

Augmenting Library Services: Toward the Sharium

Gary Marchionini

march@ils.unc.edu

University of North Carolina at Chapel Hill, USA

Abstract

The conception and work of libraries have always been shaped by the external representations of thought manifest in physical media of expression. Whether stone tablets, books, or magnetic recordings, libraries serve to preserve these objects and to provide access to the thought carried in such objects. New media of expression will surely affect the conception and work of libraries. These changes are not supplantations as much as augmentations in the continuing evolution of thought and communication. Theories of information science seek to explain these augmentations and postulate new possibilities for theory and practice. This paper presents a model of digital library evolution that augments service by facilitating community-based sharing of time and information. In the sharium model, people and their interactions are as important as information resources. Digital library content and tools serve as the environment to bring people together for problem solving and intellectual exchange.

Keywords: digital library, collaboration, open source

1. Introduction

Digital libraries (DL) are emerging in a variety of forms and venues around the world (e.g., see [6]). As the logical extensions and augmentations of physical libraries in the electronic information society, DLs extend existing resources and services and also have the potential to augment libraries by enabling new kinds of human expression and problem solving [12]. DLs clearly extend services by providing broader and faster access to some library resources. Like all innovations, digital libraries will go through phases that emulate, replicate, extend, and finally augment existing solutions. This paper aims to encourage the DL research community to first look beyond the content within libraries to other library services and roles that digital libraries may emulate, and then to ways that digital libraries might yield new kinds of services beyond today's physical libraries. To illustrate one trajectory toward these goals, the concept of a sharium is introduced to describe digital libraries that combine elements of learning communities, scientific laboratories, and special

libraries to facilitate communication and distribute the load of solving information problems. The sharium is used to consider extending current research more fully in the public services area of libraries and propose leveraging technology to create new levels of human interaction and contribution.

A new term may be helpful at this point in time to jar us from the somewhat constraining connotations of the terms "digital" and "library." The sharium is a workspace with rich content and powerful tools where people can work independently or collaborate with others to learn and to solve their information problems. A sharium is all the things that a library is today, but adds strong sharing components. In the sharium model, people and their interactions are as important as information resources. Digital library content and tools serve as the environment to bring people together for problem solving and intellectual exchange.

Figure 1 illustrates the sharium work space. It shows that individuals may work alone or with other individuals or groups to leverage DL resources to achieve a variety of goals. DL resources include various communication channels, files of content, and tools. People may simply use the DL resources as a messaging service with options to preserve and analyze interactions. This is analogous to using the physical library for one-on-one or group meetings. People may take advantage of DL services to search and browse the collection individually or collaboratively. This is an extension of current physical and DL search support. Most importantly, people can use the DL as a problem solving space where individual or collaborative investigation and construction of new knowledge takes place. The channel in the figure is depicted more thickly to suggest that more time, content, and interaction takes place as people work to achieve their goals. People may also make contributions to the DL, a new service that electronic environments facilitate. Finally, people may use existing DL content in presentations that range from static displays (e.g., open a channel that displays a screen display for an exhibition) or active presentations (e.g., live events streamed over a video channel). Most importantly, the sharium work space illustrates that people leverage technology and information content to solve problems and collaborate in flexible ways.

This paper examines the potentials for library extension and augmentation in three sections. First, creating facilities and tools to support sharing of time and expertise during the collaborative problem solving that takes place in physical libraries is a grand challenge for extension and amplification in digital libraries, especially for services such as reference that have been largely ignored in DLs to date. In this regard, the sharium leverages the user community itself to share expertise and time to add new value to libraries. The second type of sharing that may be supported is not typical in physical

DLs. Clearly, libraries exist to aggregate, preserve, and serve information manifested in artifacts (whether analog or digital) and our efforts to transition to DLs must address these basic responsibilities.

