

through problem solving and discovery and when what they learn can be applied, even if only in another class. This paradigm shift from memorizing facts to discovering the information needed to solve a problem allies learning with research and therefore teaching with research.⁶ Software applications and database developments do not often take advantage of these elements of learning, and it may be up to the librarians who evaluate and acquire these tools and products to also assess their value for learning. Computer simulations, for example, can model the behavior of complex systems to show the effect of individual variables or the interactions of multiple variables, an idea that is difficult to convey by lecture. We must aim therefore not just to automate current teaching practices, as many virtual classrooms do, but to seek out and select, develop, and employ technologies that stimulate and aid learning.

Electronic information significantly changes the learner's perceptions and uses of information. For one thing, people extract bits and pieces of information from digital sources, and the learner, rather than the author of a text, must provide the context for that information.⁷ One aspect of hypertext and hypermedia, for example, is its capacity to link sources in ways that disrupt the continuity of a narrative (Landow 1992, pp. 52–56, 71–87). A play or novel is no longer a text to be read through but a series of bits of information linked to other sources. The power of the media creates an archive of information that the learner dips into as he or she wishes. One reads in rather than through a document, and the author of the document merges imperceptibly with the reader who accesses it (Bolter 1991, pp. 153–159, 166–168). Moreover, the medium of interaction also shifts. Just as the oral tradition was oriented toward the group and print toward individual meditation, electronic interaction appears to shift the orientation again toward group learning.

The challenge for libraries, then, is to respond to these changes in teaching and learning and create an environment for problem solving and student-centered learning. The gateway library will supplement traditional library reading and study spaces with flexible areas for interaction among learners and with multimedia technologies.⁸ This is not just an incremental addition of technology into existing library programs and space but a reorientation of the library to actively acquire and participate in the development of the tools used in learning.⁹

Expert Systems and Librarians as Experts

Access to information has been the principal focus of librarians in recent years. The principal problem for learners, however, is too much information. To filter out excess and identify the useful must now become our primary concerns. Information is expanding faster than anyone can process, store, retrieve, and use it. A kind of Gresham's law of information is operating in which not only does bad information threaten to drive out the good but the sheer volume of information threatens to overwhelm whatever might be useful. The defining problem for librarians is to create the tools that will enable learners to locate the information they need and deliver it in the form in which they need it.¹⁰

Part of the problem is that library cataloging and classification schemes are predicated on a knowable universe and a limited output of publications—a model that is inadequate in a digital world. Moreover, as the metaphorical web of information becomes reality, thus linking the bits and pieces of information, we are faced with our inability to evaluate and create hierarchical relations among data that reflect their relative importance.¹¹

Knowledge is continually changing, and the individual researcher is unlikely to have an overview of the entire knowledge system. One of the challenges for gateway librarians will be to provide this overview by mapping the changing world of information and developing the navigational tools that will enable a learner to traverse an unruly informational landscape and then evaluate the bits and pieces of information they discover.¹² Librarians must shed the passive posture that views their work as essentially reactive to current trends in scholarship. The knowledge base must be deepened by librarians who trace the contours of fields of knowledge and design maps, templates, or filters for learners to discover what they need from the surfeit of information.¹³ Traditional library cataloging schemes will not do. Instead, we will need to develop expert systems that incorporate the changing nature of inquiry *and* the sources that are discovered that pertain to it. But expert systems are only as good as the most recent design, and they require the attention of expert humans to keep them updated and mediate between their limits and the rising expectations for information.

Implications of Information Technology for Libraries and Universities

The gateway as a response to information technology and to the influence of digital information on teaching and learning has a number of implications for both libraries and higher education. How the two spheres interact and respond to these changes will profoundly affect the future of both. In this section, I briefly mention three implications of these changes on libraries and some implications for higher education.

Implications for Libraries

One implication of the dramatic growth in the quantity and variety of information is that librarians will become increasingly specialized. They will need expertise to manage the sheer volume of sources needed for research, the changing nature of inquiry, and the continued development of information technology. Although the need for library generalists will continue, specialized knowledge on the environment, for example, or on comparative literary and historical studies that cut across disciplines will require a greater depth of knowledge about sources and how they are used in research. Moreover, technology will impose its own demands for expertise. The volatility in technology involving images, data, multimedia, as well as text will demand constant attention and will affect the requirements and training for library positions.¹⁴ The question is whether the library will maintain its role in supporting the information needs for research or whether academic departments will acquire their own information specialists and thereby further fragment knowledge and diminish the value of the library in the academy.

Despite the trend toward distributed computing, greater centralization of some library services is called for by the high cost of support for distributed computing and networked information (more than the cost of equipment). Indeed, more coordinated and even centralized library support for some information needs is one of the features of the gateway. One can argue that library services, especially reference and instruction, can also be distributed over the network. But until the systems for retrieving information become as powerful as our capacity to store it, it seems likely that teaching and instruction and even reference support will

still need to be conducted face-to-face in the library. Technology undoubtedly can improve discovery and enhance our ability to locate needed information. After all, this is one of the aims of filters and expert information systems. But research and discovery are highly associative processes, and the changing nature of inquiry, even more than volatile technology, will necessitate human intervention to satisfy information needs for the foreseeable future.

