CHAPTER

NEW DEVELOPMENTS AND CHALLENGES

11

Since the emergence of digital libraries in the 1990s, the development of digital libraries has entered a new era. The new directions of digital libraries include social media applications, large-scale digital libraries, multilingual digital libraries, and digital curation. Simultaneously, researchers and practitioners face challenges and problems brought by these new developments as well as problems inherited from the initial development of digital libraries.

SOCIAL MEDIA APPLICATIONS AND THE IMPACT ON DIGITAL LIBRARIES

DEFINITIONS OF SOCIAL MEDIA TOOLS

The most popularly applied social media in digital libraries include blogs, microblogs, photo sharing, podcasts, RSS feeds, and social networks, such as Facebook and Twitter. There is some cross-classification as a few social media applications have more than one function. Table 11.1 offers definitions of different types of social media presented in one of the author's recent work (Xie and Stevenson, 2014).

SOCIAL MEDIA APPLICATIONS IN DIGITAL LIBRARIES

The evolution of web technologies has allowed social media tools to become a part of digital libraries. Users of digital library are no longer passive receivers of information (Mitropoulos et al., 2014); now they can respond and contribute to the digital library landscape. Social media tools have been applied in libraries and digital libraries but have not been fully investigated. According to Emery and Schifeling (2015), academic libraries have a long history of adopting new technologies including social media tools. There are no specific data regarding the application of Twitter in digital libraries. We know, however, that the application of social media in digital libraries has been gradually increasing. The increased development of digital libraries has resulted in many institutions treating them as an extension of their institution, as is the case with the University of California and the California Digital Library. However, it is important for digital librarians to know their users in order to provide appropriate digital outreach services. As many institutions have already implemented social media into other facets of services, it seems natural to begin to add social media to digital library interfaces.

Digital libraries either have their own unique social media pages or use their institution's social media pages to disseminate information to users and followers. For example, Twitter, Facebook, and social bookmarking sites were incorporated into the California Digital Library, opening more opportunities for the organization to communicate with the existing and potential user communities (Starr, 2010). Figs. 11.1 and 11.2 present examples of the applications of social media tools in digital libraries.

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Table 11.1 Definitions of Different Types of Social Media

Types	Definitions	Examples
Blogs	Opinion or information-based web sites consisting of discrete entries or "posts"; readers can comment on and engage in ongoing discussions with the blogger and/or other readers of the blog.	Blog
Microblogs	Allows users to communicate with followers by writing short messages, typically 140 characters, or sharing images or links to web pages. Content is frequently tagged by users with a hashtag, which is a method of categorizing posts across multiple users.	Twitter, Tumblr
Photosharing	Online image and video hosting sites that allow users to share, comment, and connect through posted images.	Facebook, Flickr, Pinterest, Twitter, Instagram
Podcasts	Multimedia digital file, typically an audio file, that is stored on the Internet and is available to download, and is similar to a radio broadcast that is available freely online.	Podcast
RSS feeds	Rich Site Summary or Really Simple Syndication is a frequently updated web feed that indicates news, events, and blog entries that a user can subscribe to and follow. RSS takes current headlines from different web sites and pushes those headlines down to your computer for quick scanning.	RSS feeds
Social networks	Online platform for users to connect and communicate with friends, professional associates, and others with shared backgrounds, interests, and activities.	Facebook, Twitter, Reddit

Adapted from Xie and Stevenson (2014), Table 1. (p. 504)

Researchers and practitioners have called to incorporate social media tools into libraries (Bhatt and Kumar, 2014; Cho, 2013; Paul, 2014) and digital libraries to promote communication with users (Gu and Widén-Wulff, 2011). More specifically, librarians need to find better approaches to communicate with users through social media (Gu and Widén-Wulff, 2011). It is a challenge to examine the interplay between information activities within two important spaces: the social web and the library (Kronquist-Berg, 2014). In particular, it is even more of a challenge to investigate users' and librarians' activities in the social web and digital libraries. Buigues-García and Giménez-Chornet (2012) identify the most implemented social media tools in libraries as Facebook, Twitter, user information services such as RSS, the publication of bulletins, and blogs. The survey results indicate that the majority prefer that libraries use social media tools to provide services to them (Bhatt and Kumar, 2014).

Schrier (2011) suggests that social media tools can promote digital collections, and recommends principles including listening, participation, transparency, policy, and strategy for digital librarians to integrate social media into a digital library development strategic plan. Griffin and Taylor (2013) assess social media's impact on special collections and conclude that only moderate success is achieved. It seems that the incorporation of digital collections into an existing social site has more impact than introducing social media tools to digital libraries. For example, posting images to Flickr results in a 200% increase in accessing the associated digital collection (Michel and Tzoc, 2010). In another study,

FIGURE 11.1 California Digital Library Twitter Page

FIGURE 11.2 Library of Congress Podcast Page

the results show that objects from digital collections uploaded to Historypin are accessed three times more than on their original platform. Interestingly, not all collections are the same in terms of their access. One of the six collections tested uncover more access in its library web site than in Historypin. It is determined that the nature of the collection contributes to the difference. Another revealing finding is that Historypin and Pinterest direct only less than 1% of the traffic back to the original digital library sites (Baggett and Gibbs, 2014).

