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Transforming the Library

The Impact and Implications of Technological Change

I. INTRODUCTION

People have been using technology to solve practical problems ever since they created tools from stones. When it comes to new technologies, LIS professionals historically have been quick to see their possibilities and to experiment with their use. For example, shortly after electric lights were invented, libraries installed them in library stacks in the nineteenth century, allowing librarians to quickly locate materials without burning down the library. Librarians have also created important intellectual technologies such as the Dewey Decimal Classification System. As early adopters, libraries were one of the first places to use computers. Today we can be certain of only two things: technological changes will continue unabated, and they will occur at an accelerated pace. Each time a library adopts a new technology, the functions and the culture of the library evolves in some way. Consider some of the changes the Internet has wrought on technical services and on the way librarians identify and deliver information to library users. It has changed the physical facility, the nature of the library's collection, and the roles of the library staff. It has changed the users themselves in terms of what they expect and how quickly they expect it. There can be little doubt that technology brings both exciting possibilities and complex problems associated with change and adaptation.

This chapter begins with a review of how new technologies affected libraries historically. The remainder of the chapter discusses some of the major issues and current challenges facing libraries.

II. TECHNOLOGICAL DEVELOPMENTS AFFECTING LIBRARIES FROM 1900

A. Developments in Microphotography

The first half of the twentieth century was a fruitful period for technological development. Major improvements in communications and transportation were especially notable, including the growth and expansion of telephone services, improvements in airplanes and automobiles, and development of the cathode ray tube and photoelectric cells. Perhaps the most notable developments for libraries were related to new photographic technologies, especially microphotography, which permitted the reproduction of print documents (reprography) onto film (microforms). The physical format was usually a roll of film, the microfilm, or a rectangular card, the microcard. As an alternative to paper, microphotography had advantages: it provided a significant amount of information in a compact medium and it was lighter and easier to store. It also proved to be an exceptional medium for the preservation of materials likely to deteriorate over time, such as newspapers, magazines, and documents. By the 1920s most libraries were using microforms.

Reprography saw additional advances in the 1960s with the development of duplicating machines, most notably the photocopier. Photocopying profoundly affected the dissemination of knowledge (as well as paper consumption). Although not as dramatic as the invention of the printing press, photocopying revolutionized communications because it permitted greater flexibility in the distribution of published materials. In essence, "libraries became publishers of single copies on demand" (De Gennaro 1989, p. 42).

B. First Application of Computer Technologies in Libraries: The 1960s

In the nineteenth century, libraries adopted new, mechanical sorting techniques using punch cards, an early precursor to computers (Buckland 1996). These early efforts at "mechanization" evolved into "library automation" in the 1960s as computers became more sophisticated. Bierman (1991) defined automation as "the application of computer and communication technologies to traditional library processes and services" (p. 67). The rationale for automation was based on reasonable assumptions that these new technologies increased efficiency, produced costs savings, and reduced the size of staff.

The first significant application of computer technologies in libraries was the creation of Machine-Readable Cataloging (MARC), which became the standard

for the creation of bibliographic records. MARC allowed librarians to enter, store, and disseminate bibliographic data electronically on computer tapes (see chapter 6). Library support agencies, known as bibliographic utilities, quickly recognized MARC's potential. One of these, the Ohio College Library Center (OCLC) was incorporated as a not-for-profit corporation serving academic libraries in 1967. OCLC loaded the MARC tapes created by individual OCLC member libraries. The member libraries then examined the centralized bibliographic records, edited them for their local institutions, and ordered tailored catalog cards electronically. The cards arrived quickly, ready for filing, in effect creating an online, shared cataloging network. The advantages quickly became clear to other libraries, and in 1972 OCLC opened its membership to nonacademic libraries (Grosch 1995). This led to tremendous growth in membership and increased cooperation among different types of libraries and among regional library networks. Consequently, in 1981 OCLC changed its name to the Online Computing Library Center. Over the decades, OCLC services grew, offering interlibrary loan and document delivery, acquisition systems, serials control, electronic publishing, and access to electronic databases. Major research libraries formed another bibliographic utility called the Research Libraries Group (RLG) that created the Research Libraries Information Network (RLIN), now a part of OCLC. RLIN offered access to bibliographic databases containing thousands of research records. It is difficult to overestimate the major changes created by MARC. The impact on cataloging departments, for example, was substantial, resulting in a significant reduction in the number of catalogers.

The 1960s was also when the first applications of online information retrieval systems developed. Initially these were prototype systems, usually consisting of a small database and one terminal. In 1966, the Lockheed Missiles and Space Company, working primarily with government agencies such as NASA, developed the earliest form of the Dialog system, containing over 200 bibliographic and reference databases (Summit 2002). Today, ProQuest owns the Dialog system and provides access to 90,000 authoritative sources and 6 billion digital pages, spanning six centuries of information. During this same period, the National Library of Medicine, one of the great special libraries in the world, was confronted with a rapid expansion of scientific and technical knowledge. It quickly became obvious that they could no longer continue manually indexing the medical literature. By recording all bibliographic citations on computer tapes, Index Medicus became a searchable database, one of the great achievements of the decade.

The decade ended with even more far-reaching developments that would significantly affect libraries several years later. In 1969 the Defense Advanced Research Projects Agency within the Department of Defense developed at the University of California at Los Angeles a computer network called ARPANET. ARPANET was

created to improve government-sponsored research by electronically linking organizations with defense-related contracts at different sites and allowing them to share research and data (Tennant 1992). One of the innovations of this system was the first practical use of a new technology that allowed discrete packets of information to be sent independently of one another across "packet-switching" networks. The discrete packet transfer increased reliability and speed, thus substantially improving the transmission of research data and analysis. Although ARPANET membership was restricted to government-funded institutions, this network was the genesis of what would become the Internet. ARPANET significantly advanced development of key Internet features such as file transfer, remote access of data, and electronic mail (Bishop 1990).

Although libraries were quick to adopt MARC records for creating catalog cards and to use computers to generate purchase orders, there remained considerable skepticism that automation could be applied practically to most library functions and services (Grosch 1995). Nonetheless, a new era had begun.

C. Use of Online Information Retrieval Systems for Reference: The 1970s

The increasing sophistication of computer technologies, including the development of the minicomputer, made online interactive capabilities a reality (Grosch 1995). Major information-dependent institutions such as the military, and business and industry, quickly recognized their potential, and commercial vendors rapidly developed a variety of databases that could be accessed through telephone lines. Although these vendors did not necessarily design their services for libraries, it was clear that libraries would be substantial users. However, due to the technical and scientific nature of the databases, academic and public libraries often created separate facilities and assigned a specially trained librarian to conduct online searches because the cost of a search was calculated based on the time it took to perform it. Even then, libraries often had to pass on at least part of the costs to the individual for whom the search was conducted—a disconcerting practice that ran counter to the normal practice of providing free services.

Online access also required search strategies that could exploit the unique flexibility of computerized systems. Perhaps the most prominent development in this area was Boolean searching, based on the nineteenth-century logic theory of George Boole. Its application in the online environment permitted searching using logical connectors such as "and," "or," and "not," which narrowed the search and yielded more precise access to large bodies of knowledge in a much shorter period of time.

Another strategy involved searching for a particular key word or phrase anywhere in the bibliographic record, including an abstract. This strategy differed significantly from traditional searches using subject terms, titles, or authors.

The 1970s also saw the beginning of early attempts to automate library circulation, serials control, cataloging, and acquisition systems. However, these systems were far more complex than anticipated, and they did not reach maturity until a decade later.

D. CD-ROMs and Integrated Library Systems: The 1980s

1. The CD-ROM

No less remarkable than online searching was the revolution in information access provided by the development of the Compact Disk–Read Only Memory (CD-ROM). One 4½" disk could contain all, or most, of the contents of standard reference tools such as the *Reader's Guide to Periodical Literature*. CD-ROMs had several distinct advantages over online searching because they were held locally and required no telephone line. Librarians could search vast databases directly using Boolean tools as well as by author, title, and subject. Libraries subscribed to vendor services that provided the CD-ROMs, thus offering a fixed-cost alternative to variable online computing costs. Information vendors sent the software and disks to load onto library computers, along with periodic updates.

2. Integrated Library Systems

a. The Development of Online Public Access Catalogs (OPACs)

Online public access catalogs (OPACs) allowed patrons to directly access the library's computerized bibliographic records using a variety of search tools, including the familiar author, title, and subject search, as well as keywords, call numbers, and ISBNs. There was no longer any need for libraries to buy catalog cards or hire individuals to file them. These savings, however, were offset by major investments in hardware, software, computer maintenance, and construction costs to change the library's physical environment and infrastructure.

Although OPACs were helpful, Borgman (1996) noted that much of the improvement in user interfaces was superficial. Library users experienced persistent problems related to their lack of knowledge of (1) the conceptual and semantic framework of OPACs' specific terminology, (2) the basic search strategies such as "browse" or "keyword" searching, (3) how to search fields other than author, title,

or subject, and (4) Boolean searching. Today, as more people are familiar with the functionalities of search engines and the Internet, they will demand the same flexibility from the online catalog (Novotny 2004). Markey (2007) noted that although online catalogs used to be where people started searching for information, Google now takes precedence. He suggested that online catalogs need to be redesigned with similar retrieval capabilities, with improved subject searching and metadata, and with the ability to return precise search results.

b. The Linked System Project: Linked Systems Protocol (LSP)

As online catalogs proliferated, the advantages of linking computers in various libraries and organizations became obvious. Unfortunately, at the time, computers could not "talk" to each other because different developers had created incompatible systems. The Linked System Project, funded by the Council on Library Resources, which involved the American Library Association, OCLC, the Research Libraries Information Network, the Western Library Network, and the LOC, sought to solve this problem. The project's solution was the linked systems protocol (LSP), also known as the Z39.50 standard (NISO 1994) which became a national standard for bibliographic information retrieval. By linking automated systems, authorized users could consult the OPACs of countless libraries and information organizations (Buckland and Lynch 1987, 1988). Realization of this goal wasn't achieved until the 1990s, with major improvements in telecommunications technologies.

c. Online Circulation Systems

Once OPACs were linked, the next logical step was automating circulation. Initially attempted in the 1970s, it wasn't until the 1980s that commercial vendors developed practical automated circulation systems. Although these "turnkey" systems were relatively inexpensive, it took considerable time for staff to bar-code the materials and convert records into machine-readable format (retrospective conversion). Additional time was needed to weed the collection to avoid spending money to input old, unused materials. Public library staff generally continued to process the materials while many academic libraries enabled "self-initiated" systems that allowed patrons to check out their own books. These more computerized systems could track overdue items, send out recall notices, produce circulation reports, and analyze how the library collection was being used and, therefore, could assist in planning.

d. Automated Acquisitions and Serials Systems

The 1980s also saw the burgeoning of systems designed to help libraries acquire materials. Some of the larger book vendors, such as Blackwell North America and

Baker and Taylor, were quite active in developing these systems. Other vendors such as Innovative Interface developed acquisitions systems for serials. All of these systems were directly linked to the vendors and the library ordered its materials online. The system could set limits so that a particular department could not exceed its budget, and produced reports for analysis and evaluation. Some systems included a serials check-in system to save labor on the cumbersome tasks of checking in magazines and other periodicals. They could also create an electronic profile of the library based on its purchases. The vendor could then automatically send materials that matched the profile without the library ordering each item, saving time for both the library and the vendor.

3. The Growth of the Internet and the World Wide Web: The 1990s

a. Growth of the Internet

Auspiciously, the birth of the Internet occurred in 1984, the result of a mutually beneficial arrangement between the Department of Defense (DoD) and the National Science Foundation (NSF). At a time when government funding for ARPANET was declining, the NSF was establishing supercomputing centers at major university research centers to support some of the most advanced research in the world. NSF needed a "high-speed telecommunications backbone" to facilitate communication among the centers. NSF negotiated with DoD to use the ARPANET technology. The NSF later invited other universities to join the network for a flat, reasonable fee and encouraged faculty and students to participate. Every linked computer used a standardized communication protocol, the Transmission Control Protocol/Internet Protocol (TCP/IP), which provided a unique, numeric IP address (e.g., 121.123.46.22) for every computer. Because most people are better at remembering names than numbers, the Domain Name Service (DNS) translated the IP address into a name (e.g., www.slis.kent.edu).

