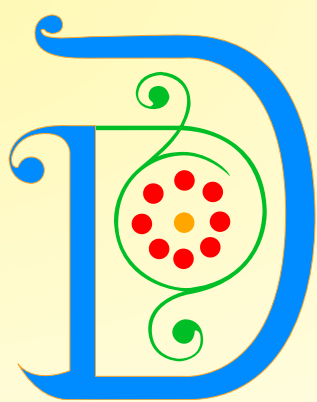




Toward a Worldwide Digital Library

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Guest Editors



DIGITAL LIBRARIES CAN BE AMONG THE MOST COMPLEX AND advanced forms of information systems because they often involve collaboration support, digital document preservation, distributed database management, hypertext, information filtering, information retrieval, instructional modules, intellectual property rights management, multimedia information services, question answering and reference services, resource discovery, and selective dissemination of information. While physical libraries develop digital components and other business and cultural organizations offer their materials over networks, thousands of digital libraries are emerging around the world, crossing all disciplines and media and ranging from the small, such as community organizations offering online catalogs and news for local constituencies, to the large, such as national libraries offering a wide variety of research and cultural treasures in multiple media.

Digital libraries extend and augment their physical counterparts by amplifying existing resources and services and enabling development of new kinds of human problem solving and expression. They offer new levels of access to broader audiences of users and new opportunities for global exchange and understanding.

Just as air travel has brought geographically dispersed people closer together physically, linking the world's diverse intellectual and cultural collections can lead to deeper understanding and wider cooperation. Given this potential and motivated by the visionary statements and articles of Vannevar Bush, J.C.R. Licklider, Ted Nelson, and others, many researchers, developers, and practitioners have pursued the goal of a worldwide digital library. The key to realizing such a vision is funda-

working protocols, such as IP and HTTP, and some design and production practices, such as hypertext home pages with search facilities. Determining which types and levels of interoperability are needed to extend and improve the federation is a fundamental challenge to realizing the goal of a worldwide digital library.

Interoperability Across National Boundaries

The general problem of linking different systems is called interoperability in the digital library community. Linking multiple systems in a useful way requires various levels of interoperability:

- Technical interoperability, which is concerned with hardware, networks, data types, and application compatibilities and protocols
- Informational interoperability, which addresses content scope, language, metadata, naming conventions, semantics, and user interfaces
- Social interoperability, which is concerned with personal and organizational rights and responsibilities

Particularly challenging about social interoperability is the need for individuals and groups with vested interests to attempt to understand all points of view and then agree

Table 1. National libraries of countries mentioned in this section

Australia	National Library of Australia	www.nla.gov.au
Brazil	University of Sao Paulo Library	www.usp.br/sibi/sibi.html (Portuguese)
Canada	National Library of Canada / Bibliothèque Nationale du Canada	www.nlc-bnc.ca
Denmark	Det Kongelige Bibliotek	www.kb.bib.dk (English)
Finland	Helsinki University Library/ National Library of Finland	linna.helsinki.fi/hyk/hul (English)
France	Bibliothèque Nationale de France	www.culture.fr (French)
Germany	Die Deutsche Bibliothek	www.ddb.de (German)
Hungary	Hungarian Electronic Library	www.mek.iif.hu/
Japan	National Center for Science Information Systems	www.nacsis.ac.jp/nacsis.f-index.html (English)
Korea	Five Library Consortium	www.dlibrary.or.kr (Korean)
Netherlands	Koninklijke Bibliotheek	www.konbib.nl
New Zealand	National Library of New Zealand	www.natlib.govt.nz
Singapore	Multiple Agencies	www.digilib.org.sg
United Kingdom	British Library	portico.bl.uk
United States	Library of Congress	www.loc.gov

mentally bottom-up rather than top-down; the challenge is to find ways to link the diverse content and perspectives provided by individual digital libraries around the world. We are beginning to see the emergence of such a global digital library in the form of a loosely coupled federation of digital libraries, each serving specialized missions and user populations. Although each of these local or national digital libraries is driven by its own collection development and access policies, the global information infrastructure and experience shared by early digital library communities facilitate basic linkages and cooperation across physical boundaries. Thus, today's federation is based on a few net-

to cooperate. This time-consuming process takes as much perseverance and will as it does analysis and innovation. Thus, the bulk of interoperability research has focused on technical and informational issues. See, for example, [4] for a summary of a Repository Interoperability Workshop and [1] for some of the social issues considered at the Social Aspects of Digital Libraries Workshop. It is clear that all levels of interoperability, including the social-political, must be addressed for a more tightly coupled global digital library to emerge.