What is conspicuously absent from these issues is attention to a second primary function of libraries, what is often termed public services. The main public service function in most libraries is reference, the process of aiding patrons with informational problem solving. With few exceptions¹, most DLs provide a search engine, a

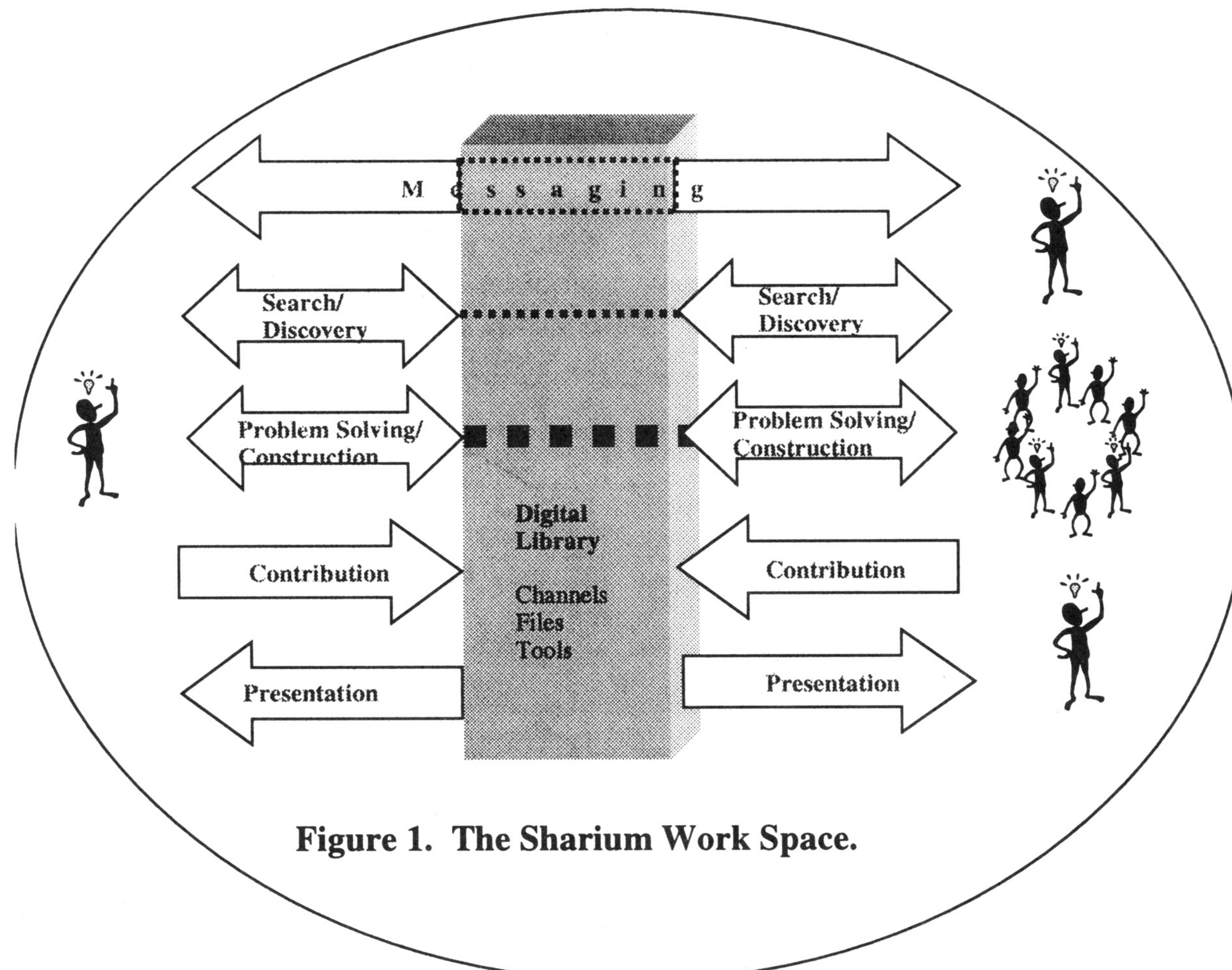


Figure 1. The Sharium Work Space.

libraries and allows individuals to contribute objects and materials to the collection. Finally, ways to augment how libraries influence learning in all venues and extend library services to the entire information life cycle are considered.

