Public-Access Computer Systems: The Next Generation of Library Automation Systems

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Historically, library automation has focused attention on the automation of internal library processes, such as cataloging; however, a new generation of library automation systems intended for direct use by library patrons is emerging. These public-access computer systems are categorized and described. The types of public-access computer systems are: (1) catalog information systems, (2) electronic information systems, (3) information presentation systems, (4) instructional systems, (5) consultation systems, (6) information service and delivery systems, (7) conferencing systems, (8) integrative systems, and (9) end-user computing facilities. To be effective, these computer-based systems must be integrated with the traditional collections and services of libraries.

Increasingly, libraries are making computer systems available for public use. Online catalogs, end-user searching services for remote databases, CD-ROM reference databases, and local reference databases on mainframes and minicomputers are examples of public-access computer systems. A public-access computer system is defined, simply, as any library computer system that a patron can use directly.

Prior to the advent of public-access computer systems, library automation had focused primarily on improving the effectiveness and efficiency of internal library functions: acquisitions, cataloging, circulation, interlibrary loan, office automation, and serials control. The benefits of automating these functions were significant, but not always visible, to library users. Now, libraries are providing users with a powerful array of computerized systems, and the long-standing effort to automate library functions is, at last, becoming unmistakably apparent to users.

This paper will survey current and projected public-access computer systems.

OVERVIEW OF PUBLIC-ACCESS COMPUTER SYSTEMS

Public-access computer systems are still emerging, but it is possible to draw a preliminary map of the territory that they will cover.

Public-access computer systems are based on computer and telecommunications technologies, which are evolving at a very rapid rate.

Several major trends are shaping the current computing environment.[1] Historically, computer and telecommunications technologies have been characterized by dramatic increases in functionality and price/performance over time and by equally significant decreases in the size of system components. Different types of information (e.g., text, audio, and graphics) are increasingly becoming digitized. High-density storage devices, such as optical disks, are emerging that can store massive amounts of information at low cost. Evolving network technologies permit computers to communicate with each other, although data exchange across heterogeneous networks is still problematic. Artificial intelligence software is maturing, and a growing number of AI products and systems are becoming available.[2]

Public-access computer systems utilize specific computers, operating system and applications software, storage technologies, input/output devices, and data communications systems to provide services to users. The unique mix of technologies employed by a public-access computer system determines its capabilities. It is beyond the scope of this paper to consider fully the diverse technological infrastructures that could be used to implement each different type of public-access computer system. Nonetheless, there are certain technical capabilities of public-access computer systems that are worth highlighting briefly. Depending on underlying software and hardware configurations, these systems can provide users with: (1) rapid dissemination of new information; (2) powerful searching tools for quickly retrieving needed information; (3) sophisticated information manipulation and analysis tools (e.g., statistical and textual analysis software) to assist the user in creating intellectual works from retrieved information; (4) ability to download information to the user's computer for further manipulation and analysis; (5) simultaneous access to system resources by multiple users; (6) remote access to needed information and services from offices, homes, and other locations; and (7) round-the-clock availability of system resources.

Given these capabilities in the context of the overall information technology environment, the library can be envisioned as evolving into an online information utility that provides users with access to local public-access computer systems and acts as a gateway to remote systems. To be effective, this new function will need to be integrated with traditional library materials and services. A number of thoughtful authors have probed different aspects of such a transformation. Works by Battin,[3] Dowlin,[4] Downes,[5] Drake,[6] Horny,[7] Lancaster,[8] and Murr and Williams[9] investigated key issues related to this subject. Parsons foresightedly speculated about possible "online public access systems."[10]

Overall, it is important to recognize that impressive technological advances do not necessarily imply that successful, operational systems will emerge in libraries that make use of these technologies. Public-access computer systems efforts by libraries and vendors will be bound by fiscal, organizational, and legal constraints that will help shape the course of their development.

