Libraries and the Digital University

Joan K. Lippincott

Introduction

The trajectory of U.S. higher education in the next 20 years is portrayed by some as an arc of potential disaster and by others as a slightly upwardly inclined plane that may have some dips along the way. Generally these scenarios focus on the teaching and learning program of higher education institutions and give very little attention to the research or service functions of those institutions. With the pace of developments in technology, and in particular those that have implications for higher education, is it sensible to predict the future of higher education, let alone academic libraries? In what ways is the recent past a prelude to the future?

In 1988, David W. Lewis, at that time the Lehman Librarian at Columbia University, wrote the article "Inventing the Electronic University," which sounded a call to librarians to take action to transform not only the library, but the university itself in light of the rapidly accelerating pace of technological developments.[1] Lewis alerted his readers to specific topics in a variety of areas, including learning and teaching, scholarly communication, preservation and access, standardization of technology, staffing, and funding, to bring the most salient issues into focus. He also provided advice for how librarians could help invent the "electronic university."

His article was important for a number of reasons, including its relatively early exposition of issues related to the impact of technology on teaching, learning, and research. While Lewis discussed The Advanced Research Projects Agency Network (ARPANET) in his article, the term "Internet" does not appear in it; the term was not yet in general use. Still, he correctly recognized that networked communication access would be widely used in universities at a time when many people still thought that network access and access to high performance computation would remain scarce resources limited to researchers. He also realized that the broad availability of communications networks would profoundly impact the major functions of the university.

Lewis understood that new technologies would result in fundamental changes in how individuals would work, whether they were students or faculty. In 1988, many libraries placed signs by their computers stating that the machines were solely for the purpose of accessing the library catalog or library-licensed databases. Lewis had a very different view, in line with much later practice, and wrote that "the scholarly process will become seamless; students and faculty will use the same machines for data collection, analysis, and communication. The library will need to encompass all of these activities."[2] At the time, most of the focus on technologies in libraries was on how they would change *library* practice; Lewis instead analyzed how technologies would change practices of the user community. This was perhaps the most important contribution

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of Lewis's article: to prompt the academic library community to think strategically about their role in the context of the mission-critical aspects—research, teaching, and learning—of their institutions. The focus of the article was not on the library *per se* or the technology developments in and of themselves but on how technologies would transform the fundamental functions of the university.

That Lewis would recognize the extent to which some of these technology developments, nascent at that time in most universities and colleges, would impact the core functions of higher education was prescient. He notes that Paul Evan Peters, the founding executive director of the Coalition for Networked Information (CNI), significantly influenced his thinking for his 1988 article.[3]

As a mark of its influence, it is interesting to note that Lewis's article was cited beginning in 1989, shortly after its appearance, by the late Peter Graham, who was highly respected for his deep analysis of research libraries and who called Lewis one of the best thinkers about libraries, and into the early 2000s, by the late, highly esteemed librarian and author Ross Atkinson.[4] While much writing in scholarly journals devoted to academic libraries takes the form of empirical studies of relatively finite topics, Lewis had the reputation for looking at the big picture and expressing his thoughts on principles, trends, and changes in practice in a mode that resonated with his peers. It is impressive that his ideas have had such longevity that his 25-year-old article was selected as one of the most influential of the past 75 years of *College & Research Libraries* by an online poll and members of the editorial board of that journal.

One of the questions to ponder is whether the institutions of higher education have changed as much in the past 25 years as has technology, and I think most would answer "no." One could argue that American society at large, some types of businesses, and many individuals' personal lives have been significantly changed due to the use of technology, while much of higher education has remained the same in 2014 as it was in 1988. However, there are facets of university operations and of research programs that have been transformed by technology in the past two decades. There is no doubt that scientific research, both methods of inquiry and modes of output, have changed dramatically in 25 years. In social science research, there has been much incremental change due to specific developments such as geographical information systems (GIS) and the ability to analyze and visualize very large data sets. Humanities research has continued, by and large, to be very traditional, in both methods and modes of publication; however, significant pockets of innovation with digital technologies exist.

