many of each type of network the nation actually needs. One conceptualization of networks posits three distinct types of networks: User-services, transmission, and facilitating networks. Facilitating networks are visualized as mediating between transmission and user-services networks. Current thinking indicates that one, two, or a few facilitating networks might be enough for the entire country, but that a large computation center would allow various smaller computers to serve the needs of departments and organizations. No long-range national plan has been developed along these lines, in part because deployment of computer resources at a national level is still threatening to many local systems.

This matter of local vs. national systems is significant enough to be a discrete and complicated issue. As the potential of computers was realized, institutions began to develop large computation centers and to increase computer capacity. Then costs began to soar, just as federal research funds with provisions for computer use began to decline. At the same time, two potentially more economical alternatives became available: Small computers for specific purposes, and large-scale networking. Those involved in computation centers obviously wanted to preserve their domains, and institutions wanted to maintain control over their computer activities. Based on these needs, it seems likely that networking is the reasonable shape of the immediate future. However, quite specific provisions are required to accomplish the economies of the larger operations and at the same time to provide participating organizations with some control and voice in policy.

A different issue involves bibliographic networks whose listings go beyond simple author, title, and source information and whose annotations are of varying lengths. The Educational Resources Information Center (ERIC) system funded by the National Institute of Education is a good example. Some involved persons have questioned whether evaluation of information could be included to help users winnow through the volume of listings stored in ERIC. With no evaluative comment, users' time can be wasted. Yet obtaining qualified evaluation would be very expensive, and, in the case of ERIC, contrary to public policy and the will of Congress. Yet if the volume of listings continues to increase and the scope of sources of information expands, the problem of selecting the valid from the invalid or questionable becomes even more serious.

THE FUTURE OF NETWORKING

This paper is intended as a primer regarding networking and as an indicator to other relevant literature. It attempts to be descriptive only, particularly with respect to controversial issues. Consistent with that posture several lines of future development can be examined. After briefly exploring a few educated predictions about the future of Western society in general and technology more specifically, this section discusses networking in coming years in terms of interdependence, rich bibliographic information, facsimile transmission, administrative and library uses of computers, and integrated projects of national organizations. Leading to the conclusion is a quick look at computerized networking in the larger context of formal and informal education needs in the future.

It is highly dangerous to anticipate what will happen in 25 years, because all sorts of accidental events can intervene to alter the parameters of the future. However, since planning is still needed, some assumptions regarding future events--perhaps an extrapolation of conditions in 1975--will portray, at least dimly, the outlines of the future into which we are moving. And it is in the context of that future that the likely uses of networking will be viewed. The editors of the Summer 1967 Daedalus entitled "Toward the Year 2000--Work in Progress" used a number of different techniques to anticipate the future, one of which was an extrapolation from present tendencies. They found that in Western society there is a basic long-term trend toward:

1. Increasingly Sensate (empirical, this-worldly, secular, humanistic, pragmatic, utilitarian, contractual, epicurean, or hedonistic) cultures

2. Bourgeois, bureaucratic, "meritocratic," democratic (and nationalistic?) elites

3. Accumulation of scientific and technological knowledge

4. Institutionalization of change, especially research, development, innovation, and diffusion

5. World-wide industrialization and modernization

6. Increasing affluence and (recently) leisure

7. Population growth

8. Decreasing importance of primary education

9. Urbanization and (soon) the growth of megalopolises

10. Literacy and education

11. Increased capability for mass education

12. Increasing tempo of change

13. Increasing universality of these trends.[24]

Several of these trends can be challenged by events which have taken place since 1967. Certainly the sudden awareness of worldwide shortages of sources of energy calls the possibility of increasing affluence into question. Also, in the developed nations such as the United States, the possibility of continued population growth must be severely challenged. However, for the most part, there seems little evidence eight years after the predictions were made that they are not rather close to the trends that have actually developed.

Assuming that such a picture of the future is reasonably accurate, one can then also extrapolate from existing technical developments to arrive at indications at least of what the technology will look like by the year 2000. A quick scanning of a few of 100 technical innovations likely in the next few years clearly indicates the potential for substantial expansion of various kinds of computer networks.