As the information environment continues to change and becomes increasingly specialized, it will require greater flexibility and even new forms of institutional organization. An avalanche of breathless literature talks about reengineering organizations, empowering people, eliminating hierarchy, and the like, but most organizational change in libraries has been as modest as it has been within universities. A gateway library that emphasizes teaching, learning, and greater specialization among staff will require a radically different structure. For one thing, the organizational unit may often be a single instructor and a few students, with individuals engaged in teaching drawn from staff spread throughout the organization. The institution needs to support the work of such units but also keep the one-person department from becoming an independent island with no vision of or allegiance to the commonweal. Most commonly this dilemma is expressed in terms of ensuring accountability in an organization composed of individuals or teams. But the real issue is not accountability. Rather, the measure of success is achievement and accomplishment. Flexibility, maintaining commitment to a common purpose and mission, preserving the individual's sense of competency in an ever-changing environment, and providing a reward structure that honors special skills and knowledge will become essential ingredients for libraries that embrace the gateway concept.

Finally, the gateway library will centralize some activities but will depend on the skills and contributions of individuals scattered throughout an entire institution. Traditionally, librarians have identified with a single organization, most often characterized by a building; now they must identify with a process or program that may be independent of one's primary affiliation. Problems of identity and loyalty, as well as the coordination of functions, may become the principal challenge and will make

issues of organizational structure, management style, and leadership even more important in a gateway library.

Implications for Higher Education

The decline of the library as the center of the academic community is of greater moment to universities than it may at first appear. The old saying, practically a homily, that “the library is the heart of the university,” was more than symbolic rhetoric. Prior to World War II, the curriculum drew together college and university faculty into a scholarly community, which the library’s collections and schemes for classification and cataloging mirrored. The curriculum and the library were part of the same intellectual frame, and the library was the physical and intellectual commons shared by all members of the community. Over the past four decades, however, the growth and success of research has fragmented knowledge and created ever more specialized areas with their own literature and scholarly publications. Hence, even before serial prices began to rise, the enormous volume of published knowledge began to alter the basic purpose and functions of research libraries. In this already fragmented environment, the library is unlikely to provide a counterweight to the centripetal forces pulling at members of the university community.

The apparently diminished centrality of the library within the university community has been exacerbated by technology. First, parts of the research community, especially in the sciences, have access to information and research sources that do not depend on the library. Second, distributed computing and networked information means nearly everyone can be less dependent on the library for at least some of their information needs. Finally, as Richard A. Lanham observes in chapter 11, both the university and the library are a reflection of the culture of print; academic departments and disciplines, classes of instruction, textbooks, and even the curriculum are responses to information and knowledge based on print. Thus, the structure and organization of universities and libraries are susceptible to the changes brought about when information is delivered by digital technology.

For all of these reasons, a battle has developed between those who wish to preserve the traditional substance and forms of the academy and

those who embrace technology, either to revivify what they see as a moribund enterprise or to increase academic efficiency and reign in rising operating costs. The library is a lightning rod for these competing views. The argument, however, is not about libraries in particular but, as many of the essays in this volume make clear, about the nature of teaching and learning.

A gateway library must think of itself as part of an international research community. No library can collect every print and primary source, let alone every piece of electronic information. The future of research will require cooperative arrangements for preserving the varied evidentiary sources now required by researchers. Because the gateway is a portal to these resources and coordinates the delivery of instructional services within the library, it is well positioned to take the lead in developing cooperative collection programs. The challenge will be to create institutional structures and incentives to sustain cooperative resource sharing and development among libraries, museums, archives, and historical societies on a national level (Dowler 1994).

Decisions about acquisitions, the methods of cataloging and providing access, and, ultimately, reference and library instruction will all be affected. Students and scholars will need to be provided with the methodological training that new curricula, new sources, and new intellectual interests demand. The authority of the text is giving way to new forms of information, and each form and genre must be evaluated by different criteria than those that apply to texts. Research universities have scarcely begun to consider how to meet these challenges, and few libraries, despite all their efforts involving automation and technology, have seriously considered the underlying intellectual problem of how to preserve or provide access to the range of sources now required for learning and research. Nor have they thought about new requirements that digital information will introduce.

The expanding definition of information and the importance of non-print sources for research test the limits of the traditional library, even as shrinking resources limit their ability to respond to these new conditions. Interdisciplinary and cross-cultural research also challenges the disciplinary framework that has served libraries and scholars for the past one hundred years. Study of the environment, for example, touches nearly

every academic discipline; it connects disparate sciences, informs public policy, and enlists ethical and humane values in an intellectual discourse that touches our lives with power and immediacy. Here, then, are the conditions for reintegrating fractured knowledge and education by honoring ideals larger than ourselves, solving problems that matter to our continued existence, and drawing on multiple ways of knowing. Here, too, are the conditions for reconfiguring the curriculum and libraries as partners in the same intellectual enterprise.