Teaching and learning in universities has had a very mixed record of change catalyzed by new technologies, with many university classes taught in lecture halls in much the same mode as they were not only 25 years ago, but 100 years ago. The commercial sector of higher education has embraced technology, both for distance education and for carefully programmed learning units for in-person instruction. Some universities and colleges have revamped curricula, for example in architecture programs or communications programs, to both use technology in instruction and to teach students the new tools of the disciplines.

There have been many significant developments in the areas identified by Lewis in his article, and this essay will identify some key developments during the time that has transpired and suggest the trajectory of these trends into the future, focusing on a subset of the issues he identified.

Learning and Teaching

Overall, there is a very mixed picture of the development of the digital university in one of its primary missions: the teaching and learning program. While there were limited but important efforts to encourage broad use of computers in higher education, such

as the PLATO project initiated at the University of Illinois in the 1960s, there was not widespread uptake by the late 1980s by higher education institutions.[5] There was attention to the use of technology in teaching and learning by some U.S. federal agencies, policy groups, and higher education leaders, but actual implementation of significant teaching, learning, and technology initiatives prior to the mid-1990s was uncommon. Educom, the higher education information technology professional organization, did not create its Educational Uses of Information Technology initiative (a forerunner of the current EDUCAUSE Learning Initiative) until 1987.[6]

In the time that has transpired since Lewis wrote his article, six cohorts of students would have spent four years sequentially in college. Students entering the university by the mid-1990s often had access to computers from the time they were in elementary school or even earlier and eventually had access to the Internet by their later school years. By the time the influential book *Educating the Net Generation* was published in 2005, information technology units and libraries were making significant efforts to both understand the way that students approached and used technology and think through how to shape teaching, learning, and associated services to best address emerging needs and preferences.[7] The students would have experienced major changes in library technologies over this period of time. For example, Lewis writes, "Dial-up access to the catalog will be only the beginning,"[8] and that was correct. Students can access not only bibliographic records but now can find full-text articles and books online from remote locations, anytime, anywhere; and they have access to a wealth of public domain and open access content, such as information produced by the federal government, image collections made available by museums, and educational videos.

By contrast, today most students likely would have experienced little change in the use of technology by their faculty in the classroom or in assignments. The main exception is the use of the course management system (CMS) or learning management system (LMS). According to the EDUCAUSE Center for Analysis and Research (ECAR) study of undergraduate students, "The institution's main website, the CMS, and the institution's library website were used by nearly all students in 2013. These same three institutionally supported IT resources also appear at or near the top of students' ratings for very/extremely important to their academic success."[9] LMS software has become one of the most ubiquitous technologies in students' daily course experience, and libraries have worked in various ways to integrate access to some of their collections and services into the LMS, with varying degrees of success. In fact, the ECAR survey of undergraduates in 2014 asked students what features they would add if they were designing an LMS today and reported that the fourth most popular response was to improve ease of access to journals and other resources.[10] According to the ECAR report, "The challenge is to meet students' expectations of functionality and performance and to support their preexisting technology environments while applying the right technologies to deepen their educational engagement."[11]

One relatively recent trend that will likely have increasing emphasis in the near future is the application of learning analytics in courses, particularly in large enrollment science, mathematics, and engineering classes. Learning analytics use data, statistical analysis, and predictive models to gain insight into student learning and provide directions for improving student success.[12] This systematic focus on student success through the use of analytics to pinpoint where students have difficulties in learning particular course material ideally informs faculty about when and how to try new pedagogical strategies. Usually these efforts involve standardized learning materials such as textbooks, problem sets, and assessment instruments such as quizzes and exams. When teaching materials are solely textbook-oriented, there is not a close intersection with what libraries can contribute to the learning process. Libraries have a clear role

in enriching coursework when students are given assignments that expose them to an array of perspectives through readings outside the primary texts of the course or are given assignments such as papers, video production, or website creation on a course topic where discovery and analysis of information resources play a key role. Learning analytics programs are not frequently used with the types of courses with less strictly structured readings and assignments.

