Collaboration Services in a Participatory Digital Library: An Emerging Design

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Abstract: Digital libraries need to provide and extend traditional library services in the digital environment. This paper presents a project that will provide and extend library services through the development of a sharium—a workspace with rich content and powerful tools where people can collaborate with others or work independently to explore information resources, learn, and solve their information problems. A sharium is a learning environment that combines the features of a collaboratory, where people collectively engage in research by sharing rich information resources, and a local library, where people come to meet, find information resources, and discuss common interests. To achieve this, collaboration services that build on synchronous and asynchronous communication technology should be integrated with other digital library services, including searching, browsing, and information management and authoring services. This paper presents our motivation for providing collaboration services and describes the types of collaboration services that will be included in the digital library.

Keywords: digital library, collaboration, library services, reference services, computer-supported cooperative work, collaboration technology.

Introduction

Like other innovations, digital libraries will go through phases that emulate, replicate, extend, and finally augment existing practices. To date, most digital library projects have focused on replicating and extending the development and delivery of a library collection. Problems associated with digitization and storage of materials, retrieval methods, and delivery of electronic documents have been addressed in various ways, and some of the worst problems have been resolved (e.g., Digital libraries 1998). However, such digital libraries have not addressed several services often provided by physical libraries, e.g., opportunities for conversations and collaboration among colleagues. In addition, they have not exploited the digital infrastructure to augment their services in ways not possible in a physical library, e.g., in supporting collaboration among users and staff across distances to locate and create information resources.

The design of the American Front Porch (AFP) project, a digital library concerned with the American South, seeks to remedy this situation through its development as a *sharium*—a workspace with rich content and powerful tools where people can collaborate with others or work independently to explore information resources, learn, and solve their information problems (Marchionini 1998). A sharium is a learning environment that combines the features of a collaboratory (Finholt and Olson 1997, Lederberg and Uncapher 1989, *National Collaboratories* 1993), where people collectively engage in research by sharing rich information resources, and a local library, where people come to meet, find information resources, and discuss common interests. Just as the front porch is often a physical interface between our public and private lives, the AFP will serve as a shared interface for a community of interest in the history, culture, and economic and social development of the American South.

This paper begins with a brief overview of the American Front Porch and its services. It then focuses on the collaboration services provided on the AFP: our motivations for providing these services, the types of services to be provided, integration of these services with other digital library services, the technologies underlying these services, and plans for evaluation of the services. The collaboration services to be developed for the AFP may have general utility and could be implemented in other digital libraries.

Overview of the AFP Participatory Digital Library

The AFP Community

We expect the American Front Porch to serve the needs of anyone with interests in the wide-ranging domain of the American South (e.g., scholars, students and teachers in schools at all levels, policy makers, and the general public with interests in the American South). However, as a starting point, our design efforts will focus on the needs of students and instructors in secondary schools and community colleges, scholars and hobbyists. This user community was selected for particular emphasis because today they must typically travel large distances to library resources or do without. For example, high school and community college teachers and students must often travel to larger university, county, and state libraries to obtain materials. Scholars must travel to institutions holding primary resources in their areas of interests. Likewise, those for whom some aspect of Southern culture is an avocation often travel to visit collections of interest to them. The digital library services proposed here may help to make collections more accessible to a much wider range of people.

The AFP Collections

Just as in the physical world rich artifacts draw people together for common purposes, so in the digital world, rich information resources will draw people together to share and create knowledge. The AFP will incorporate many types of resources in different media, from different servers, with different levels of quality and metadata. The initial collection will be a federation of established institutional repositories with well-defined acquisition, metadata, quality control, and usage policies (e.g., the Library of Congress, the National Archives and Records Administration, the University of North Carolina, the University of Virginia, and Duke University). Thus, much of the AFP will draw on existing and emerging digital

collections and integrate these collections with information from a variety of less formal sources, including personal items.

Collaboration Services in the AFP Participatory Digital Library

Motivation for Collaboration Services

Past studies have found that, in a variety of situations and contexts, people typically seek information from another person (e.g., Chatman 1993, 1996, Sonnenwald 1995, Taylor 1991, Vakkari *et al.* 1997). While computer-based information retrieval systems are continually improving, there is little evidence to suggest that these systems will replace individual preferences for interaction with other individuals when seeking information. Indeed, throughout the ages, library users have valued interactions with librarians and others at the library. Sonnenwald (1998) presents a theoretical framework that discusses the role of collaboration in human information behavior. Smith (1994) has proposed a complementary framework for describing how groups meld their respective ideas into a coherent whole. We will apply both perspectives to support AFP users.