> Multiple applications of lasers and masers for sensing, measuring, communicating, cutting, heating, welding, power transmission, illumination, destructive (defensive), and other purposes...
> Extensive and intensive world-wide use of high-altitude cameras for mapping, prospecting, census, land use, and geological investigations...
> New techniques in adult education...
> Inexpensive "one of a kind" design and procurement through use of computerized analysis and automated production...
> Three-dimensional photography, illustrations, movies, and television...
> General use of automation and cybernation in management and production...
> Extensive and intensive centralization (or automatic interconnection) of current and past personal and business information in high-speed data processors...
> Other new and possibly pervasive techniques for surveillance, monitoring, and control of individuals and organizations...
> New and more reliable "educational" and

propaganda techniques for affecting human behavior--public and private...

Practical use of direct electronic communication with and stimulation of the brain...

Automated universal (real time) credit, audit, and banking systems...

Inexpensive high-capacity, world-wide, regional, and local (home and business) communications (using satellites, lasers, light pipes, and so forth)...

Practical home and business use of "wired" video communication for both telephone and television (possibly including retrieval of taped material from libraries or other sources) and rapid transmission and reception of facsimiles (possibly including news, library material, commercial announcements, instantaneous mail delivery, other print-outs)...

Pervasive business use of computers for the storage, processing, and retrieval of information...

Shared-time (public and interconnected) computers generally available to home and business on a metered basis...

Other widespread use of computers for intellectual and professional assistance (translation, teaching, literary research, medical diagnosis, traffic control, crime detection, computation, design, analysis, and, to some degree, as a general intellectual collaborator)...

Home computers to "run" the household and communicate with outside world...

Home education via video and computerized and programmed learning...[25]

At about the same time the editors of "Toward the Year 2000" were trying to peer into the future, Harold B. Gores, then president of the Educational Facilities Laboratory, attempted a more limited view of the American college campus in 1980.[26] His observations, coupled with those of the Daedalus group and compared to events which have actually occurred, add a dimension of validity, especially regarding computers, libraries, and the possibilities of networking.

Assuming partial fidelity to the increases in information being accumulated, Gores noted that with libraries doubling their size every 16 years, within a very short period the costs of building, purchasing volumes, cataloging, and servicing would bankrupt even the wealthiest institutions. The solution simply had to be--not more buildings and more books--but a changed concept of the library and an expansion of the parameters and insights from the emerging field of information science.

He felt that by 1980 individual university libraries will have automated a number of clerical procedures used for acquisitions, serial control and circulation, and that smaller colleges will be banding together in statewide systems for centralized ordering and processing. The library space used for those purposes then will be re-deployed for new technical processes such as production of materials by xerography. Clearly OCLC, BALLOTS and MARC have established prototypes for this prediction.

As smaller networks expand in number, they will become more interdependent, predicted Gores.[27] Networks of networks will be linked to massive storage capacities to maintain all but the most frequently used materials. Even frequently used materials of substantial volume will be maintained in many libraries in microform, obviating the need for construction, more space, and employment of more custodial people. The fact that small institutions such as La Verne College in southern California now advertise the ERIC microfiche collection as one of their principal bibliographic holdings suggests how close to the mark that observation is.

Another development will be placing the contents of a number of card catalogs into a computer which will make enormously rich bibliographic information available at great distances from the central catalog. Again, both BALLOTS and OCLC exemplify the spirit of what Gores had in mind. He further felt that eventually a complete national catalog, entirely computerized, will be available via a number of channels to obtain quite specific categories of information.[28]

Beyond these activities lies the possibility of facsimile transmission, where documents can be reproduced by xerography in one library and the facsimile transmitted over telephone lines to be received in another. In 1975, a few prototypes of this development exist, but technical problems of substantial magnitude still intrude. Eventually, says Gores, "...we may see an international link by communications satellite between, say, the British Museum Library, France's Bibliothèque Nationale and America's Library of Congress."[29]