With the increased use of learning analytics, it is likely that more personalized learning environments will be developed for students in the future. Students may be offered different learning materials (videos, problem sets, and the like) based on what the analytics software predicts will be most useful to a particular student's learning characteristics. In 2014, the *Horizon Report* identified "the rise of data-driven learning and assessment" as one of their mid-range trends driving change in higher education in the next 3 to 5 years, and it described both the increasing use of educational analytics and the types of adaptive learning software that respond to individual learners' needs.[13]

Three ways in which some libraries are directly involved or could be involved in significant aspects of the digital university's teaching and learning with technology programs are: administering or collaborating with a center that supports faculty in their efforts to innovate in their pedagogy; leading or supporting open educational resources initiatives, including providing resources for massive open online courses (MOOCs), as well as providing licensed educational resources; and renovating library spaces to provide areas outside classrooms to encourage collaborative and problem-based learning.

Some libraries administer the centralized teaching, learning, and technology support center for the institution; there is no standard set of services for such units, but they may focus on support for the institutional LMS or may provide a broad array of services including instructional design, development of new types of learning spaces, audiovisual classroom support, and media production for courses. Whether or not the library is the center for teaching and learning with technology, some librarians are working with faculty to develop more integrative uses of technology in new types of class assignments and in the teaching and learning process.[14] There are many opportunities for collaboration with faculty and campus partners such as the center for teaching and learning or an office of undergraduate education.

In support of education, some academic libraries are bringing their open access principles into the realm of e-textbooks. In 2014, the Open Education Conference, held for the 11th time, included a "Libraries and OER" (Open Educational Resources) track for the first time in its history.[15] Librarians are also promoting open educational resources in their partnerships with MOOCs or are serving as the licensing specialists for content to support MOOCs.[16] Whether for a MOOC or a standard in-person or online course, librarians could play a role in educating faculty about the availability of open educational resources, since so many are unaware of how to obtain them.[17] Most of those resources, such as those in the National Science Digital Library (NSDL),(https://nsdl.oercommons.org/), MERLOT (http://www.merlot.org/merlot/index.htm), or the videos of Khan Academy (https://www.khanacademy.org/), are not owned or licensed by the library, and librarians would need to make a concerted effort to move beyond the confines of their own resources when they develop library guides, link to resources in a course management system, or consult with faculty and students. If librarians play an increasing role in instructional design and partnerships with faculty in teaching and learning initiatives, this will become more prevalent practice. In addition, librarians can assist faculty in identifying those educational resources the library already owns or licenses and make them available for courses, and can play an increasing role in such areas as e-textbook licensing.[18]

With the rise of ubiquitous digital content, many have predicted the demise of the library as "place," believing that individuals will no longer have the need to come to a physical facility named a "library." Lewis was not one of those individuals, and he wisely stated, "There will be a need for a public scholarly space on campus" and noted that it would contain computers, various types of electronic information, and an "inviting environment for both individual exploration and group learning."[19] What he describes is similar to library environments of the twenty-first century, especially learning/information commons spaces.[20] These renovated or newly constructed spaces offer a choice of quiet or collaborative areas with ample power outlets for students' devices as well as wireless access, information resources, hardware, specialized software, and services; these spaces are tremendously popular, especially with undergraduate students.

There are many opportunities for libraries and librarians to shape teaching and learning in the digital university, but it will take a concerted effort and genuine interest in the teaching and learning environment of the institution for libraries to make a meaningful contribution. These efforts must go beyond typical, basic information literacy instruction in how to find and evaluate information in both print and digital form. *The Framework for Information Literacy for Higher Education*, developed by an ACRL Task Force, provides conceptual guidance on the integration of information precepts into courses and emphasizes that librarians must work with faculty and other partners to develop an instruction program that addresses institutional learning priorities.[21] Librarians also have opportunities to link information literacy with scholarly communication as they explore topics presented in instruction sessions.[22] Such information will assist students to become sophisticated in their understanding of the information society, not just the digital university. As instructors, librarians need to follow trends in pedagogy and implement learning experiences for students that are problem-based, hands-on, and collaborative. Librarians should consider how they might support an ongoing record of student work (such as electronic portfolio, student capstone work in a repository, or other mechanisms) to assist students in future education and employment. Librarians also need to continue the work of renovating library facilities to support a broad range of learning needs, not just the individual, quiet study areas identified with traditional library facilities. Libraries have the potential to be genuine learning labs for the digital university, providing hardware, tools, facilities, and expertise so that students can develop new types of information products (videos, websites, data visualizations) in their fields of study.