Equally important will be user demand for these systems. Convenient access and adequate user support will be necessary to nurture the use of public-access computer systems. Users are likely to continue to be cost-sensitive, and, if they are being charged, they will ration their use of public-access computer systems. Issues related to fees for service, equitable access, and library subsidies will become increasingly important as public-access computer systems become an increasingly visible and critical part of library services. When considering scenarios about technology-driven changes in library collections and services, it is important to remember that the library plays an important social role as a provider of no-cost or low-cost information to those who cannot afford to obtain this information directly from publishers and other information vendors.

Public-access computer systems offer exciting prospects for libraries and their users. Librarians should neither be discouraged by the obstacles that must be overcome in order to make them a reality nor expect that their libraries will be transformed overnight into the elusive "electronic library." As was the case in past automation efforts, progress will be made in a steady, evolutionary fashion. A variety of pioneering projects, most of which will be done with relatively modest resources, are likely to explore the benefits and problems associated with new types of public-access computer systems before they are adopted on a wide-spread basis by libraries.

As libraries continue to develop public-access computer systems and provide them

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to their users, they are likely to concentrate their efforts in the following broad areas.

CATALOG INFORMATION SYSTEMS

These systems give library users direct access to bibliographic, authority, summary and detailed holdings, and item-status information (or to subsets of these types of information) about materials in library collections. These systems typically offer users powerful retrieval capabilities, such as keyword and Boolean searching. A single-institution online catalog represents a typical contemporary catalog information system.

The long-term goal in the catalog information systems area will be to make information about remote library collections as accessible to the user as information about the local library collection.[11] This trend can be seen in the efforts of library consortia either to establish online union catalogs that reflect their joint holdings or to link the separate institutional online catalogs of their member libraries. On a broader level, libraries will increasingly provide public access to the regional, national, and international databases of bibliographic utilities, such as WLN, RLIN, and OCLC. As libraries provide users with instant access to information about remote library collections, issues related to libraries' ability to support increased resource sharing and to ensure rapid delivery of requested materials will become more critical.

An example of a local catalog information system is the UCLA Library's ORION system, which is written in PL/I and runs on a mainframe computer.[12] ORION, which is under authority control, offers users a diversity of searching techniques with which to retrieve bibliographic, authority, and holdings data, including exact phrase, keyword, Boolean, call number, and control number searching (e.g., ISBN) as well as search limitation by different criteria (e.g., location, date, and language).

Hildreth describes a variety of enhancements to online catalogs that could be incorporated in the next generation of these systems, including user interfaces that provide more feedback and prompting, system reformulation of search keys to correct user-input errors, search techniques derived from information retrieval research (e.g., relevance feedback, stemming, and term weighting), and expanded bibliographic records that contain information from the tables of contents and indexes of books.[13] These types of system enhancements are applicable to all types of catalog information systems.

ELECTRONIC INFORMATION SYSTEMS

These systems provide users with access to a growing variety of reference and source materials in digital form. Sophisticated searching techniques are commonly available in electronic information systems, and analysis tools may be incorporated as well.

Representative types of electronic information include: (1) indexes and abstracts; (2) full-text reference works, such as directories and encyclopedias; (3) full-text journals; (4) full-text newswires; (5) full-text books that are not reference works; (6) numeric databases, such as census data; (7) digitized audiovisual materials, such as graphic images; and (8) hypermedia, which organize other types of electronic information materials into a network of frames.

Electronic information materials may be derived from printed or audiovisual materials, or they may exist solely in digital form.[14] As electronic information continues to evolve, new information formats, which draw upon the unique capabilities of computer technology and have no equivalents in prior technologies, will emerge.

In the foreseeable future, electronic information systems are likely to complement, rather than dramatically displace, traditional materials in libraries, such as books. The development of electronic information systems by publishers is likely to be driven primarily by marketplace forces rather than strictly by technological capabilities. The provision of electronic information systems by libraries will be strongly influenced by economic factors and intellectual property rights issues, reflecting high costs relative to those of traditional materials and attempts by copyright holders to restrict use of electronic information materials.