In one of the author's own studies, Xie and Stevenson (2014) explored social media application in digital libraries. In order to represent a variety of digital libraries developed or sponsored by different types of organizations, 10 institutions were selected from the following cultural institutional types for inclusion in the study: public libraries, academic libraries, museums, government agencies, and international organizations. Each institution's digital library has its own social media application, and these social media applications are well maintained and updated. Among all the social media tools, Facebook and Twitter are the most heavily utilized in these institutions overall, whereas blogs and Flickr are the most popular choices to convey or promote digital library–related information. While eight of the ten institutions use blogs to communicate digital library information, the Denver Public Library's Digital Library is the only one offering a digital library–specific blog, entitled "Western History and Genealogy."

Furthermore, in the same study, Xie and Stevenson (2014) find that while social media tools are mostly available on the institution homepage, users can also engage in social media activities on the digital library's collection level specifically in about 50% of the selected institutions. Because few institutions have dedicated social media tools for digital libraries, it is difficult to identify the patterns or frequency of updates for these tools. The interaction between librarians and users is the key to applying social media to digital libraries; in the study, different levels of interactions were observed, including very strong, strong, and weak.

FUNCTIONS OF SOCIAL MEDIA IN DIGITAL LIBRARIES

Previous research suggests that the inclusion of social media within a digital library brings benefits to users' utilization of digital libraries. According to McDonnell and Shiri (2011), integration of social media into a digital library leads to more successful search results because users are more comfortable using the digital library. Paul (2014) recommends three activities that library and information services can engage in to take advantage of social media tools: information communication, knowledge organization, and knowledge distribution. These functions are echoed by the author's own study results. The findings of Xie and Stevenson's study (2014) show that providing information, marketing/promotion, peer-to-peer connections, and information sharing are the main functions that social media plays in a digital library environment. All institutions in the study use social media, in particular Facebook and Twitter, to convey information related to their library or digital library activities or status, such as when digital library maintenance is scheduled. Many institutions employ social media as marketing/promotion tools to promote their upcoming digital collections and events. Some institutions actively engage their user group on Flickr by asking users to unveil the mystery of a specific image. Facebook and Twitter are the two most popular tools for peer-to-peer connections between librarians/institutions and users as well as between the users themselves. The results indicate that the item level of the digital collection allows the best opportunity for connection between the digital library and users through social media. Information sharing occurs when institutions link their digital collections with other digital

or physical collections through different social media tools. Blogs, Facebook, Twitter, Flickr, RSS feeds, and YouTube are the most common tools to share information with users.

The main function of social media, as used by libraries, is the promotion of collections and services. Khan and Bhatti (2012) conducted a study that explored how different types of social media applications could be utilized to market library services; they conclude that social media tools such as Facebook, wikis, LinkedIn, blogs, and YouTube are considered positive for the promotion of library services. However, it should be noted that the findings of this study are based on perspectives from librarians and library and information science school academics. It is equally important to survey users in order to make decisions regarding the selection of social media applications for libraries and digital libraries. Taranto (2009) notices that the integration of social media has become part of library outreach programs. Twitter is deemed an effective tool to attract new audiences to the California Digital Library (Calisphere), as well as to promote its collections (Starr, 2010). However, very little research has been conducted to investigate the functions of social media in digital libraries.

In another of the author's research projects (Xie and Stevenson, 2015, unpublished data), 15,713 tweets were analyzed from the Twitter pages of 15 digital libraries. The number of tweets per digital library varied from 18 to 1272. The number of followers for each of these Twitter accounts ranges between 92 and 9138, and they had a following range of 37–2088. Five types of functions were identified from the data: information, promotion, related sources, social connection, and social identity; each type has its own subcategories. The functions that social media plays with respect to digital libraries based on the gathered Twitter data are the following:

- Information
  - information-digital library
  - information-digital library-problem
  - information-digital library-reference question
  - information-digital library-staff
  - information-institutional
- Promotion
  - promotion-digital library-collection
  - promotion-digital library-connection
  - promotion-digital library-event
- Related resources
  - related resources-digital library
  - related resources-institutional
- Social connection
  - social connection-digital library-interaction
- Social identity
  - social identity-digital library-collection
  - social identity-digital library-institutional
  - social identity-digital library-interaction
  - social identity-digital library-social media

The data reveal that the majority of tweets focus on offering information rather than on interaction. Since social media tools are created to facilitate interactions, the use of social media in digital libraries has therefore not reached its full potential. More research is needed to identify the reasons for this

phenomenon in an effort to better understand how to promote interaction in the application of social media in digital libraries.

Social media has inherent problems that have been recognized by researchers in the LIS field including information divides, digital divides, information overload, and poor information literacy skills. Moreover, challenges exist related to the dynamic nature of the information presented in social media and how to organize social media information that is by nature disorganized (Bawden and Robinson, 2009; Kronquist-Berg, 2014; Serantes, 2009). Most important, social media application in digital libraries is just at its infancy. The return on investment is not yet evident, and there is an urgent need to promote user engagement. Providing prompt responses to user interactions and providing relevant information are the keys to engaging users (Lamont and Nielsen, 2015; Webb and Laing, 2015).