Scholarly Communication and E-Research

While the general public often perceives that the main focus of higher education institutions is their teaching program, many administrators and faculty focus much more on the research mission of the university than on teaching and learning. Even in master's-level universities and selective liberal arts colleges, it is the faculty's research agenda and their publication record that counts most in promotion and tenure decisions. Use of technology in research has major implications for the digital university and ideally would bridge into teaching and learning activities but frequently does not.

In the twenty-first century, researchers are expanding the horizon of discovery by using continually emerging new tools, sources of data, and the capabilities of high-performance networks. E-research is a term that encompasses methodologies used by researchers and scholars in a variety of disciplines; e-science and digital humanities are terms that are used to describe technology-intensive research methodologies in those respective areas. Every contemporary researcher uses technology in some way in his or her research, and ownership of personal technologies is a given. In 1988,

by contrast, Lewis noted a study that indicated that close to half of humanities and social sciences scholars "now have a personal computer for their exclusive use."[23] Today, researchers use anything from the simplest functions of word processing technology to complex data visualizations. Technology has transformed the tools of doing research, the type and amount of data that can be collected and analyzed, and the modes of representation and dissemination. This change had already begun in 1988 and Lewis discussed the potential of technology to make accessible the data underlying published research, the emergence of electronic-only journals, and the rise of informal channels of scholarly communication that would democratize participation in the ongoing scholarly conversation (counterbalanced by the need to maintain prestige factors in online journals).

The landmark 2003 National Science Foundation Report *Revolutionizing Science and Engineering through Cyberinfrastructure*, authored by a panel headed by Daniel Atkins, gave visibility within the broad higher education community to the concept of cyberinfrastructure, which "refers to infrastructure based on distributed computer, information, and communication technology" and is a requirement for a knowledge economy.[24] The report signaled that a major change was in process in the modes of scientific research and that an infrastructure composed of communications networks, instruments, tools, people, and information was essential for the conduct of contemporary science. The report also noted the significance of parallel developments in the National Science Foundation for funding for development of large digital libraries; these would work in concert with the other pieces of cyberinfrastructure. Currently, the term cyberinfrastructure has generally been replaced by "e-science" or "e-research."

In 2006, the American Council of Learned Societies' report entitled *Our Cultural Commonwealth* attempted to paint a similar vision for the humanities and social sciences.[25] The report made the case for developing a robust technology infrastructure for scholarship in the humanities and social sciences, identified challenges, and proposed a framework for action. The report discussed the importance of "extensive and reusable digital collections" and charged libraries to work with scholars on developing digitization priorities. Some of the key challenges identified in the report included the need to rethink economic models of production and to develop trusted methods for preservation in the digital environment. It is interesting to note that the report includes as a "necessary characteristic" of the emerging model the notion that "if public funds are involved in the creation of a digital resource, proportional elements of those resources should be freely available to the public."[26] This type of requirement was codified for scientific research by the National Institutes of Health beginning in the mid-2000s.

The new forms of scholarship such as websites of primary sources, data visualizations, and 3-D reconstructions of ancient archaeological sites, have had some problematic consequences for their creators, especially in the humanities. Promotion and tenure committees, composed of senior faculty who may conduct research in traditional modes and only acknowledge the research outputs of journal articles and print monographs, may not recognize the value of a faculty member's sophisticated research using or developing digital tools. Faculty innovators may find that their e-research projects have dire consequences for their ability to advance in their careers. One notable initiative has been by the Modern Language Association (MLA), which issued guidelines for evaluating work in digital media in 2000 and has given a heightened profile to this issue in more recent years.[27]

Libraries are supporting new modes of scholarship in a variety of ways; among them are: curation of data and other components of research, addressing new economic models for publication of scholarship, taking on publishing programs, and establishing

digital scholarship centers. Libraries have traditionally curated the publication record; but, in the digital university, that is only one part of the record of scholarship. Clifford Lynch notes that, "with the arrival of the data-intensive computing paradigm… it has become clear that data and software must become integral parts of the record … [and] require systematic management and curation in their own right."[28] While referring to the sciences, Lynch's observations apply to developments in the social sciences and humanities as well, where large data sets and the literature of fields themselves are being analyzed by computer programs to surface, identify, and address new types of research questions. Some libraries are developing programs to advise faculty on data management and curation and are addressing the need for repositories to house both large and small collections of data.