Events as they have unfolded since 1968 have tended to clarify some earlier projections. R.E. Levien and C. Mosmann, writing in 1972, focused on administrative and library uses of computers. They observed that, viewed in their most general aspects, the library and the computing center are natural partners, being vehicles to assist in the collection and manipulation of information. While that partnership largely has been unfulfilled, several changes could hasten a rapprochement. First, the university research library faces the enormous problem of financing, administering and managing collections growing exponentially in size. Second, college and school libraries oriented toward service to students must disseminate information through media other than books. When libraries become learning resource centers, the reality of close relationships with computers becomes apparent. Third, as fields have grown and become interrelated, cataloging requires more than a unilateral decision from one field or specialized library. This third change clearly has opened the way for computer-based methods of circulation, cataloging, indexing, and retrieval.

Obviously, computers have proven to be of importance in acquisitions and serial control. Major libraries collect new books at the rate of perhaps 500 each working day. Ordering, checking arrivals, and keeping track of the status of books in process, as well as budgeting and paying bills, constitute a clerical system into which computers can move with relative ease, and the same techniques are applicable to serials and periodicals. While the number of libraries using computer-assisted acquisition in the mid-1960's was relatively small, in 1975 the number is growing rapidly.

To a lesser degree, computers have been used successfully to assist with circulation. It is always desirable to know where documents are and to be able to direct a future user to the current user. Few manual systems have been completely satisfactory. A better system would be automated and implemented on an on-line computer system. A few larger universities have moved in this direction with either a librarian or user noting check-out or -in of a document with coded identification cards. This information is then fed immediately to a continuously revised catalog system. Lists of overdue books and other special categories can be printed and distributed daily to relevant administrative offices. By 1966 some 165 libraries were using computers in some aspects of their circulation systems, with the more successful maintaining large circulations.

Most libraries which have used computers in acquisitions also have become involved in computerized cataloging. Since 1966 the Library of Congress has operated its MARC (Machine Readable Cataloging) which weekly distributes microfilmed lists of bibliographical information acquired during the previous week. Participating libraries can convert information on magnetic tape directly to their own computer systems and then onto printed cards which are placed in the card catalog. Once libraries begin to use this sort of information, it is possible to consider computer assistance to other library functions, including publication of lists of new books by author, title, subject and organization, and specialized acquisition lists which might appeal to only one or two individuals or agencies. Individual users can be informed almost automatically when books related to their specific interests enter a system.

If specialized bibliographies become a larger activity, it will be necessary to supply more varied indicators suggesting the appropriateness of given documents. Computer-based systems now provide the means for a much more elaborate indexing system. For example, the materials classified by the ERIC Clearinghouses are identified by a growing number of descriptive terms, listed in a constantly expanding thesaurus.

Networks also can be used for compiling book catalogs rather than a card catalog, although this has proven too cumbersome for large libraries. Through a network in which several catalogs are linked together, specialized book listings can be derived and distributed to relevant users, although full implementation of this scheme seems to lie considerably in the future.

Efforts toward new and more sophisticated services for library users all have been of a research nature or have been sponsored by special, national organizations rather than individual libraries. Two projects which give a flavor of this work can be described briefly: MEDLARS and INTREX. The MEDLARS system of the National Library of Medicine is an example of a very extensive operational library service for a specialized community. For bioscience, health and medicine, MEDLARS indexes virtually every relevant book, journal article and report. Catalogs of new titles are published monthly; specialized bibliographies are produced upon request. Approximately a quarter million titles are indexed each year. Such a service is obviously well beyond the capabilities of any individual library; it must be provided through joint ventures or through national sponsorship. [See also the description of the National Library of

Medicine's TOXLINE earlier in the paper.]