LARGE-SCALE DIGITAL LIBRARIES

CHARACTERISTICS OF LARGE-SCALE DIGITAL LIBRARIES

The development of large-scale digital libraries is rooted in years of research. Early digital library concepts emerged from visionary thinkers in the 1930s and 1940s (Bush, 1945; Wells, 1938) even before the birth of modern computers. The first digital libraries began to take shape in the 1990s, funded by several agencies of the US government (Griffin, 2005), with projects developing metadata standards, architectures, and digitization best practices. One of the earliest large-scale digital libraries, the American Memory Project, is an extension of the largest physical library in the world—the Library of Congress. The project focuses on American history and culture and includes digitized copies of original primary sources. The project lays the groundwork for future large-scale digital libraries. "While many of these large-scale digital libraries have been created for the general public, some serve more specific audiences of scholars and educators in different disciplines or domains" (Zavalina and Vassilieva, 2014).

More recent large-scale digital libraries have several characteristics in common. Most obvious is that they incorporate large collections. American Memory was considered a large project when it was created and contained more than 135 collections. HathiTrust, a more recent large-scale digital library, contains 13,000,000 volumes with 4.5 billion pages of text (Hinze et al., 2015). Another feature common to large-scale digital libraries is that many organizations must collaborate in support of the project; a single institution cannot do it alone. HathiTrust, Smithsonian Institute, National Archives and Records Administration, New York Public Library, etc. are the partners of the Digital Public Library of America (DPLA). It is worth noting that the open invitation to join enables DPLA to build its own contributor community (Vandegrift, 2013). The need to integrate a variety of metadata is also a common aspect of large-scale digital libraries. It is imperative for large-scale digital libraries involving multiple partners to find ways to allow their resources—particularly the metadata associated with the digital resources—to be combined together into a unified collection. One of the core operational services is creating a central metadata repository to organize collection items in the National Science Digital Library (NSDL). The NSDL architecture consists of a common core metadata vocabulary, core metadata with different domain specific metadata, and harvesting of the metadata and its use (Lagoze and Van de Sompel, 2001; Zia, 2001). At the same time, based on a user study of potential user groups of the HathiTrust Digital Library (Fenlon et al., 2014), metadata enrichment that advances the traditional bibliographic record is highly needed. It includes incorporating scholar-enriched metadata, tracking the origin of enriched metadata, and enabling interoperability of metadata across different domains.

A final characteristic of many large-scale digital libraries is the need for multilingual support. Europeana was created as Europe's digital library with 4.5 million digital items drawn from every member of the European Commission (Purday, 2009). Understandably, it is vital that projects such as this embrace and support multiple languages. Thus, common functions of large-scale digital libraries must include the assimilation of objects and metadata schemas from multiple contributing partners, often with diverse languages, into cohesive large collections.

CHALLENGES AND PROBLEMS

Large-scale digital libraries can offer users access to a wealth of high-quality resources, but they also face challenges. Although successful, HathiTrust presents an example of the challenge of copyright issues facing many large-scale digital libraries. Due to legal restrictions, the collection is not always able to provide access to the desired content. Another challenge associated with HathiTrust and other large-scale digital libraries is that it is not easy for users to find relevant and useful documents from large-scale digital libraries, which apply traditional lexically based retrieval techniques. A semantic search approach is suggested to overcome the lexical search approach (Hinze et al., 2015). The DPLA is a large-scale digital library functioning as a portal, aggregating digital resources from disparate collections; it exemplifies another challenge facing large-scale digital libraries: sustainability. Initially funded by a private foundation as well as the National Endowment for the Humanities, funding is limited, and the project will eventually have to seek further options to sustain itself. A fourth challenge of large-scale digital libraries can be found in Europeana. Considering that this digital library has digital objects from 1000 collections throughout Europe (Purday, 2009), it is evident that integrating metadata schemas from a variety of institutions is difficult. Although large-scale digital libraries have come a long way from the imagination of futurist thinkers, issues regarding copyright, search functions, sustainability, and metadata interoperability still require more thought, more attention, and more research. The last but not the least significant challenge is that users apply different information-searching strategies in the large-scale digital libraries, in particular in distinct domain areas. However, there has been no systematic investigation of information searching in domain-specific large-scale digital libraries. The comparison of user searching in NSDL and Opening History (OH) shows that the domain and interface design both contribute to the differences in searching in different domain-specific large-scale digital libraries. From a domain perspective, concepts and objects are the most frequently searched queries in NSDL whereas place, person, corporate body, ethnic group, event, and class of persons are the most common queries in OH. This suggests that different-faceted searches are required for different domains. From an interface design perspective, a digital library with more advanced options attracts more users to engage in more sophisticated searches. There is hence a need for creating advanced search options in large-scale digital libraries (Zavalina and Vassilieva, 2014).

MULTILINGUAL DIGITAL LIBRARIES

THE NEED FOR MULTILINGUAL DIGITAL LIBRARIES

Researchers have agreed that the internationalization of the user interface is important (Agosti et al., 2009a). Multilingual digital libraries offer valuable information resources for diverse user groups that speak different languages. They further reinforce individual cultures, promoting diversity and improving a global

information infrastructure (Budzise-Weaver et al., 2012; Nichols et al., 2005). There is a rapid growth in research on multilingual digital libraries "since the need to support retrieval across languages becomes even more urgent given the increasing interaction between different cultures" (Vassilakaki and Garoufallou, 2013). Relevant literature can be classified into two areas: the "system oriented" and the "users oriented." System-oriented research focuses on offering solutions for effective multilingual information retrieval from a technical perspective, whereas users-oriented research concentrates on examining users' behaviors and expectations in interacting with multilingual digital libraries (Vassilakaki and Garoufallou, 2013).