This special section is a snapshot of the current state of digital library development around the world and extends the special section in *Communica-*

tions in April 1995 [2].¹ Our intention here is to collect a set of brief descriptions of wide-ranging projects highlighting interoperability challenges at all levels. Table 1 provides names of and URLs for national libraries of the countries mentioned in this section. Many of these national libraries are engaged in exciting digital library developments, and all of the industrialized countries are funding ongoing efforts at universities and other public institutions. Additionally, the British Library provides Gabriel, a gateway to all of Europe's national libraries (see portico.bl.uk/gabriel/).

Information is a basic human need, and civilization advances when people are able to apply the right information at the right time. To win universal support for this notion, substantial advances are necessary in linking the world's many digital libraries more closely. Supported by an emerging global information infrastructure, including the Internet and the Web, continued progress toward an international digital library requires several types of efforts.

Interoperability, Multilingual Support, National Aspirations

The articles in this section, revealing this progress, as well as the many challenges ahead, are organized into five parts, three addressing interoperability directly, one demonstrating a variety of local or national development efforts, and one focusing on different technical solutions to meeting universal needs.

 We first need a range of possible solutions for the general problem of interoperability. The lead article, by Paepcke et al., explores this problem in detail, elucidating the trade-offs and synergies in the varied solutions. The solutions explored here may be applied to all levels of interoperability. One important approach, adopting international standards, is highlighted in the article by Moen, who covers how Z39.50 (which in an early form was the basis for the distributed information retrieval system Wide Area Information Servers, WAIS) facilitates multiple clients' access to myriad types of information from a number of museums.

Second, worldwide digital libraries have to integrate all special types of information. Multimedia resources are especially important in a global, multilingual digital library. The first article in this section, by Gladney et al., continues Moen's museum

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¹However, little mention is made of the NSF/ARPA/NASA Digital Library Initiative, the U.K.'s eLib, ERCIM's efforts in Western Europe, and high-profile projects in France, Japan, China, the Netherlands, and other nations. See the list of digital library research at www.dlib.org/projects.html#national for pointers to these projects.

thread but broadens to consider large document archives from around the world that are of particular cultural and scholarly import, as well as technical solutions that add considerable value for rights management. Shifting to government information, particularly statistical data, Dippo shows how cooperative efforts can serve the varied needs of U.S. citizens by integrating national information from many agencies. Cowen et al. take this down to the community level, showing how local needs are served through textual and spatial data.

Third, worldwide digital libraries have to provide multilingual support. Multiple languages may be considered a cultural interoperability problem; as the world's people gain access to global networks, language barriers have to be overcome. Maeda et al. consider these language barriers at the level of character sets. Leong et al. explore language barriers from the perspective of Singapore—a nation in which the problem is particularly acute. Klavans and Schauble provide a note about an international effort to develop multilingual search support for digital libraries.

The fourth section profiles several digital libraries supporting local and national needs. For example, continuing the thread from the previous section on national development, Witten et al. describe efforts in New Zealand, highlighting collections of computer science technical reports and music. Endres and Fuhr deal with related efforts in Germany, especially those supporting education and research in computer science. Kovacs covers a broader geographical area, Eastern Europe, as well as broader technical functions, namely resource discovery. Gonçalves and Medeiros explain how four efforts are integrated in Brazil, and Myaeng describes similar work in Korea. Finally, McKnight explains an important university program under the U.K. eLib project.

In the final section, four articles describe designs and techniques digital librarians can use to build digital libraries meant for universal use. Shneiderman et al. propose a search interface framework that ensures a minimal set of capabilities for effective query formulation. Pejtersen views information retrieval from a semantic perspective for the purpose of supporting collaborative design, and Talja et al. consider applying discourse analysis to user requests. Finally, Treloar surveys the role of innovative libraries and electronic journals.

Because most of these articles describe working development efforts, they can be sliced into many thematic categories. For example, from a system point of view, the information life cycle [1], which

considers information as artifact and social process, may be used to organize digital library efforts. From the information seeker's point of view, as defined by Paepcke et al. [3], efforts may be organized by such activities as discovery, retrieval, interpretation, management, and sharing.

However, no matter how you slice it, digital libraries have to address a host of technical, informational, and social challenges. We encourage readers to examine the project Web sites cited here to learn more about the related efforts and the guest editors' page purl.lib.vt.edu/dlib/pubs/CACM199804.htm.

Conclusions

Whether for political or practical reasons, many local and national efforts to build digital libraries are under way, and more will arise in the future. Commercially available or locally constructed digital libraries are maturing, handling many types of information, and affording basic support for searching and linking. These services are being expanded through widespread research efforts and international agreements about content, formats, rights, and usages. As solutions begin to overcome barriers to interoperability and multilingual collection processing, we move closer to a worldwide digital library and the global understanding and cooperation that will follow. ■

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