The resulting NSF-linked network formed the foundation of what was to become the Internet. The growth of the Internet brought increased attention to national productivity issues and international competitiveness. During the George H. W. Bush administration, Democratic Senator Al Gore introduced legislation to develop a national "information highway." The National High Performance Computing Act of 1991 ensured an efficient national communication system and mandated the creation of the National Research and Education Network (NREN) to increase electronic access to federal agencies, industry and business, libraries, and educational institutions. While moving toward this goal, however, a significant shift in political attitudes occurred during the Clinton administration. Private groups

with a significant stake in the Internet's development advocated for greater privatization, less reliance on government financial assistance, and regulatory relief (Gomery 1994). At this critical juncture, the telecommunications industry (e.g., telephone, television, and cable industries) and private enterprises, as well as literally thousands of interested individuals and organizations, became the primary developers of the Internet.

The involvement of all of these varied participants created a network of networks with an open architecture, the Internet we have today. In an open-architecture structure, individual networks can be designed for specific environments and user requirements, with their own unique interface, but which can be available to other users and/or providers (Leiner, et al. 2010). This open structure produces tremendous flexibility, a concept Zittrain (2006) referred to as "generative capacity."

> Generativity denotes a technology's overall capacity to produce unprompted change driven by large, varied, and uncoordinated audiences. . . . The Internet is built to be open to any sort of device: any computer or other information processor could be part of the new network as long as it was properly interfaced, an exercise requiring minimal technical effort. (pp. 1974–1976)

The Internet is an especially generative technology because it is highly adaptable, relatively easy to use, makes a variety of difficult tasks easier, and is accessible to a wide audience using many applications. The fact that developments and innovations were not controlled by a small number of proprietary interests or governed by a centralized unit created tremendous potential for growth and creativity:

> The design of the Internet also reflects both the resource limitations and intellectual interests of its creators, who were primarily academic researchers and moonlighting corporate engineers. These individuals did not command the vast resources needed to implement a global network and had little interest in exercising control over the network or its users' behavior. . . . The resulting Internet is a network that no one in particular owns and that anyone can join. (Zittrain 2006, pp. 1989, 1993)

Librarians quickly recognized its values. Kuttner (2006) observed, perhaps somewhat romantically, "In some respects the Internet is just an extension of the physical library, the Enlightenment dream of a universal encyclopedia" (p. 13).

i. Early Features of the Internet

Electronic Mail: First introduced in October 1972, electronic mail (e-mail) allowed individuals and organization to quickly communicate locally or worldwide. Groups of individuals could subscribe to a mass e-mail list known as a

"Listserv" and post information to the list, usually on a particular topic or area of interest. A Listserv allowed a common message to be sent to thousands of individuals, promoting further discussion and responses from Listserv members. Some Listservs were open, others had restricted membership and there was usually an administrator who handled membership and other administrative functions.

Remote Login: Remote login allowed an individual to access thousands of computer systems located anywhere in the world. Tennant (1992) identified the significant advantage of remote login:

> What makes this application truly remarkable is that ease and speed of access are not dependent upon proximity. An Internet user can connect to a system on the other side of the globe as easily as . . . he can connect to a system in the next building. In addition, since many Internet users are not at present charged for their network use by their institutions, or at least are not charged by the level of their use, cost is often not a significant inhibitor of usage. Therefore the barriers of distance, time and costs, which are often significant when using other forms of electronic communication, can be reduced in the Internet environment. (p. 2)

File Transfer: The File Transfer Protocol (FTP) allowed the transfer of electronic files (reports, numerical data, sounds, and images), including large amounts of data referred to as archives, from one computer to another. This function still occurs as an integral part of other, more sophisticated, services.

b. The World Wide Web

The development of the World Wide Web was closely related to, but distinct from, the development of the Internet. The Web's technology was developed for CERN (European Organization for Nuclear Research) in 1989 under the direction of Tim Berners-Lee. In one of the most extraordinary acts of public generosity, Berners-Lee placed this technology in the public domain making it openly and freely available worldwide (Pew Research "World Wide . . . 2014). The World Wide Web Consortium (W3C), created in 1994, established working groups to develop Web protocols and guidelines. Since then W3C working groups have produced technical reports and open source software; promoted standardization by making recommendations regarding social, legal, and public policy concerns; and addressed accessibility issues related to usability for people with disabilities (World Wide Web Consortium 2010).

The Web created exciting new possibilities. Using a variety of protocols including HTML (hypertext markup language) and HTTP (hypertext transfer protocol), Web designers could embed sound, video, graphics, and illustrations in documents.

When the document was accessed, the embedded images and sound were also available. In a hypertext environment, these documents have visible (highlighted) links to other documents, which allow ideas or terms to be connected. A user can move from one part of a text or document to another merely by clicking on the highlighted term. Navigation between documents is accomplished by graphical Web browsers. In the 1990s, Netscape and Internet Explorer were popular browsers that displayed Web documents and enabled the hyperlinks (December and Randall 1995).

Establishing standards and consistency on the Web was one of the goals of its early developers. W3C was created in 1994 to develop common protocols and guidelines that would enable long-term growth of the Web (World Wide Web Consortium 2010). Over the years, W3C working groups produced technical reports and open source software and promoted standardization by making recommendations regarding the architecture of the Web. They also addressed features that affect interaction with Web users, including social, legal, and public policy concerns, and accessibility issues related to usability for people with disabilities.

Finding information on the Web requires the use of search engines. Fielden and Kuntz (2002) describe a search engine as "an automated software that matches a searcher's topic terms (keywords) with an indexed list of documents found on the Web . . . arranges that list according to some order of relevancy, and provides hyperlinks to those documents so that they might be visited" (p. 13). Search engines do not search the entire Web, but rather a particular database or specific collection of documents, which can be composed of millions of websites and documents. Google, for example, indexes billions of Web documents.

Search engines in the 1990s performed many of the functions they do today. They compiled collections of websites by sending out what are called spiders, robots, bots, or crawlers to locate as many seemingly relevant documents as possible. Located documents were then scanned by software that created an index based on the keywords in each document. Some crawlers might scan entire documents, or just the title and certain segments. When someone typed a query, the search engine related the search terms to the index and produced the relevant pages. Each search engine was unique and therefore the results might vary substantially. For example, some but not all search engines ranked the contents from most relevant to least relevant. Ranking might be influenced by the tags assigned to a particular Web document, or the frequency of keywords or phrases. By the late 1990s and into the early twenty-first century a number of search engines existed, including Google, Yahoo, Mozilla, and Bing.

For LIS professionals, the proliferation of websites and their growing use was a mixed blessing. Despite the volume of information available, there was serious

concern about its quality and trustworthiness. The traditional methods librarians' used to evaluate and select informational materials did not apply to the search-engine process. Librarians' worst fears were realized in a study by Pew (Associated Press 2005), which reported that one in six adult users could not tell the difference between unbiased search results and paid advertisements. Thirty-eight percent of adults searching the Web did not know the difference between sponsored links and regular ones and less than half could indicate which links had been paid for. Librarians began to address this issue by establishing their own Web pages that guided users to specific sites that had been vetted like other library materials.

III. TECHNOLOGY AND LIBRARIES IN THE TWENTY-FIRST CENTURY

A. The First Decade: 2000–2010

1. Web 2.0 and Social Media

As the Internet continued to evolve, dramatic improvements in applications increased the potential for social interaction and the creation of online communities. The Internet became a dynamic network where the users added to the online content—in effect creating an "architecture of participation" (O'Reilly 2005, p. 7). The participatory nature of this activity prompted a new phrase—Web 2.0 or "social media"—to describe the evolution from consultation with Web pages to social interactions among Web users. Curtis (2014) characterized social media in the following way:

> Social media are Internet sites where people interact freely, sharing and discussing information about each other and their lives, using a multimedia mix of personal words, pictures, videos and audio. At these Web sites, individuals and groups create and exchange content and engage in person-to-person conversations. (p. 1)

A variety of new social media formats appeared: blogs, wikis, and social networks.

a. Blogs

A blog or Weblog "refers to a category of Website where the content is presented in a continuing sequence of dated entries. Put simply, 'a blog is an online diary'" (Kajewski 2006, p. 157). Blogs permit an individual or a group to post their ideas on a website, permit others to respond and link to other websites. Users can react to the content, contribute their own content, and see others' comments as well. Blogs can be highly personal—of interest primarily to one's family or friends—or they can

disseminate information on a broad scale; some report or analyze current news or political events. During national or international crises, blogs have been a major source of news when traditional sources were either unavailable or suppressed by authorities. Libraries used blogs to communicate news or information to the public about new services, new books, and AV materials, and to stimulate discussion, as well as to promote the library and its services (Kajewski 2006).

b. Wikis

The wiki, derived from the Hawaiian word for "quick," was designed in 1994 by Ward Cunningham, an Oregon-based computer programmer, for the purpose of collaborative development (Stephens 2006). A wiki differs from a blog in that the content is created without any defined owner or leader, and wikis have little implicit structure, allowing structure to emerge according to the needs of the users (Mitchell, 2008). Chawner and Lewis (2006) described a wiki as "a server-based collaborative tool that allows any authorized user to edit Web pages and create new ones using nothing more than a Web browser and a text entry form on a Web page" (p. 33). The term wiki can refer to a website or the software that runs it. Wikis do not require knowledge of coding or programming languages; rather they use a "simple text-based markup language that is easy to learn" and allow any user with a Web browser to insert new pages, enter new content in existing pages, or delete information (Cochenour 2006, p. 34).

Perhaps the best-known application of the wiki technology is Wikipedia, a massive, dynamic, ever-expanding, and changing reference tool. Rather than relying on a limited number of "experts" to create the tool, thousands of contributors and reviewers collaboratively contributed to its creation, what O'Reilly (2005) referred to as harnessing a "collective intelligence" (p. 9). Underlying this revolutionary approach was the belief that the community of users could also be creators and contributors to the content. Wikipedia has editors and several hundred experienced users, designated as administrators, with the authorization to regulate content and users (Binkley 2006). Because users also "vet" the encyclopedic entries, some critics argued that Wikipedia's approach invited inaccuracies or fraud, but to date there is little evidence that it is less accurate than other similar tools (Eiffert 2006):

> Bottom line: Subject to ongoing critical review, Wikipedia articles are generally well-researched and substantiated by footnoting and linking to sources, allowing readers to judge the quality of information being used. Moreover, Wikipedia entries often have more and more current information. (p. 83)

In fact, Wikipedia's breadth of coverage and constant updating made it one of the most consulted sites on Google (Crovitz 2009).

c. Social Networks

Although first launched in the late 1990s, social networking found its first success in Friendster, a site created in 2002 for people to connect with their friends, make new friends, and date (Digital Trends 2014). The site was tremendously popular: in three months Friendster had more than 3 million users (Curtis 2014). The following year, a professionally oriented site, LinkedIn, was introduced, and a new social network, MySpace, competed directly with Friendster. For a time, MySpace was a favorite among young people who were attracted by

> . . . music, music videos, and a funky, feature-filled environment. It looked and felt hipper than major competitor Friendster right from the start, and it conducted a campaign of sorts in the early days to show alienated Friendster users just what they were missing. (Digital Trends p. 7)

MySpace declined in popularity, in turn, as a newer social media tool, Facebook, founded in 2004 at Harvard University, gained exposure. Facebook's highly attractive features led to its quick expansion and in 2006 it was open to public access. Facebook launched its open platform in 2007 which permitted third-party developers to create applications that operated within Facebook itself. Facebook also introduced the "Like" button which engaged its users in a unique way and which was quickly appropriated by other social networks, like Twitter (Digital Trends 2014). In 2008 Facebook overtook MySpace in number of visitors, and by 2009 it was recognized as the most widely used social network around the world with more than 200 million users—twice that of MySpace (Curtis 2014).

Librarians noticed that young people and students were frequently using the library's computer terminals for access to social networking sites. The issue for LIS professionals was how to exploit the popularity of social networking to benefit the library. Could the library create its own social presence? Perhaps social networking was an opportunity for libraries to communicate with users, promote library services, and strengthen their relationship with users. Among many discussions on these issues, there was particular concern of the potential misuse and victimization of library users by online predators (Chu and Meulemans 2008).

2. Really Simple Syndication (RSS) and Podcasting

Really Simple Syndication (RSS) is "an XML-based document format for the syndication of Web content so that it can be republished on other sites or downloaded periodically and presented to users" (RSS Advisory Board 2010, p. 2). A "feed" is the stream of content from an RSS account. Feeds allow online sources to send information to users in real time once the user subscribes to the feed and possesses the

necessary software (Wikipedia 2009). This is a highly valuable medium to maintain awareness of current events. Users might receive messages about news, events, and activities sent to their designated communication devices. Commercial enterprises can inform customers about sales and new product developments; libraries can push announcements to patrons about upcoming activities, the latest services, or newest materials being acquired by the library.