Language is an essential part of a user's cultural identity. According to Gäde (2014), two steps are essential for the creation of multilingual user interfaces: internalization and localization. First, with respect to internationalization, flexible source code is needed to satisfy linguistic or culture-specific requirements. Second, regarding localization, the customization of date formats, symbols, icons, and other culture-specific elements needs to be done for each supported language. Some of these customizations are language and culture dependent such as date formats. Large and Moukdad (2000) bring to light the challenge for languages that use non-Roman script. Adoption of multiple language interfaces is the key for multilingualism in digital libraries. Two typical solutions involve an active interface language and passive interface language change options. An active interface language option allows users to change the interface language via drop-down menus, and a passive interface language option automatically chooses users' languages based on their data, such as IP address and language settings (Gäde, 2014). Focusing on the strategies of building multilingual digital libraries, Budzise-Weaver et al. (2012) conducted a case study of American multilingual digital libraries. They found that collaboration and crowdsourcing were the most important strategies for creating multilingual digital libraries.

After surveying 358 subjects from 19 different countries, Wu et al. (2012) report their findings on multilingual services, multilingual search functions, and interfaces. Their findings indicate the need for the following multilingual services: translation functions for terminologies, having materials organized by subjects, search functions for multilingual information, and full text translation. Specific to multilingual functions and interfaces, the most desirable capabilities are translations for less commonly used languages, organizing search results by languages, search interfaces for multilingual information, having a multilingual translation toolbar, and offering multilingual translation dictionaries. User needs and expectations for multilingual access features are affected by the user's own language; in particular, non-English users experienced strong multilingual needs for multilingual information access. According to Petrelli et al. (2002), search assistance and interactive information retrieval functions are even more important when users have to deal with content in multiple languages. Performing various tasks using an interactive multilingual prototype, study participants expressed the need to choose the language they wanted to conduct a search in based on the individual's skills and the information-seeking task. Based on their findings, the authors suggest that user-assisted query translation should be offered as an advanced search option if the initial query translation fails or does not satisfy the user's information need. A survey focusing on multilingual access to Europeana found that the majority of users (80%) were willing to control the query translation process themselves (Agosti et al., 2009b).

MULTILINGUAL DIGITAL LIBRARIES: USER STUDIES

User studies are essential for the development and enhancement of multilingual digital libraries. Multilingual digital libraries need to investigate their target users' needs and preferences. Bilal and Bachir (2007b) point out that lack of language skills is one of the contributing reasons that Arabic-speaking

children do not recognize the representations embedded in the interfaces of the International Children's Digital Library (ICDL). Arabic-speaking children have search behaviors in ICDL unique to that demographic. As expected, and highlighting the importance of a multilingual interface, they clicked on "Arabic" from the pull-down menu to browse Arabic books. Intuitive design across different cultures and backgrounds is essential for the development of multilingual digital libraries (Bilal and Bachir, 2007a,b).

Agosti and her associates (2009a) performed user studies on the use of Europeana utilizing user surveys on multilingual information access. Browsing and searching were the main activities for users to interact with multilingual content. While 88% of the users at least sometimes browsed multilingual content, 84% of them at least sometimes searched for multilingual content. It seems that participants of the study show different preferences in interacting with query formulation and expansion functions. More than half of them (52%) never or seldom specified their desired language for the results. The majority of them wanted to have the results displayed in multiple target languages. Another interesting finding is that 80% of them preferred to interact with the query translation process and to iteratively refine it. Preferences of the study participants were equally distributed among the following ways of presenting multilingual results: in relevance order with results in different languages, organized by languages and then relevance, and highlighting results in different languages in different colors. The complexity of the user interface may contribute to user preferences in regard to language; 44% of participants indicated they did not like or were unsure about the multilingual results filtering function. Only 28% of them showed an interest in having a multilingual results translation function, mainly because of the advanced language skills of the participants. The majority of the participants preferred a multilingual user interface in their native language. Interestingly, the majority of them also liked to switch the user interface into their native language manually rather than have it automatically switched by the system. In another user study of the European Library Web portal, Agosti et al. (2010) found that switching the interface language automatically does not assist users in navigating the web portal, with poor translation quality further contributing to the problem. Marlow et al. (2008) explored users' needs and the design implications for the Multimatch Project, which offers multilingual/multimedia access to cultural heritage artifacts on the web. Automatic query translation was found to be the option for users conducting searches in unknown languages. Thesauri could be used to cover variations of words across languages. Users also needed assistance in browsing documents in foreign languages, the solution for which is to provide an interface that automatically translates summaries and/or documents into alternate languages.

Keegan and Cunningham (2005) examined 4 weeks of usage logs from the New Zealand Digital Library (NZDL) while switching the default language settings between English and Maori every week. They found that users performed more searches during the English weeks. During the Maori weeks, 74% of the users changed the language setting back to English. Moreover, users exhibited different searching and browsing behaviors during the English weeks in contrast to the Maori weeks. Users in Maori sessions preferred browsing, whereas users in English sessions were more likely to search. In a different setting, Gäde and Petras (2014) analyzed usage log data of the Europeana digital library. They discovered that the majority of users selected their native language in their browser (69%) and when using Google (91%), but only 31% of them selected their native language in Europeana. It suggests that users of Europeana accept the default English version, which contradicts the results regarding their language selection behavior with Google and browsers. The proposed explanation is that users do not change the language in Europeana because it requires greater effort, infrequent use of the system, a perceived lack of benefit, or lack of comprehension of the default language. Further analysis of query language, usage of language facets, and language of viewed objects can shed more light on the issue.

