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Technology Alone is Not Enough

Many have traced the evolution of information transfer from drawings on the walls of caves to inscriptions on stone tablets, to scribes writing on papyrus or other early forms of paper, to "Gutenberg technology." By now it has become trite to mention that computer and electronic communications together represent another revolution in the transfer and utilization of knowledge. Yet I mention it because we have only scratched the surface in understanding and using these mechanisms for supporting human learning and for facilitating human decision-making.

We are rapidly approaching the point at which the mechanical and inherent cost impediments of media and mechanisms for information transfer and knowledge production will disappear as limitations to reaching the full potential of information systems. With these impediments out of the way, what is left to inhibit knowledge creation and dissemination are the arrangements necessary to derive the revenue for supporting the information processing, distribution and use mechanisms, and, most of all, the limitations of human intelligence to deal with complex situations.

But this is getting ahead of the story. Let us first review the foundations that have been prepared for improving information handling.

Possibilities and Practicalities

I had the privilege of leading a study of the status of information technology and its application to libraries. It was done under the auspices of the National Academy of Sciences, and was supported by the Council on Library Resources. The results were published in 1972.¹

When we entered that study, the implied question was: "Why hasn't computer technology brought the dramatic revolution to library functions that had been expected?" And, when we started, we expected to find that some underlying technology improvement was necessary for the expected improvements in library operations to occur. Yet when we finished the study, one of our conclusions was: "The primary bar to development of national level computer-based library and information systems is no longer basically a technology feasibility problem. Rather it is the combination of complex institutional and organizational human-related problems and the inadequate economic/value system associated with these activities."² That conclusion is even more valid today than it was in 1972.

The papers in this clinic feature several examples of new tools that are becoming widely available for a variety of information system purposes. They are very interesting and promising tools, and need to be well understood for their potential for being used in the library environment and as substitutes for functions now performed in library environments. In reading about these tools throughout these papers, one should keep in mind that they must be understood far more deeply than the obvious potential each of these tools may promise individually. The proper attitude was well stated in the November 1980 issue of *Datacomm Advisor*:

Technology has advanced to a stage where the products and services of computer companies and the telecommunication companies are converging with those of the office equipment companies to produce information systems that can tie together dispersed information functions. The computer industry talks of distributed systems, but what we really mean are computer systems that are physically distributed but logically interconnected to respond to the information needs of an organization.³

This statement emphasizes that it is extremely important to understand the larger context in which the information system tools are to be applied so that they can be truly effective.

Libraries and Information Technology

Information technology is multifaceted and includes computers, telecommunications, various output devices (including photocomposers, nonimpact printers, and other image media), as well as interactive terminals. In general, information technology must provide:

- means for storage of information, appropriately organized;
- mechanisms for input of the information for machine handling;
- means for information transfer from producer to organizer, to and among storehouses, and to the consumer; also, related methods for maintenance and management of the storehouses;
- means for intellectual and physical access;

- mechanisms for output from machine form for human use;
- mechanisms for manipulation of information and for control associated with all of the above functions.⁴

Libraries, as storehouses and as institutions to enable the use of recorded human knowledge, have been around for a very long time. They are much maligned and often unappreciated institutions. Primarily because of economic pressures, they have applied technology to aid the functioning of internal library operations in acquisitions, cataloging, circulation, and interlibrary loan. Attention is now turning to improving the service-providing aspects of libraries, such as subject access and document delivery.

Toffler, in his book *The Third Wave*,⁵ referred to libraries as "Second Wave" institutions based on the printed word, centralization, economy of scale, etc. He questioned how will libraries function as social memory in the future, when the information transfer medium has shifted to computer-dominated methods and there is greater decentralization and individualization in information use.