RSS technology was the foundation for "podcasting." Podcasts were "audio files that [could] be downloaded and played either through a computer or an MP3 player such as an iPod" (Balas 2005, p. 29). With the RSS technology people no longer had to access the Web each time they wanted certain information; rather, once they subscribed to a particular feed, new files were downloaded automatically. It was the syndication aspect that made podcasts unique. Podcasts became quite popular for news updates and music downloads. They contained video as well as audio content and could be sent to phones and other communication devices as well as computers. In 2013, 27% of Internet users listened to podcasts (Pew Research, 'Over a Quarter" 2013). LIS professionals have used podcasting for training and development for patrons and staff, book reviews, updates on the library, a source of presentations or lectures, and library tours. The library became not only a place to access podcasts (some libraries loan iPods), (Stephens 2005; Kajewski 2006) but a content creator as well.

3. Internet2

Although originally designed for research and development, the Internet evolved to serve popular and commercial purposes. Nonetheless, the original purpose remained critical for academics and scholars. Consequently, in 1996, more than 200 U.S. universities and other institutions of higher learning, seventy corporate partners, and forty-five government agencies and laboratories as well as fifty international partner organizations collaborated to found the Internet2 Consortium. Its purpose was not to replace the Internet but to enhance and improve it and share new developments with others in the educational community (Internet2 2009). To that end, members promoted "leading-edge network capabilities and unique partnership opportunities that together facilitate the development, deployment, and use of revolutionary Internet technologies" (Internet2 2009, p. 1). Ultimately, their goal was "to accelerate research discovery, advance national and global education, and improve the delivery of public services (Internet2 2014). The Internet2 network is now in its fourth generation with 8.8 Terabits of capacity; providing an advanced platform for U.S. researchers and educators to share greater quantities of data over a 100 gigabit-per-second network. As of 2014, there were more than 500 members including 250 U.S. universities, 82 major corporations, 68 affiliate members including

government agencies, 41 regional and state education networks, and more than 65 national research and education networking partners representing over 100 countries. The members of Internet2 collaborate on a variety of initiatives and technical issues through working, special interest, and advisory groups. Initiatives such as its "K20-Initiative" extended technologies, applications, and content to a wide range of educational and cultural institutions including colleges, universities, primary and secondary schools, libraries, and museums (Internet2 2014). As a vital and continuing force, innovations produced by the Internet2 community have transformed higher education and extended its influence beyond its members, affecting more than 93,000 institutions both in the United States and around the world.

4. The Growth of Google

In the first decade of the twenty-first century, search engines became everyday information tools for millions of people around the globe, including LIS professionals. Yahoo, Mozilla, and Bing were household names, but Google ruled. Google began as a research project of Sergey Brin and Larry Page. The company incorporated in September 1998 and its first location was a garage in Menlo Park, California. Once online, within a few weeks, Google was conducting 100,000 searches a day. Quickly recognized as a state-of-the art search engine, venture capitalists clamored to become a part of the enterprise. By June 2000, Google was indexing 1 billion pages, handling 18 million search queries a day, accepting advertisements, and generating more than $19 million in revenue. It was the largest and busiest search engine on the Internet. The next year, Google indexed 3 billion pages and generated more than $86 million in revenue (Robison 2007). Google continued to grow, adding Gmail, Google Scholar, and Google Books (see discussion below). By 2010, Google was indexing one trillion sites (Curtis 2014).

LIS professionals closely monitored Google's rise, often feeling somewhat overwhelmed by what was happening in the online environment. OCLC reported survey findings in 2005 that convey some of the reasons:

- Seventy-two percent of the respondents had used a search engine at least once, and among people who used online sources for information, 84% started with search engines. Sixty-two percent indicated that Google was the most frequently used search engine, more than 40 percentage points ahead of the nearest competitor—Yahoo.
- Search engines were viewed more favorably than libraries as a place to get information, although both were favorably viewed: 88% viewed search engines favorably compared to 79% for libraries.

- Ninety-three percent believed that Google provided worthwhile information compared to 78% for a library's website.
- When compared to the library, people reported that they thought search engines were much faster, more convenient, easier to use, cost effective, and available. Libraries were viewed as more credible, trustworthy, and accurate.
- When comparing the information provided by a search engine and the information received from a librarian, people were equally very satisfied from both sources, although they received the information from the search engine more quickly. In general, they felt that search engines were equally trustworthy when compared to library sources. (De Rosa et al. 2005)

5. Mass Digitalization and Google Books

Libraries and other institutions have digitized materials for years, but the scale of such efforts accelerated with Google Books. In December 2004, Google entered into a partnership to digitize and index more than 10 million unique titles with five major research libraries known as the G5: the University of Michigan, Harvard, Stanford, Oxford, and the New York Public Library. The goal was formidable: "Our ultimate goal is to work with publishers and libraries to create a comprehensive, searchable, virtual card catalog of all books in all languages that helps users discover new books and publishers discover new readers" (Google "Books" 2015).

The project had two parts: a "Partners Program" and a "Library Project." The Partners program allowed publishers to enter their books, with embedded features, called "snippets" such as previews, into the Google Books database. A visitor to Google books could browse the publishers' content that would help foster book sales. To protect the book from inappropriate copying, publishers could limit the amount of content available. Google Books also provided links to bookstores and online retailers (Google "Google Books Library Program" 2015). Because publishers were voluntarily making their copyright materials available, there was no significant controversy over this aspect of Google Books.

The "Library Project" was an entirely different matter. In this case, major libraries permitted Google to scan significant portions of their library collections. Google did not seek permission to scan copyrighted works owned by the libraries. In exchange for scanning, Google provided the libraries with digital copies of their scanned books. Google also stored a digital copy of these works. Using metadata, the book was indexed and digital copies were then made available, allowing an

individual to search the extensive database of scanned titles by word or phrase. As of 2013, more than 20 million copies had been scanned and the number of library partners increased to forty, including several institutions from other nations. A Google Books search was similar to a typical Google search: searchers designed their own queries and Google returned a list of books fitting the query. As Google described it,

> When you click on a search result for a book from the Library Project, you'll see basic bibliographic information about the book, and in many cases, a few snippets—a few sentences showing your search term in context. If the book is out of copyright, you'll be able to view and download the entire book. In all cases, you'll see links directing you to online bookstores where you can buy the book and libraries where you can borrow it (Google "Books" 2015).

From the perspective of a typical user or researcher, this was a wonderful tool. A vast number of books could be searched and accessed to determine the relevance of the title and whether purchasing the title or borrowing the title was merited. If a book was out of copyright, the entire title could be downloaded.

From a publisher's perspective, however, Google Books represented a significant copyright violation. Consequently, in 2005, the Authors Guild brought a class action suit accusing Google of copyright infringements. Google responded that their activity fell under "the doctrine of fair use" which permits an individual or organization to make a single copy of a work without the permission of the copyright owner. A protracted series of negotiations led to a proposed settlement early in 2011. However, the judge overseeing the case, Judge Chin, rejected the proposed settlement "on the grounds that is was not fair, adequate, and reasonable" (U.S. District Court 2013, p. 13). Despite further efforts to reach a settlement, an agreement could not be reached. On November 14, 2013, Judge Chin issued a ruling in favor of Google (U.S. District Court 2013). The judge acknowledged that on the face of it, Google made copies of copyrighted works with intent to make a profit. However, the judge also noted that Google did not sell the digitized books. As a result, the judge ruled that the use of the copyrighted works was "transformative," that is, the scanned text was used in a manner and for a purpose that was fundamentally different from selling the book to a prospective reader. The use was "transformative" because (1) the texts were repurposed as part of a comprehensive index intended to aid the discovery of the books by scholars and others, (2) the "snippets" provided were used to facilitate the search process, and (3) the texts were transformed into a format that allowed for significant research purposes such as data mining which supported new fields of research (U.S. District Court 2013). The judge concluded,

> In my view, Google Books provides significant public benefits. It advances the progress of the arts and sciences, while maintaining respectful consideration for the right of authors and other creative individuals, and without adversely impacting the rights of copyright holders. It has become an invaluable research tool that permits students, teachers, librarians, and other to more efficiently identify and locate books. It has given scholars the ability, for the first time, to conduct full-text searches of tens of millions of books. It preserves books, in particular out-of-print and old books that have been forgotten in the bowels of libraries, and it gives them new life. It facilitates access to books for print-disabled and remote or underserved populations. It generates new audiences and creates new sources of income for authors and publishers. Indeed, all society benefits. (U.S. District Court 2013, p. 26)

Interestingly, while the Google Books case was going through the courts, in 2011 the Authors Guild also sued the HathiTrust. The HathiTrust described itself as "a partnership of major research institutions and libraries working to ensure that the cultural record is preserved and accessible long into the future." The trust had more than ninety partners, and membership was open to institutions worldwide. The focus of the trust was to build comprehensive and widely accessible digital archives from materials that originally appeared in print. The HathiTrust Digital Library combined in digital form the scholarly collections of the partner institutions, securing the digital content, making it accessible to the partners through keyword searching, and preserving the content for future generations (HathiTrust 2014). The trust did not, in general, deliver the digital content, but delivered titles and page numbers to help researchers locate and acquire the desired materials. However, it did provide full-text content to individuals who were blind or otherwise print disabled (Barclay and McSherry 2012).

As in the Google case, the guild claimed that the digitization of the materials was a copyright violation. The judge at the federal district court level supported the HathiTrust, declaring the creation of a searchable database for scholarly purposes was a transformative use and a significant contribution to the advancement of science and the arts—a fundamental reason for copyright regulation (Barclay and McSherry 2012). The guild appealed and the appellate court again supported the HathiTrust's transformative use of the database and the provision of full text to the visually disabled (EFF 2013). In the future, it will be important for LIS professionals to stay up-to-date on any new rulings that might arise from these or other cases that could limit access to scholarly knowledge.

6. Preserving Digital Content

Digital preservation is addressed from the academic library's perspective in chapter 6 on library organization. This section discusses digital preservation issues generally.

Historically, the purpose of preservation was to protect an item. Use of the item, in fact, was often perceived as one of the threats to preservation: using rare and fragile paper documents, for example, might cause them to deteriorate further. In contrast, preserving information in a digital format increases access; fragile documents could be converted to a digital format so that millions can access them. Digital preservation is a "series of managed activities necessary to ensure continued access to digital materials for as long as necessary" (DPC 2012). It can take many forms, including making a "digital double" of a paper document or a physical object.

Candidates for digital preservation include cultural objects such as artworks that are difficult to access due to their remote location or fragility; scientific data both current and historical; and books, journals, and other paper records for educational, business, and governmental purposes. The need for digital preservation also extends to Web pages and datasets that were born digital; that is, they were originally created digitally and might not have a representation outside the digital environment. As more and more information appears on the Web, how do we preserve Web content? It is now common to search for a website and see the familiar message: "File Not Found." A significant proportion of sites can disappear from the Web in just a few years, and there are billions of sites.

Caplan (2008) identified at least three functions of digital preservation: (1) protecting materials against unauthorized alterations, (2) conserving storage media to avoid deterioration, and (3) maintaining digital materials so they can be used over time. This third function suggests a larger notion that Caplan referred to as "digital curation," which takes a "life-cycle approach focusing on the ongoing use and re-use of digital materials" (p. 38). In other words, digital information originally created and stored in a now-obsolete format should be able to migrate to a new format, thus restoring access. This concept revealed a new perspective: the importance of preserving access (Zeng 2008):

> The survival of a document is not dependent on how long the medium carrying it will last, but on the capacity of that document to be transferred from one medium to another as often as possible. . . . The most significant threats to digital continuity concern loss of the means of access. (p. 8)

Access and preservation are related but distinct activities. Failure to recognize this distinction was a serious problem at the end of the twentieth century because often the medium employed to store content, such as magnetic tape and CD-ROMS, was not particularly stable, certainly not as stable as paper. In our rush to provide access, LIS professionals must remember that in order to preserve the content, the access medium must be stable. This problem is referred to as "fixity." That is, print materials have some permanence, but electronic text is impermanent. The ease with

which digital material can be altered also raises serious questions about its capacity to serve as a preservation technique. Regardless of format or medium, eventually all electronic data will need to be refreshed or transferred to a new technology; otherwise, the content might be lost.