MULTILINGUAL DIGITAL LIBRARY LANGUAGE SEARCH FUNCTIONS

A survey was conducted by the authors to examine the functions associated with language of several key multilingual digital libraries including Europeana, European Library, International Children's Digital Library, Meeting of Frontiers, The Perseus Digital Library, and Project Gutenberg. Table 11.2 presents these digital libraries, their sponsors, content coverage, targeted audience, default language, and types of language-selection functions. The number of available languages is presented in parentheses immediately following each language function. The results show that users can set the language to search or browse using one of three main approaches: (1) select a language option from the main page (or sometimes any page) of a digital library; (2) select a language option from advanced search options; (3) select a language option when they refine their searches.

Oard (1997) points out that challenges for multilingual digital library development focus on query formulation and document selection. Another challenge is the delivery of high-quality documents selected by users. Moreover, he raises many of the nontechnical issues with digital libraries related to the diverse needs of users and the social impact and availability of technology. Recently, upon reviewing the relevant literature on multilingualism in digital library, Diekema (2012) identifies several following challenges that multilingual digital libraries face:

- *Cross-language barrier*: the key for multilingual digital libraries is to enable users to search across different languages. The first challenge is the availability of digital information objects in various languages.
- *Data management*: this challenge is associated with translating metadata, instructions, and the interface in a way that makes sense to users. Internationalization and localization are the key. Indexing multilingual documents and using OCR documents are the related challenges.
- *Representation*: this challenge corresponds to the selection and standardization of encoding schemes and the fact that not all languages are included in encoding schemes.
- *Development*: the challenge here is to create international software by considering subtle and sensitive cultural differences. Cross-cultural collaboration is the solution. Another challenge is related to representing cultural materials to ensure accuracy of the information.
- *Interoperability*: this challenge is to build a system architecture and data-sharing method that allow digital libraries to translate one query into all of the applicable languages and present relevant items from all of the languages represented in the digital library.

For interoperability, digital libraries must be able to establish common strategies, data models, processes, and structures in order to build and support multilingual collections (Vassilakaki and Garoufallou, 2013). After analyzing four multilingual digital libraries, Budzise-Weaver et al. (2012) conclude that machine translation and cross-language information retrieval techniques have not been applied and implemented into the development of digital libraries. While some information scientists focus on system-side technical challenges of digital libraries such as automatic translation, other researchers believe the challenge for multilingual digital library research is largely associated with their users and the countries and cultures they represent. Clough and Eleta (2012) emphasize the importance of understanding users, their profiles, and the context of digital library use in order to effectively design multilingual digital libraries. Gäde (2014) focuses on several issues regarding user studies of multilingual digital libraries, including small sample sizes on the basis of the target population and recruiting users who speak different languages. Very few studies analyze digital library usage data from the perspective

Table 11.2 Multilingual Digital Libraries and Their Search Functions

Name	Sponsors	Coverage	Targeted Audience	Default Language	Language Selection Functions
Europeana	Cofunded by the European Union—museums, archives, libraries, etc.	Cultural heritage—books and manuscripts, photos and paintings, television and film, sculpture and crafts, diaries and maps, sheet music, recordings, drawings, newspapers, letters, and newsreels	General	English	Drop-down menu (web page—any pages including main page) (30) Search: refine by language (30) Translate into (52) any web page
European Library	CENL (The Conference of European National Librarians), LIBER (Ligue des Bibliothèques Européennes de Recherche—Association of European Research Libraries) and CERL (Consortium of European Research Libraries)	Digital items and bibliographic records: humanities, social sciences, natural sciences and mathematics, biomedical sciences, and technological sciences	Research community worldwide	English	Drop-down menu (web page—any pages including main page) (36) Search: refine by language (45) Advanced: refine by language (400+) 36 (any web pages)
International Children's Digital Library	International Children's Digital Library Foundation National Science Foundation (NSF) and the Institute for Museum and Library Services (IMLS), a collaborative project between the University of Maryland and the Internet Archive	Books: a collection of books that represents outstanding historical and contemporary books from the world	Children	English	Main page (5), search by language link Search: refine by language and location (20) Book search by language and advanced search (79) Keyword search (79) Book summary depends on available language (drop-down menu)
Meeting of Frontiers	US and Russian libraries: The Library of Congress, Russian State Library (RSL), etc.	Manuscripts, maps, films, photographs, sound recordings, printed material, and sheet music	For use in US and Russian schools and libraries and by the general public in both countries	Both support (2) English and Russian	Web page (2) Russian is not supported in search page
The Perseus Digital Library	Annenberg/CPB Projects, Digital Library Initiative, etc.	Mainly the history, literature, and culture of the Greco-Roman world and other disciplines	Not specified	English	Language support depends on works Search by language (6)

The number of available languages are presented in parentheses immediately following each language function.

of users from different countries with different languages. Most important, Vassilakaki and Garoufallou (2013) stress the need for user studies to generate tangible and usable findings that can apply to the enhancement of the user interface design for multilingual digital libraries.