Another way that libraries are supporting digital scholarship is through the development of full-service digital scholarship centers or labs that provide high-end hardware, software, and tools; expertise; and consultation on technologies, standards, preservation, intellectual property, and project management.[29] These centers in libraries are particularly important for disciplines, like many in the humanities, that do not have large grant funds to support expensive hardware or tool development; and they are also important training grounds for graduate students to become familiar with new tools for doing research. In addition, digital scholarship center staff often partner with faculty to integrate work on digital projects into undergraduate courses.

In addition to developing the technologies to underpin digital scholarship and scholarly communication, by the early 1990s institutions began to focus on the policy and economic issues associated with changing the modes of communication. While simply transitioning the traditional monograph and journal systems to the digital environment was a response by many publishers, some in academic institutions saw opportunities for the implementation of new economic models and, in particular, freely available scholarly content on the Internet. The Association of Research Libraries formed the Scholarly Publishing and Academic Resources Coalition (SPARC) in 1998 to create a more open system of scholarly communication. SPARC is a very active component of the global Open Access movement. Another mechanism for change in the scholarly publishing system is the emergence of libraries' direct involvement in publishing. In a 2013 survey by the Library Publishing Coalition (LPC), 95 percent of the 115 library publishing programs that are profiled in the LPC directory stated that they focus mostly or entirely on open access publications.[30]

So far, the ability to develop new channels for publication and scholarly communication have not resulted in an easing of the economic pressures on libraries caused by high journal subscription costs, especially in the sciences. It remains to be seen whether U.S. federal government policies, such as that articulated in the 2013 Office for Science and Technology Policy (OSTP) memorandum, which calls for the published results of federally funded research to be made freely available (after an embargo period, if needed) and for researchers to develop data management plans for the digital data resulting from federally funded research, will ultimately result in a system that has a new economic model.[31] Will the "digital university" put in place policies or systems that make the products of research of its own academics freely available? Will scholarly societies, which often have close ties to universities through memberships and editorial boards, develop new economic models for publication, allowing for open access of their products? Publications by scholars are the tangible result of the achievement of the research mission of universities, and open dissemination of research results would have implications for the global reach of universities and the capabilities for the reuse and innovative combination of the products of scholarship.

Access and Preservation

While libraries have built strong collections of digital resources, they seem to have lost their authority as "the" organizers of information; with full-text searching capabilities available through many systems, some rigorous cataloging practices have perhaps diminished in importance. Discovery of scholarly information is now in flux, with libraries rethinking such key developments of early automation as the MARC record. Commercial library discovery systems seek to emulate the ubiquitous Google search box, but many library users still find library resource access to be too complicated. In a recent Ithaka S+R issue brief, Roger Schonfeld challenges librarians to consider that relying on a service like Google, instead of a library-purchased discovery layer for the local integrated library system, might be "effective enough" to keep the library from making an expensive investment.[32]

Even in organizing institutional information resources, the traditional strength of libraries, librarians seem to be floundering. Items in the institutional repository, including electronic theses and dissertations, are not part of many libraries' catalogs. Digitized special collections and archives materials may be in their own content management systems with distinct finding aids. It can be challenging for users to understand how to access these distinctive resources.

On the other hand, consortial or cooperative initiatives are emerging to address large-scale needs for access and preservation of data as well as publications. Such initiatives as SHARE, DPN, APN, HathiTrust, Portico, LOCKSS, MetaArchive, and others are attending to the need to develop robust infrastructure and storage for large collections of digital content. They are also addressing economic models and policy issues for concerns in preservation, such as the need for legal agreements for access to and ownership of digital content after a publisher or other entity has gone out of business. Librarians are the primary movers in many of these organizations; in some, they are working in partnership with information technology organizations, higher education associations, and others.