With the continued trend of digital collections residing in the hands of commercial vendors rather than libraries, the preservation of data might rely on the commitment of those vendors to preserve their data. Unlike libraries, one of whose traditional missions is to preserve access to cultural data, vendors are driven by the commercial value of the data they possess; as soon as the data loses its revenue-generating potential, there is little incentive for them to retain it or make it accessible. In 2010, the Blue Ribbon Task Force on Sustainable Digital Preservation and Access (BRTF) (2010) attempted to address these issues and made a series of recommendations designed to foster sustainable digital preservation. They include:

- providing financial incentive to commercial owners of digital content to preserve materials that are in the public interest
- issuing governmental mandates when appropriate
- revising copyright laws to permit archiving of some commercial digital content by stewardship organizations acting in the interest of long-term preservation
- developing agreements among relevant parties to implement policies and procedures that preserve digital content throughout its life cycle: creation, selection, preparation, and secure transfer of the content
- creating policies and processes to transfer commercial digital content to public stewardship for preservation after the content has lost its market value but is still of value for research, cultural, or other public purposes
- developing techniques that significantly reduce the costs of digital preservation, including storage, energy consumption in system maintenance, preservation/curation strategies, and access
- creating both market-based and public-good-based funding models for producing and preserving digital content

These recommendations highlight what LIS professionals have realized for some time: that the magnitude of the digital preservation challenge cannot be met by individual libraries or singular organizations alone. Rather, the stakeholders who produce and distribute digital content must collaborate with libraries and other public institutions in order to maintain our cultural heritage and traditions. The LOC National Digital Information Infrastructure and Preservation Program's National Digital Stewardship Alliance (NDSA) is one example of such a partnership. The

mission of NDSA is "to establish, maintain, and advance the capacity to preserve our nation's digital resources for the benefit of present and future generations" (NDSA 2014). The alliance has more than 160 partners including universities, businesses, professional associations, and governmental and nonprofit organizations. NDSA has three primary objectives related to preservation:

- identifying, communicating, and advocating for common needs of member organizations
- convening and sustaining a national community of practice for digital stewardship
- providing professional development opportunities for staff at member organizations (NDSA 2014)

Despite these collaborative efforts, it is difficult to see a truly national coordinated plan for the preservation of digital content coming to fruition in the near future. Some organizations might wish to centralize particular content and provide access to it; others might adopt a distributed approach assigning distinct preservation responsibilities to various participant institutions. Some entities will have a commercial purpose in preserving content; others will offer its content openly for the public good.

Efforts at digital preservation are also occurring at the international level as awareness grows that sharing digital knowledge can produce economic and political stability. On an international level, however, several barriers present themselves: (1) digital preservation has not been a development priority as other more pressing needs are often present, (2) there is a lack of awareness of the importance of digital preservation for social and economic development, (3) there is a lack of appropriate laws, standards, and critical technologies, and (4) there is a lack of competent professionals to manage preserved records (Thurston 2012). As a consequence of these factors, in 2012, UNESCO sponsored an international conference on "The Memory of the World in the Digital Age" in Vancouver, British Columbia. One result was the "UNESCO/UBC Vancouver Declaration." The declaration emphasizes the need to make digital preservation a priority and to establish models for trustworthy digital preservation techniques that provide long-term preservation solutions. It also recommends collaborations among UNESCO, members of the archive, library, and museum communities, and governments to protect, preserve, and devise methods of effective dissemination of digital documents (UNESCO 2012).

One thing is certain: the volume of digital content that will need to be preserved will continue to grow rapidly as will the magnitude of the institutional, national, and international challenges to preserve it for future use.

B. The Second Generation: 2010–

Today, it is no longer feasible to discuss the development of technologies without also discussing their societal impact. Computer networks, which we thought of as simply ways computers were linked, have now become social networks composed of people using technologies to create human networks. One enables and fosters the other. The result is that our focus turns less to the devices themselves and more to their uses, their social potential, and their consequent impact on traditional institutions—in our case, libraries.

1. The Pervasive Use of Technology and the Internet

Most Americans are now online. Eight-seven percent of the adult U.S. population use e-mail or accesses the Internet using a mobile device. The percentages are over 80% for men, women, urban, suburban, or rural dwellers, whites, African-Americans, and Hispanics, at all educational levels except high school or less, and for all age groups except those over 65. The percentages exceed 90% for many of these groups (Pew Research "Internet Users" 2014).

What do most American adults use the Internet for? Figure 4.1 provides a list of the most frequent uses and the percent of use (Pew Research "Trend Data" 2013). Using a search engine as an information-seeking tool is at the top of the list (91%), using e-mail follows at 88%. Eighty percent or more of adults seek information on a hobby, search for a map or driving directions, and check the weather. A quick review of the entire list indicates the considerable depth and breadth of Internet use.

Among teens, the findings are even more pronounced. Ninety-five percent of teens are online and the percentage has been this high since 2007. Ninety-three percent of teens either own a computer or have access to a computer at home. Black teens are less likely to have a desktop or laptop at home than white teens; older teens (14–17) are more likely to have them than younger teens (12- 13). Similarly, 78% of teens own cell phones, 47% own smartphones, and nearly a quarter (23%) own a tablet computer. Nearly three in four teens indicate that they access the Internet on their cell phones, tablets, or other mobile devices, and a quarter, compared to only 15% of adults, indicate that cell phones are their preferred means of Internet access. Predictably, a major destination for teens is social networks. Older teen girls with smartphones (34%) use them almost exclusively to access the Internet (55%) (Madden et al. 2013).

Generally, people believe that the Internet has been a benefit. Ninety percent of adult users believe that it has been a good thing for them personally; only

FIGURE 4.1
Adult Internet Use

(Use 50% or greater)	
Use a search engine to find information	91%
Send or read e-mail	88%
Look for information on a hobby or interest	84%
Search for a map or driving directions	84%
Check the weather	81%
Look for information online about a service or product	78%
Get news	78%
Go online just for fun or to pass time	74%
Buy a product	71%
Watch a video on a video-sharing site	71%
Visit a local, state, or federal government website	67%
Use a social networking site	67%
Buy or make a reservation for travel	65%
Do any banking online	61%
Look online for news or information about politics	61%
Look online for information about a job	56%
Look for how-to, do-it-yourself, or repair information	53%
Look for information on Wikipedia	53%
Use online classified ads or sites	53%
Get news or information about sports	52%
Take a virtual tour of a location online	52%
Search for information about someone you know or might meet	51%

Source: Pew Research Center. 2013. "Trend Data (Adults)." www.pewinternet.org/Static-Pages/Trend-Data-(Adults)/Online-Activities-Total.aspx.

6% believe that it has not been helpful. Three-quarters (76%) also believe that it has been good for society. Similarly, the value people place on the Internet has increased over time; more than half (53%) believe that it would be very hard for them to give it up, an increase from 36% in 2006. Approximately 39% of adults believe the Internet is essential to them for work or other reasons. Compare this to only 35% who say that it would be very hard for them to give up television or 28% who would find it hard to give up their telephone. Many Internet users (67%) also believe that their online activities with family and friends have generally strengthened their relationships, while only 18% believe it has weakened them. Internet use,

by those who use it, seems to have substantial, salutary effects. The perceived social benefit cross all demographic characteristics: race, income, educational level, and age (Pew Research "The Web" 2014).

These data make it abundantly clear that Internet access and use is now ubiquitous. Going forward, LIS professionals must focus less on the technologies themselves and more on their social effect and the consequent impact on libraries. Three issues are likely to be prominent in such discussions: broadband access, mobile devices, and social media

a. Broadband Access

Broadband access to the Internet remains an issue although access is clearly increasing. In fact, the number of individuals without broadband access (the digital divide), dropped from 270 million in 2000 to 86 million in 2012. As of September 2013, 70% of American adults had high-speed connections in their home, compared to only 3% in June 2000. Currently about 74% of whites, 62% of African-Americans, and 56% of Hispanics have broadband connections. There appear to be no gender differences. Not surprisingly, broadband use increases with income and level of education: 90% of college graduates, and 91% of those earning more than $75,000 use broadband compared to 52% of those with incomes less than $30,000 or those with no high school diploma (28%). Older people over age 65 are less likely than younger people ages 18–29 to use broadband access (47% vs. 81%, respectively) (Pew Research "Mobile Technology" 2014). People residing in rural areas also have less access.

The primary reasons given by individuals without broadband access at home appear to be cost of the service and computer equipment, lack of digital literacy and comfort with computers; and the belief that online access is not useful or worthwhile (Horrigan 2013). Interestingly, the Pew Internet Project ("Three Major" 2014) found that as people adopted higher-speed, always-on connections, they became different Internet users: they spent more time online, performed more activities, watched more video, and became content creators themselves. Horrigan (2013) suggested that LIS professionals focus less on the lack of access to broadband technology and refocus attention on increasing digital literacy and skills so people can be effective in using it.

b. Mobile Devices

Mobile devices have revolutionized the daily lives of almost every American. Digital Trends (2014) characterized this change:

> Over the course of the past two years, "Fourth screen" technology—smartphones, tablets, etc.—has changed social networking and the way we communicate with

> one another entirely. What used to sit on our desks now conveniently fits in the palm of our hands, allowing us to effortlessly utilize functionality once reserved for multiple devices wherever we go. (p. 9)

The following discussion briefly examines three of these devices: cellphones, smartphones, and tablets.

i. Cell Phones

As of January 2014, 90% of Americans owned cell phones and used them not just for making phone calls: 82% took pictures, 80% sent or received text messages, 56% accessed the Internet, 50% sent or received e-mail, 44% recorded video, and 43% downloaded apps (Pew Research, "Mobile Technology" 2014). Picture taking tends to rise with income and educational level and declines with age. More than 90% of cell phone owners under the age of 35 take pictures. A similar pattern emerges with texting and e-mail activities. Gender and ethnicity do not seem to play any role in these activities. Accessing the Internet, however, is another matter. A typical pattern emerges for age, income, and level of education, but whites use cell phones less than African-Americans and Hispanics. Young people ages 18–29 are substantially more likely to download apps than any other group, 65% compared to individuals 30–49 (53%). Twenty percent or less of individuals over 50 download apps (Duggan and Rainie 2012).

ii. Smartphones

As of January 2014, a majority of adult Americans (58%) owned smartphones, up from 35% in 2011 (Pew Research "Mobile Technology" 2014). Like many of the new devices, ownership is greater among young people; about 80% under the age of 35 compared to 18% over 65. Ownership consistently increases as educational attainment and income increases and the differences are considerable. For example between 60%–70% of individuals with some college or a college degree own smartphones while percentages among individuals with a high school education or less vary between 36% and 46%. Individuals in urban and suburban areas have substantially greater ownership than in rural areas (59% vs. 40%). Similarly individuals earning $75,000 or more have much higher rates of ownership than those earning $30,000 or less. The iPhone and Android platforms dominated (Smith 2013).

iii. Tablets

As of January 2014, 42% of adult Americans owned a tablet computer compared to 3% in May 2010 (Pew Research "Device Ownership" 2014). Although there are no differences by ethnicity or gender, owning a tablet is positively

related to increasing household income and level of education. Households earning more than $70,000 are much more likely to own a tablet than those with incomes under $50,000 (56% vs. 28%). Similarly, 49% of college-educated individuals have a tablet, compared to 26% of those with a high school education or less. Of particular note is that contrary to typical patterns related to adoption of other new technologies, adults between the ages of 35–44 (49%) are more likely to own a tablet than young people. This pattern has emerged only in the last few years and might reflect a major increase in ownership among parents with minor children at home (Zickuhr 2013).

c. Social Media

Social networking comprises the largest block of time spent on the Internet. People spend 20% of their PC time and 30% of their mobile time on social networks. Young adults (25–34) were most likely to use social media in the office; and nearly a third of young people (18–24) use social media in the bathroom! As of September 2013, among individuals using the Internet, 74% of adults used some type of social networking site. Of those, 71% used Facebook, 19% used Twitter, 21% used Pinterest (an online visual pin board), and 17% used Instagram (taking and sharing pictures) (Pew Research "Social" 2014). Many different groups use social networks but generally, they appeal most to women and to adults between the ages of 18 and 29—the same group most heavily using Facebook. Adults between 18 and 29, African-Americans, and urban dwellers use Twitter. Women, adults under 50, whites, and those with some college education use Pinterest; and adults 18–29, African-Americans, Latinos, women and urban residents primarily use Instagram (Duggan and Brenner 2013). More than three-fourths of people who use social media feel connected and informed as a result, a positive feeling. Staying in touch with friends and maintaining professional connections are the most often cited reasons for using social media. Among individuals who "dual screen" that is, use a mobile device such as a smartphone or tablet while watching TV, more than 40% say they visit social networking sites (Neilsen and NN Incite 2012).

As noted earlier, teens, particularly African-American teens, were the largest users of social networking sites. Eighty-one percent of teens ages 12–17 used social networking sites, compared to 67% of adults. Twenty-four percent of teens used Twitter, compared to 16% of adults. Older female teens (14–17) were much more likely than younger teens or older male teens to use social networking sites. Three-fourths of teens who visited social media sites visited them on a daily basis. Facebook dominated teen use (93%), compared to MySpace (7%) (Madden et al. 2013).