INTREX is a research project at MIT, designed as a complete system of library techniques making full use of computer capabilities. Comprehensive indexing will be coupled with a natural, on-line request language to allow users to consult a computer-based file in much the way they would consult a reference librarian who happened to have memorized the complete library catalog. Many of the components of such a system have been produced in experimental environments, but they have never before been assembled into a library system. There are, for example, computer programs that will retrieve from a file of titles those satisfying such complex user requests as "publications dealing with cattle ranching or farming (but not sheep herding) in the western United States before 1850." Other programs have experimented with the problem of providing some computer-based service corresponding to the browsing which many scholars feel to be an important part of their use of libraries. Some attention has been given to the possibility of answering questions with facts rather than references, for example, by quoting answers from the texts of books instead of referring the inquirer to a bibliographic reference. INTREX is testing a number of its developments on materials drawn from the MIT engineering library.[30]

A nationwide look at the possibilities of computerized library networks within the framework of an integrated program has been summarized by the National Commission on Libraries and Information

Science in a booklet, Toward a National Program for Library and Information Services: Goals for Action.[31] In this discussion of current problems of libraries, concerns of the private sector, trends toward cooperative action, and recommendations for a national program, the Commission stresses "equal access to information for all citizens through interconnecting services and a central core of information."

In spite of the evidence of rather impressive activity revealed by this monograph and bibliography, the use of computers in libraries is still not as widespread as its proponents believe it should be. While most large libraries have begun some minimal applications of computers, computer use in smaller school, college and public libraries is still in its primitive stage. Even less well-developed are the computer services to library users as distinguished from service to library managers. This is partially so because librarians really know very little about how individual users actually make use of library facilities and materials. It may well be that the availability of a rich computer technology and a growing number of networks will force a full examination of how people use information. If carefully done, this examination could lead to substantial revolution and reform of library work.

Whether all these developments take place and become part of the mainstream of American education will depend in part on changes within formal educational structures. In general, with some significant but minor exceptions, formal education has been concerned primarily with dealing with people from approximately age 5 to perhaps age 25, with that concern expressed in rather formal structured activities carried on in specifically designated localities. In the mid-1970's, a substantial groundswell of opinion says that this sort of formal education for limited segments of the population probably should diminish in importance, while other kinds of education should expand. The Carnegie Commission on Higher Education, anticipating a learning society, reached a number of relevant conclusions, especially pertaining to post-secondary education.[32] The Commission believes post-secondary education should be concerned comparatively less with the young and more with people of all ages. The Commission also believes that more and different channels should be available for people to proceed through their various developmental learning stages. As education concerns itself with all ages, facilities such as continuing education, libraries and museums should come to play a much more central role as potent educational resources. With greater variety of educational opportunities, people should be better able to move flexibly from one of life's endeavors to another. Obviously, to achieve such an ideal, new policies must be developed regarding financing, accreditation, coordination and management in the expectation that the 'learning society' can be a better society.[33]

The widely publicized Newman Task Force on Higher Education (a parallel group to the Carnegie Commission) sees the future in a similar light with respect to computers, networks and related phenomena. The Task Force senses considerable new interest in educational diversity as new structures emerge which stress variation in sequences, times, places and intensities of learning. Institutions of society not primarily concerned with education, such as the Armed Services, have become increasingly potent originators of diverse educational activities. Such diversity is desirable, the Task Force states, because not everyone profits from the rather limited form of formal education. Since this is so, society should recognize and legitimize the serious educational activities of peripheral institutions, especially private institutions which have greater freedom to experiment. Underlying much of this concern for new kinds of institutions and new patterns of learning is the belief that education as a formal launching pad for the rest of one's life is an archaic notion. People change, knowledge changes and society changes, and people should be helped by many instrumentalities to cope with those changes. Obviously, those instrumentalities require something more than a campus. They require flexible sources of information, easy access to information and easy ways of of selecting relevant from irrelevant information.[34]

Based on such reasoning, the Carnegie Commission in its policy statement on the fourth revolution focuses specifically on networks for communications and information. It argues:

> Existing libraries and information centers have played a vital role in the formal and informal education of the American people. Until recently, our pattern of independent library establishments serving neighborhoods, communities, schools, colleges and special interests of various kinds