The question of ownership is likely to be especially problematic, since neither licensing nor accessing a database gives the library any permanent claim on it. Maintaining parallel print and electronic collections is an expensive solution to part of this problem; however, it does not address the issue of ensuring permanent access to information that is available solely in electronic form. These databases may be discontinued by vendors for economic or other reasons. Without a national program that, at minimum, targets preservation of databases that exist solely in electronic form, we are in danger of losing an increasingly important part of our intellectual heritage. A potential model for such a preservation effort is the Knowledge Warehouse, a pilot project in England that is exploring legal, commercial, and technological issues related to the preservation of electronic information, including electronic working copies created as part of the print publication process.[15,16]

An example of an electronic information system is Carnegie Mellon University's Library Information System, which utilizes the STAIRS retrieval software running on a mainframe computer.[17] The mainframe computer is linked to the campus local area network. The Library Information System includes databases such as *Academic American Encyclopedia*, Computer Database, Houghton Mifflin's *American Heritage Dictionary*, Magazine Index, Management Contents, National Newspaper Index, and Trade and Industry Index. The system enables users to search these databases using keyword, Boolean, proximity, and search limitation (e.g., date limitation) techniques.

INFORMATION PRESENTATION SYSTEMS

These systems provide users with a structured sequence of screens that describe library-related topics, which users can review at their own pace. Typically, an information presentation system will be menu-driven, with the user moving up and down a hierarchy of screens; however, with the advent of hypermedia, systems are being created that use a network of interconnected information frames.

A representative information presentation system is the Information Machine at the University of Houston Libraries written in QuickBASIC and running on a microcomputer.[18] The Information Machine provides users with menu-driven access to explanations of library research strategies, materials, systems, facilities (complete with library maps), services, open hours, policies, and other orientation information.

INSTRUCTIONAL SYSTEMS

These systems interactively teach users about library-related topics, analyzing user responses and varying the information presented in accordance with them. Current instructional systems, commonly referred to as computer-assisted instruction systems, use drill-and-practice, tutorial, simulation, and game techniques to teach needed material.[19]

Prototype intelligent computer-assisted instruction systems, which are based on expert system technology, have been developed, and researchers are examining how these systems can be grounded in learning and instructional design theory.[20] These systems may provide much greater tailoring of instruction to individual learner differences than is currently possible in conventional CAI programs.

An illustrative instructional system is a CAI program at the University of Delaware Library, which employs the PLATO software as its authoring language and runs on a mainframe computer.[21] A microcomputer version was also developed which includes four lessons that treat the card catalog and LCSH, periodical indexes, newspaper indexes, and government documents indexes.

CONSULTATION SYSTEMS

These systems advise users, much as a professional librarian would, about library-related topics. Consultation systems are typically based on expert system and related artificial intelligence technologies. They are knowledge-based systems that embody the special expertise of library staff in using the library's collections, systems, and services.

Expert systems have three primary com-

ponents: a knowledge base that contains facts, rules, and other representations of human knowledge related to a particular topic; an inference engine, which solves problems by manipulating information in the knowledge base in a way that mimics human reasoning; and a user interface, which permits system interaction with the user and explains system findings.[22]

A representative consultation system is the University of London's PLEXUS system, a prototype expert system that is written in Turbo Pascal and runs on a microcomputer.[23] This system, which is intended for public library use, is designed to identify relevant sources of information (e.g., individuals, books, and institutions) that can assist a user with a specific gardening problem. After building a profile of the user, PLEXUS allows the user to enter free-text questions about gardening, and it employs knowledge about the user, gardening, and gardening resources to identify appropriate resources to answer those questions.

INFORMATION SERVICE AND DELIVERY SYSTEMS

These systems allow users to request library services (e.g., mediated online search) and document delivery (e.g., local delivery or interlibrary loan of an item). This latter objective may be achieved through delivery of a physical item or the transmission of digitized information derived from a physical item.