Although privacy continued to be a concern among most adults, it did not appear to be of much concern to teens. Older teens were likely to share even more personal information than in the past: 92% posted their real name, 91% posted a photo of themselves, 84% posted personal interests, 82% posted birthdates, 71% posted their school's name and city or town where they lived, and 53% posted their e-mail address. One in four posted a video of himself or herself. On the other hand, younger teens tended to accept as friends only those people they knew or members of their extended family. Only a third were friends with people they had not met (Madden et al. 2013).

C. Technological Innovations Transforming Library Functions

It is informative to turn now to some of the technological innovations that have had a direct impact on libraries. Almost all the basic functions of libraries have been affected in one way or another and it is not possible to address all the technological developments and their implications. Rather, the examples below are suggestive of the breadth and magnitude of the changes that have occurred or are now occurring in four areas: the evolving collection, the evolving search process, the evolving space, and the evolving technological infrastructure.

1. The Evolving Collection

a. Digital Libraries

Although the traditional concept of a "library" remains firmly fixed in peoples' minds, a new type of library emerged with the growth and expansion of the Internet—a "digital library." Digital libraries began in their most primitive form in the 1990s as collections of photos posted on local Web homepages. At that time there were no standards for their creation, no way to effectively search them, no way to support the wide variety of digital materials—photos, images, documents, books—and few of these collection were sustainable over time (Zick 2009).

With the development of metadata standards, additional software advances, and increasingly sophisticated search engines, these issues were soon resolved, and digital libraries grew rapidly in the first decade of the twenty-first century, particularly in response to the growth of distance-learning opportunities at universities. In the absence of a physical library, students taking courses online required access to a virtual library (Fox and Urs 2002; Wright 2002). Since the environment was electronic, the format of the collection could include text, graphics, video, audio,

images, data sets, and software (Fox and Urs 2002). Calhoun (2014) described some of the characteristics of mature digital libraries:

> systems and services, often openly available, that (a) support the advancement of knowledge and culture; (b) contain managed collections of digital content (objects or links to objects, annotations and metadata) intended to serve the needs of defined communities; (c) often use an architecture that first emerged in the computer and information science/library domain and that typically features a repository, mechanisms supporting search and other services, resource identifiers, and user interfaces (human and machine). (p. 18)

This characterization notes that most digital libraries are open to all members of the community for which it was designed, which might be the general population or a specialized group such as scientists. Similar to public libraries, they should provide democratic and egalitarian service, usually free or at little cost, and their organization and structure should be similar to traditional library databases. The repositories for content can range from file systems to distributed storage systems. Indexing and metadata support the search functions along with systems for locating digital objects. Finally, the user interfaces allow users to perform searching, browsing, visualization, and delivery (Calhoun 2014).

Despite the obvious potential, the challenges for creating successful digital libraries are considerable. In 2007, the NISO Framework Working Group, under the sponsorship of the Institute for Museum and Library Services, developed guidelines or principles for creating good digital library collections—the *Framework of Guidance* (figure 4.2).

In their short history, digital libraries have been collections of digital content, much like traditional libraries have been collections of print materials. But just as traditional libraries have evolved, the same forces driving those changes—the growth of social networks and the increasing involvement of users (or citizens)—have led to the creation of *social* digital libraries. These libraries also emphasize participation and involvement of the users, and focus on the social usefulness of the digital content. Calhoun (2014) identified a variety of contributions such digital libraries make, including increasing access to digital content on an international, national, and local level; promoting the free flow of ideas through crowdsourcing, blogs, and wikis; empowering and informing the citizenry as a whole through virtual public libraries, mobile interfaces, and online exhibits and archives; making formal online educational opportunities available; assisting in the archiving and preservation of content; and providing economic benefits by improving access to technical, scientific, and cultural content.

FIGURE 4.2
Nine Principles for Building a Digital Collection

1. A good digital collection is created according to an explicit collection development policy.
2. Collections should be described so that a user can discover characteristics of the collection including scope, format, restrictions on access, ownership, and any information significant for determining the collection's authenticity, integrity, and interpretation.
3. A good collection is curated, which is to say its resources are actively managed during their entire life cycle.
4. A good collection is broadly available and avoids unnecessary impediments to use. Collections should be accessible to people with disabilities and usable effectively in conjunction with adaptive technologies.
5. A good collection respects intellectual property rights.
6. A good collection has mechanisms to supply usage data and other data that allow standardized measures of usefulness to be recorded.
7. A good collection is interoperable.
8. A good collection integrates into the user's own workflow.
9. A good collection is sustainable over time.

Source: NISO Framework Working Group 2007, p. 4.

Regardless of type, successful digital libraries provide quality content, ease of use, sustainable funding, an enthusiastic audience, a quality brand, and an excellent discovery system (Calhoun 2014). Among the larger digital libraries with broad scope and appeal are Europeana, JSTOR, Project Gutenberg, American Memory, and Internet Archive.

With the development of the semantic Web and linked data, the potential to create a network of digital libraries capable of integrating into a larger digital library infrastructure becomes possible. Calhoun (2014) identified four key elements required for achieving this lofty goal:

1. *They must be interoperable.* It is critical, if sharing of digital content is desired, that the computer systems be able to communicate with each other effectively. This is particularly challenging because most libraries remain "hybrid"—combinations of digital and non-digital items—the non-digital content being inaccessible by search engines. The systems must be able to share syntactic structures so that navigation, querying interfaces,

and viewing interfaces are compatible across systems. Common metadata formats, protocols, and standards are needed to ensure interoperability.

2. *There must be community engagement.* Digital libraries are designed to serve specific communities; these communities can be highly focused or very broad. Regardless, creators of successful digital libraries must thoroughly investigate the needs and practices of the audience being served. Developers must be deeply committed to the library's success and ideally are credible and respected members of the community.
3. *Intellectual property issues must be addressed.* To the extent possible, digital library creators must be active proponents of open access and the integrity of public domain; the new frontier might require a total rethinking of intellectual property. For example, digital libraries raise a host of new issues: "What constitutes the public domain?" "How can we prevent the public domain from shrinking?" "How can we promote mass digitalization of the world's knowledge and insure access to all?" "How can we ensure that libraries lawfully digitize content for the purpose of preservation?" "How can we protect scholarly communication?" "How do we develop expertise concerning licensing, authentication and authorization to access licensed scholarly content?" "Who can best develop models in the linked data world to lawfully exploit the semantic Web, digital library, and other online information services?"
4. *The library must be sustainable.* Sustainability has been a major problem for digital libraries: some have succeeded while many others failed. Sustainability requires answers to questions in three core areas: economic, social, and ethical:

   Economic: "Does it have ongoing funding and a successful business model"? "Does it have measurable standards to determine effectiveness?"

   Social: "Is the content valuable and relevant to the intended audience?" "Are members of the audience aware of the library?" "Does the library have the ability to preserve its content and provide long-term access?"

   Ethical: "Can the library insure the broadest possible access?" "Does it promote the free exchange of ideas?" "Are intellectual property rights respected?"

It is certainly possible that, if these questions can be successfully answered and intellectual property issues can be ameliorated, in the near future, many or most of the successful digital libraries will be linked together. The vision of a national or even

worldwide digital library will become a reality. All types of traditional libraries are likely to benefit from such an achievement.

b. The Rise of Electronic Books (E-books)

Although adoption was initially slow, electronic books grew rapidly and were a substantial part of the book market by the middle of the second decade. In 2014, e-books made up 30% of all U.S. book sales; more than 19% of all books sold in the United States were Kindle titles (Quora.com 2014; Bercovici 2014). There were many good reasons why e-books became popular: searchable text, cross-referencing with hyperlinks, compact size, adjustable fonts and text size, and e-readers with sufficient memory to store hundreds of books (Castro 2007).

Readership of e-books also rose steadily. In 2011 17% of the U.S. adult population read an e-book in the previous year, in 2012 that number jumped to 23%, and a 2014 study by Pew revealed that 28% were reading e-books (Pew Research "E-Reading" 2014). Interestingly, parents of minor children were more likely than nonparents to read e-books (38% vs. 27%). From this, we can deduce that children's exposure to e-book reading was growing as well.

This is not to say that Americans stopped reading print books. A 2013 study found that 70% of adults had read a print book in the last twelve months, an increase of 4% over the previous year, and that parents still believed that it was important for their children to read print books (Pew Research "In a Digital" 2013). The initial fear that e-books might replace print books was allayed by Zhang and Kudva (2014), who found that only a very small percentage of e-book users restricted their reading solely to e-books. They also concluded that

> e-books have firmly established a place in people's lives, due to their convenience of access, but e-books are not yet positioned to replace print books. Both print books and e-books have unique attributes and serve irreplaceable functions to meet people's reading needs. . . . (p. 1695)

Nonetheless, use of e-books is expected to grow. This growth will be enabled in part by the fact that ownership of either a tablet or an e-reader continues to grow: 24% of American adults owned an e-book reader, 42% owned a tablet (Pew Research "Device Ownership" 2014), and 43% had either one or the other (Pew Research "Tablet" 2013). Pew found that 57% used a specifically designed e-reader (Kindle or Nook), 55% used a tablet to read e-books, 29% used a computer, and 32% used a cell phone. With the exception of computers, there have been substantial increases in the use of these devices for reading e-books since 2011 (Pew Research "E-Reading" 2014).

The implication of the Pew data for libraries is significant. Their findings revealed that 12% of e-book readers borrowed an e-book from the library over a recent twelve-month period. Although this suggests substantial use of the library for this purpose, Pew also found that many people (58%) were unaware that their library provided access to e-books. Identifying a substantial marketing gap, 48% of owners of e-book reading devices did not know, and 47% of people who read an e-book in the past year were unaware of the library's e-book services. Among the borrowers of library e-books, more than half criticized the library for not having the e-books they wanted or complained about being on waiting lists. Nearly one in five expressed concern that the e-books available were not compatible with their readers. Despite these criticisms, nearly half the people surveyed expressed interest in borrowing readers with desired books already loaded on them, and about one in three indicated an interest in receiving library instruction on e-books and how to download them. Of those who regularly borrowed e-books, about four in ten indicated that the library was their starting point for accessing e-books.

As noted earlier, adopting new technologies changes libraries—providing e-book services changes the character of library use, library holdings, and LIS professionals' roles. Pew found that e-book patrons used branch libraries less and the library website more, that funds for the purchase of e-books reduced the amount available for print materials, and that librarians provided more technical support to assist people accessing e-books and less time performing traditional reference functions (Zickuhr et al. 2012).

E-book services generate a variety of new complexities for libraries. Initially, many major publishers were reluctant to make e-books available to libraries. Some were willing to make them available but only after an embargo period during which time only a print version was available to libraries. After considerable negotiation, by the end of 2013, all major U.S. publishers, including Macmillan, Simon & Schuster, and Penguin Book Group, agreed to some type of e-book lending to libraries (ALA 2014). Polanka (2011) identified several other issues. For example, e-books are priced differently than print materials. The negotiated price depends on the vendor's selected business model; some vendors assess annual fees, others charge per-use fees. E-book purchases generally involve licensing agreements with use and restriction requirements related to intellectual property issues and questions of ownership. That is, do libraries own the items or just the right to access them? Polanka suggested that libraries concerned about ownership issues might acquire items mostly in the public domain or only those subject to open access. Widdersheim (2014) believes there is a deeper problem with e-books because, at least in the current market, e-books are embedded in a highly commercialized environment;

major corporate interests are involved in their development and distribution. For example, e-book readers are provided by only a few vendors and each reader restricts the content that can be downloaded on them reflecting individual vendor's proprietary interests. He observes, "Binding libraries to specific technologies is a central marketing strategy for e-content and e-vendor manufacturers" (p. 105). By determining what content is available and by licensing rather than selling that content, the vendors and developers create an artificial scarcity that they control, including subsequent denial of access to that content.

Although print collections will remain an integral part of library collections, there is no doubt, however, that e-books will be an increasingly important part of many library collections going forward, and libraries will be struggling with establishing economic models that work for them and for e-book publishers. Libraries will need to provide online resources in an intuitive, easy-to-use, one-stop shop. Given the ever-expanding marketplace, librarians might increase their flexibility and responsiveness by continual beta testing of new services and functions (Emery and Stone 2013). How libraries will balance shifting format demands with often-declining budgets represents a major challenge in the years to come.

c. Electronic Resource Management Systems (ERMS)

As digital content proliferated, librarians quickly recognized that managing digital content required significantly different strategies than managing print collections. Anderson (2014) noted that

> . . . the very physicality of the book makes its management simpler; the book is on order, then it is in processing, then on the bookshelves, checked out, returned, repaired, and finally discarded. Electronic resources have no such simple life cycle. (p. 6)

Traditional integrated library systems were insufficient to manage electronic resources. In response, librarians initially developed a variety of techniques, procedures and workflow schedules on an *ad hoc* basis. As online resources gained traction, the Digital Library Foundation of the Council on Library and Information Resources urged vendors to develop software systems that included functionalities to deal with e-resources. The first commercially produced electronic resource management systems were developed between 2003 and 2005 (Emery and Stone 2013; Anderson 2014). ERMS were simply "any software that helps to manage electronic resources" (Anderson 2014, p. 9). Open source ERMS are now available as well.

