Digital Libraries: An Overview
by Candy Schwartz

Digital libraries are complex systems that stretch institutional resources and capabilities, but also offer unparalleled opportunities for new and improved user services. An overview of the basic components of a digital library looks at the challenges and the potentials.

It is an understatement to say that the phrase “digital library” (DL) means different things to different people. As part of a class project, students in a digital library course recently found 64 different formal and informal definitions of “digital library.” These range from what one could call the “strict” definitions underlying much of the federally funded DL research, such as:

Digital libraries are organizations that provide the resources, including the specialized staff, to select, structure, offer intellectual access to, interpret, distribute, preserve the integrity of, and ensure the persistence over time of collections of digital works so that they are readily and economically available for use by a defined community or set of communities.

...and to much looser characterizations, as seen in:

A digital library is a distributed electronic collection that covers virtually all fields of human endeavor including art, music, medicine, science, movies, videos, books, product literature, newspapers, brochures, and catalogs.

An analysis of the multitude of definitions, as well as mission statements and project proposals, indicates that digital libraries are seen as resources that ideally:

- Serve a defined community or set of communities;
- May not be a single entity;
- Are underpinned by a unified and logical organizational structure;
- Incorporate learning as well as access;
- Make the most of human (“librarian”) as well as technological resources;
- Provide fast and efficient accessing, with multiple access modes;
- Provide free access (perhaps just to the specified community);
- Own and control their resources (some of which may be purchased); and
- Have collections that:
  - Are large, and persist over time,
  - Are well organized and managed,
  - Contain many formats,
  - Contain objects, not just representations,
  - Contain objects that may be otherwise unobtainable, and
  - Contain some objects that are digital ab origine.

These elements, especially as related to ownership and control of collections of digital objects, position a digital library as a separated set of resources and activities within (or perhaps not associated with) a traditional library. However, in an environment of e-books, e-journals, wired communities, and remote services, traditional libraries conduct their business in a sometimes uneasy space lying between the tangible and the virtual. The concept of the “hybrid library,” which seems to have originated in Europe, reflects the realities being faced by libraries as they attempt to integrate externally purchased electronic monographs, serials, and access services with digital collections produced in-house. Pinfield, Eaton, Edwards, Russell, Wissenburg, and Wynne feel that the hybrid library is more than a temporary state of affairs:

The hybrid library is on the continuum between the conventional and digital library, where electronic and paper-based information sources are used alongside each other. The challenge associated with the management of the hybrid library is to encourage end-user resource discovery and information use, in a variety of formats and from a number of local and remote sources, in a seamlessly integrated way. The hybrid library should be “designed to bring a range of tech-
The hybrid library is the context within which most academic digital libraries are found—the ecosystem of the digital library, as it were.

Whatever words are used, those creating and maintaining digital libraries of one kind or another are probably less concerned with shades of meaning than they are with coping with the sheer amount of organizational, technological, and human effort involved. Even the digitization of a small collection requires thinking about funding, conversion methods, information architecture, metadata, preservation, interface and presentation design, evaluation, and integration into existing structures. Decisions, drawing on the knowledge and expertise of many, need to be made from the general policy level (e.g., deciding which segments of the community will have access to the digital library) down to such fundamental things as file type (e.g., choosing the format in which sound files will be stored and delivered to users). Other authors in this issue look at projects and institutions that have managed to navigate successfully through these complexities, or look at how DLs might evolve. The purpose of this article is to provide context through an overview of the components of digital library work, and also to point to resources for further exploration. This is the tip of the iceberg.

**SETTING THE WHEELS IN MOTION**

Many libraries and other institutions maintain collections of purchased or converted digitized information. However, the notion of separate entities called “digital libraries,” and the now substantial community that will have access to the digital library) down to such fundamental things as file type (e.g., choosing the format in which sound files will be stored and delivered to users). Other authors in this issue look at projects and institutions that have managed to navigate successfully through these complexities, or look at how DLs might evolve. The purpose of this article is to provide context through an overview of the components of digital library work, and also to point to resources for further exploration. This is the tip of the iceberg.