2. Sharing Time and Expertise

The DL research and development community has identified many important research problems and is working with practitioners and businesses to create and maintain digital collections. The most common research and development issues addressed in the DL literature include: object acquisition and digitization; development of indexing and search procedures and tools; delivery of digital objects instantly and globally; management of intellectual property rights; security and authority; interoperability within and across DLs; and managing the long-term integration of analog and digital materials. Although these are critical problems for DLs, they center on the technology and content of libraries. See [13] for a framework that discusses the relative progress in technology, content, services, and communities in

query or browse-based user interface, and possibly a frequently asked question (FAQ) list and expert information seekers to help themselves. This is akin to eating out of vending machines--we should at least be able to get to the level of fast-food drive through and aim toward the full-service restaurant! With the exception of work on intelligent reference agents, this is an important aspect of physical libraries that is yet to be addressed by the DL R & D community. This has been recognized by many in the DL community (e.g., [16]).

It is easy to understand why these problems have not been addressed—they are exceedingly difficult to solve and this was known long before the WWW caused everyone to be an online searcher. Studies of the search interviews that intermediaries conduct with patrons before conducting online

¹ See for example, the National Agricultural Library InterNic service provides an HTML form modeled on reference interview templates (<http://www.agnic.org/orsp/>) and the Virtual Reference Desk (<http://www.vrd.org/>) provides online reference support.

searches (e.g., [4]) and investigations of professional intermediaries actually conducting searches in online databases (e.g., [7]) demonstrate the conceptual challenges of reference services. More than a decade of research at MIT on the Intrex and Conit systems to automate online searching (e.g., [15]) illustrates the complexities of online interactions and the need for user support in using online services. Search front-ends such as Grateful Med for medical literature and various interfaces for end-user searching of commercial services gave end users access to online information but even these systems included training, manuals, and online help to support fairly sophisticated end users such as medical and legal students and practitioners. The long series of studies of online public access catalogs (OPACS) demonstrate the wide range of problems undergraduates and other end users have with even fairly recent systems (e.g., [5]).

WWW search services have addressed the problem by applying thirty years of information retrieval research to allow users to enter "natural language" queries that return ranked lists of hits from the entire universe of material. Unfortunately, people tend to enter very few terms (one or two) in their queries and seldom limit their search to particular partitions within the corpus. Only recently have search services begun to incorporate relevance feedback options, and result set management functions (e.g., sorting, subsearches) are rare. It is certain that with increased familiarity the general population's facility with these systems will improve over time but it seems clear that even with powerful tools, people are often unable to solve their information problems on their own. Vendors of integrated library systems have been slow to add these search facilities to their software and libraries have focused on making these systems accessible through the WWW rather than building new DLs from the ground up--in effect adding remote access to existing systems rather than integrating the local catalog and databases into a larger DL architecture. This is certainly understandable given the critical nature of reliable library services on campuses and communities. Initiatives such as the California Digital Library (<http://128.48.112.54/>) and NC-Live in North Carolina (<http://www.nclive.org/>) may help existing libraries integrate advanced DL services with existing online services so that patrons can find the information they need.

Good user interfaces to search systems can make query specification and browsing easier for information seekers. Shneiderman, Byrd & Croft [20] have identified a taxonomy of search features that should be included in search interfaces but given that even professional intermediaries have difficulty helping users specify their true information needs, improved query specification interfaces are only part of the solution.