ERMS manage digital content throughout the life cycle of the resource. Pesch (2008) identified six major phases: acquiring, providing access, administering,

supporting, evaluating, and renewing (or discarding). Each phase has several steps: acquiring requires attention to titles, prices, licensing and invoicing; providing access includes attention to cataloging, registration, searching and linking; administering involves use rights, check-in, claims, and title changes; support involves contacts and troubleshooting; evaluation analyzes usage and cost data; and renewing includes renewal orders, invoicing and title lists. More recently Stone and Emery (2013) organized these six phases into what they called "TERMS": Techniques for Electronic Resource Management. The TERMS workflow included investigating new content, acquiring new content, implementation, ongoing evaluation and access, annual review, and cancellation and replacement review (Emery and Stone 2013).

Some ERMS were designed to be used independently; others could be integrated into an existing library system. Different ERMS often could not "talk" with each other. In fact, they were implemented in only a limited number of libraries. Many libraries kept their homegrown systems. Although Anderson (2014) noted that the National Information Standards Organization developed an "open URL" standard that created a "durable, flexible link between citation and full text, a link that is sensitive to the library holdings to ensure that patrons are linked to subscribed content" (p. 7), he further noted that "no system is perfect, and each one, be it homegrown, commercial, or open-source, has its own complexities and idiosyncrasies" (p. 5). Among the more notable complexities are the cost and difficulty of implementing them, including significant adjustments to workflow in technical services. In addition, the platforms and models for some digital content, such as e-books, remain in flux. Implementation is particularly challenging when technological and business models are unstable. Consequently, before acquiring an ERMS, the advantages and disadvantages should be weighed carefully. Anderson (2014a) raised several issues that should be explored, including how well the system will integrate disparate electronic databases within the library and between vendors, and to what extent it can connect the knowledge databases to other critical functions such as budget, subscription, and purchasing, management, administration, licensing, and reporting. "How well does the system execute budgetary, subscription, and purchasing functions?" "How well does it store administrative information such as publisher and vendor contact information, pricing, usage data, invoice data, and journals held by the library?" "How well does it track licenses for e-content?" "Can it maintain all the necessary terms of each license and track it against the relevant digital resources?" Finally, how well can it produce necessary reports such as budget, check-in, and usage data?

The need for ERMS will persist and grow. The issues of flexibility, standardization, and interoperability of such systems will be of primary importance as well as the

cost and complexity of implementation and operation. LIS professionals will need to keep abreast of developments in both the commercial and open-access arenas.

d. Demand Driven Acquisitions (DDA)

The concept of Demand Driven Acquisitions, also known as patron-driven acquisitions, is not new. DDA has been part of library practice since LIS professionals began monitoring interlibrary loan requests and selecting materials based on those requests. When patrons requested individual titles that were then evaluated and potentially selected for inclusion, DDA was operating. It was also an aspect of ordering materials based on the number of holds placed on a particular title. Nonetheless, although historically present, these practices generally played only a small role in developing print collections. Selecting materials for the library traditionally has been the bailiwick of librarians and subject specialists. Even with automated systems, it was still LIS professionals who created the computer profiles, and defined and limited the domain of materials to be selected. Following this practice, referred to as a "just-in-case" model, the librarian attempted to anticipate the needs of users. In fact, there was no guarantee the selected items would be used; a certain percentage of materials were never used. In today's fiscal environment, this is a serious problem.

The National Information Standards Organization (NISO) defined demand-driven acquisition as "acquisition of library materials based on patron use at the point of need" (NISO 2014, p. 3). Although the definition applies to print and audio-visual materials as well as digital content, it has been only since collection development budgets have shrunk and demands for digital content have increased, that DDA has evolved to become a serious factor in selection practices. Today, DDA refers to a "just-in-time" model. Vendors or aggregators prepare library e-content profiles, often based on previously ordered print materials, and provide these records to the library that are then up-loaded into the library's catalog. Users peruse these records in the discovery process in the same way they would look for an item on a commercial site like Amazon. Once selected, access to the e-book is immediate (Caminita 2014). In some business models, whether a library subsequently purchases that e-book is based on "trigger activity," how a particular e-book is being used by a patron. For example, when a user accesses a particular e-book, the first few minutes of use are usually free (Cramer 2013). According to Downey (2014) although triggers can vary, "purchase triggers commonly consist of 10 page views, 10 consecutive minutes of use within a title, or one page (or portion thereof) copied or printed" (p. 108).

Many librarians remain skeptical about allowing patrons to determine acquisitions. Among their concerns are the following: users will add only popular items, not

necessarily high-quality materials; users are only interested in their own needs, not the broader needs of the community; the collection will be skewed by a small number of heavy users; individual items might be of interest to only a narrow segment of the population; and users are not aware of the budgetary constraints facing libraries. Bushman (2014) further warned that DDA generally promotes the acquisition of e-books, and although understandable in terms of responding to user demand, there might follow unintended consequences. For example, promoters of DDA, especially commercial vendors, have reason to overplay its futuristic aspects and play down the fact that many people, both children and adults, still prefer to read print. LIS professionals must resist vendors' strong marketing seduction and remain deliberate in their choices. They must be wary of skewed collections that meet individual's immediate needs but no longer meet the library's mission to promote learning and inquiry. Bushman argued that the environment created by reading print is more conducive to learning and permits the reader to get more deeply involved in the text. Another concern is that costs will no doubt grow as demand grows; how libraries will fund these spiraling costs over time is uncertain.

In contrast, NISO (2014) stated that increased use of DDA will rebalance libraries' collections "away from possible use toward immediate need" (p. 1). Other benefits of DDA systems are that they

- provide users with immediate access to a wide range of titles to be purchased at the point of need
- present many more titles to their users for potential use and purchase than would ever be feasible under the traditional purchase model
- make it possible, if implemented correctly to purchase only what is needed, allowing libraries to save money or to spend the same amount as they spend on books now, but with a higher rate of use (p. vii)

DDA is still in its infancy in terms of widespread library adoption but growing steadily, particularly among academic libraries. Recent studies in academic libraries found that as much as 40% of the print collection never circulated (Caminita 2014; Downey et al. 2014). As a result, many academic libraries adopted DDA as a complement to traditional selection practices. Brigham Young University found that their DDA program was 94% cheaper and materials circulated 1,300% more on average than the traditionally selected electronic items! Further, after the first month of purchase, more than two-thirds of the traditionally selected items were not used compared to only 30% of the DDA-selected items (Howland et al. 2014). Downey et al. (2014) reported similar findings at the University of Vermont. After implementing a DDA program, the user-selected books had better circulation rates

than the traditionally acquired books. In another study of academic librarians with DDA programs, Nixon et al. (2014) found most of the librarians surveyed were highly supportive of the program and believed that the users selected appropriate materials used by both faculty and students.

The weight of the evidence to-date is that library users are in fact better predictors of subsequent circulation than either librarians or vendor profiles (Tyler et al. 2013). These findings suggest that DDA will become more widespread, fostering yet another library transformation in which users will play an important role in building the library's collection: both print and electronic. Complementing traditional acquisition practices, Harrell et al. (2014) concluded,

> As libraries of all types struggle with the ability to meet the needs of their customers while managing with lower budgets and space constraints, patron-driven acquisitions can be used to supplement a balanced collection. (p. 155)

e. Radio Frequency Identification (RFID)

RFID is among the many technological developments affecting circulation and control of the library collection. According to Caldwell-Stone (2014) RFID

> enables the tracking and monitoring of physical items by attaching an RFID tag or transponder to an item. Each tag consists of an internal antenna and a computer chip that stores data. When the tag is scanned or interrogated by a reading device equipped with its own antenna, the tag communicates its data wirelessly via radio waves to the reader.

RFID has been used in libraries since 1999 and its most common use was for self-check-out machines and security gates as well as for inventory, shelf-reading, weeding, and locating misplaced or incorrectly shelved materials (Ayre 2012; Singh and Mahajan 2014). RFID tags are easier to use than bar codes because they don't need to be aligned, and, depending on the type of tag, can be read from considerable distances. There are two types of RFID tags: active and passive. Passive tags "have no power source and no on-tag transmitter" (BISG 2004, p. 3). The tags themselves are relatively inexpensive and rely on an external reader to activate them. Active tags have "both an on-tag power source and an active transmitter. . . . They are usually used in manufacturing, such as tracking equipment and other high value assets, and toll collections systems" (BISG 2004, p. 3). Libraries generally employed passive tags.

Caldwell-Stone (2014) identified several advantages to RFID:

> Because RFID tags do not require a clear line of sight and allow multiple items to be read in a stack, far less time and human effort are spent on processing materials.

> Patrons using RFID-enabled self-check stations and automated sorting equipment further free up library staff for essential work. Handheld RFID readers can be moved along the shelving units to read the tabs attached to books on the shelves, allowing for more efficient and frequent inventory of the library collection. And by eliminating the need for the repetitive movements required by traditional barcode scanning technology, RFID can help reduce the incidence of repetitive stress injuries among staff and the costs associated with lost time and worker's compensation payments. (p. 39)

These substantive benefits contributed to broader adoption, particularly in academic and special libraries (Ayre 2012; Handy 2014). Despite these advantages, emphasis on RFID slowed as attention has shifted to digital content (digital libraries) and digital access of materials such as discovery systems. Another barrier to adoption was cost: tagging, equipment, software, and staff time can represent substantial initial and ongoing expenditures. Ayre (2012) speculated smartphone technology might overcome some of these costs and enable increased use of RFID technologies.

Despite its usefulness, a persistent concern with RFID has been its potential to violate patrons' privacy rights. Warfield (2005) noted that "RFID's fundamental privacy threat comes from the fact that the tags reveal their information to any compatible reader" (p. II). For example, readers could link a borrower's name to a particular book title. Privacy advocates and the ALA advocated for establishing a taskforce with the Book Industry Study Group (BISG), a trade association involving publishers, manufacturers, and book distributors. The final report, issued in 2004, incorporated many of ALA's concerns and offered a variety of guidelines and four principles:

1. Implement and enforce an up-to-date organizational privacy policy that gives notice and full disclosure as to the use, terms of use, and any change in the terms of use for data collected via new technologies and processes, including RFID.
2. Ensure that no personal information is recorded on RFID tags which, however, might contain a variety of transactional data.
3. Protect data by reasonable security safeguards against interpretation by any unauthorized third party.
4. Comply with relevant federal, state, and local laws as well as industry best practices and policies. (BISG 2004, p. 2)

In addition, ALA created its own policy *RFID in Libraries: Privacy and Confidentiality Guidelines*, which was adopted by the Intellectual Freedom Committee (IFC) in June 2006. The essence of the policy states:

> Because RFID tags might be read by unauthorized individuals using tab readers, there are concerns that the improper implementation of RFID technology will compromise users' privacy in the library. . . . Libraries implementing RFID should use and configure the technology to maintain the privacy of library users. (ALA 2006, p. 1)

The IFC also advised libraries to make sure that information stored on RFID tags was kept to a minimum and that the library's privacy and confidentiality policies were reviewed and updated regularly to ensure that the rights of their patrons were protected. Similarly, the IFC recommends that patrons should be clearly informed regarding the RFID technologies used by the library.

2. The Evolving Search Process

a. Discovery Systems

Historically, the technical functions of the library and the public service functions were separate. With the application of computers to these functions, many of the processes and practices were changed and streamlined, but the distinctions between public service and technical departments remained. With the advent of integrated library systems (ILS) and online-computer-access catalogs, discussed earlier, the integration of internal processes began in earnest. A remaining barrier was the fact that the catalog remained focused on print holdings, notably books, while other materials such as periodicals, digital repositories, and information on the Web were accessed using electronic and manual indexes and independent Internet access. The consequence of these silos was that library users still had to use multiple access points to obtain the knowledge they required. As the powerful search engines of the Internet gained wider usage, the inefficiency of the library's search process became increasingly obvious. Libraries lost their competitive position as a provider of information and content. Libraries and library vendors have been struggling to catch up ever since. In the first decade of the twenty-first century, libraries began to reconfigure and redesign their websites into what is referred to as next-generation library catalogs. Breeding (2014) noted,

> These products included search and retrieval technology and modern interface conventions and were generally designed to work independently from any given integrated library system. The search capabilities of these products were based on the creation of a new index, populated by exporting records from the ILS and from repositories maintained by the library. This approach allowed them to use more

> modern and powerful search and retrieval technologies . . . open-source products widely used in all information technology sectors with very advanced capabilities.