**Why Digital Libraries?**

The focus of the Digital Library Initiative is “to dramatically advance the means to collect, store, and organize information in digital forms, and make it available for searching, retrieval, and processing via communication networks—all in user-friendly ways.” Why have so many libraries and other institutions, with or without federal funding, turned their hands to creating digital libraries? Some of the reasons have to do with advances in information technology—increasingly both scholarly and recreational materials are being made available in electronic formats, either in addition to or instead of print. The costs of creating, storing, and transmitting digital information have decreased, and the technology to support distribution and access is widespread. Rising acquisition and subscription fees (not to mention shelving and processing costs) have forced libraries to seek other ways to make information available, and content aggregators and e-book publishers are providing the means.

Perhaps more importantly, digital libraries support service improvement. Information search and navigation across electronic information resources is faster, with enriched points of access, and alternative methods for browsing and exploration. The resources themselves can be segmented, rearranged, annotated, and enhanced in ways not possible before, and can be directly integrated with desktop productivity tools for local analysis and processing. A digital environment enables cross-community interactivity and collaboration, regardless of physical location. Also, digitization presents opportunities for long-term preservation of bodies of knowledge, if not of the original carriers of that knowledge.

**UNDERNEATH THE HOOD**

The planning, creation, and execution of a digital library draws on the expertise of many, and requires making difficult choices at almost every stage. Most DL projects, although they may have official directors, are underpinned by teams that bring together (or draw on as needed) people with capabilities in collection development, cataloging and representation, networking, software engineering, preservation, imaging, human computer interaction, copyright law, project management, and other related areas. Options, alternatives, and questions lurk around every corner of the path to the realization of a digital library.

**The Resources**

Library collections, digital or otherwise, are formed by decisions about what to acquire, from which sources, in which format(s), and how to preserve materials once acquired. In digital libraries, these decisions are complicated by a number of factors.

Digital objects can be text, image, sound, moving image, multimedia, datasets, software, three-dimensional files, and possibly other as yet unknown types. Even within one type, such as text, there is a plethora of formats (e.g., plain text, rich text, Word, Postscript, PDF, and marked up in HTML or another SGML or XML document type). Additionally, there...
are questions as to what constitutes an object—for example, is a digital book one object, or is each chapter, illustration, table, table of contents, title page, and index a separate digital object? If individual components of an intellectual document are disaggregated, then can they be re-aggregated with components of other intellectual documents? Answering questions of this nature depends on an understanding of the eventual use of the material, and requires complex object management capabilities, as well as considerations of intellectual property rights.

Selection and acquisition of materials for library collections is a thoughtful process, involving a balance between meeting user needs and observing fiscal constraints. In digital libraries, the costs of acquisition may include not only purchase or subscription, but also conversion to digital format. Considerations of what to collect may, therefore, be influenced by whether an item is already owned by the institution, or in the public domain, has already been converted, or is digital to begin with. Conversion of print text and image materials (leaving aside sound, or video) is costly and time-consuming, involving document preparation, scanning, inspection for quality control, probably some degree of optical character recognition, more inspection, editing, and indexing—not to mention storage, transmission, and display of the object once converted.

Preservation and archiving is one of the thornier problems for libraries with electronic content, whether acquired through subscription services, purchase, or conversion. There are serious concerns with the archiving and access policies (or lack thereof) of journal publishers and content aggregators. However, in the context of an institution’s created digital content, preservation is up to the institution. Apart from questions about which formats and versions should be archived, collection managers need to worry about media deterioration over time, and technological obsolescence as software and hardware platforms change. Relying on standards to be persistent is risky, as is attempting to preserve hardware and software specific to points in time. Migrating files as platforms change is generally recommended, and requires diligent planning and good record keeping, but Clifford Lynch suggests that this too has its risks, and he supports an algorithmic approach.6

A Place for Everything, And . . .