Voices for Progress

There have been many visionaries who have projected and worked toward enhanced information systems to support knowledge organization and application. Vannevar Bush, in the *Atlantic Monthly* of July 1945, described the Memex as a mechanized memory (before computers) for recording, retrieving and using knowledge in the intellectual work of individuals.⁶

Doug Engelbart, in his work of many years which led to the Laboratory for Augmentation of Human Intellect at the Stanford Research Institute, demonstrated a prototype of an "electronic Memex" and showed how to use it for a variety of purposes. It was very clear, from observing that work, that enhancement of information systems requires intellectual discipline and training in addition to automated tools. Engelbart also rediscovered the necessity for formal organization of information in the role of information center for the Advanced Research Projects Agency (ARPA) network.

J.C.R. Licklider and colleagues at the Massachusetts Institute of Technology (MIT), in the MAC system and, subsequently, the MULTICS time-shared computer system, showed that flexible computer-supported environments were effective both for computational support of science and engineering and for report production—a forerunner of modern word processing. (TYPESET and RUNOFF were programs implemented on the MIT systems which have many descendants in the present generation of

word-processing systems.) Also, a farseeing, but premature, experiment in library automation, INTREX, was performed on that computer system base.

Murray Turoff of the New Jersey Institute of Technology has demonstrated in his Electronic Information Exchange System (EIES) the productive potential for a geographically and temporally dispersed interaction among individuals, and support of that interaction via organized recorded knowledge. Computer conferencing is another facet of information organization, storage and use.

F. Wilfrid Lancaster of the University of Illinois has always been a leading proponent of "paperless information systems." He has documented the implications of such systems, and library institutions would be well advised to understand those implications.

I have had the privilege of knowing all of these visionaries except Vannevar Bush, who was somewhat "before my time." What is striking, and what these researchers have in common, is that they all were unhindered by tradition and that, at one time or another, were not believed by their contemporaries.

In his National Federation of Abstracting and Indexing Service Miles Conrad Memorial Lecture in March 1980, Carlos Cuadra expressed the challenges to libraries in coping with the change in emphasis in the following way: "I do not know how well libraries will manage to shift their emphasis from a *collection* orientation to an *access* orientation, but I believe their survival depends to some extent on their success in doing this."⁷ The technology tools covered in these papers are concentrated on some of the means to achieve the access orientation.

Issues and Problems

Let us turn to the issues and problems that library and information professionals must face now and in the future. These fall into four categories:

1. distributed function in an integrated environment,
2. integration of information support with the work environment,
3. the economic framework, and
4. the role of the information professional.

Distributed Function in an Integrated Environment

Several years ago, much of the focus of library automation technology attention was on the central facilities required to implement library management processes—the computers, information storage media and software for large databases, and basic teleprocessing and communication

networking. In these papers, much of the attention has moved outward to the technology that will interface directly with the system users. The key elements in that technology are microcomputers of increasing power and low-cost input/output devices suitable for operation at the user site. These furnish the basis for providing functions for the user which are more responsive for small tasks than can be supported remotely over today's normal communication lines. They also provide the opportunity to support the user's own work flow directly.

These tools, however, should not be considered as isolated entities except for the most trivial jobs. Even if there were a super videodisc which would hold all the world's knowledge, its utility would have to be understood in the context of the total system necessary to collect, organize and update the information to be stored on it.

The most important functions the microcomputer technology can fulfill are to provide machine support directly to the user for coping with a heterogeneous collection of information resources, and to support the individualized interaction with that information subsequent to retrieval. Systems for online information services from library systems and from the various facets of the information industry have developed at different points in time, were guided by different design goals and principles, and are driven by different economic and service motivations. A universally standard interaction language, standard data representation, and common query formulation strategies do not exist and are not going to be developed, any more than all the countries in the world are going to switch to Esperanto. The modern Tower of Babel is embodied in the growing patchwork of resources loosely linked together by various data communication networks. Something is needed to bridge the gaps.

Intelligent terminals or, in some cases, locally supported clusters of terminals provide ways to cope with the heterogeneity and to bridge the gap between human skills and habits and the details of interacting with computer systems. Ranging from almost trivial to very challenging, the functions to be considered for implementation in such terminals include:

- automated support for administrative trivia, such as LOGON, passing of accounting and identification information, etc.;
- command language mapping and command "script" management;
- query analysis and management of the selection of resources to be accessed;
- merging and formatting of retrieved results for viewing;
- data management of, and retrieval from, private work files; and
- computer-aided training for use of all of the above-listed functions.