> has appeared adequate to the nation's needs. But now the situation has changed. The information revolution has completely overwhelmed some of the smaller and medium sized library establishments, and they have abandoned all hopes of keeping up with it. Moreover, the new technologies for communication and information storage and retrieval involve heavy expenses that many individual libraries cannot afford. There is also growing concern among librarians for other weaknesses of the nation's library system, including the fact that there is no comprehensive inventory of the nation's information resources (with the result that existing information centers are under-utilized). There is also concern for inequities in the delivery of information services.
>
> In several locations across the country, public and college libraries are forming regional library networks in response to such problems. In higher education the Ohio College Library Center and the New England Library Network are significant examples. Preliminary plans and proposals for such networks have been made in other parts of the country. To the degree that these networks become effective they make the information resources of large libraries available to small colleges with limited budgets. They also give colleges and universities a stronger united voice in claims for right of access to communications media controlled by government, and more financial capability to adopt advanced information and communication technologies.
>
> As long as the organizational framework of such networks provides those individual institutions with superior collections with adequate compensation for the use of their holdings (possibly by user's fees), we believe that information and communications networks are a logical answer to many of the problems now facing college and university libraries. Moreover we regard such networks to be, potentially, the hubs of instructional networks in higher education that should be organized on a regional level.[35]

And the Commission makes the formal recommendation that "the introduction of new technologies to help libraries continue to improve their services to increasing numbers of users should be given first priority in the efforts of colleges and universities, government agencies and other agencies seeking to achieve more rapid progress in the development of instructional technology.[36]

CONCLUSION

A somewhat more skeptical conclusion is also possible. Computing and networking have proven themselves as essential to education, but for the most part as a service supplied by experimental facilities. If such services are to live up to their potential, the equipment and ideas must be transplanted from the experimental environment to the working environment. This means that expensive and easy-to-use equipment must be developed and some way discovered to place the various requisite services on a financially self-sustaining basis. As the search for solutions to these problems progresses, the interdependency of education and the need for cooperative effort become apparent. Resource sharing and super-centralization of activity may provide users with sophisticated computing and a wide range of systems, but cooperation of a monolithic sort would likely be hurtful. Super-systems should never be so complete as to deny important work being done outside of the system, if the specific needs of some individual or agency require it.

Networking is no panacea. It is useful and can be still more useful if various issues are resolved. Its success or failure will rest on the rationality of planning and whether some of the mistakes of the past can be avoided. In the mid-1960's, for example, third generation computers were introduced to produce efficiency. However, they were so expensive and required so much re-programming that they seriously threatened some institutions' budgets and convinced some leaders that computers were a curse in disguise. As computers are linked into networks in the future, care must be taken to avoid making them excessively costly or threatening.

Finally, it seems clear that the major problems to be overcome with respect to educational or research use of networks are not technical. Technical problems either have been solved or the directions established to solve them. The real problems are political, organizational and economic. Governmental policy must be refined so as to produce health and balanced growth rather than uneven and unplanned partial growth. Universities, by tradition independent, must find ways of reorganizing their uses of computers so as to optimize effectiveness and institutional autonomy. They need to mature to a point where they will trust external agencies. And as has been indicated earlier, stable, long-range systems of financing must be found.

FOOTNOTES

[1]Lee Burchinal, "Telecommunications: Revolutionizing Science Communications," Bulletin of the American Society for Information Science, Vol. 2, No. 1 (June/July 1975), 9.

[2]George J. Feeney, "Concentration in Network Operations," in Networks for Research and Education. Sharing Computer and Information Resources Nationwide, ed. by Martin Greenberger and others (Cambridge: The Massachusetts Institute of Technology, 1974), pp. 182-188.

[3]Martin Greenberger, "Report of Workshop II," in Networks for Research and Education, ed. by Greenberger, p. 374.

[4]Charles Mosmann, Academic Computers in Service: Effective Uses for Higher Education (San Francisco: Jossey-Bass, 1973), pp. 43-44.

[5]James C. Emery, "Problems and Promises of Regional Computer Sharing," in Networks for Research and Education, ed. by Greenberger, pp. 190-193.

[6]Ibid.

[7]Mosmann, Academic Computers, p. 46.

[8]Charles H. Warlick, Computers in Instruction (Princeton, N.J.: EDUCOM, 1973), pp. 1-2.

[9]Ibid., 3.

[10]Ibid., 4.

[11]Ibid., 9-10.

[12]"Stanford University's BALLOTS System," Journal of Library Automation, Vol. 8, No. 1 (March 1975), 31-50.