As users employ more powerful tools for quickly identifying needed local and remote library materials in printed form, they will want equally convenient and speedy access to the information itself. Unless adequate attention is paid to information delivery, enhanced access to bibliographic and electronic information systems may create a "library with glass walls" instead of a "library without walls"—needed information can be quickly identified but not readily obtained.[24]

An example of this type of system is the Electronic Access to Reference Service system at the Health Sciences Library of the University of Maryland at Baltimore. The system is written in MIIS and runs on a minicomputer.[25] This menu-driven system allows users to search the online catalog, request a mediated online search, ask a reference question, submit an interlibrary loan request, request that an article be photocopied and delivered, submit book purchase requests, read electronic mail from library staff about service requests, and read library news notices.

CONFERENCING SYSTEMS

These systems give users a way of exchanging points of view on different topics in a public or private forum.[26] Unlike electronic mail systems, which provide one-to-one or one-to-many message services, computer conferences allow users to read ongoing dialogues by many participants on specific issues and to contribute to those dialogues. Computer conferences can be available to all or restricted to particular participants. A computer conferencing system can support a number of simultaneous conferences on different topics.

For academic and other research libraries, computer conferencing provides a new way of disseminating scholarly knowledge, potentially on a national or international basis, if appropriate network and inter-network links exist. Given their mutable nature, computer conferences offer interesting challenges in the areas of access and preservation.

An example of a library-sponsored computer conference is a private conference for librarians affiliated with the university library system, independent campus libraries, and the library school at the University of Michigan.[27] This system, which is one of many conferences supported by the University's CONFER conferencing software, enables librarians to electronically discuss a variety of issues of mutual concern and to make announcements of general interest.

INTEGRATIVE SYSTEMS

These systems provide users with convenient access to diverse local and remote public-access computer systems, new services based on these systems, and simplified techniques for utilizing these systems. Other types of public-access computer systems will be unified into a cohesive information network environment by integrative systems.

As the number of public-access computer systems offered by a library increases, there will be a need to reduce the complexity of administration and use of these systems. Integrative systems will be developed to meet a variety of objectives, including: (1) permitting the use of a standard library workstation with a multiplicity of local and remote systems; (2) establishing a coherent networking strategy to provide access to these systems; (3) providing users with an interface that organizes the use of these systems; (4) assisting users in identifying appropriate systems to meet their needs; (5) teaching users how to utilize these systems; (6) linking heterogeneous systems to provide enhanced services to users (e.g., connecting an indexing database with an online catalog to identify locally held journals); (7) providing tools for further analysis and manipulation of information from different systems; and (8) furnishing a uniform user interface that masks underlying system differences in command syntax, retrieval capability, controlled vocabulary, and record structure as much as possible.

An example of an integrative system is the DoD Gateway Information System, which is being developed by the Defense Technical Information Center.[28] This prototype system offers the user: (1) a directory of available online databases, which can be searched by subject; (2) a variety of communication services, including electronic mail, online conversations with other users, and automated log-on to online systems; (3) a knowledge-based, common command language system for accessing heterogeneous online databases; and (4) post-search processing tools that can perform tasks such as converting records to a common format, eliminating duplicate records, sorting records by different keys, and analyzing search results.

END-USER COMPUTING FACILITIES

Microcomputer workstations housed in the library can provide users with access to a diversity of software tools, including business software (e.g., database management, spreadsheet, and other programs), programming languages and utilities, and scholarly productivity software (e.g., specialized foreign or scientific word processing, citation management, desktop publishing, and other programs). These workstations can be linked together in a local area network in order to share hardware and software resources. Given appropriate data communication linkages, these workstations can also access software packages, databases, and services on institutional or remote computers, including public-access computer systems provided by the library.

The linkage of increasingly powerful microcomputer workstations to public-access computer systems may bring into existence the long-awaited "scholar's workstation," an integrated computing environment for producing intellectual works. This may be achieved through a careful blending of resources: access to catalog and electronic information; a coordinated set of software tools to create, analyze, and manipulate information; and hardware to accomplish information transfer, production, and output.