Until sufficiently powerful microcomputers in intelligent terminals are developed, an alternate implementation site for the more complex func-

tions would be a service host on the network to supply such intermediary services.

Present major library "networks" are not truly computer networks. They are mostly centralized service functions reachable over public and private communication networks. Some distribution of function is beginning, but this is a relatively recent development. As one becomes serious about linking these so-called networks with each other and with other electronically accessible information services for total information support for users, the kinds of bridging functions discussed will become more necessary.

Integration of Information Support with the Work Environment

The visions of Memex will not be fully achieved until retrieval of information from formal sources (libraries and other information services) can be merged naturally with locally generated information for further use in the work flow of the information seeker. This is one of the most important needs to fill by means of distributed function, as discussed previously. In order to do this, the information must be received in the local system in digital (machine-readable) form rather than as the image of a page, or must be selectively converted from the received image by generalized OCR techniques that are not yet widely available.

Because libraries are now storehouses of printed materials, and so far only relatively small amounts of specialized materials are becoming available in computer-system-usable form from any source, there will long be a document delivery image interface for information users who must summarize, extract and rekey those aspects that are to be reused in their work. Nevertheless, library and information service delivery systems should take into account the evolving work environment of those they serve.

The Economic Framework

Despite what is becoming technologically feasible, the economic framework for information services remains in an early stage of development. As it relates to libraries, the economic framework still rests mostly on the mechanisms of the pre-photocopy publication industry and institutional funding of library services.

There have been changes, of course. New copyright laws have been passed, and attempts have been made to define the impacts of new technology. "Fee-for-service" practices have been instituted which depend on use-oriented metrics, such as "first-time use" charge of OCLC, and some net-lending libraries are charging a fee for interlibrary loan. However, the institutional funding mechanisms of governmental authorities at various levels still cope much better with fixed annual fees rather than fees based on

use level. Although many industrial laboratories continue to regard their library support as part of fixed budget overhead, some treat library functions as charge-back services of value related to the direct effort of doing work. (The costs of information functions *should* be regarded in the same category as the cost of equipment for laboratory investigations.) The software industry has pioneered pricing and conditions-of-use terms that are based on the *use* of the software, rather than on the physical means of transfer of the software and the work necessary to install and maintain it.

Nevertheless, there remain issues in the economic framework that are not yet adequately settled. Contractual agreements for the access to and reuse of information, following the software marketing practices, theoretically would be able to cover any definable condition. However, we have not yet been able to cope with the transfer of retrieved information to local support systems for reuse, an important capability from the user's point of view. The boundaries of control and compensation for derivative files, especially if they come from multiple sources, remain a source of controversy between database suppliers and service vendors.

Also, information flow across national boundaries, as an item of commerce, is being subjected to the same protectionist trade policies as other goods of commerce. The communication tariffs imposed by foreign PTT (postal, telephone and telegraph authorities), which are usually governmental bodies outside the United States, are the equivalent of trade barriers for other (e.g., automobile and electronic equipment) industries. The U.S. information industry is at a disadvantage because of them.

But perhaps the most immediate economic problem facing libraries is the economy of resource sharing. The cost squeeze of the 1960s—continuing today—forced libraries to find ways to eliminate duplicative work. The initial existence of OCLC and its meteoric rise were based entirely on the advantages of resource sharing for shared cataloging.

Today, other economic facets are entering the library network picture. Some of these have different effects. To the extent that duplicative work, developmental or operational, is eliminated, resource sharing continues to be beneficial to the total society of information producers, organizers, storehouses, and especially users, by reducing the total expense of providing a specific level and range of services to users and thus reducing the total cost to the funding sources (both institutional and market-based). But to the extent that the resource-sharing actions simply redistribute the total cost of providing the information services over the total population, they are self-destructive.