[13]Ibid., pp. 41-42.

[14]Ronny Markoe, "The Cooperative Information Network--A Report," California Librarian, Vol. 35, No. 3, 16-21.

[15]Ibid., 20.

[16]Ibid., 21.

[17]William Axford, ed., Proceedings of the LARC Institute on Computerized Serials Systems (St. Louis, Missouri, May 24-25, 1973) (Tempe, Arizona: Library Automation Research and Communication Association, 1973).

[18]Northeast Academic Science Information Center, Year 2 Report, March 1974-February 1975 (Wellesley, Mass.: New England Board of Higher Education, 1975).

[19]Ibid., 18-20.

[20]Greenberger, Networks for Research and Education, p. 3.

[21]J.C.R. Licklider, "Potential of Networking for Research and Education," in Networks for Research and Education, ed. by Greenberger, p. 49.

[22]Dennis W. Fife, "Primary Issues in User Needs," in Networks for Research and Education, ed. by Greenberger, p. 93.

[23]Greenberger, Networks for Research and Education, p. xi.

[24]Herman Kahn and Anthony J. Wiener, "A Framework for Speculation," in Toward the Year 2000: Work in Progress, ed. by Daniel Bell (Boston: Houghton Mifflin Company, 1968), p. 74.

[25]Ibid., 79-84.

[26]Harold B. Gores, "The American Campus--1980," in Campus 1980, ed. by Alvin C. Eurich (New York: Delacorte Press, 1968), pp. 279-298.

[27]Ibid., 286-287.

[28]Ibid., 286-288.

[29]Ibid., 288.

[30]Roger E. Levien, ed., The Emerging Technology: Instructional Uses of the Computer in Higher Education (A Report and Recommendations by the Carnegie Commission on Higher Education) (New York: McGraw-Hill Book Company, 1972), p. 45.

[31]Toward a National Program for Library and Information Services: Goals for Action (Washington, D.C.: National Commission on Libraries and Information Science, 1975), pp. vii-xii.

[32] Lewis B. Mayhew, The Carnegie Commission on Higher Education: A Critical Analysis of the Reports and Recommendations (San Francisco: Jossey-Bass, 1973).

[33] Toward a Learning Society. Alternative Channels to Life, Work and Service (A Report and Recommendations by the Carnegie Commission on Higher Education) (New York: McGraw-Hill Book Company, 1973).

[34] The Second Newman Report, National Policy and Higher Education (Cambridge: The Massachusetts Institute of Technology Press, 1974), pp. 41-48.

[35] The Fourth Revolution, Instructional Technology in Higher Education (A Report and Recommendations by the Carnegie Commission on Higher Education) (New York: McGraw-Hill Book Company, 1972), pp. 34-35.

[36] Ibid., 51.

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GLOSSARY

ACCESS

Availability of data from the computer, usually with reference to the difference between batch and online systems.

ACCESS CONTROL

Tasks imposed on a network or any of its components, performed by hardware, software, and administrative controls, to control usage of the system. Included are monitoring of system operation, insuring of data integrity, user identification, recording system access and changes, and methods for granting users access.

BATCH PROCESSING

A procedure in which a number of transactions to be processed by the computer are accumulated and processed together. Usually they are sorted into order and matched sequentially against affected files, normally in a deferred mode.*

CENTRALIZED COMPUTER NETWORK

A computer network configuration in which a central point in the network provides computing power, control, or other services.

CIRCUIT SWITCHING

A technique in which connection is made prior to the start of communication and is used exclusively until the connection is released.

COMMON CARRIER

In telecommunication, a public utility company that is recognized as having a vested interest in and a responsibility to furnish communication services to the general public, e.g. Western Union, the Bell System.

COMMUNICATIONS COMPUTER

A computer that acts as the interface between another computer or terminal and a network, or a computer controlling data flow in a network.

* Reprinted with permission from Handbook of Data Processing for Libraries, Second Edition, by Robert M. Hayes and Joseph Becker (Los Angeles: Melville Publishing Company, 1974).

COMPUTER

A device capable of accepting information, applying a prescribed process to the information, and supplying the results of these processes. It usually consists of input and output devices, storage, arithmetic and logical units, and a control unit.