Conclusion: Questions about Boundaries

In reading these essays, one is struck by how infrequently the fundamental issue under discussion is the technological or the budgetary deficiencies we generally blame for educational and library problems. More often, it appears, the most intractable problems, with the most promising potential solutions, direct us to changes in institutional and organizational structures, goals, and objectives. We may find, for example, that the educational goals of an institution are really more important to the quality of education than the methods and tools that they employ. Creating an organization, for example, that connects scholars, library, and technical staff may be more important to the effective use of technology within a university than acquiring a large quantity of technological tools. The relationship between print and electronic sources, the kind of instruction that helps students and faculty locate and use information, and strategies that promote collaboration among institutions to provide access to information are all organizational issues. Who should develop the navigational tools and create filters or expert systems that help people locate the sources they need? What kind of skills are needed to work in this new environment? Should the entrepreneurs who develop database and interactive applications for learning be librarians, other information experts within the university, or commercial agents? And, most important, what does literacy mean in a digital age, and who should teach it, and how should it be supported?

In their struggle to define the library of the future, librarians too often bolt new technology, programs, and services on to existing functions. The library must focus not only on how information may be packaged and

disseminated in a networked environment but also on the nature and qualities of electronic information. We err when we assume that electronic information is essentially the same as print and that the role of the library will therefore remain the same or, alternatively, disappear. The question we must ask is, will the library respond to information technology by simply overlaying electronic tools and information on to the existing structure, or will the library fundamentally alter the environment for teaching and research and thereby the reality of learning? The disciplinary boundaries that govern academic study will be increasingly expanded by digital technology, and the university administrative structures that support them will follow. The gateway, by sponsoring systemic changes to the way in which libraries support teaching, learning, and research, provides a bridge to the future and to the inevitably evolving structures and mission of higher education.

Notes

1. This bimodal perspective is most clearly conveyed in this book in the chapters by Paul Ginsparg (chapter 4), Richard C. Rockwell (chapter 5), and John Unsworth (chapter 6), who tend to view information technology through the systems lens, and the chapters by Richard A. Lanham (chapter 11), Karen Price (chapter 12), and James Wilkinson (chapter 13), who focus principally on the effect of digital technology on cognition and the processes of knowing. Jan Olsen (chapter 9) appears to be in the systems camp but is constrained by the practical considerations of managing a library that is still in transition from a traditional to an electronic library. Although they also address the uses of technology in teaching and learning, Anita Lowry (chapter 14), Roy Rosenzweig (chapter 15) and Steve Brier (chapter 15) are concerned less with digital literacy and more with technology's potential to improve learning within the existing culture of print. Peter Lyman (chapter 10) oscillates between the two views, stressing the cognitive view when discussing teaching and learning and the systems view when addressing scholarly communication and the growth of networked information.
2. In chapter 2 Patrick Manning describes changes in the study of history and its implications for the discipline and the requirement for a variety of sources. Anthony Appiah (chapter 3) appeals for new sources from an interdisciplinary perspective but fears that their acquisition will be hindered by old agendas and traditional views about what is worth acquiring.
3. Richard C. Rockwell (chapter 5) argues that distinctions among kinds of information are breaking down and that this blurring of boundaries will necessitate rethinking the organizational structures that currently divide them.
4. The most thoughtful exploration of this topic is Lanham (1993).

5. Throughout chapter 11 Richard A. Lanham especially considers the implications of literacy for education in the age of the electronic word.
6. James Wilkinson, in particular, emphasizes in chapter 13 the changes in teaching that have occurred in recent years.
7. Karen Price's chapter 12 is especially good at explaining the differences in learning that occur in a digital environment.
8. The best descriptions of this are in the articles by Anita Lowry (chapter 14) and Jan Olsen (chapter 9).
9. Roy Rosenzweig and Steve Brier explore the advantages and some dangers of electronic media in chapter 15.
10. Paul Ginsparg (chapter 4) and John Unsworth (chapter 6) both stress the need to add value to information to make it useful. For Unsworth adding value is a matter of survival for the humanities. For Ginsparg, too, there is a question about which agency, commercial or academic, will ultimately develop the tools needed to improve the usefulness of information.
11. Wilkinson (chapter 13) is eloquent on this point.
12. Steve Fuller (1994) provides a perceptive analysis of expert systems and research.
13. Richard C. Rockwell (chapter 8), in particular, thinks librarians must address these concerns and take the lead in providing the tools and expertise that are needed to effectively use information.
14. Jan Olsen (chapter 9) is particularly good at describing the implications of the various electronic genres for library staff.

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