DIGITAL/DATA CURATION

DIGITAL/DATA CURATION DEFINITIONS

Digital libraries not only contain digital objects but also digital data. Digital data curation is a new area for digital library researchers and practitioners to explore. According to Walters (2009), digital libraries and archives set the foundation for digital curation and associated programs. Citing the DELOS Digital Library Reference Model Foundations for Digital Libraries, Chowdhury (2010) identifies the shifts in the field of digital libraries as signified by moving from a content-centric to a person-centric system and focusing on communication, collaboration, and interaction instead of just accessing information in the digital library. Weber et al. (2012) point out that "digital research data have introduced a new set of collection, preservation, and service demands into the tradition of digital librarianship" (p. 305). Digital curation is a collaborative activity starting with research planning and ending with data reuse.

According to the Digital Curation Center (DCC) (n.d.), "digital curation is maintaining and adding value to a trusted body of digital research data for current and future use; it encompasses the active management of data throughout the research lifecycle." Lord and Macdonald (2003) define digital curation as "the activity of managing and promoting the use of data from its point of creation, to ensure it is fit for contemporary purpose, and available for discovery and re-use. For dynamic datasets this may mean continuous enrichment or updating to keep it fit for purpose. Higher levels of curation will also involve maintaining links with annotation and with other published materials" (p.12). Data curation is a comparatively older concept; however, in many contexts, "data" and "digital objects" are treated the same. Therefore, digital curation and data curation have been considered as synonyms in recent publications (Ball, 2010; Giaretta, 2007). Digital curation is an interdisciplinary field, embracing archival, information, library, and computer science (Dobreva and Duff, 2015).

DIGITAL/DATA CURATION PROCESS AND ISSUES

The lifecycle of data curation has been the focus of research. (Cervone, 2010; Higgins, 2009, 2011; Lynch 2008). Yakel (2007) further highlights the key areas of data curation: the lifecycle of data from record creation; the involvement of records creators and digital curators; the appraisal and selection of materials; access development and provision; and ensuring preservation, usability, and accessibility of the objects. In addition to the above areas, Ramírez (2011) also emphasizes the importance of creating metadata for descriptions, proving the authenticity and reliability of the data, and complying with data requirement standards. Citing other researchers' works (Brandt, 2007; Macdonald and Martinez-Uribe, 2010), Harris-Pierce and Quan Liu (2012) identify several issues in data curation: storage capacity, data sharing, data description and organization, confidentiality, intellectual property rights, complexity, and developing new approaches to managing data.

Walters (2009) proposes a model for data curation program development in a university setting. The four main components of the model consist of: (1) the assessment of how faculty create, store, manage, share, and use data; (2) the selection, design, and development of the technology platforms to

support lifecycle process of data; (3) the selection and creation of service models addressing methods of importing large data sets, metadata creation, cost model for data storage use and reuse, as well as data transfer; and (4) the development of data curation policy. The Curation Lifecycle Model as proposed by the DCC is shown in Fig. 11.3. Digital data, consisting of digital objects and databases, are at the center of the model. The full lifecycle of the digital curation includes the following four levels:

- *Description and representation information*: create appropriate and standard metadata to ensure data can be used and reused
- *Preservation planning*: plan for preservation through the digital curation lifecycle
- *Community watch and participation*: monitor community data and engage in the development of standards, tools, and software
- *Curate and preserve*: pursue planned management and administrative actions

On the basis of a comprehensive literature review, Poole (2015) discovers that sharing data, open access, and the reuse of science data are the key issues in research on digital curation. Not all scholars are willing to share. For researchers who see the benefits of sharing data, only a minority of them actually do,