Staffing

Lewis's article suggested that the merging of academic computing and library services was beginning and was a clear trend for the future. While this has been true in a number of liberal arts colleges and a relatively small number of other types of higher education institutions, it has not generally been the case at research universities. Some academic libraries do have functions that, in other institutions, would be part of the information technology unit, such as administration of the learning management system, classroom technologies, media production, and instructional design. Services supporting e-research may be part of the library and/or information technology units. Merging library and information technology units has been more difficult than envisioned 25 years ago; and, in large schools, many of the academic computing functions are now carried out in departments or schools, while central information technology units may focus on infrastructure and administrative aspects of technology. Information technology units within many universities have changed significantly since Lewis wrote his article, generally shifting their focus to major enterprise administrative systems and reducing their involvement in teaching, learning, and research. The NSF *Cyberinfrastructure* report called for "Enduring institutions with highly competent professionals to create and procure robust software, leading edge hardware, specialized instruments, knowledge management facilities, and appropriate training."[33] In most universities, these functions are largely addressed by computing centers or academic computing groups within departments, and not by libraries, although exceptions exist. An exception is the emerging role of librarians in data curation, which is an important aspect of e-research.

As Lewis pointed out, there is an increasing need for new types of specialized staff in libraries. The Council on Library and Information Resources (CLIR) Fellows program is a new model for attracting specialized and highly trained staff into academic libraries.[34] Their programs have recruited recent PhDs, mostly from the humanities but more recently from the social sciences and sciences, to work in structured programs in academic libraries. The program seeks to familiarize the fellows with library principles and practice, and the fellows work to infuse their scholarly training, perspective, and specialized technology skills into the libraries where they have been placed. Whether a PhD is required to succeed as a librarian in the digital university is debatable, but there is a clear need to infuse libraries with individuals who have developed or can develop highly specialized technology skills. Since technologies are changing so rapidly, these individuals also must have the capability to embrace change. Some graduate programs, especially those within iSchools, are preparing information professionals for new types of roles in libraries or other settings.

Libraries are also working to develop closer partnerships with faculty in both research and learning initiatives through implementation of an expanded liaison model, which incorporates elements of the kinds of positions held by collection development, reference, and instruction librarians.[35] These librarians may be the bridge between the new technologies of the digital university and the faculty who are less fluent in those systems.

Conclusion

In an essay that describes some possible futures for higher education in 2024, futurist Bryan Alexander posits a scenario, "Two Cultures," in which one part of the higher education system is online only and successfully offers sophisticated, multimedia learning environments that allow students to have highly flexible learning schedules. In parallel, another part of the higher education system offers a primarily brick-and-mortar setting that "synthesizes the best of face-to-face teaching with what the digital world has to offer," including opportunities for students to complete a portion of their education through online courses.[36] Alexander describes this second environment as one that provides access to many forms of content via the library and includes consultations with librarians as well as other types of staff in person or online. Students develop media production skills along with their disciplinary studies. This scenario strikes me as a likely depiction of the future for teaching and learning in higher education institutions. It is, in a sense, following the trajectory of a gentle upward slope into the future, drawing on current practices and strengthening them, providing many options that suit individuals with different types of needs at various points in their lives; the primarily online scenario is particularly relevant for students who are older than the 18–22-year-old cohort and who would especially benefit from a flexible system since many have jobs and young children. What is currently incomplete in the online environment is the sense of a community with strong academic and social dimensions. Certainly elements are there and may be working successfully for some individuals, especially those who become engaged in online course discussion groups. Platforms that work to develop a virtual sense of community, where individuals take on an identity through an avatar in a visually represented virtual world, such as Second Life, have not succeeded well in establishing higher education communities so far. Librarians, instructional technologists, student affairs professionals, faculty, and others could all work in partnership to design better academic/social communities for the digital university.

One thing we have learned in the past couple of decades is the risk of predicting developments too far out in this era of rapidly changing technologies. Some of the

things that Lewis did not imagine when he wrote his article around 25 years ago are the World Wide Web, the ubiquity of network access outside the university setting, the enormity of the collections of digital content now available, the huge popularity of media via the network (for both academic and personal use), the significant role of social networking in society, and the rapid adoption of powerful mobile devices by everyone from scholars to young children.

Many of the changes that have been implemented in the past 25 years have significantly transformed universities. In the research environment, many faculty, especially in the sciences, are actively building the digital research environment, not the digital university *per se*; their research environment does not have boundaries of the university since most digital scholars and researchers work in cross-institutional teams. Information technologists have built the networking and storage infrastructure that is critical for the scholars' work, and they have participated, along with computer scientists, domain faculty, and (occasionally) librarians, in building tools for specific disciplines or purposes. Librarians are actively designing or participating in the design of information infrastructures to provide access, curation, identity management systems, and other components for a wide array of digital information products for research; they are building facilities to accommodate high-end tools like visualization software to democratize access to the new modes of research to individuals in all disciplines, and they provide expertise to support those researchers.

