



A virtual library for building community and sharing knowledge

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Libraries are hubs for social and intellectual interactions in communities and organizations. Virtual libraries should serve the same purpose, yet virtual libraries often focus simply on making their holdings available. In this article an on-line corporate library is described that places knowledge sharing and community building at the core of its design. The library system supports personal websites that are visible to the entire organization. Personal topic profiles for library research services, information services choice and collaborative research requests provide employees with views of each others' activities and interests. In particular, information about research questions being asked across all parts of the organization provides a unique window on the company's goals and activities. Collaboration and interest-matching tools help employees to share knowledge across the organization and to form special interest communities.

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1. Introduction

Imagine a library in which patrons enter anonymously, never looking at each other and never being recognized by the library staff. There are no chairs, tables or open spaces in this imaginary library because the only activity allowed is finding and taking away books. The primary goal of any tool in the imaginary library is to allow people to find what they want as fast possible so that they can get out in a hurry. The staff's job is to count the number of people who enter the library. This imaginary library is a bleak shadow of the reality of most libraries which, despite popular misconceptions, are lively places with many interactions going on at any given time. Unfortunately, this is the type of library that is reflected in many on-line library sites.

Digital libraries have stressed categorization, indexing and search of documents. Often digital libraries are nothing but documents and a search tool. Similarly, research on digital libraries is dominated by indexing and retrieval mechanisms. The usefulness of such tools is not in dispute, however this is not the whole picture of what libraries can and should be about. In this paper, we discuss a corporate library designed to foster community building and knowledge sharing across the organization.

1.1. SOCIAL BEHAVIOR IN LIBRARIES

Ethnographic studies of behavior in libraries show that library patrons spend a considerable amount of time interacting with staff members and with one another (Ehrlich & Cash, 1994; Levy & Marshall, 1995; Rao et al., 1995; Bishop & Star, 1996). In fact, libraries serve as informal meeting places for people with common interests and can be instrumental in the formation of special interest groups (Hinds & Kiesler, 1995; Constant, Sproul & Kiesler, 1996).

The observed behavior of others in a situation contributes to a sense of the situation's ambience, or social atmosphere. This sense is often important in determining whether people like a place or situation and whether they will return. Retailers have always been sensitive to the ambience of their stores and strive to create various feelings. This has generalized easily into e-commerce applications (since, among other things, it is not far from the notion of the "feelings" or "ambience" of print publications). But this type of ambience is generally created, both in real and virtual settings, by using the physical features of the environment: hot or cold colors, crowded or empty spaces, graphical elements and messages.

Another type of ambience comes from the behavior of people in the environment. The sense of a "quite" place vs. a "busy" place is a determination made on the basis of what people are doing. In places like libraries or bookstores, many content-rich social interactions and observations occur. Because the physical layout of libraries or bookstores is related to the topics in various sections, people tend to notice others in the same sections and can assume that there are common interests (Bishop & Star, 1996; Covi & Kling, 1996). For example, a person standing around in a certain area of a library or carrying a stack of books can be quickly identified as a "nature lover" or "poetry fan" based on the area they are in or the type of books they are carrying. A person pulling a book off of a shelf may invite a comment such as "That's a good book" or "There's a better book on that topic". The collection of such observations and interactions provides an "information ambience" and creates a social value for institutions like libraries.

An interesting example of carrying the information ambience of a certain type of store into cyberspace is amazon.com, which allows readers to comment on books and shows what other books people have bought in association with any particular book being browsed. These traces of the activities of other people add a richness to the amazon.com experience that moves it closer to the experience of a real bookstore and farther from the experience of a mail-order house.

1.2. IDENTITY IN CYBERSPACE

Anonymity is a hallmark of cyberspace. However, anonymity blocks community building and knowledge sharing. It precludes the creation of a social atmosphere based on observed behaviors. If a website, like a virtual library, is to support community building and knowledge sharing, then the patrons have to be identified and observable to others. Identity, in these cases, does not have to encompass a broad range of personal characteristics. Consider again the case of a person taking books from a shelf in a library; it is sufficient to initiate a meaningful conversation if the person's presence and behavior is visible and if the content of the materials he/she is choosing is visible. It is not necessary to know more about the person.

For a community to develop over a period of time, however, it is important to learn who people are and how to find them, at least in the context of the library. There are many groups that meet in particular places at particular times in which the participants only know each other's names, relevant interests and purposes and histories that are relevant to the group. This slice of identity and behavior is enough to support special-interest communities.

Thus, the following aspects of identify need to be supported in the design of digital libraries if they are to have social value.

Identity via purpose. This is the way people know each other in many commercial and informal transactions. A library staff member may have people identified by their goals when they come into the library, e.g. "the guy who reads all the nature books", "the woman who always looks at telecom stocks on the internet" or "the vice president who is always asking questions about downsizing". These identities are not personas developed and displayed by the library clients, rather they are observed identities that arise from behaviors in the context of the library itself. Thus, in cyberspace, they cannot be entirely represented by client-crafted homepages, but instead have to be the result of some mechanism that creates a visible record of client activities.

Asynchronous visibility. If identities are to be derived from behavior, then it follows that the behaviors have to be visible. Unlike real life, where co-presence in time is usually required to observe others, in virtual space it is possible to record behavior and make the traces visible. Buying habits are recorded by amazon.com so that, when a new buyer is looking at a book, they can be informed about what others with similar interests have done in the past by observing the information provided by the virtual environment. It is like seeing someone else in a bookstore who is holding a collection of books that includes one that you are interested in, however it is asynchronous.