This situation is best illustrated by an old story, called the "Tragedy of the Commons" and first described by William Forster Lloyd in 1833.⁸ The tragedy of the commons is depicted by a pasture open to all. Each herds-

man attempts to maximize the number of cattle in his herd as a hedge against the ravages of tribal wars, poaching and disease. However, as time goes on, conditions change. More social stability is achieved, reducing tribal wars and poaching, and progress is made in conquering disease. The total number of cattle of all the herdsmen reaches the total carrying capacity of the common land. As a rational being (which of course every good manager is) each herdsman seeks to maximize his gain. He is guided by principles of utility. For example, he asks, "What is the utility *to me* of adding one more animal to my herd?" The positive return is the proceeds from the sale of the added animal. There is a negative impact, also because the added animal causes overgrazing to occur, and thus reduces the efficiency of fattening for market all the animals in all the herds. However, the herdsman who added the extra animal only bears the burden of a fraction of that disadvantage, so it is still to his own advantage to add the animal. He and all the other "rational" herdsmen continue to add animal after animal, each to maximize his own return, until total ruin is reached; the overgrazing of the pastures goes beyond the limits of survival. The pasture dies, and all the herds are wiped out.

The destructive aspect of resource sharing in the library community—that part which shifts costs rather than totally eliminating them—is the equivalent of the above story. The urge is to minimize the cost of operation of each party (i.e., maximizing individual return), and the eventual result will be the wiping out of the total revenue support base necessary to supply the very substance of existence—a classic case of "killing the goose that laid the golden egg," otherwise known as suboptimization. The economic dynamics are the same, and ruin is the inevitable result. Clearly, joint economic planning and "statesmanship" are called for. Establishment of incentives to cause this to happen is one unsolved problem.

The Role of the Information Professional

Research libraries and information service intermediaries should look forward with enthusiasm to changes in their roles as library and information technology evolves. Job enrichment should result as the information professional expands into substantive work and decision-making, not remaining merely as an efficient conduit for information on the basis of which others make decisions and take actions.

The argument about "end users" versus information intermediaries as a target for the design of information service delivery system is pointless and nonproductive. More and more people who are not deeply trained in the intricacies of interaction with library and information systems will need to use computer-based systems, just as they have used card catalogs and indexes and other information location tools for many years. It was

recently reported that more than 50 percent of the use of the New York Times Information Bank had already shifted to end users, rather than be used mostly by librarians or other information professionals.

The demands of the system requirements for such purposes were brought home directly to me by my daughter's frustration as a student in using the library system at Ohio State University. It is a well-established computerized catalog and circulation support system from which I get excellent service (via my local reference librarian!).

There will not be enough information professionals to handle the bulk of the interfaces with library and information systems of the future. The systems we design and operate must accommodate both classes of use. I see the important expanded roles of information professionals as these:

1. Through the understanding of information organization and retrieval principles and processes, the information professional will fill a prime role in the design of man-machine dialogue and algorithms for use by persons less experienced in information system intricacies. This elevates the attention and efforts of the information professional to the meta-level, a higher intellectual pursuit than simply personal proficiency in organizing and finding information. However, to do this, the professional can not think just about what he does well personally. He must develop a deeper understanding of processes that can be used successfully by those less highly trained.
2. Performing the very difficult information retrieval tasks for poorly formed questions and for investigations that require capabilities at the limits of those available from established service systems will still require the attention of the experienced information professional. For example, an experienced stock car driver can safely get far more performance out of an automobile than can the general population of drivers.
3. Expansion into performing interpretative studies, including studies requiring subject expertise beyond that of information system skills, is another direction for enrichment. Studies performed by the Congressional Research Service for members of Congress and the many interpretative reports for business planning, financial management and technology applications that are being marketed are two examples. As our society becomes more and more an information-dominated one, these functions will be needed more universally, and the persons who perform them must have dual competence—subject and information mechanics.

Conclusion

I hope that these remarks cause you to think about the multifaceted issues and impacts you face as library and information professionals. Our activities are crucial in the effective functioning of modern society, which is very dependent on effective utilization of past knowledge as a support base for present understanding, innovation and decision-making. We are called upon to make effective use of technology toward those ends.

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