Another approach to assisting people in finding information in digital forms is to offload the complexities of the search process to software. The Michigan DL project envisioned user interface agents as one of three types of autonomous, intelligent agents that will serve to carry a user profile and query through the architecture to find information (e.g., <http://www.cnri.reston.va.us/home/dlib/July95/07birtingham.html>). Other research groups have similar research agendas as well as downloadable tools and prototypes (e.g., MIT <http://lcs.www.media.mit.edu/groups/agents/> and University of Maryland Baltimore County <http://www.cs.umbc.edu/agents/>). Although this is a provocative line of development, no working systems for general information seeking have yet emerged. More significantly, the information-seeking process is most often embedded in a larger problem solving context that involves learning and decision making—at the very least, users must still be able to articulate queries, let alone define good profiles and manage their agents.

Given the challenges of search, it is no wonder that browsing (in the form of scanning and selecting links--often called "navigation", [11]) is a primary mode of search in the WWW and for many DLs. Presumably, DLs offer people better organization so that analytical search and browsing strategies can both be applied adequately. Typically, users enter a query and receive back a large partition of the database and navigate from this partition. Alternatively, they may start with a high-level classification of content and systematically navigate through smaller sets to candidate objects. Although there is good progress in creating dynamic query interfaces [17,19] that closely couple the query and navigation tactics so that people can quickly and easily explore DLs, the need for reference librarian assistance remains a significant challenge in DLs.

Clearly, hiring millions of professional intermediaries to serve the world's population is not a viable solution. Ideally, people should be able to solve most of their own information problems and obtain help after personal efforts have not been fruitful. Systems should help us do so, and when we cannot solve a problem ourselves, other humans must be consulted. This is fundamentally a communication and apportionment process and the sharium provides a model for this communication and apportionment. In the search and discovery process, users take advantage of a cascading set of search and browse services and those interactions are then taken into account if human consultation is required.

This is especially important given that email and other communications functions are among the most popular and useful applications of

the Internet². For example, compare the number of email messages you read and compose each day to the number of web pages you browse or compose. This notion is not lost on the WWW entrepreneur community. The recommendation features of Amazon.com are one aspect of its success and new Internet services are appearing daily to provide advice and information garnered from contributions of community members³. Libraries have an opportunity to leverage the long-standing expertise in selection as a basis for leveraging community expertise to address the reference challenge.

Libraries have always served as meeting places where people physically get together (e.g., public libraries often have meeting rooms for community groups and academic libraries have study rooms and commons where students and faculty can meet). The ancient Library of Alexandria was as much a university and gathering place for scholars as a collection of scrolls. Libraries are spaces where people can come together to collaboratively solve information problems. People are drawn to these spaces by the material resources assembled to meet the common needs of a community of practice. The virtual community aspect of DLs was one of the main foci of the UCLA-NSF Social Aspects of Digital Libraries Workshop (<http://www-lis.gseis.ucla.edu/DL/>).

A promising thread of DL research is to find ways to bring people together to help each other, especially when individual information-seeking actions are unsuccessful. A sharium will provide facilities and tools to allow community members to share their time and expertise. To be scalable, this approach must go beyond the excellent preliminary, specialized online reference services that link information seekers to professional librarians (e.g., [1,10]) to link any individuals or groups on a just-in-time basis. Newsgroups (USENET News) and electronic bulletin boards, and more recently, chat rooms allow communities of practice to form as support question answering. Ackerman's AnswerGarden systems [2] <http://www.ics.uci.edu/~ackerman/docs/cscw96.ag2/>

² See Anderson et al. [3] for a discussion of the many social and political implications of universal access to email.

³ Thirdvoice (www.thirdvoice.com) and allows people to post notes on websites. Odigo (www.odigo.com) provides a set of space and services for sharing. Epinions (www.epinions.com) will provide advice on products and services by inviting reviews and comments from experts, and Fields of Knowledge (<http://www.FieldsOfKnowledge.com>) aims to create an infography of scholarly resources by inviting contributions from experts and providing royalties according to the usefulness of their contributions.