Hess's detailed survey of seven microcomputer facilities located in academic libraries provides a good overview of contemporary efforts in higher education.[29]

CONCLUSION

Public-access computer systems represent the next step in the evolution of libraries. They provide an opportunity to synergetically blend printed and computerized information resources to create new, more effective library services. The library as we know it is not "dead," but it will be transformed.

Traditional library collections and services as well as existing library automation systems will provide a firm foundation for building public-access computer systems. In the near future, the library is unlikely to abandon print and metamorphose completely into a sophisticated system for providing electronic information and computer-based services. However, public-access computer systems will play an increasingly important role in libraries, and they will change the nature of the library in fundamental ways. Although the library as a physical entity will not disappear in the foreseeable future, the need for the user to walk through its doors will diminish over time, and increasingly its re-

sources and services will be available in remote locations around the clock. Except in a small number of well-funded, innovative libraries, this change is likely to be incremental rather than swift and dramatic.

If the last generation of library automation systems is any guide, public-access computer systems could have a lengthy development cycle, gradually evolving from single-function to integrated systems. With careful planning, we can lay the foundation for eventual integration as we establish public-access computer systems.

An important step is to implement a high-capacity, library-wide local area network to permit access to a multiplicity of public-access computer systems from individual microcomputer workstations. With this essential infrastructure in place, local public-access computer systems can be added as network servers in a modular fashion and appropriate linkages to external public-access computer systems can be established as required. Gateway or bridge connections to institutional local area networks, dial-access ports, and other appropriate linkages can provide needed access to public-access computer systems for remote users.

Equally important is being cognizant, when developing or purchasing public-access computer systems, of the need eventually to integrate them. Standardization efforts in the computer, library, and publishing communities will play a key role in ensuring that systems can be effectively integrated, and libraries should be sensitive to whether their proposed public-access computer systems comply with applicable existing and emerging standards, such as the Common Command Language for Online Interactive Information Retrieval,[30] the Information Retrieval Service Definition and Protocol Specification for Library Applications,[31] and the Open Systems Interconnection[32] standards.

The challenge ahead is to balance our ongoing, increasingly expensive commitments to traditional information resources and services with the significant investment of human and fiscal resources required to make public-access computer systems a reality. Library automation systems aimed at computerizing internal library functions were costly; however, they did not alter the nature of the library's collections. Electronic information systems change library collections, providing better access to information at higher costs. These electronic information costs will constitute a significant and growing proportion of the total cost of providing public-access computer systems. Unlike equipment or software costs, which are primarily front-end costs, electronic information license or access fees will not drop significantly after the first year of use; rather, they are permanent costs subject to fee increases.

Libraries and library automation vendors have an overall record of success in creating complex, sophisticated library automation systems. Public-access computer systems offer exciting new challenges, which libraries and vendors will overcome to create a new generation of library automation systems that will provide library users with improved access to information resources and library services.

REFERENCES

1. Douglas E. Van Houweling, "Information Technology: A Survey From the Perspective of Higher Education," *Library Hi Tech* 4:23–28 (Winter 1986).
2. Linda C. Smith, "Artificial Intelligence and Information Retrieval," *Annual Review of Information Science and Technology* 22:43 (1987).
3. Patricia Battin, "The Library: Center of the Restructured University," *College & Research Libraries* 45:170–6 (May 1984).
4. Kenneth E. Dowlin, *The Electronic Library: The Promise and the Process* (New York: Neal-Schuman Publishers, 1984).
5. Robin N. Downes, "Journal Publishing, Resource Sharing, and New Information Technology," (Paper presented at The Impact of Rising Costs of Serials and Monographs on Library Services and Programs conference, Oklahoma City, Feb. 26, 1988).
6. Miriam A. Drake, "From Print to Nonprint Materials: Library Information Delivery Systems," *EDUCOM Bulletin* 23:28–30 (Spring 1988).
7. Karen L. Horny, "New Turns for a New Century: Library Services in the Information Era," *Library Resources & Technical Services* 31:6–11 (Jan./Mar. 1987).