In digital libraries, the integration of human-human interaction and human-text interaction is possible for the first time due to the convergence of information and communications technologies afforded by digital media. Imagine the following scenario involving a local resident, Josephine, interested in pre-Civil War slave life on a nearby plantation.

> During the summer, an article in the local paper reported that the zoning board was considering a new subdivision for a tract of farmland that was once part of the Latta Plantation (c.1800). Josephine was curious about the plantation. Her local public librarian suggested she use the American Front Porch to pursue her interest. Through her home computer, she accessed the AFP and made a series of selections from the hierarchical templates (she preferred navigating through the menus to typing in a question). As she was browsing the materials available through the University of North Carolina's project, *Documenting the American South*, she found the autobiographies of Annie L. Burton, a slave from Alabama, and Sarah Morgan Dawson, self-described as a "Confederate girl", and became more interested in how these two young women, each in her own way, coped with the stress of life during the Civil War. Hoping to find additional information about local conditions just before and during the War, Josephine posted a question about the Latta Plantation to the slavery interest board and several related moderated MOOs were suggested. The next day, she joined in a discussion in one of the MOOs and brought the diaries/autobiographies to the attention of other participants. During the interaction, one participant who lives in Detroit said that she had notes that her great-grandmother made about how she and her sister hid in a barn for three days while a battle raged in the neighboring town. The other participants convinced her to take the notes to a library near her home and have the notes scanned and contributed to the AFP sharium with her own personal annotations.

This scenario illustrates how human information behavior is woven around (i.e., is shaped by and shapes) individuals, social networks, situations, and contexts (Sonnenwald 1998.) When collaboration and communication technology is integrated with other digital library resources, such as information retrieval tools and texts, new problem solving, learning, and information creation and dissemination possibilities emerge.

Types of Collaboration Services

We argue that collaboration services should facilitate and augment human information behavior, and, as a starting point, we are designing collaboration services based on research of human information behavior in a variety of settings (e.g., Sonnenwald 1996, 1998, Vakkari *et al.* 1997, Wilson 1998.) The services we propose to incorporate in the AFP digital library include:

(a) dynamic reference services where a reference librarian can conduct a reference interview using synchronous audio (and video when warranted) and can share the results of the search dynamically with the user;

(b) collaborative information exploration where a user and librarian (or other expert) can, at the same time, search and examine library resources, each participant seeing what the other is doing and discussing what is happening with each other;

(c) collaborative information creation where any number of individuals can create a resource for their own use and/or for donation to the AFP;

(d) synchronous and asynchronous interaction among people with similar interests and/or problems, including library staff who may need to discuss collection management issues, etc.;

(e) synchronous and asynchronous interaction among individuals and subject matter experts; and,

(f) synchronous and asynchronous interaction among teams involved in ongoing projects, ranging from several weeks to several months.

These types of collaboration services require mechanisms for people with common interests to identify one another as well as tools for conducting the discussion. Expertise is a precious and scarce resource, and one of our aims is to provide it when it is necessary, but also to protect the experts so that they are not overwhelmed. We will develop a cascading set of mechanisms that may be selected by users or triggered automatically after several self-directed search iterations and a consultation of the automated knowledge base. Levels of support will be tuned to match questions to experts and shelter experts from questions that could easily be answered automatically. In particular, two approaches to reference and referral services appear promising.

First, questions will be referred to experts if the question-asker has already attempted to locate the relevant information him/herself. If searching or browsing the database fails to identify relevant information, the searcher may request an expert consultation and will then be asked to participate in a question clarification dialogue. When the question clarification dialogue has been completed, the person requesting a consultation will also review all his/her recent system interactions, marking those that are relevant to the current question. A representation of the question, generated from a linguistic analysis of the search history and the information recorded during the question clarification dialogue, will then be matched against representations of the expertise and availability of those members of the community

serving as subject or reference experts. For this purpose, the experts must provide a self-description, i.e., a profile, guided by a template that standardizes the description of each expert, encouraging a complete and accurate representation of that person's expertise and availability. The profile will allow the experts to explicitly limit their availability (at particular frequency levels, to particular subsets of the AFP community, or by their immediate accessibility when a question is posed). In this way, the benefit to the searcher will be balanced against the burden on the expert.