[cscw96.ag2.html](http://www.ics.uci.edu/~ackerman/docs/cscw96.ag2.html)) are the best examples of a hybrid solution that combines FAQ and email question answering (with the human-generated answers automatically added to the evolving FAQ). Finding ways to organize and coordinate services ranging from ad hoc question asking to extended discussions is a DL challenge. Key technical problems include:

- fostering and insuring quality control;
- transitioning information seekers from self-directed search to reference and community assistance when people do not succeed with self-directed approaches;
- developing layers of assistance from fully automated (e.g., FAQs), through community assistance (e.g., posting a question to a newsgroup), to professional assistance (e.g., online with a reference librarian), including hybrid solutions; and
- creating interfaces that do not overwhelm or frustrate information seekers as they transition through the various service layers.

Considering DLs in this communication sense seems exactly the right thing to do given that much of the crucial knowledge we need, and can best understand, is contained in other people's heads--only formalized manifestations generalized to facilitate communication are externalized into publications of various kinds. Interacting with other people who have the knowledge we need personalizes and customizes that knowledge and makes it much more accessible and useful. Additionally, the interaction itself provides metacognitive benefits and aids in finding the needed information in our own heads as we act to articulate, reflect, and examine feedback. It seems essential that if DLs are to truly evolve to be as useful as physical libraries they must strongly address communication capabilities in general and the reference problem in particular.

3. Sharing Content

Unless the donor is a significant personage with an interesting or extensive collection, most librarians shudder when people wish to donate books or materials to the collection. These materials must be sorted, tagged, cataloged, shelved, and preserved--all expensive activities. Thus, donations of books and journals to physical libraries are often more a burden than help and understandably few libraries actively promote patron giving of such materials. A sharium, on the other hand will solicit and welcome patron contributions of physical artifacts and/or their digital representations. This leverages the communication and exchange power of the Internet.

Contributions of physical materials may take several forms. First, actual objects may be transported to the library and the digital system leveraged to facilitate acquisition and integration into the physical collection and additions to the

digital finding aids. Expert, original cataloging may be supported by electronic tools or possibly replaced by contributor cataloging supplemented with community commentary and descriptions. Second, a digital representation for the object may be created and transmitted to the DL. In this case, support for good quality digitization and description is essential. For example, someone may find in their attic a set of letters or a map that relates to a specialized digital collection. These objects could be digitized at a local public library or school using an appropriate sharium template and submitted with any metadata the contributor can supply. In this case, the contributor keeps ownership of the artifact and the DL provides the digital representation. Other variations are possible, where the contributor or the library maintains both physical and digital manifestations. The simplest case is already used in some DLs (e.g., the Alexandria DL allows users to contribute URLs) where users are encouraged to submit links to related sites or DLs.

The key technical research issues for such an environment then relate to:

- developing contribution mechanisms that allow people to easily digitize and/or transport objects;
- managing content authority and quality;
- insuring access (metadata formats; preservation and persistence; provenance).

Unlike a physical library, where the burden of collection development is on the librarian, in a sharium, the community assumes some of the responsibility for quality control. The examples of collaborative filtering (e.g., [9,18]) illustrate practical means by which communities may categorize and rate information objects. Collaborative ratings only provide one aspect of quality and other approaches must be taken as well. These include well-known methods of peer/panel review, and personal annotations made by contributors or users. We can envision tiers of ratings where objects may exist in multiple "bins" of quality, topic, and authority. For example, a four tier scheme might distinguish objects appraised and cataloged by experts; objects contained and described by trusted parties such as major research libraries; objects appraised and cataloged by a significant portion of the user community; and objects appraised and cataloged by contributors alone.

Contributors may wish to maintain ownership of objects while providing access to the community. Policies and tools for preserving objects and links and templates for assigning metadata must be added to the digital librarian and patron toolkits.