To be of use in a collection, digital objects must be more than the collection of bits that result from creation or conversion. They need to be identified, described, stored, and disseminated. They may be rendered in different formats for different circumstances. Stored in repositories, each digital object must have its own unique identification, or name. The name is used to retrieve the item, associate metadata with it, associate it with other objects, and act as a reference in citation. The name should persist over time and over migration from one physical location to another, and should resolve quickly. The Corporation for National Research Initiatives (CNRI) “handle” system is one of the best known and widely used naming and object management systems.

Many types of metadata, serving different purposes, might be associated with a digital object (or subset of objects) in a repository:

- Descriptive metadata include content, or “bibliographic,” description (including subject access) and possibly content ratings or evaluation information;
- Administrative metadata relate to terms and conditions of use, provenance (e.g., original source, date of creation, and version), processing (e.g., file format or internal structure), transactions (e.g., date of deposit or request), and object interrelationships; and
- Structural metadata concern information that makes the object usable, for example, to enable page turning in an electronic book.

Work on metadata in specific communities may suggest more, depending on the nature of the object.8 Some metadata can be created automatically, but much requires human labor.

The applications software underlying a digital library can be completely customized, purchased from one vendor, or put together from existing products (preferably conforming to accepted standards). Most digital libraries take the last route, which then entails some work in system integration. Underlying any digital library is, of course, a collection of servers, network technologies, storage devices, and attendant software tools and staff dedicated to distributed information management. Making many objects available to, for instance, a large campus community, requires strong capacious networks and sizeable active storage and delivery capabilities. Deployment of streaming media, familiar to most of us through Real Audio and Real Video, will make even more demands on capacity and expertise. Add to this the need for security and authentication management (some of which is likely to be already in place), and distributed transaction processing, and it becomes clear that the impact of digital library activity on institutional computing resources is far from trivial.

At the Wheel—Welcome to the Library

A digital library is more than the resources and the aggregation of hardware and software that manages them. It is also a collection of services, developed (one hopes) with users in mind, although those users may be hard to define. What users will remember about a library will be the services it provided, and the means through which those services were available, whether those means were library staff, self-guided instruction, architectural and interior design elements, or a machine-driven interface.

Services

Digital libraries can potentially support a range of traditional and not-so-traditional library services. Although advanced DL research projects exploit the possibilities of a digital-only world, working digital libraries for the most part support functions that closely resemble their brick-and-mortar library counterparts, in slightly different guises.

Information Seeking and Retrieval

All digital libraries are searchable, whether through direct query entry or through some form of browsing, or both. LC’s American Memory project, which is one of the more well-developed and complex digital libraries, offers direct search through the entire collection, or through selected collections, with the same kinds of options (match any words, all words, this exact phrase) as Internet search engines. Users may also browse through collections, and within a collection can browse subject and author indexes.

Reference Query Fulfillment

Very few digital libraries are sufficiently advanced to have incorporated interactive reference services. Most offer an e-mail contact for queries, and one or
more frequently asked question (FAQ) files, which typically focus on either descriptions of the technology or information about the resources. For example, digitized collections at Duke University are listed on the home page of the Rare Book, Manuscript, and Special Collections Library, along with a link to a page that provides e-mail and telephone contact to reference services for those doing research in the collections, whether print or digital.

**User Training**

User training (i.e., bibliographic instruction) can take many forms—guides, tutorials, manuals, finders, workshops, videos, or one-on-one guidance. Few digital libraries have well-developed user training as yet. In addition to FAQs, many digital libraries carry guides to using the collections. As a typical example, the Lester S. Levy Collection of Sheet Music at Johns Hopkins University includes several useful pages on searching and browsing. The William Blake Archive goes further than most in providing a very well-developed virtual tour, extensive help documentation, a history of the project, an FAQ, a bibliography, and information on editorial principles, the editors, and the technology.

**Current Awareness**

The closest most digital libraries get to current awareness is a “what’s new” page, or a regular newsletter available at the Web site. This is hardly a personalized current awareness service. Some (e.g., CalFlora hosted at the University of California) will subscribe users to an e-mail announcement service. In the future, digital library services will include the development of personalized information spaces that will customize the user experience based on knowledge about individuals, their past behaviors and preferences, and their connecting technologies. This kind of interaction is on the research agenda of DLI projects at institutions such as Cornell University.