Second, we propose that reference services should be based upon library practice. Librarians assist with question asking by conducting reference interviews to help people articulate their information needs (e.g., Jennerich and Jennerich 1997, Dewdney and Michell 1997, Ross and Dewdney 1994, Dervin and Dewdney 1986). These techniques have also been applied in online reference services (Tibbo 1995, Davenport and Procter 1997, Abels 1996, Abels and Liebscher 1994, Billings *et al*. 1994) and there has been at least one attempt to model the reference interview in a digital library (National Agricultural Library 1998). We will build upon these and other online reference services to create multiple levels of reference service.

Figure 1.Overview of AFP Service Components
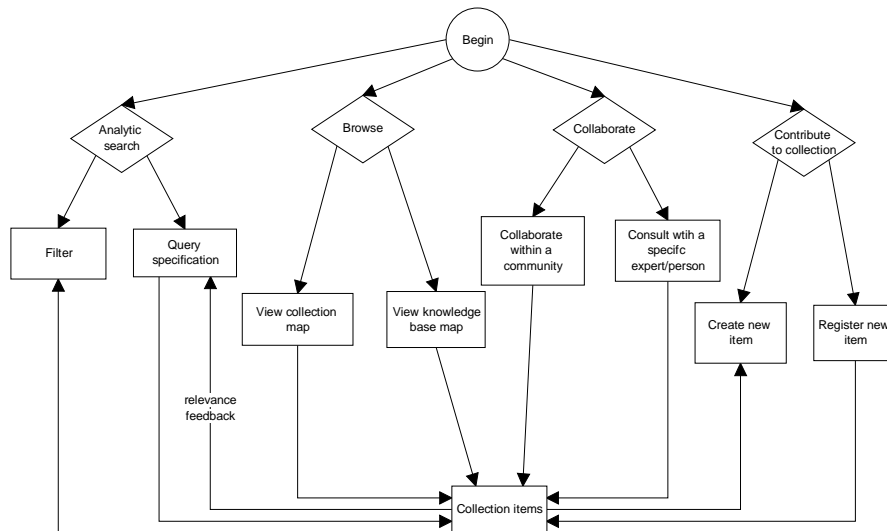
Integration of Collaboration Services with other AFP Services

The AFP will provide a variety of services (see Figure 1) that will be integrated with the collaboration services described above to provide an integrated digital environment. For example, as a registered user enters the American Front Porch, s/he may wish to ask a specific question, browse the collection, interact with other community members, or create or share a new information artifact. If the goal is to ask a particular question, a query is specified and addressed to the knowledge base or to the entire AFP database. If the user's initial goal is browsing, the user may view a map of either the collection or the knowledge base developed through past uses of the sharium. If the goal is to communicate with others in the AFP community, s/he may select from the available collaboration services offered (described in the previous section). If the goal is to contribute to the AFP, s/he may develop a new item or register an existing item or a newly created item.

Several additional interaction routes are available to members of the AFP community and are implicit in this design. For example, questions that arise in ongoing discussions may motivate participants to conduct a search or browse the database, so there will be an easy route from the collaboration services to the browsing and search services. As a user is engaged in a search, s/he may wish to discuss it with an ongoing discussion group or form a group focused on the question topic; thus, there will be an easy route from the searching/browsing services to the collaboration services. The successful integration of these services represents one aspect of next-generation interfaces that support information seeking.

Analytic Search. An important goal for AFP searching services is to provide user-oriented querying and presentation tools that incorporate different topic areas, multiple media, and distributed collections seamlessly. This goal applies for all users of the AFP, whatever their levels of subject or searching expertise. Because the AFP incorporates materials/referrals of many types, information seekers will be able to choose what best meets their needs. For example, the results of a basic search for parlor songs from the 1890's might include:

- Scanned sheet music and a MIDI file of "The Lost Chord"
- Two human experts in that type of music that can be contacted
- References to several books and articles related to 19th-century popular music
- A web page, created by another AFP user, discussing the ways in which music reflects the social and political issues of our times, with historical examples from the late 1800's
- Sample search strategies ("scripts") to follow for researching music-related topics

As illustrated in this example, the retrieval process will provide feedback to the searcher related to vocabulary support (Koenemann 1996, Wildemuth *et al*. 1998) and improving his/her search strategy, as well as retrieving objects of interest.

Browsing. Many of those participating in the AFP sharium may wish to browse the available materials, rather than conduct an analytical search. Browsing involves identifying an entry point, examining information, and assessing its value in an iterative process (Marchionini 1995). AFP browsing services will be based on the provision of various overviews and maps of the collections and previews for specific items. Multiple options for visualization will be explored, in order to identify those that are most useful in the context of a distributed heterogeneous collection in the social sciences and humanities.