Supporting both ephemeral and physical sharing requires significant technical developments but fundamental research on human motivations and behaviors in shared environments is also needed.

We know that people are motivated to share, whether for philanthropic or self-preservation motives. Public libraries serve to share expensive resources across a community and the Linux community (<http://www.linux.org/>) represents one of the most successful digital shared libraries of user-contributed objects. Studies of the Linux Software Map (LSM) usage (<http://metalab.unc.edu/pub/Linux/LSM-TEMPLATE>) and contributor behavior patterns are underway and preliminary results demonstrate the quality of both code and metadata contributions (<http://research.opensource.unc.edu>). Sharing code or information to build brand recognition or ancillary service markets has become a bone-fide business model as companies like Netscape and Sun open source major products. Surely, DLs have important roles to play in authenticating and adding value to such repositories (e.g., the Linux archives provide no version control and DLs may develop provenance streams that not only help users but also encourage continued contributions by validating and documenting personal contributions). Whether people are more willing to share ephemeral or physical objects, what critical mass is necessary to develop a collection, and whether people will share in more general, ad hoc areas remain open research questions.

4. Using Information and Learning

Another way to think about the sharium concept is to consider refining and expanding the range of services that libraries offer. Information is created, distributed, used/reused, and archived/destroyed. The information life cycle suggests that creation of new information benefits from existing information. Libraries have traditionally focused on the distribution and storage aspects of this life cycle, leaving creation to authors and publishers and addressing usage only within the constraints of academic library settings. As a distributed problem solving space, the sharium facilitates *creation of information* by bringing together authors/creators and raw materials to facilitate both ephemeral and formal communication. In this regard, Widerhold [21] has demonstrated how creators can more easily link directly to users without depending on publishers and libraries as distinct elements in an information value chain. As more information is created by teams of individuals working in a shared, virtual workspace, using shared instruments and information resources, it makes sense that this new information is best managed and distributed from the source--the shared workspace--rather than from separate systems and channels.

DLs have new opportunities to provide authoring tools that integrate search and discovery, collaborative authoring, version control, documentation, and publication activities. By

providing better information management and creation tools, DLs leverage collections in much the same way that laboratories share scientific equipment by leveraging networking and collaboration tools [8]. Additionally, these tools will help creators consider storage and retrieval issues at the time of creation rather than as add-ons after the fact (e.g., tools may assist in adding metadata, provenance, and citations), and specify user options such as display modes, language translations, and required sequences or related materials. Just as the WWW has allowed anyone with Internet access to publish simple web pages, a sharium will allow anyone to "check out" and use style sheets, XML DTD's, and other templates to facilitate creation and contribution of new products⁴. These capabilities will expand DL service to the creation phase of the information life cycle.

Using information requires that people not only are able to map relevant information to their needs, but also that they can interpret, understand, and apply the information. A dissertation may be highly relevant to a school-child's information need, but it may not be understandable and thus not meet their needs. A PDF table of statistics may be understandable but may not be useful for the person who wishes to manipulate and analyze the values with their favorite statistical package. Reference librarians take the patron's experience and knowledge into account when recommending materials, but DLs have yet made little effort to prioritize results based on user characteristics or format requirements. Providing ancillary tools such as glossaries, links to related works with different reading levels, and multimedia alternatives can help people in understanding retrieved information. Links to reviews or underlying metadata can help people interpret results. Giving people choices for formats, coverage/granularity, and manipulation tools can help them use primary data and metadata easily and more effectively. Likewise, DLs have made few efforts at leveraging patron interactions with content or other patrons to improve services. Individual and community usage patterns can support personal history tools and inform decisions about the value of content and tools in the DL. A metatheme related to information use is to provide systems that help people find and use information while reflecting on the information-seeking process-teaching people to fish rather than providing the immediate fish. This is particularly important for inexperienced patrons. Clearly, much research is needed to create techniques to customize

⁴ Just as services such as Kinkos have evolved from copy facilities to work spaces where customers can use a variety of production tools, a sharium will provide a wide variety of distributed tools and resources that clients can use alone or collaboratively.

information and interactions to people's needs and preferences so they can make more effective and efficient use of these resources and experiences.