**Learning Facilitation and Collaborative Activities**

Public libraries traditionally work closely with local schools, and school and academic libraries are directly involved in the curricula of their parent institutions. Digital libraries as well are concerned with helping educators make the most of electronic resources and services. The University of Michigan Digital Library Teaching and Learning Project has resulted so far in online learning resources in a number of different subject areas for high school and middle school students. The Perseus Project, at Tufts University (and one of the oldest digital libraries) devotes a section of the site to “Teaching with Perseus,” including syllabi and class notes, comments from instructors, and teacher and student guides. Similarly, the Colorado Digitization Project includes a section on “Working with Schools,” with lesson plans and links to additional tools and resources. Classes using these resources could meet entirely in cyberspace, although it is likely that most of them do not. Digital libraries can, of course, support collaborative research activities among individuals who may be far removed from each other, and from the digital library. This has been a subject of research interest—for example, the University of Michigan Digital Library site illustrates a visual collaborative information space in research on user interfaces—but little has surfaced in actual working demonstrations.

**Users and DL Interaction**

On the other end of these services are users, who may be a restricted community (when access is limited to authenticated users), or may be Internet surfers at large. For at least the primary community, consideration must be given to expected access capabilities. Technology and connectivity at the user end will vary with respect to speed, capacity, device, and graphic display, and this should be taken into account in interface design. Users may also face physical challenges, restricting their ability to use a keyboard, or requiring the use of an assistive device that translates information into spoken words. For the most part, digital libraries rely on pointing devices (e.g., mice, stylus, etc.) and keyboards for interaction, and are primarily designed for display on desktop or laptop computers, although the huge growth of interest in wireless computing, and the development of standards for transmitting and displaying Web-accessible information on handheld devices, is likely to lead to more work along the lines of Cornell University’s Nomadic Digital Libraries noted earlier.

In addition to accommodating technical constraints and special needs in user communities, a digital library should accommodate varying levels of expertise, and should offer flexibility in methods of exploration. Users should be able to find objects directly (analogous to finding a specific author or subject in a library catalog), and should also be able to browse systematically. The interface, together with the underlying infrastructure, interprets digital objects for presentation to the user, manages the relationships among objects, and may have also to negotiate terms and conditions for use of objects.

**Direct Search**

End users of library online public access catalogs (OPACs) and commercial online secondary services (e.g., SilverPlatter) usually can choose to search by keyword (that normally includes words from title, subject heading, and other content describing fields), or by a particular field (e.g., title, subject, author). Under “advanced” options, such systems offer Boolean searching, truncation, and perhaps proximity functions (i.e., this word within so many words of this other word). Retrieval is usually based on exact match to the query, that is, the results contain exactly what the user specified. If the system cannot match to a query, either the user is told that nothing exists, or an index of alphabetically close words may be displayed for browsing.

On the other hand, a look at the world of Internet search engines demonstrates almost infinite variations on the theme of “type something and we will try to find the best answer.” Many include advanced options similar to those just mentioned, but retrieval is based on primarily statistical algorithms that take into account the amount and distribution of query words in Web page representations (as well as many other factors). Query words are usually stemmed (suffixes are removed, and other transformations may occur), and almost invariably something is retrieved (although in some cases the results may have very little relevance).

Direct search in digital libraries is usually similar to the OPAC or online searching model, employing search templates or index navigation tools. This takes advantage of the fact that digital libraries hold well structured data and metadata, providing the basis for fielded search and browsing through indexes. Also, many digital libraries contain non-text objects, which do not lend themselves to text-based statistical retrieval algorithms (although some interesting work is being done in image pattern matching). Digital libraries frequently employ one of the prevailing standards for managing search—these include the Z39.50, structured query language (SQL), and tools developed for
Web search engine applications (e.g., Open Text). Experimentation with sophisticated statistical and linguistic algorithms is thus far usually confined to research settings.