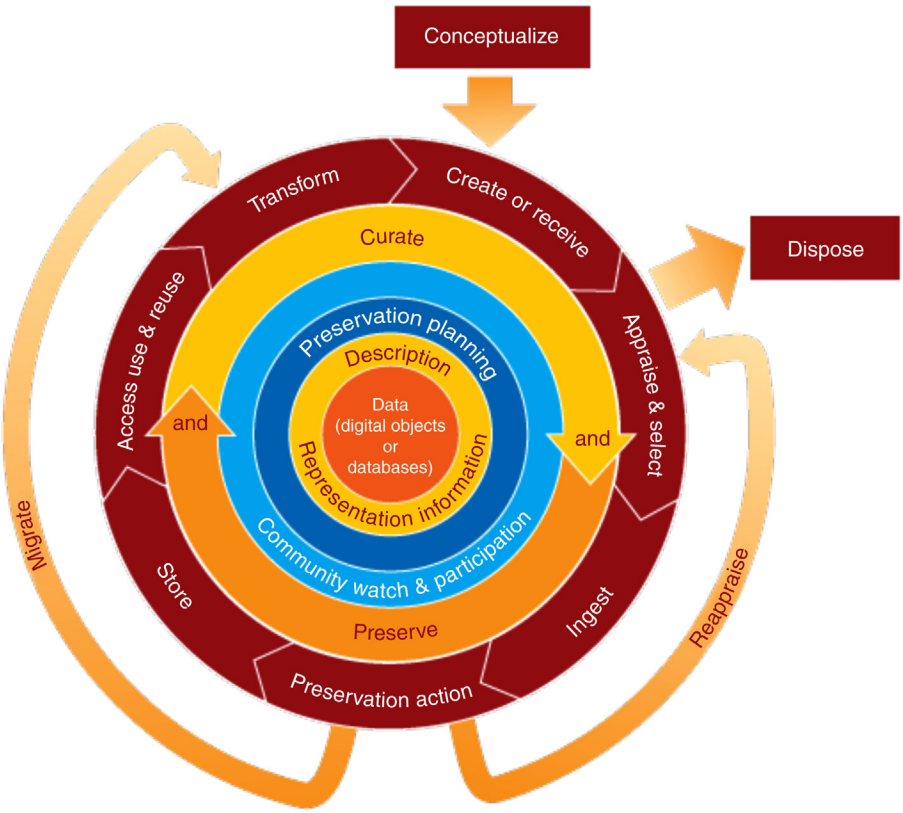

FIGURE 11.3 DCC Curation Lifecycle Model

(http://www.dcc.ac.uk/resources/curation-lifecycle-model)

because of various reasons including standards, time, intellectual property, potentially revealing errors, and funding (Borgman, 2010; Scaramozzino et al., 2012; Schofield et al., 2009; Tenopir et al., 2011). After conducting focus groups with faculty and other researchers, McLure et al. (2014) reveal the needs of researchers in relation to data curation. There is a definite need for data curation as researchers are involved in data collection, especially as their file sizes increase moving into the future. They consider the key stages in accomplishing projects as the planning, creating, producing and transferring stages. For library support, they expect to have opportunities for training regarding data management, but most importantly, they would like to have a central system that collects, stores, and disseminates data for them. Peer and Green (2012) report how an open data repository, including experimental data, metadata, and files, is created for a specific research community. The feedback from the community shows the success of the repository, which enables researchers to play out their data management plan as part of the study. Alerts regarding newly available data promote further research on this subject.

Ball (2010) summarizes a variety of standards and tools for data curation. For example, the following are used for the preservation of metadata:

- *The PREMIS Data Dictionary* containing five entities: intellectual entities, objects, events, agents, and rights
- The Complex Archive Ingest for Repository Objects (the CAIRO Project)
- Investigating Significant Properties of Electronic Content over Time (InSPECT)
- *The Data Documentation Initiative (DDI)*: focusing on the social science data standard
- *The MOLES metadata profile* with five entities: deployment, activity, production tool, data, and data granule
- *The Scientific Metadata Model (SMDM)* with several associated models
- *Dublin Core Application Profiles (DCAP)* with five components: functional requirements, domain model, description set profile, usage guidelines, and encoding syntax guidelines
- *Software preservation project*: examining the cost and benefits for software repositories

There is an increasing recognition of the importance of research data management. Survey data from UK universities indicate that limited research on data management has taken place in libraries, especially in research institutions. The top priorities are offering research management advisory and training services. The majority of respondents state that their libraries have engaged in their institution's research data management policy development (Cox and Pinfield, 2014). Analysis of job advertisements for digital curation highlights the following top five required knowledge and skills: familiarity with working in an information technology–intensive environment, knowledge of standards and specifications, proficiency with tools and applications, project management, and functional skills for curation. At the same time, seven types of responsibilities are also identified: curation activities, training and consultation, project management, professional and research activities, other library duties, policy and procedures, and outreach and advocacy (Kim et al., 2013). Data curation not only covers research data but also the institution's historical data. Collaboration, in particular involving the library as a partner, is required to be successful in digital curation (Latham and Poe, 2012).

CHALLENGES AND PROBLEMS

Challenges can be associated with different aspects and perspectives on digital curation. The Cornell University Library (CUL) Data Working Group (DaWG) (2008) raises challenges from organizations'

perspectives: financial sustainability, appraisal and selection, digital preservation, intellectual property, confidentiality and privacy, and participation by data owners. Harris-Pierce and Quan Liu (2012) discover that there is a gap in LIS education on data curation. The LIS curriculum is not able to keep pace with the need for information professionals who are able to manage data curation. In addition, standardizing course objectives and learning outcomes is essential for adequate data curation education. Peer and Green (2012) specify the following challenges in creating an open data repository: policy, technology, sustainability, extensibility and scalability, and interoperability. In surveying current activities, Cox and Pinfield (2014) discover that respondents believe that library staff do not have adequate skills needed for research data management and that resources and funding issues are additional challenges for digital curation.

Generated from the two data curation summits, Weber et al. (2012) propose that future research on data curation should focus on different approaches of educational training, interoperability issues between publishing workflow and academic research data archiving, and finding a commonly agreed upon vocabulary. On the basis of a review of the literature, Poole (2015) effectively summarizes the challenges and future research on digital curation as follows:

- *Sustainability*: the challenges are connected to the technical, social and economic infrastructure, funding models, plans, and policies.
- *Costing*: the challenges correspond to costs required for the lifecycle of the data and metrics for the cost model.
- *Planning and policy*: the challenges focus on the development of local, national, and international policies, in particular policies on legal issues.
- *Training and education*: the challenges concentrate on the role of library and information science, a balanced curriculum, and training for researchers and professionals.
- *Researcher practice*: the challenges are relevant to the understanding of the data practices of researchers in different domains.
- *Raising awareness*: the challenges are in regard to the awareness of data sharing, data reuse, and advocating for the significance of digital curation.