This innovation was known as a "discovery system," a "discovery layer," or a "discovery platform." Vendors as well as practitioners adopted this terminology for the next generation of library interfaces. Discovery interfaces generally exceeded the capabilities of traditional ILSs, but also relied on information contained in them, so integration of the systems was needed. The term "discovery" is now generally applied to the process of identifying, locating, and delivering content to a user.

Current discovery products focus on a level termed "Web scale." Web scale generally applies to "the discovery services that, usually through massive indexes, aim to represent the full body of library content . . . these discovery services aim to address the full breadth of content resources relevant to libraries" (Breeding "Discovery . . ." 2014, p. 13). In other words, "Web scale" discovery layers maximize the ability of the user to identify, locate, and receive delivery of any content regardless of format or location. This includes access to the library's book collection, DVDs, local electronic content, digital image collections, institutional repository materials, content from full-text and abstracting and indexing resources including e-books, and licensed content available by remote access (Vaughn 2011). Among the vendors offering Web-scale discovery services are OCLC's WorldCat, ProQuest's Summon, Ex Libris Primo and Primo Central, Innovative Interfaces Chamo Discovery, and Ebsco's Discovery Services. Some open source ILS/Discovery systems are now emerging and growing in popularity, representing about 12% of the market in 2014. Koha and Evergreen are two examples (Breeding 2014, 2015).

OCLC WorldCat Discovery Service is the oldest and largest of Web scale discovery systems and provides an instructive example. OCLC (2014) describes WorldCat Local in the following way:

> WorldCat Local is a Webscale discovery solution that delivers single-search-box access to more than 1.8 billion items from your library and the world's library collections. It connects people to all your library's materials—electronic and digital and physical—as well as to the delivery services that get them what they need.

According to OCLC, WorldCat Local locates quickly and easily the materials needed; connects the users to those materials; and provides the means for the user to explore those materials—at last achieving a "one-stop" shop for information seekers (OCLC 2014, under "Overview"). Among its features are the following (OCLC 2014):

- Search results include multiple formats of materials such as electronic materials, digital items, databases, music, video, maps, journals, theses, and print.

- Users can quickly link to online resources, place hold or request items, and borrow materials from other libraries.
- A locally branded search box that can be placed on any Web page.
- Link resolution and an A to Z list built on the WorldCat knowledge base connects users to articles and synchronizes electronic resource holding with records in the WorldCat dataset.
- Branch-level holding displayed when Local Holdings Records (LHRs) are present.
- Social networking tools allow users to create and share lists, write reviews, rate items, and more.
- Faceted browsing by author, format, year, audience, topic, and more.
- Ten interface languages include: Czech, Dutch, English, French, German, Italian, Korean, Portuguese, Simplified Chinese, and Spanish.
- Detailed usage statistics through a hosted tracking/metrics tool.
- Browser-based, mobile-specific version compatible with almost any phone.

Despite the attractiveness of discovery systems they are still very much in the development phase. Particularly many public and school libraries, in contrast to academic libraries, remain satisfied with their ILS systems and have not implemented discovery software. Vendors, therefore, will continue to offer newer and enhanced ILS versions for the foreseeable future that include the management of e-books and demand-driven acquisitions (discussed above) (Breeding 2014, 2015). Nonetheless, Breeding (2014) observed,

> Discovery services continue as a major area of activity, seen by libraries as especially critical given their intimate connections with customers, serving as one of the main delivery vehicles for access to collections and services. (p. 1–2)

There is little doubt that as time passes more and more libraries will adopt such systems. The most compelling reason is that most users, socialized to the expectations of information access on the Internet, will expect the same efficiencies with library services and resources. Libraries contain many resources that remain for the most part unsearchable—part of the "deep Web." Libraries have an opportunity through discovery systems to offer their unique resources and at the same time make the needed connections to the vast information world outside. The extent they are able to do so easily, quickly, and reliably might determine if they will thrive in the future. In this sense, the discovery systems might well help them compete and survive in a dynamic information environment.

b. Virtual Reference Service (VRS)

In the past, people often began their search process at the library reference desk. Today, the ubiquity of the Internet, the proliferation of websites, the growth of digital libraries, and the rise of social networks have all combined to make information access easy and convenient for millions of people. One consequence of these changes has been the decline in face-to-face reference services in both public and academic libraries. In academic institutions alone, reference use has dropped 25% annually since the late 1990s (Henry 2011; Tyckoson 2011; Zhang and Deng 2014). In response to these changes, LIS professionals developed new VRSs that could exploit the new technologies and continue to serve their constituencies in the new electronic environment. VRSs have many names, including "digital reference" and "Ask-a-Librarian," but the Reference and User Services Association (RUSA 2010) of the ALA, defined them in the following way:

> Virtual reference is reference service initiated electronically where patrons employ computers or other technology to communicate with public service staff without being physically present. Communication channels used frequently in virtual reference include chat, videoconferencing, Voice-over-IP, co-browsing, e-mail, and instant messaging. (p. 1)

Early forms of VRS usually took the form of e-mail. This is usually considered an "asynchronous" form of virtual reference in that the queries came in at one point in time and the answers were provided later. Although e-mail was a useful mechanism that is still employed today, it has at least two drawbacks: the response was not immediate, and it was not possible to see or hear the patron. As a consequence, the reference librarian was not able to take full advantage of the reference interview (Arya and Mishra 2011). As early as 1995 the "chat" facility was used by the Internet Public Library. Now, with the development of social media, chat, instant messaging, and other forms of synchronous communication, VRS has moved to an entirely new level and the immediacy of the face-to-face interview has been effectively, albeit not perfectly, simulated. The size of the library often determines which technique is used. A study by Wanucha and Hofschire (2013) found that among large libraries serving 500,000 or more, nearly 80% employed e-mail, a majority used chat services, and 40% provided text services. Among libraries serving 100,000 to 500,000, 63% used e-mail, but only 38% provided chat. In libraries serving 25,000–1000, nearly a majority (48%) used e-mail VRS. Some libraries collaborate with other libraries to provide VRS and some states provide virtual reference service on a statewide level. For example, Ohio offers the KnowItNow 24X7 reference service which in 2013 conducted more than 40,000 chat reference sessions, and handled more than 2,000

text messages and 870 e-mails (Boozer 2014). The benefits of collaboration include increased hours of availability, shared staffing responsibilities, increased availability of expertise, and cost savings from vendors (ALA 2014).

There are many considerations in the design and implementation of a VRS. RUSA (2010) identified many of them in its "Guidelines for Implementing and Maintaining Virtual Reference Services" (2010). Among the issues addressed by these guidelines are the following:

1. VRS needs to be carefully integrated into current reference service as a long-term commitment.
2. The audience for the service needs to be identified;
3. Appropriate institutional policies need to be adopted and levels of service defined. These include standards and expectations of behavior of staff, policies regarding privacy and confidentiality of user queries, and hours of service.
4. There needs to be a meaningful commitment in terms of budget, equipment, staffing, and maintenance.
5. The appropriate software must be selected.
6. The library's digital collection must be evaluated and if necessary enhanced.
7. An ongoing evaluation of VRS must be implemented.

There are many reasons that VRS is desirable. The strongest motivation is convenience. People do not have to travel to use the service, and VRS is often provided well after closing hours, sometimes 24/7. In addition, VRS can take advantage of multiple social media channels for communication such as chat, e-mail, and Facebook.

However, even when implemented well, VRS presents significant challenges. Connaway and Radford (2011) conducted a series of research studies on the factors that promote or dissuade people from using VRS. Resistance to using VRS can come from a variety of sources. For example, older users tend to be resistant because the new technologies can be unfamiliar and frustrating. Millennials, on the other hand, are less resistant than baby boomers, but they still prefer face-to-face contact. Their resistance stems less from the technologies, with which they are generally comfortable, but more from personal issues such as the need for reassurance from librarians.

Connaway and Radford (2011) argue that there needs to be a fundamental reconceptualization of reference service in the virtual environment. They noted that to an ever-increasing extent, people's virtual lives are entangled in their "analog" lives—their everyday life of work, play, and friendships. They refer to this

entanglement as "synchronicity" (p. 2). They believe that if virtual reference is to succeed, it must do more than provide information; the service must establish strong relationships with potential VRS users. A successful VRS program not only attracts a user the first time, it stimulates the desire to use the service again and again. If the information obtained is accurate and users are comfortable with the service, they likely will return. Comfort is important: many people prefer face-to-face relationships in the reference process because the user can build a relationship with the librarian. Establishing this interpersonal connection in the online environment is particularly important for VRS to succeed. If users feel the librarian abrupt or disinterested, they are not likely to return. Similarly, if the librarian closes the interview poorly or abruptly, users will not be attracted to VRS.

Interestingly, another reason why people in general do not use VRS is that they are simply unaware that the service exists. Libraries have not done the job they need to do to make the service widely known. Based on these findings and others, Connaway and Radford made many suggestions to improve the chances of VRS success. These are summarized below:

1. Aggressively market and promote VRS services. Create an awareness of the service through face-to-face opportunities in the library. For example, when a user is at the reference desk, remind them of the VRS. At library training sessions on VRS or other library resources, make sure that the attendees are aware of the service.
2. Ensure that there is sufficient support to assist patrons in using the VRS.
3. Provide 24/7 service if possible, respond quickly and efficiently.
4. Design catalog interfaces and databases to mimic popular Web browsers.
5. Provide access from mobile devices.
6. Increase convenience by integrating other library services and tools into the VRS site.
7. Be especially sensitive to teenagers and assure them their questions are welcome.
8. Make sure during appropriate library training and programs that VRS is mentioned.
9. Use clarification techniques to ensure the right question is being addressed. Employ open-ended questions and determine question type: is it for a school assignment, or what they might be using the information for?
10. Provide specific and accurate answers, always act with courtesy, be patient and do not appear hurried, close the session making sure the information need was satisfied, and provide a pleasant "goodbye."

As with any new and developing service, a variety of challenges arise, including administrative, start-up, and maintenance costs; selecting appropriate software; availability and licensing of electronic resources; policies for provision of services; staffing and scheduling; marketing issues; impact on facilities; and negotiating collaborative activities with other libraries. Nonetheless, use of these services is expected to grow and will likely be heavily used. In a study of U.S. adults, Pew (Zickuhr 2013) found that 37% were "very likely" and another 36% were "somewhat likely" to use an online "Ask a Librarian" service if a library provided it. Many people enjoy their contact with librarians and insofar as libraries can create a VRS service that is convenient, personal, welcoming, accurate, and efficient, including such a service is likely to become a staple of the library and a significant benefit to its users. In such an environment, the very nature of reference service will continue to change: the physical reference desk staffed by reference librarians will likely persist but decrease in importance and use.

c. Social Question & Answering Services (SQA)

When people search for information online, their first choice is usually a search engine, but an alternative growing in popularity is the use of social question and answering services, sometimes referred to community-question answering (CQA). These sites often compete with VRS. Radford et al. (2012) described SQA in the following way:

> Social Q&A services are community-based, and purposely designed to support people who desire to ask and answer questions, interacting with one another online. People ask questions to the public and expect to receive answers from anyone who knows something related to the questions, allowing everyone to benefit from the collective wisdom of many.

SQA is a peer-to-peer public forum in which all users potentially participate as information seekers and information givers. SQA exemplifies the collaborative and egalitarian spirit of social networks. Participants not only answer questions, but they can evaluate and rank responses and comment on them as well. Some SQA services also encourage collaborative problem-solving in which multiple members attempt to address a problem posed by another participant. One example of SQA service is Yahoo! Answers, which as of August 2014 had more than 6.1 million visitors per month (Quantcast.com 2014). SQA is low cost and response time for answers is usually short (Shah and Kitzie 2012). In addition, users appear satisfied overall. Zhang and Deng (2014) reported that 70% of users were satisfied or very satisfied with the answers they received from Yahoo! Answers and only 18% were dissatisfied.

Students, overall, prefer SQA to VRS, but they also indicate that they test the veracity of the answers they get through SQA by consulting external sources (Radford et al. 2012). Interestingly, the credibility of an SQA service for students increases, if the student locates the site though a Google search. Google lends credibility (Shah and Kitzie 2012). In general, the quality of the answer is not related to how fast the answer is provided (Chua and Benerjee 2013).