Browsing and Navigation

Digital libraries can take advantage of the flexibility of electronic presentation to offer far more in the way of browsing than traditional library catalogs. The same collection can be navigated under different views, depending on the nature of the information. The following examples illustrate possible approaches.

• New York Public Library (NYPL). The NYPL’s Digital Library Collections include collections of stereoscopes, prints and photographs, text, and archival finding aids. Each of these uses different browsing methods. In addition to direct search, the stereoscopic collections organize images for browsing by theme (e.g., “Niagara in winter”). After choosing a theme, the initial screen describes the collection and suggests related subject headings, and the “tour” shows nine thumbnails to a screen, with options to view the front, back, full color view, and catalog record. Digital Schomburg visual and text resources (about African Americans in the 19th century) include direct search as well as browse by title, author, and literary form for text materials, and by subject category or genre for images. Archival finding aids are presented using DynaText/ DynaWeb (now owned by Enigma, Inc.), which uses the underlying EAD (Encoded Archival Description) markup to generate expandable tables of contents for browsing.

• Alexandria Digital Library Project. The Alexandria Digital Library (ADL) at the University of California Santa Barbara was developed with DLI funding from 1994 through 1999 (further NSF funding is now supporting the extended Alexandria Digital Earth Prototype—ADEPT). The ADL focuses on geospatially referenced data, that is, all objects in the library are associated with one or more geographic locations. Library objects include data sets, gazetteers, bibliographies, reference tools, aerial photographs, Landsat images, and many other types. Navigation exploits the underlying geospatial metadata—the user specifies location through a dynamic map browser, and then can search within location by collection, data type, subject, and a variety of different parameters depending on the collection. Results are displayed in text descriptions as well as being foot printed on a map, which can be used to zoom in to a fine level. The ADL is also accessible by map browsing through the California Digital Library.

• Berkeley Digital Library Project. Like the ADL, the University of California at Berkeley was one of the projects funded under the first Digital Libraries Initiatives. The collections at Berkeley are diverse, including botanical, zoological, and geographical data and photographs, more than 300,000 pages of environmental documents, and tens of thousands of images, mostly of California. The entire library is outlined in a “Quick Access to the Collections” matrix. All Berkeley-held information can be searched by keyword through a single interface based on Berkeley’s Cheshire II search engine and Java scripting. Each result is listed at the bottom of an automatically generated collection hierarchy, showing its location, and all levels of the hierarchy are active links. In addition, collections have their own search and navigation tools, including simple search templates, dynamic maps, browsable categories, scannable alphabetical indexes for almost all searchable fields, and even a foray into image pattern matching based on “Blobworld” research. The TileBar interface used with the California environmental document collection is particularly innovative—it presents a visual method of assessing which part of a long document is relevant to a query.

MEANWHILE, BACK IN THE FACTORY

Apart from the underlying architecture, and the development of services for users, managers of digital libraries have to cope with practical matters such as ongoing funding and maintenance, proper management of intellectual property rights, and assessing the effectiveness of digital services with a view to continuation, expansion, and improvement.

Economic Support

Most large-scale digital libraries got their start with a combination of grant funding and institutional support. Grants, of course, terminate, and although funded research is usually completed by the time this happens, it is not quite so easy to close the doors of a funded digital library once the money runs out. Like most libraries, digital libraries grow, and even in the case where digitization of a discrete collection may have been completed, resources will still be needed for ongoing maintenance and access provision. Wealthier institutions might be able to support such activities in the normal course of business, and in some cases additional grant monies can be obtained. For many others, cooperation is a common avenue—being virtual rather than tied to a specific brick and mortar location, a digital library can be deployed by a consortium of institutions sharing the costs of equipment, resource acquisition, and personnel. Cooperative ventures have the additional advantage of broadening the base of owned digital resources.

Other possibilities include revenues from advertising (not completely unheard of on academic Web sites, although this can be contentious), support in the form of money or technology from information industry partnerships, and user charges. This last is not an attractive option for libraries of any kind, and would require robust and secure transaction management. On the other hand, this type of infrastructure is likely to already be in place for rights management purposes, and will become increasingly necessary as libraries provide access to e-books owned by publishers.