8. F. W. Lancaster, *Libraries and Librarians in an Age of Electronics* (Arlington, Va.: Information Resources Press, 1982).
9. Lawrence E. Murr and James B. Williams, "The Roles of the Future Library," *Library Hi Tech* 5:7–23 (Fall 1987).
10. Jerry L. Parsons, "On-Line Public Access Systems: An Overview," *Technical Services Quarterly* 1:41–49 (Summer 1984).
11. Ibid., p.44–45.
12. James Fayollat and Elizabeth Coles, "Database Management Principles of the UCLA Library's Orion System," *Information Technology and Libraries* 6:102–15 (June 1987).
13. Charles R. Hildreth, "Beyond Boolean: Designing the Next Generation of Online Catalogs," *Library Trends* 35:654–62 (Spring 1987).
14. F. W. Lancaster, *Libraries and Librarians in an Age of Electronics*, p.54–62.
15. R. Williamson, "The Knowledge Warehouse: Legal and Commercial Issues," *The Electronic Library* 6:10–16 (Feb. 1988).
16. Michael Buckingham, "The Knowledge Warehouse: Technical Issues," *The Electronic Library* 6:6–9 (Feb. 1988).
17. Nancy Evans and Thomas Michalak, "Delivering Reference Information Through a Campus Network: Carnegie Mellon's Library Information System," *Reference Services Review* 15:7–10 (Winter 1987).
18. Jeff Fadell and Judy E. Myers, "The Information Machine: A Microcomputer-based Reference Service," *Reference Librarian* no.23:75–112 (1989).
19. Robert V. Bullough, Sr. and LaMond F. Beatty, *Classroom Applications of Microcomputers* (Columbus: Merrill Publishing Co., 1987), p.109–25.
20. Halyna Hajovy and Dean L. Christensen, "Intelligent Computer-assisted Instruction: The Next Generation," *Educational Technology*, 27:9–14 (May 1987).
21. *Bibliographic Instruction in ARL Libraries* (SPEC Kit 121) (Washington, D.C.: Association of Research Libraries, Office of Management Studies, 1986), p.64–66.
22. Kamran Parsaye and Mark Chignell, *Expert Systems for Experts* (New York: John Wiley & Sons, 1988), p.32–34.
23. A. Vickery and H. M. Brooks, "PLEXUS—The Expert System for Referral," *Information Processing & Management* 23, no.2:99–117 (1987).
24. Jane D. Segal, personal communication, July 1988.
25. Frieda O. Weise and Marilyn Borgendale, "EARS: Electronic Access to Reference Service," *Bulletin of the Medical Library Association* 74:300–2 (Oct. 1986).
26. F. W. Lancaster, *Libraries and Librarians in an Age of Electronics*, p.25–27.
27. William C. Manspeaker, Rebecca M. Dunkle, and Selden S. Deemer, "Microcomputer Installation and Support at the University of Michigan Library," *Information Technology and Libraries* 5:301–2 (Dec. 1986).
28. Allan D. Kuhn and Gladys A. Cotter, "The DoD Gateway Information System (DGIS): The Department of Defense Microcomputer User's Gateway to the World," *Microcomputers for Information Management* 5:77–87 (June 1988).
29. Anne Hess, "Notable Collections of Microcomputer Software and Hardware in Academia; The Findings of a Study: 1986–1987," *Library Software Review* 7:74–107 (Mar.–Apr. 1988).
30. Katharina Klemperer, "Common Command Language for Online Interactive Information Retrieval," *Library Hi Tech* 5:7–12 (Winter 1987).
31. Ray Denenberg, "NISO Draft Standard Z39.50: Information Retrieval Protocol," *Library Hi Tech News* no.39:1, 7–8 (June 1987).
32. Ray Denenberg, "Open Systems Interconnection," *Library Hi Tech* 3, no.1:15–26 (1985). ■■