As the AFP collections are used more heavily, it is expected that a knowledge base will be developed, focusing on those topics most often searched. The entries in this knowledge base will be browsable, with the topics organized hierarchically.

Contributing to the collection. While searching and browsing, users may take advantage of tools that help them understand, manage, and use the relevant objects they located. Users of the AFP's collections also may wish to create/author reports, presentations, or other types of works incorporating information or artifacts from the collection. Initially, we will provide two classes of authoring tools. The first class of tools will support traditional types of reports and presentations, which incorporate one or more items from the collection. For example, a report on Civil War marching bands may include a photograph of a band, an image of a concert program, and a sound clip of a song. The second class of tools will support the creation of "guided tours" of a portion of the collection, containing an annotated path through a series of selected items, which can then be followed by others. We expect the variety of authoring tools to increase as users develop innovative ways of utilizing the collection.

User-created materials, as well as user-held existing materials, are candidates for addition to the AFP collections. The goal is to allow members of the AFP community to also be developers of collection objects. However, concerns about the quality or perspective of objects donated by individuals and the quality of the object descriptions must be met. Our approach will be to work with collection objects in four categories. The AFP federated collection first will include objects that are digitized by the AFP project, including those held by partner institutions. Collections of other libraries (most notably the Library of Congress) and publishers (commercial or non-commercial) will also be of interest to the AFP community, and will be incorporated as federated collections. Works created and/or held by individual community members present the most challenging component of the AFP collection development policy. Building on typical review and publication procedures, contributors will be asked to submit objects for community review and acceptance before these objects are incorporated into the general collection. The fourth category of objects includes those waiting to be reviewed or those whose authors prefer to provide them to a limited audience whom they define. The combination of these categories of objects in the AFP collection will result in a diverse collection of information resources.

Technologies Supporting Collaboration Services

Collaboration services envisioned for the AFP project will require new end-user tools and thoughtful integration of existing tools and reference services into new combinations. Familiar tools such as e-mail, distribution lists, electronic bulletin boards, newsgroups, and chat rooms will be provided in the earliest stages of AFP development. Finally, we will develop new tools to support collaborative groups engaged in ongoing projects. These tools must support synchronous interaction, including Internet-based voice and video discussions among small groups and shared editing and drawing tools. However, they must also include tools that support asynchronous collaboration, such as joint authorship of documents so that team members may share and combine their respective contributions without tripping over others. One particular tool for this purpose is the JavaObjectWeb system, being developed by Smith and his colleagues. It enables distributed groups to develop hypermedia documents comprised of Java objects, and facilitates incorporating these new documents into existing

collections to support continuous, organic development of the library. Equally crucial are distributed software infrastructures for building collaboration services based on large, media-diverse, tightly coupled information spaces. Two major technological support components for collaboration services are distributed network storage and metadata (MD) management.

Distributed Network Storage Solution. Currently users often experience highly variable retrieval times when accessing objects on the Internet. The performance of any given data transfer is determined by dynamic network and server conditions, including the "distance" of a user from an Internet server, the time of day, and server load. Successful large, time-sensitive data transfers, such as multimedia files that combine synchronized audio and video, are often impossible on the Internet during peak-load hours or across large distances. Similarly, shared browsing and retrieval operations for the proposed collaboration services will place timing constraints on the network transfer of objects, and these types of services could be effectively unusable depending on the geographical location of users and other resource demands on the network.

To address these issues, the AFP project plans to adopt and extend a scheme for data replication under development by the Internet2 Working Group on Storage (Beck and Moore 1998). This scheme provides a structured form of data mirroring, incorporating a mechanism for transparent resolution of URLs to physical servers which eliminates the requirement that the user input the address of alternative servers and the placement of replication servers throughout the network. With this approach, users should experience *consistently* small delays in retrieving, browsing, or searching. In addition, tools can be built that will transparently place large objects onto a local server within schools or other sites with low-bandwidth links and thereby enable experimentation and learning with the rich array of informational resources, authoring tools, and collaborative experiences available through the AFP digital library.