Maintenance

Maintenance of a digital library involves both the equipment and the collection. As with any computer-based service, hardware and software upgrades and modifications need to be carefully planned. In the case where that infrastructure is managing one or more repositories of digital objects, attention must be given to the effect of any change on object storage and access. The problems of, and approaches to, obsolescence management were mentioned earlier.

Collection management, the set of activities which is intended to ensure that a library’s internally held and externally provided resources meet the needs of its users, leads to weeding and acquisition. Dealing with withdrawn or newly acquired materials in a digital library is more than a matter of modifying cataloguing records and adjusting shelf space. Adding and deleting digital objects requires control of all versions of the object,
and adjustment of pointers to objects, and is complicated by inter-object relationships.

**Rights Management**

Intellectual property rights pertain to text, images, data, and other media in digital libraries as much as in any other setting. Managing property rights necessitates coping with licensing agreements, payment systems, secure transactions, user authentication, and usage tracking. In some cases it may be difficult to determine intellectual ownership—historically interesting photographs found in a little-used filing cabinet may lack any identifying notes, but they are still someone’s property. Even when ownership is known, and permission is granted for use, that permission may be restricted (for example, only so many accesses at one time). Further complications arise when an intellectual object is decomposed into multiple physical objects (e.g., the chapters of a book, each as a separate object), and can be reaggregated with other objects with their own permissions. It is also possible that rights might be granted for members of a restricted community to use an object, but the object could be part of a digital library that is a cooperative venture among a number of different communities.

Clearly rights management is a challenge, and our understanding of the legal, administrative, and technological aspects of intellectual property and copyright in digital environments is still evolving. Librarians and information science organizations, including the American Library Association (ALA), the Association of Research Libraries (ARL), and the Coalition on Networked Information (CNI), have been active in influencing legislation and policy development, as well as in helping the library community at large to understand both national and international copyright law.\(^1^1\)

**Evaluation**

“If you build it, they will come.” Well, probably, but once they arrive, will they find what they need, easily, and will they come back? And if not, why not? These are the kinds of questions that can be addressed by systematic evaluation. The purposes of digital library evaluation could be, among other thing:

- To measure achievements against goals (assuming goals have been enumerated);
- To test a system component;
- To compare several competing solutions to a problem; and
- To determine whether and where problems exist, or, to assess the success of an attempt to address a problem.

Measurement implies the existence of rules, or metrics—to say that something performs better implies that it performs better with respect to some measurable effect. Evaluation might be concerned with usability, looking at the efficiency, effectiveness, and satisfaction with which users can achieve specified goals. Although measuring efficiency might be relatively straightforward, there is little agreement as to how to measure effectiveness and satisfaction in library contexts. Alternatively, evaluation might be concerned with the relevance of retrieved information—another area of ongoing research and few accepted standards.

Digital library evaluation is further complicated by a plethora of data gathering tools (e.g., surveys, interviews, focus groups, transaction logs, and observation), channels (e.g., in person, online, “snail” mail, e-mail), and settings (e.g., data could be captured during sessions in prototype digital libraries, or in controlled laboratories, or in real working DLs). Add to this the very nature of the setting, and the challenges are even more pronounced, as Ann Bishop observes.

The design and evaluation of digital libraries . . . are complicated by the newness of the systems, their ability to integrate a range of functions that were previously designed and evaluated separately, the heterogeneity of their user population, the physically distributed nature of usage, the ability to fragment and rearrange previously integrated documents and images, and the rapid versioning of digital objects.\(^1^2\)

In this scenario, it is not surprising that conferences have been devoted to digital library evaluation,\(^1^3\) and that D-Lib has created a Working Group on Digital Library Metrics. In connection with a workshop sponsored by the Working Group, Paul Kantor, who has been concerned with performance measurement and libraries for more than 20 years, underscored the complexity of digital library evaluation.