As might be expected, some librarians have substantive concerns about SQA especially in regard to the questionable authority and accuracy of the answers given. Despite librarians' suspicions, however, some have chosen to participate in SQA services by providing high-quality answers and then identifying themselves as librarians to educate participants about the expertise of librarians and the usefulness of VRS (Radford et al. 2012). Interestingly, in exploring the relationship between SQA use and VRS use, Zhang and Deng (2014) found that 70% of the Yahoo! Answer respondents indicated that were not aware that libraries even had VRS services.

When comparing VRS and SQA services, Shah and Kitzie (2012) note that both have their strengths and weakness. Based on their review of the research, the strengths of each are summarized below:

VRS outperforms SQA on

1. *Customization:* VRS services tend to identify both the specific question *and* contextual factors such as intended use.
2. *Quality:* The quality of answers tends to be higher.
3. *Relevance:* VRS tends to minimize irrelevant information.
4. *Accuracy:* VRS focuses more attention on accuracy of the answer even if it takes long to answer the query.
5. *Authoritativeness:* Answers are generally more authoritative because of the subject and information-seeking expertise of the librarian.
6. *Completeness:* Librarians tend to exert extra effort to ensure that the answer addresses the need in its entirety.

On the other hand, SQA services tend to outperform VRS on the following characteristics:

1. *Cost:* With no forms to complete and immediate, free access to a large community, there are few if any real costs to the service.
2. *Volume:* Because answers are saved for others to consult, popular SQA services such as Yahoo! Answers have a vast collection of answers for consultation. These answers are indexed by Google, which makes the site easy to access.

3. *Speed:* SQA sites provide answers more quickly than VRS.
4. *Social aspects:* Popular SQA services frequently provide easy connections to other external social media sites such as Facebook.
5. *Engagement:* While VRS sites are used to ask a question and obtain an answer, SQA sites invite exploration and interaction beyond the answer itself.
6. *Collaboration:* SQA services invite interaction and information exchange and discussion.

Given the advantages of each, it is likely that both SQA and VRS will persist and users will determine which service is selected for a given question. Nonetheless, the evolution of SQA services will need to be monitored to determine their future impact on library services, including VRS.

D. The Library's Evolving Space

A library building is more than a container for content, digital or print. It is a cultural space recognized as a place of learning. Its presence in a community is both practical and symbolic:

> The library has often, and for obvious reason, become synonymous with reading and literacy, but the true definition of the library has always been ideological and transcendent of format: to inspire, facilitate learning, to advance knowledge, and to strengthen the community. In this, a library's space is different from that of a warehouse, as it has values, a philosophy, a spirit, and a soul. Not just a personalized space, it is personified as a lexicon of local culture and the human experience. (Małczewski 2014, p. 37)

How library spaces are changing is more than a reflection of changes in technology; they are an expression of how the library adapts to changes in the larger culture—how patrons see the library, and how the library views itself and its mission. Changes in a library's physical spaces are less about changes in blueprints and floor plans and more about ensuring that the library remains relevant and continues to accomplish its critical mission.

Historically, library space was primarily devoted to two aspects of library service: (1) the physical collection and access to it and (2) reference services. Today's libraries recognize that spaces emphasizing book collections and the reference desk do not reflect the changes in how twenty-first-century users seek and use information. The new information technologies create a culture of self-sufficiency among

many information seekers, and although the library remains an important provider of information, its role and centrality in this area have declined. But the cultural significance of libraries remains: to educate, to promote an informed citizenry, and to disseminate knowledge. As a response to the change in information-seeking behavior of users, the library must refocus its attention to other critical functions and in doing so, reimagine its space. We examine three such spaces below.

1. *Spaces for Learning*

   While libraries continue to provide space that supports individual learning, many libraries also create places where people can use appropriate technologies to work collaboratively to complete school assignments or personal projects. These spaces reflect the greater emphasis now placed on collaborative learning in schools and higher education. For example, public libraries establish "homework help" centers that assist students with assignments and instruct them on learning strategies. They also offer classes on computer use and computer coding. Many academic libraries create learning commons where students can interact, use search engines, and complete assignments and presentations, often with the aid of multimedia production software. Academic libraries also incorporate various centers that improve students' skills in math or "writing centers" that help them prepare papers and improve general writing skills. Space might also be devoted to online classrooms for in-house and university-wide classroom education or training.

2. *Spaces for Creating*

   As library patrons became creators of content, libraries provided spaces and resources. These "makerspaces" provide tools, often state-of-the-art technologies such as 3-D printers, laser cutters, and advanced video and audio production software, as well as traditional technologies such as sewing machines. Malczewski (2014) referred to these resources as libraries' *dynamic content*, in contrast to passive, traditional materials such as books, and they are yet another way libraries actively engage with the community.

3. *Space for Engagement*

   Library spaces today focus less on internal operations and more on the needs of their communities. While many of these needs remain informational, they might also be social. Library space that helps people accomplish social tasks or cope with social challenges is becoming more common. For example, libraries help people register to vote, complete forms and applications

> for jobs, sign up for health insurance or Social Security, and provide shelter and support to cope with disasters such as hurricanes or floods. Many libraries offer retail spaces to sell discarded books, Internet cafes, dedicated spaces for teens and for parenting classes, spaces for business meetings, digital labs, and community collaboration spaces. Some libraries even offer their land for community gardening (ALA "State of" 2014). A particular focus remains on literacy with libraries providing programming for adult literacy, information literacy, and emergent literacy. Academic libraries provide spaces for collaborative research activities and discussion rooms such as a "faculty commons" (Maloney 2014). Both individuals and groups benefit from these activities, but their focus is on service to the community of users rather than just on one individual.

As libraries design and redesign their spaces, they are cognizant of the ever-changing environment in which they operate. Flexibility is a high priority; classrooms can be reconfigured into meeting rooms or collaborative learning centers; tables, chairs, even walls are moveable; equipment and technologies are portable and wireless. It is not clear that all libraries have actually obtained equilibrium in attempting to deal with emerging space needs; it is probably best to describe the current situation as a *dynamic equilibrium*; an ever-changing environment as library users place new demands and expectations on a critical cultural institution. In these new spaces, LIS professionals and the public engage in new ways that foster relationship-building, human interaction with technology, and collaboration.

E. The Evolving Technological Infrastructure: Cloud-Based Computing

As noted throughout this chapter, libraries continually adopt new technologies to improve their internal operations and to provide enhanced services to their users. Some of the adopted technologies have included integrated library systems, Web portals, websites, digital libraries, and institutional repositories. Each new innovation resulted in significant costs to the library for hardware, software, and trained staff to maintain and upgrade these services as needed (Bansode and Pujar 2012). Cloud computing represents a significant advance in network access and has the potential to help libraries control some of their costs while continuing to provide enhanced services to users as well.

> The National Institute of Standards and Technology (NIST) defined cloud computing as

> A model for enabling ubiquitous, convenient, on-demand network access to a shared pool of configurable computing resources (e.g., networks, servers, storage, applications, and services) that can be rapidly provisioned and released with minimal management effort or service provider interaction. (Mell and Grance 2011, p. 2)

Breeding (2012) identified some of the defining characteristics:

- An abstract technology platform that involves generalized access to remote computing resources rather than locally owned and managed discrete services
- A utility model of computing involving fees charged for levels of use rather than capital investment in hardware or permanent software licenses
- Computing that's provisioned on demand, with resources allocated as needed
- Elastic quantity and power of the computing resources that increases at times of peak use and scales down when demand is lower
- Highly clustered and distributed computing infrastructure that spreads computing tasks across many devices to maximize performance with high fault tolerance for the failure of individual components. (p. 2)

More simply, Corrado and Moulaison (2012) applied the concept directly to libraries: "it is enough to think about cloud computing as library data and services hosted beyond the library's walls and accessible via the Web" (p. 49).

There are actually several different types of "clouds." Beaty (2013) identified five types: the "public" cloud, the most common and the one used by the public for Web-based applications such as e-mail, social media, YouTube, iTunes, and so on; a "private cloud" owned by a particular user or a third-party cloud provider, a "community cloud" used by groups of users with a common purpose or interest such as several like-minded businesses, departments within a corporation or governmental agency, or a parent company and its partners or subsidiary companies; a "hybrid cloud" in which some of the applications are located in a public cloud and others in a private cloud; and finally a fifth type of cloud recently emerged, the "federated cloud," in which users obtain cloud services from a provider who in turn might contract with other cloud providers to broaden the reach of the users (much like cellular phone services that create agreements with other services to expand coverage).

Cloud-based computing in libraries is based on a model known as "Software-as-a-Service" (SaaS). Libraries use a vendor's cloud applications, infrastructure, and hardware to provide the needed library services. This model, according to Breeding (2014a),

> . . . trades higher upfront costs, incurred by libraries for equipment and software licenses, for a comprehensive annual subscription fee. Leveraging economies of

> scale, SaaS providers have the potential to enable savings for libraries over time compared with direct and indirect costs of maintaining local servers and related infrastructure. (p. 3)

SaaS allows simultaneous access to multiple applications on the Web, providing numerous benefits to the library, including

> *Efficiency:* cloud computing maximizes use of server time, energy, and results in minimal downtime;
>
> *Flexibility:* services can be expanded immediately to meet changes in demand;
>
> *Cost savings:* the computing time is paid for incrementally on an as-needed basis, staff is not needed for implementation, maintenance and upgrading of equipment and software;
>
> *Mobility:* cloud-base systems can be accessed by mobile devices;
>
> *Storage:* storage capacity can be increased on demand;
>
> *Ease of operations:* IT responsibilities are shifted to the cloud provider;
>
> *Mission focus:* cloud-based activities reduce the time spent on IT activities and allow staff and administration to focus on meeting the goals and mission of the organization. (Bansode and Pujar 2012; Corrodo and Moulaison 2012; Han 2010)

Rather than taking on the responsibility and costs for hosting, maintaining, and upgrading multiple servers and applications over the library's own network, these responsibilities and costs are moved to the cloud provider.

The array of services that can be moved to the cloud is considerable and includes both administrative and service functions such as the library's website, integrated library systems, digital repositories, learning object management systems, ILL, and public and private storage systems including backup and file-sharing activities (Han 2010). Cloud-based discovery services allow access not only to the catalog, but to a wide array of information resources the library holds or has access to, including special collections, digital repositories, journal databases, citation management systems, and e-books (Bansode and Pujar 2012; Corrodo and Moulaison 2012).

Although the advantages of cloud computing appear considerable, they must still be weighed against fees and other costs including transition costs and backup storage costs. Other concerns relate to the reliability of the cloud service, maintenance quality, and amount of down time; the capacity of the service to ensure data security and confidentiality; and effective management of the data in the system. Once the data is in the cloud, who owns and controls it? Can the data be mined by the vendor? What happens to the data if the vendor goes bankrupt or if the library

is not timely in its payments—can the library lose access to its data? (Bansode and Pujar 2012; Breeding 2012; Corrodo and Moulaison 2012). Acquiring cloud-based services is also likely to increase the library's dependence on Internet access and greater bandwidth, and will have substantial impact on the library's IT department and staff (Breeding 2012).

The development of cloud-based services is still in its early stages, and few libraries have adopted it. But as vendors develop more sophisticated cloud-based systems, such as OCLC's WorldShare, ExLibris Alma, Amazon Web Services (AWS), and Google Apps, it is inevitable that a large number of libraries will eventually move in this direction.

IV. SUMMARY

Libraries in the United States have been adapting to changing technologies since the nineteenth century. But the changes incurred by the introduction of computers, the Internet, digitalization, social networks, and mobile devices have created true transformations in library services, collections, and facilities. In a real sense, these transformations have just begun. Physical collections remain important, but they play a decreasing role as access to digital content ascends in importance. As library users grow accustomed to the convenience of Google and other powerful search engines, their expectations about the convenience of library service have risen as well. Users want their library search experience to have the look and feel of Google while at the same time they also want the diversity of services and personal touch that libraries provide. Libraries have worked hard to satisfy these demands. Electronic catalogs have evolved into discovery services that bring the library collection, access to digital content far beyond the walls of the library, and access to LIS professionals' expertise to the users' fingertips. The focus today is on the user—whether it is providing virtual reference service or demand-driven acquisition.

Increased information access is just one part of the library's transformation. The relationship of the library to its community is shifting as well with increased outreach and engagement. While serving individuals remains important, LIS professionals are interacting with groups in new ways. They create makerspaces within the library so that users can contribute content. They are more civically involved in their communities and help people trying to navigate government and other online services. They promote digital literacy and work to embed the library in the fabric of an electronically connected society. The end result of these transformations is unknown. One thing is clear: LIS professionals will need to be flexible and open-minded about

these transformations. The stakes are high, but the results might again demonstrate the centrality of the library in the lives of those they serve.

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