COMPUTER NETWORK

An interconnection of assemblies of computer systems, terminals, and communications facilities.

DATA

A general term used to denote the basic elements of information which can be processed or produced by a computer.

DATA BASE

A file of information, usually in machine-readable language. Can be the entire collection of information available to a given computer system.

DECENTRALIZED COMPUTER NETWORK

A computer network, where some of the network control functions are distributed over several points in the network.

DISTRIBUTED NETWORK

A network configuration in which all node pairs are connected either directly or through redundant paths through intermediate nodes.

FULLY CONNECTED NETWORK

A network in which each point in the network is directly connected with every other point.

HARDWARE

The mechanical, electrical, magnetic, and electronic devices or components of a computer.

HETEROGENOUS NETWORK

A network of dissimilar host computers, such as those of different manufacturers.

HIERARCHICAL NETWORK

A computer network in which processing and control functions are performed at several levels by computers specially suited for the functions performed.

HOMOGENOUS NETWORK

A network of similar host computers, such as those of one model of one manufacturer.

HOST COMPUTER

A computer attached to a network primarily providing services such as computation, data base access, or special programs or programing languages.

INPUT/OUTPUT

Commonly called I/O. The process of transmitting information from an external source to the computer or from the computer to an external source.

INTERACTIVE SYSTEM

A system which allows direct communication between a person at a terminal and a computer, and vice versa.

LINK

A communication path between two points in a network through which data may pass.

MESSAGE SWITCHING

A method of handling messages in which the entire item of information (message) is transmitted to an intermediate point in a network, stored for a period of time, and then transmitted again towards its destination.

NETWORK

An interconnected or interrelated group of stations, terminals, computers.

NETWORK OPERATIONS CENTER

A specialized installation that assists reliable network operations. Typical activities include monitoring of network status, supervision and coordination of network status, supervision and coordination of network maintenance, accumulation of accounting and usage data, and user support.

NODE

A point in a network--may be an end point of a junction common to two or more branches of a network.

OFFLINE SYSTEM

A system in which peripheral devices, such as card readers, card punches, magnetic tape feeds, and high-speed printers, operate independently of the central processor of the computer.

ONLINE SYSTEM

A system in which peripheral devices are in direct and continuing communications with the central processor of the computer.

OPERATING SYSTEM

A computer program by which the computer controls its management of other programs, assigning storage and input/output devices to them, controlling compilation of them, sequencing them, and the like.*

PACKET SWITCHING

A process of transmission whereby a group of data elements is transmitted as a whole and the communications link is occupied only for the duration of transmission of the packet.

PASSWORD

A string of alpha-numeric characters that is recognizable by automatic means and that permits a user access to protected storage, files, or input/output devices.

PROCESS

A systematic sequence of operations to produce a specified result or a set of related procedures and data undergoing execution and manipulation by one or more computer processing units.

*See page 68.

REGIONAL COMPUTER NETWORK

A computer network whose nodes provide access to a defined geographical area.

RESOURCE SHARING

The joint use of such resources as computational power, brain power, programs, data files, and storage capacity by a number of members of a network.

RING NETWORK

A computer network where each computer is connected to adjacent computers.

SINK

The point of usage of data in a network.

SOFTWARE

A set of computer programs, procedures, rules and associated documentation concerned with the operation of a computer.

SOURCE

The point of entry of data in a network.

STAR NETWORK

A computer network with peripheral nodes all connected to one or more computers at a centrally located facility.

TELECOMMUNICATION

Any transmission and reception of intelligence of any nature by electromagnetic systems.

TERMINAL

A device that permits data entry into or data ~ it from a computer system or computer network, very often a keyboard device similar to a typewriter.

TIME SHARING

The use of a device, especially a computer, for two or more tasks during the same time interval. This allows a number of users to execute programs concurrently and to interact with the programs during execution.

TURN AROUND TIME

The elapsed time between submission of a job to a computing center and the return of results.

VALUE ADDED SERVICE

A communications service utilizing communications common carrier networks for transmission and providing added data services with separate additional equipment.

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