The “performance” of a digital library is a complex relation among inputs, outputs and constraints. Realistic evaluation of alternative technologies and designs for digital libraries will result in a wealth of data. Typically, configuration A will seem better than configuration B with regard to some, but not other scales or criteria. This will be true whether the measures are measures of input (or cost, bandwidth, operating expense) or output (activity, timeliness, reliability, usability. . . .). In such situations it is not possible to arrive at a single realistic measure of value, which takes all of these aspects into account.\(^1^4\)

**THE OPEN ROAD**

One of the problems of a “library without walls” is just that—the absence of physical dividing lines that separate the library from the rest of the world, and that also give us some sense of being able to control, or at least see, our collections and our users. Digital libraries, and all libraries that take advantage of digital resources, have to operate in a sometimes-nebulous space that is populated with invisible players, all of whom have some stake in DL activities. Authors (i.e., creators of intellectual property), publishers, content aggregators, e-book retailers, hardware and software vendors, library administrators, DL researchers, and users—each has an agenda, and each is trying to make sense (and in some cases dollars) out of an unpredictable environment with an unprecedented rate of change. Managers of digital libraries have to pay proper attention to the rights of content creators and sellers, figure out where to acquire content from competing providers, select the best affordable technological infrastructure, placate fiscally conservative directors, encourage ongoing DL research, help users find their way through complex and growing collections, ensure preservation of content for future generations, and compete against other information services for user attention.\(^1^5\)

On the other hand, it’s a very exciting time to be a librarian, especially in academic settings, where much of the digital action is happening. Internet 2 opens the doors to research in using such tools as real-time dynamic visualization to support information retrieval, or multicasting for user interaction through audio and video. Remote learning is on the increase, and is obviously well served by organized and structured libraries that are equally oblivious to physical location. Tools that promote interoperability, such as the Z39.50,\(^1^6\) as well as work on interper-
ability of metadata, point to a future where it will be commonplace to use more than one library or digital library at a time (and the distinction between the two will be unimportant to users). So fasten your digital seatbelts and keep both hands on the wheel, because it’s going to be an interesting ride—not one to sit back and relax on, lots of curves and falling rocks, but a spectacular view at the next rest area (and there is no end).

APPENDIX

RESOURCES

Links to all of the Web-accessible items listed below (and mentioned in the article) can be found on the author’s Digital Libraries Web page, <http://web.simmons.edu/~schwartz/ mydigital.html>. This page also contains a long list of initiatives and projects.

Monographs

- Michael Lesk, Practical Digital Libraries: Books, Bytes, and Bucks (San Francisco, CA: Morgan Kaufmann, 1997). A good overall introduction including details on technical structures as well as chapters on issues such as evaluation, economics, and intellectual property rights.

Journals

Although many library and information science journals and listserv lists have content related to digital libraries, the following titles have a DL focus.

- Ariadne <http://www.ariadne.ac.uk/>. E-journal, noteworthy for understandable overviews of new technologies that have an impact on digital libraries.
- DIGLIB@infoserv.nl-bnc.ca <http://www.ifla.org/II/lists/diglib.htm>. Listserv list focusing on research.
- DigLibs@sunsite.berkeley.edu <http://sunsite.berkeley.edu/DigLibs/>. Listserv list concerned with practical aspects.

Web Sites

- Arts and Humanities Data Service (AHDS) <http://ahds.ac.uk/>. Although primarily a gateway to arts and humanities networked resources, the AHDS also maintains an excellent collection of general resources, including Information Packs, Guides to Good Practice, a series on Managing Digital Collections, and other publications.
- DELOS <http://www.iei.pi.cnr.it/DELOS/>. The ERCIM Working Group concerned with digital libraries has pages on their own work as well as general DL conferences, journals, Websites, and so forth.
- Digital Libraries Initiative, Phase 2 <http://www.dli2.nsf.gov/>. NSF home for information on the national Digital Libraries Initiatives program, co-sponsored by a number of different funding agencies.
- Digital Libraries Resources <http://www.albany.edu/~ls973/digital.html>. Long and well annotated list of resources in various categories, maintained by Lorre Smith.
- Digital Library Federation <http://www.clir.org/diglib/dlhomepage.htm>. Under the umbrella of the Council on Library and Information Resources (CLIR), the Federation includes the Library of Congress (LC), the National Archives and Records Administration (NARA), the New York Public Library (NYPL), and a number of university libraries. The site includes a number of presentations (slideshows and papers) on fundamental concepts and issues.
- Digital Library Information and Resources <http://www.canis.uiuc.edu/~bgross/dl/>. Very current and well annotated resource list, kept up to date by Ben Gross, doctoral student and visiting scholar at the University of Illinois, Urbana Champaign.
- Digital Toolbox <http://coloradodigital.coalliance.org/toolbox.html>. From the Colorado Digitization
Project, including general resources, as well as pages on administrative, technical, metadata, intellectual property, funding, and vendors.