An important application of the overall information life cycle and libraries in general is to support *learning*. Academic libraries have long supported student learning in terms of finding pertinent information, although using information has typically been viewed as a private concern of library patrons. Public libraries serve as centers for self-directed learning. The great Carnegie libraries were created in large measure to allow those who could not go to universities the opportunity to freely learn on their own. Special libraries in corporate centers support research and development (highly directed learning) and inservice training, as well as retrieval for production goals. We have argued that DLs will bring formal (school-based), informal (self-directed), and professional learning closer together [14] as technology and information are shared by different communities. The sharium can act as an open school where individual, self-directed learning that libraries have always facilitated can be extended to collaborative, self-directed learning unconstrained by distance and time.

Many DLs aim to directly serve both formal and informal learning needs. For example: the Learning Page at the Library of Congress (<http://memory.loc.gov/ammem/ndlpedu/>) provides excellent primary materials for students and teachers, the University of Michigan DL Teaching and Learning Project (<http://mydl.soe.umich.edu/index.html>) guides students to do inquiry-based learning with Internet tools and resources, the Perseus DL supports thousands of instructors and students in classics courses as well as thousands of users from homes and offices (<http://www.perseus.tufts.edu/>), and MedlinePlus at the National Library of Medicine (<http://www.nlm.nih.gov/medlineplus/>) provides basic information on health topics, dictionaries, and pointers to literature, services, and organizations. Some projects provide learning environments that leverage knowledge in people's heads as well as information resources to form learning communities. To support classics research and the sharing of instructional materials and techniques, the Stoa project allows classics scholars to share materials and discuss ideas (<http://www.stoa.org/>). SRI supports the Tappedin project, a community of thousands of teachers and researchers who share ideas, explore web-based resources collaboratively in real time, and communicate and share materials through synchronous and asynchronous tools (<http://www.tappedin.sri.com/>). The Baltimore Learning Community (BLC) (<http://www.learn.umd.edu>), is a DL of multimedia materials augmented by lesson-construction and presentation tools for middle school science and social studies. The BLC encourages teachers to

contribute the lessons they create and provides indexing and search services for those contributions as part of the community model and system infrastructure.

These examples illustrate that DL resources can be used for formal, school-based learning (Learning Page, Teaching and Learning Project, Perseus, BLC), self-directed, professional learning (Tappedin, Stoa, BLC), and casual, informal learning (Learning Page, Perseus, MedlinePlus). Libraries have new opportunities to support self-directed learning. These opportunities include supporting alternative schools, special interest group learning environments, and self help/do-it-yourself materials in all areas. DLs will surely continue to support formal and professional learning, but have the potential for great impact on the life-long learning that has become so crucial to intelligent life in the information society. However, much of the learning in life is rooted in human interactions rather than information. To this end, there is a great need for DL research on new models and techniques for fostering communication in an information-rich space to develop both individual and shared human potential.

5. Directions

It is unclear what extensions and augmentations will prove most effective and what the business models will be for sustainable DLs. It is likely that some combination of open source DLs, for profit DLs, and publicly supported DLs will coexist with physical libraries for the foreseeable future. The challenges of extending existing services and creating new services are significant for libraries that are already heavily resource-strained to maintain paper and electronic subscriptions, acquire new materials, and keep up with the day-to-day demands of patrons using the library. Adding new services may seem an unfair burden, and new library entities will have some advantage in moving aggressively toward the sharium. However, the resources and experience of existing libraries position them to leverage experience and credibility to augment services. Those that do so wisely will garner the support needed to grow and thrive in the globally connected, informed new century.