Most important, digital curation is a complicated activity mainly because of the increasing complexity of digital objects and the evolution of the contexts of using these objects (Dobreva and Duff, 2015).

CHALLENGES AND PROBLEMS OF DIGITAL LIBRARIES

Despite the successful development of digital libraries and extensive research on different aspects of digital libraries, researchers and practitioners still face a variety of challenges and problems. The following is a summary of critical issues digital libraries face, including the key challenges as well as associated research questions for future study.

- *Diverse user needs and information behaviors*: children, students, elderly, and disabled users differ in domain knowledge, system knowledge, information-retrieval knowledge, interaction styles, and physical and cognitive development. In particular, people with disabilities encounter physical, cognitive, and affective challenges when interacting with multimedia materials in digital libraries. In addition, multilingual digital libraries are essential for global access. Related questions for further research include the following:

  - How can we design digital libraries to support diverse user needs and user behaviors?
  - How can digital libraries best be designed to support people with disabilities?
  - What are the preferred features for multilingual digital library searching and browsing?
  - Can one-size-fits-all digital libraries be developed?
- *The gap between research and practice*: it is important to promote the communication between research and practice. Practice benefits from research outcomes, while at the same time, research also needs to investigate issues that are relevant to practitioners. Related questions for further research include the following:
  - How to facilitate communication between researchers and practitioners?
  - How to promote collaboration between researchers and practitioners?
  - How to promote the application of digital library research into practice?
- *Interoperability, standards, and aggregation of digital libraries*: major efforts have been undertaken to aggregate content from individual digital libraries and to provide portals for global searching and retrieval. A lack of interoperability and standards associated with data conversion, metadata, interface design, etc. has been recognized as a critical problem and a fundamental challenge since the early days of digital library development, arising from the fact that digital libraries are designed and developed by different organizations. It is not only a technical challenge but also a source of user frustration. Related questions for further research include the following:
  - What are the key issues of interoperability in creating large-scale digital libraries?
  - What are the standards critical to the development of digital libraries?
  - How to ensure interoperability and the application of standards among digital libraries?
- *Ensure sustainability*: digital library sustainability is a complicated topic with related issues ranging from the longevity of digital information—including the stability of digital formats and storage medium and flexibility to incorporate new items—to funding for digital libraries. Related questions for further research include the following:
  - How to ensure the stability of digital formats and storage media and solve associated obsolescence issues?
  - How to ensure a digital library has the flexibility to add new digital objects after its initial development?
  - How to ensure the funding for digital libraries after the initial development?
- *Copyright protection and fair use*: copyright is an ongoing concern for digital library developers and users. The concept of fair use must be fully considered in the development of digital libraries while do not overstep and infringe on copyright. There is no clear and comprehensive guidance on copyright and fair use in digital libraries. Related questions for further research include the following:
  - What are the main concerns of copyright issues in digital library development?
  - What are the best approaches to provide clear copyright information?
  - What are the best solutions to solve copyright problems in digital libraries?
  - What are the challenges in protecting copyright in global digital library environments and at the same time support fair use?
- *Complexity of digital library evaluation*: the dynamic and complicated nature of digital libraries greatly impacts the complexity of digital library evaluation including evaluation dimensions, evaluation criteria, and measurements. Different stakeholders of digital libraries have diverse

perceptions in terms of the importance of digital library evaluation criteria. Related questions for further research include:

- What are the main components of digital library evaluation models/framework?
- What are the key digital library evaluation dimensions, criteria, and associated measurements?
- How can digital library evaluation criteria and measurements be matched with diverse evaluation objectives or purposes?
- How to apply both qualitative and quantitative approaches to evaluate digital libraries?
- What are the similarities and differences in evaluation criteria and measurements from digital library researchers, designers, and users?

- *New web technologies applied to digital libraries*: various social media tools have been applied to promote the use of digital libraries. However, the use of social media in digital libraries has not reached its full potential to enhance interactivity between librarians and their users. The dynamic, ephemeral nature of the information provided through social media also poses a challenge. As new technologies emerge, it is important to consider how they might be applied to digital libraries, as well as their corresponding benefits and problems. Related questions for further research include the following:
  - How to promote interactions between librarians and users of digital libraries?
  - How to organize and manage the dynamic information created and distributed through social media?
  - How to deal with the inherent problems of social media in relation to digital divides, information overload, and poor information literacy skills?
  - What is the role of linked data in making digital library resources visible and discoverable on the open web?
  - What are the new developments in technologies that can be applied to digital libraries, and what are their benefits and problems?
- *Mobility of digital libraries*: a trend of digital library use is its mobile access. Page views in Europeana from personal mobile devices increased at a rate four times higher than that of office devices between 2010 and 2011 (Nicholas et al., 2013). Mitropoulos et al. (2014) also confirm that mobile access to digital libraries increases along with the rise in the use of mobile phones. This trend of mobile access suggests the overall trend for future digital library use. As such, it has significant impact on digital library interface design. Related questions for further research include the following:
  - What are the unique behaviors of mobile users in their interactions with digital libraries?
  - How to design digital library interfaces to facilitate the use of different mobile devices and different browsers to effectively interact with digital libraries?

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