- IFLA Electronic Collections and Service <http://www.ifla.org/II/>. The International Federation of Library Associations and Institutions (IFLA) maintains 30 or more Web pages that are well organized guides to extensive collections of library-related links. Five or six of these concern DLs.


### Regular Conferences


- American Society for Information Science (ASIS) Annual Meeting <http://www.asis.org/>. Usually contains papers and sessions of relevance to digital libraries. Print proceedings; abstracts and some papers online at the ASIS Web site.


- International Conference on Digital Libraries (DL) <http://www.acm.org/pubs/contents/proceedings/series/dl/>. Sponsored by several Special Interest Groups (SIGs) of the Association for Computing Machinery (ACM). Print proceedings; full text online in the ACM Digital Library; some content at the site for each annual conference.

- International ACM SIGIR Conference on Research and Development in Information Retrieval <http://www.acm.org/pubs/contents/proceedings/series/sigir/>. Always has content related to digital libraries—SIGIR is the Special Interest Group on Information Retrieval. Print proceedings; full text online in the ACM Digital Library; some content at the site for each annual conference.

### Notes and References


11. Several Web sites provide excellent collections of resource links on copyright in the library context, including texts of legal documents as well as explanations in lay terms. A few of the best are ARL’s Copyright and Intellectual Property page <http://www.arl.org/info/frn/copy/copytoc.html>, the Berkeley Digital Library’s SunSITE on Copyright, Intellectual Property Rights, and Licensing Issues <http://sunsite.berkeley.edu/Copyright/>, Yale University Library’s Liblicense <http://www.library.yale.edu/~license/index.shtml>, and a wonderful “but what if” Copyright FAQ <http://ahds.ac.uk/ukgd/copyright-faq.html> co-produced by the Arts and Humanities Data Service (AHDS) and the Technical Advisory Service for Images (TASI). For international resources, the International Federation of Library Associations (IFLA) maintains Information Policy: Copyright and Intellectual Property <http://www.ifla.org/II/copyright.htm>.


13. In 1995, NSF and the Graduate School of Library and Information Science, University of Illinois at Urbana-Champaign, sponsored the 37th Allerton Institute, with the title “How We Do User-Centered Design and Evaluation of Digital Libraries: A Methodological Forum” (1995). The 1996 Allerton Institute was a follow-up on the same general theme. The programs and some papers are available at: http://edfu.lis.uiuc.edu/allerton/. At the same institution, the 35th Clinical on Library Applications of Data Processing, held in 1998, had the theme “Successes and Failures of Digital Libraries” (the proceedings were published in mid-2000; Susan Harum & Michael Twidale (Eds.), Successes and Failures of Digital Libraries, Urbana, IL: Graduate School of Library and Information Science, University of Illinois at Urbana-Champaign, 2000).


15. Ronald J. Heckart discusses the importance of paying attention to tools developed for user interaction in e-commerce settings in “Imagining the Digital Library in a Commercialized Internet,”
16. Distributed search across multiple databases using Z39.50 can be seen in projects such as COPAC <http://www.copac.ac.uk/> and Europagete <http://europapte.dtv.dk/>, as well as commercial products like OCLC’s SiteSearch <http://www.oclc.org/oclc/menu/site.htm> and Bookwhere2000 <http://www.bookwhere.com/>. Many digital libraries use Z39.50 compliant systems.