References

- [1] Abels, E. G. (1996). The e-mail reference interview. *RQ*, 35, 345-358.
- [2] Ackerman, M.S. & McDonald, D. W. (1996). AnswerGarden 2: Merging organizational memory with collaborative help. *Proceedings of the ACM Conference on Computer-Supported Cooperative Work (Boston, November 16-20, 1996)*. New York: ACM, 97-105.

- [3] Anderson, R.H., Bikson, T., Law, S., & Mitchell, B. (1995). *Universal access to e-mail: Feasibility and societal implications*. Santa Monica, CA: Rand.
- [4] Auster, E. & Lawton, S. (1984). Search interview techniques and information gain as antecedents of user satisfaction with online bibliographic retrieval. *Journal of the American Society for Information Science*, 35(2), 90-103.
- [5] Borgman, C. (1996). Why are online catalogs still hard to use? *Journal of the American Society for Information Science*, 47(7), 493-503.
- [6] Digital libraries [theme issue]. (April 1998). *Communications of the ACM*, 41(4), 28-32.
- [7] Fidel, R. (1984). Online searching styles: case-study-based model of searching behavior. *Journal of the American Society for Information Science*, 35(4), 211-221.
- [8] Finholt, T.A., & Olson, G.M. (1997). From laboratories to collaboratories: A new organizational form for scientific collaboration. *Psychological Science*, 8(1), 28-36.
- [9] Goldberg, D., Nichols, D., Oki, B., & Terry, D. (1992). Using collaborative filtering to weave an information tapestry. *Communications of the ACM*, 35(12), 61-70.
- [10] Lankes, R. D. (1998). The virtual reference desk: Building expertise into information systems. Paper to be presented at the 1998 *Annual Meeting of the American Society for Information Science* (Pittsburgh, October 26-29, 1998).
- [11] Marchionini, G. *Information seeking in electronic environments*. NY: Cambridge University Press.
- [12] Marchionini, G. (1998). Digital Library Research and Development. In A. Kent (Ed.) *Encyclopedia of Library and Information Science*. Vol 63, Supplement 26. NY:Marcel Dekker. 259-279.
- [13] Marchionini, G. & Fox, E. (1999). Progress toward digital libraries: Augmentation through integration (Guest Editors' Introduction). *Information Processing & Management*, 35(3), 219-225..
- [14] Marchionini, G. & Maurer, H. (1995). The roles of digital libraries in teaching and learning. *Communications of the ACM*, 38(4), 67-75.

[15] Marcus, R. (1983). An experimental comparison of the effectiveness of computers and humans as search intermediaries. *Journal of the American Society for Information Science*, 34(6), 381-404.

[16] Paepcke, A. (1996). Digital Libraries: Searching Is Not Enough. *DLIB Magazine*, May, 1996.
<http://www.dlib.org/dlib/may96/stanford/05paepcke.html>

[17] Plaisant, C., Marchionini, G., Bruns, T., Komlodi, A., & Campbell, L. (1997). Bringing treasures to the surface: Iterative design for the Library of Congress National Digital Library Program. *ACM CHI '97 Conference*. (Atlanta, March 22-27, 1997), p. 518-525.

[18] Shardanand, U. & Maes, P. (1995). Social information filtering: Algorithms for automating "Word of Mouth." *Proceedings of CHI '95* (Denver, May 7-11, 1995). NY: ACM Press, 210-217.

[19] Shneiderman, B. (1998). *Designing the User Interface*. 3rd ed. Reading, MA: Addison-Wesley.

[20] Shneiderman, B., Byrd, D., & Croft, B. (1997). Clarifying Search: A User-Interface Framework for Text Searches. *DLIB Magazine*, January, 1997.
<http://www.dlib.org/dlib/january97/retrieval/01shneiderman.html>

[21] Weiderhold, G. (1995). Digital libraries, value, and productivity. *Communications of the ACM*, 38(4), 85-96.