Metadata Management. To illustrate the demands that collaboration services make on metadata, consider a scenario in which two performance artists jointly create and contribute a multimedia object incorporating an audio of a folk song and video of a corresponding dance interpretation. The jointly owned information resource is created using AFP tools and maintained in the AFP proper with appropriate modification permissions assigned. Upon donation of the resource to the AFP, specific cataloging information will be provided by the users and maintained in the AFP knowledge base. This will include Dublin Core based elements, as well as subject categories specific to Southern culture, literature, art, and history. An initial quality annotation will indicate the source of the information object. Eventually, experts and users may judge the resource to be of high quality and utility, and the object's quality annotation will be augmented.

In order to make the AFP useful for its specific user community while simultaneously ensuring interoperability in the wider electronic environment, we will use commonly accepted standards for descriptive metadata, such as the rapidly emerging Dublin Core Metadata (1997) for individual items and the Encoded Archival Description (1997) for collection descriptions, *supplemented* with AFP-specific metadata elements that address our particular operational and research needs. In addition, we will employ the emerging Resource Description Framework (RDF 1998) for encoding metadata descriptions with the instantiation of RDF in the eXtensible Markup Language (XML).

Evaluation of Collaboration Services

We propose to evaluate/study the collaboration (and other AFP) services from multiple perspectives, including human-computer interaction, information seeking tasks and processes, and human information behavior within its social context. Each of these dimensions generates important questions whose answers will help determine if collaboration services will support and augment human information behavior.

Human-Computer Interaction. Some questions relate to which technologies best support user tasks and processes. Does a shared, distributed electronic notebook facilitate the sharing of information when users are collaborating? Does synchronous video among distributed workstations facilitate the reference interview or referral process? Additional questions focus on the usability of the technology. How should shared pointers be implemented? Which views of data and instrument controls need to be shared and how tightly do they need to be coupled? What level of network performance is necessary for effective collaboration? These types of questions will be investigated using cognitive task analysis methods (Rasmussen *et al*. 1994) and usability testing methods (Rubin 1994, Dumas and Redish 1993). These studies will be conducted during the development process to facilitate iterative design and development of the AFP.

Information Seeking Tasks and Processes. It is also important to evaluate how the services affect information seeking tasks, processes, and outcomes. Do the services affect how people search in digital libraries? Can information exploration be successfully conducted using this technology? For example, Rice (1992, 1993) has argued that a sense of presence is more difficult to achieve through computer-mediated communication and that tasks that involve creative, interpersonal, and outcome-oriented activities may require a strong sense of social presence. We will study information seeking tasks and processes using multiple methods, including experiments, observation, automatic protocol tracking, user logs, and interviews.

Human Information Behavior within its Social Context. As discussed in other research (Finholt and Olson 1997, Dourish *et al*. 1996), the introduction of collaboration technology may change the way work is conceptualized. It may influence what questions are asked, and facilitate (or impede) the discovery of new solutions and/or the production of knowledge in unforeseen ways. Furthermore, we know aspects of the setting (e.g., the reward structure) may influence the use of technology (Starr and Ruhleder 1996). In the context of the AFP, will users be able to bridge differences in their cultures, specialized languages, work practices, and perspectives to effectively use collaboration services? Are there other constraints or supports that will influence the use of the collaboration services? These research questions are qualitative in nature, and we propose to use qualitative research methods, such as semi-structured interviews (McCracken 1998) and critical incident interviews (Flanagan 1954), to learn participants' expectations, perceptions, and evaluations of the collaboration services and their outcomes.

Conclusion

The AFP builds upon previous work on digital libraries, in order to augment typical collection development, searching, and browsing activities with an array of services that support collaboration among a community of people. By providing collaboration services, the American Front Porch project will create a digital library that integrates analog and digital resources with the intellectual resources distributed in the user community. One necessary step in reaching this goal is the design and development of collaboration services that are integrated with other services, including analytic search, browsing, and collection development tools. This approach supports preferences people have for interacting with others when searching for information, while also allowing them to work individually. The proposed collaboration services may also have general utility in other digital library contexts. For example, in a variety of distance learning contexts, where students typically have limited access to library professionals and other students, digital library collaboration services could help provide such access to enhance the students' learning opportunities.

However, challenges remain. These include developing mechanisms for identifying possible collaborative partners, facilitating contributions to the library, and providing a library interface that effectively provides access to multiple services and combinations of services for users with different goals, constraints, and interests. Previously, many technical limitations prohibited implementing these ideas. Although technical challenges still exist, we propose several technical solutions to support collaboration services within the American Front Porch Participatory Digital Library.

However, further research is necessary to implement the planned collaboration services in ways that support effective AFP use. Integration of the results of these studies with current technologies will improve our understanding of systems that can augment human information behavior.

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