Lewis noted Pat Battin's call in the mid-1980s for libraries to "create an institutional capacity to reinvent the university in the electronic age." She not only wanted libraries to reinvent *themselves* in the digital environment, but to provide some underpinnings for the work of the university in research, teaching, and learning.[37] It is important to confirm that many academic libraries have, in fact, developed or contributed to the development of robust infrastructures to support research, teaching, and learning in the digital environment. Many libraries have reinvented themselves in substantial ways, with new types of collaborative spaces for active learning, with technologies and services that enable library users to create new multimedia products and not just view films or listen to audio, with very different configurations and expertise of staff, and with significant investment in digital information resources. There have been a number of other societal developments, in addition to innovations in technology, that have prompted change in higher education. Major cutbacks in the funding of public higher education institutions, the greatly escalating cost of tuition, the changing demographics of student populations, and many other factors have elicited a range of responses from libraries and higher education institutions and will continue to shape the higher education environment into the future.

Within higher education institutions, disciplinary faculty culture, particularly with regard to what type of scholarship (in terms of methodologies used, publication medium, and publication venue) is needed for tenure, promotion, and overall recognition by their peers, has not changed much in recent decades, and librarians themselves cannot change that culture. While librarians may act as a catalyst, guide, or partner, disciplinary faculty themselves, in universities and through their professional societies, must change their culture. Those faculty who are active in creating the digital university recognize this. The authors of the NSF *Cyberinfrastructure* report state, "Only domain scientists and engineers can revolutionize their fields."[38] The American Council of Learned Societies report notes that "Librarians, rather than scholars, have provided much of the recent leadership within the academy on issues of cyberinfrastructure in the humanities and social sciences," but stated that it is necessary for academic administrators and scholarly societies to take up the call for developing cyberinfrastructure for those fields and also noted the need for tenure and promotion policies to recognize and reward digital scholarship.[39]

With the rise of the World Wide Web, Google, and ubiquitous, 24-hour access to information in a variety of modes, many people predicted the demise of libraries. However, libraries continue to maintain a vital role in the emerging digital university. Librarians have proven to be insightful leaders, putting into place the kinds of technologies needed for teaching, learning, and research. They are often among the early adopters of new technologies in their institutions. Most academic work in the digital environment is done by teams, not by individuals working alone. In partnership with faculty, students, staff, and their communities, librarians will continue to have a strong role in the digital university.

Notes

1. David W. Lewis, "Inventing the Electronic University," *College & Research Libraries* 49, no. 4 (1988): 291–304.
2. David W. Lewis, "Inventing the Electronic University," *College & Research Libraries* 76, no. 3 (2015): 298.
3. David W. Lewis, e-mail to the author, Sept. 4, 2014; quoted with permission. He wrote that Paul Evan Peters: "was a significant unreferenced influence on my thinking for the article… He had gathered a group of wonderful forward thinking and acting librarians around him (the program committee for the first LITA conference would give you the core group) and I could never have written the article had I not been blessed to have known and worked with Paul." Note: The first LITA conference was held in September 1983. The Coalition for Networked Information (CNI) was founded in 1990.
4. P.S. Graham, "Research Patterns and Research Libraries: What Should Change," *College & Research Libraries* 50, no. 4 (1989): 433–40; R. Atkinson, "Learning from the Past: The Acquisition Librarian as Change Agent in the Transition to the Electronic Library," *Library Resources & Technical Services* 48, no. 3 (2004): 216–26.
5. Stanley G. Smith and Bruce A. Sherwood, "Educational Uses of the PLATO Computer System," *Science* 192 (Apr. 23, 1976): 344–52.
6. Robert C. Heterick, Jr., "Educom: A Retrospective," *Educom Review* 3, no. 5 (1998): 42–47, available online at https://net.educause.edu/ir/library/html/erm/erm98/erm9853.html [accessed 7 December 2014]. Note that Educom is a predecessor organization, along with CAUSE, to the organization known today as EDUCAUSE.
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