Connection process and community facilitators. Communities of interest do not just spring up because the environment affords community building. It is important to have processes which, or individuals who, facilitate community building. Examples of processes include bulletin boards and meeting announcements, which are well established in cyberspace. Individuals who facilitate community building are people who can observe the behavior of others in a common environment and make connections among them. This is often a critical role for librarians. Library staff can and do get informal "interest profiles" of their clients by noticing where the clients spend their time and what they request or check out.

1.3. LIBRARIES AS KNOWLEDGE CENTERS

Information relevant to the ongoing activities of a community or organization will tend to flow into a heavily used library. For example, if a school district begins a program on environmental education, the library serving the district will begin to receive many questions about environmental issues from students. Staff members will notice relevant library materials being checked out. Similarly, if a corporation plans a new product launch or a strategic acquisition, the corporate library will begin to receive requests for specific market information or for corporate financial information, from a variety of sources involved with the corporate action. Indeed, it is something of a sport of research librarians to figure out what is going on in the community they serve.

Librarians use the information about community activities to help them determine what is most relevant to their clients. For example, a corporate research librarian might provide different information in a company profile if he or she thinks the profile will be used to negotiate a merger instead of entering a competitor's market. Because one of the research librarian's roles is to filter and focus information, inferences about community activities, as reflected through the goals of the researcher's clients, are very important in guiding the researcher's work.

Unfortunately, the concentration of information about community activities is often a lost resource for an organization. Librarians use it locally for their own purposes, but it seldom leaves the library and is unavailable to rest of the community. While confidentiality is sometimes required between research librarians and their clients (and is, in fact, part of the code of ethics for library researchers), there is nonetheless a potential value in sharing a library's unique perspective with others in an organization.

2. A corporate virtual library for building community and sharing knowledge

We recently developed and deployed an intranet-based system for handling research requests at U S WEST, a telecommunications company in the western United States[†]. The system is designed to address issues of client identity and community, and to leverage the knowledge that is implicit in librarians' interactions with their clients. In this section, the system and its development are described in detail.

2.1. REQUIREMENTS AND DEVELOPMENT

The overall system was developed incrementally over the course of approximately 24 months. A user-centered methodology was adopted in which staff and clients were observed and interviewed about their activities. Prototypes to support library activities were developed and used by the staff with changes made in response to feedback.

The initial requirements called for a system that provided access to library information services and supported library research interactions. Overall goals were set in planning meetings involving the head librarian (KR), the library staff and the developer (SR). Subsequently, the developer interviewed staff members about their jobs, observed researcher-client interactions and developed a task analysis of library researchers' activities. This task analysis is described in more detail in Section 2.6

The first iteration of the system involved a library website with access to information services and research requests. The research component was the only personalized aspect of the system (this stage is described in Robertson, Jitan & Reese, 1997). As this system was being used, planning began on a "push" capability that would deliver personalized research material to clients according to their interests. The initial plan for pushing research involved email, however, interviews with clients suggested that they already got too much email and that they needed research categorized and packaged. Thus, it was

[†] The system has subsequently been licensed by MediaOne, an international broadband and wireless company.

decided that each client would receive a personal “push page” with research article titles organized according to the client’s interest profile. Each title would link to an article. An optional email notification of new material was also part of the requirement.

Library clients also indicated that in the initial system they did not like the fact that they were presented with many options for information services but could not necessarily access all of them. Thus, it was also decided to bring the information services capability into the personal sites, presenting clients with icons only for those services to which they subscribed.

In the end, the requirements for the final phase of the library system involved expanding the personalized research request component into personalized client websites that included access to information services, an interest profiling and research push capability, and the research request system.

2.2. OVERALL SYSTEM ARCHITECTURE

Figures 1 and 2 provide an overview of the system architecture. In the figures, web pages are shown in solid-lined rectangles, processes supported by cgi scripts are shown in ovals and databases used by the system are shown in dashed-line rectangles. Arrows indicate interconnections among web pages, when web pages send and receive data from processes, and when processes pull from and write to databases. All cgi scripts are written in Perl.

One part of the library website consists of a set of interconnected web pages with typical library functions, e.g. a library catalog and checkout service, library staff pages, descriptions of services offered and categorized links to various other internet and intranet sites. We will not discuss these components of the library website since the focus in this paper is on the community-building and knowledge-sharing aspect. Figure 3 shows the home page of the U S WEST library, with links to various sections in the left column. The remainder of the paper deals with the system after a client has gone to the “Personal Sites” link from the home page.

2.3. LIBRARY CLIENTS’ PERSONAL SITES

Preliminary discussion of requirements with the library staff showed clearly the significance of the social and interpersonal aspects of research interactions. Staff members were very concerned that an intranet-based request handling system would complicate, or even eliminate, the personal relationship between them and their clients. They were justifiably concerned about removing the research activities from their “community context” (Nardi & O’Day, 1996).

To address this issue, each client of the library and each staff member was provided with a “personal website”. Initially, a client’s personal website was an intranet page containing his/her contact information and links to his/her ongoing and archived research. The personal websites have since evolved into a set of customizable web pages from which clients not only view their research requests, but also access on-line research services, get library news and receive personalized information that is filtered and “pushed” by the library staff.

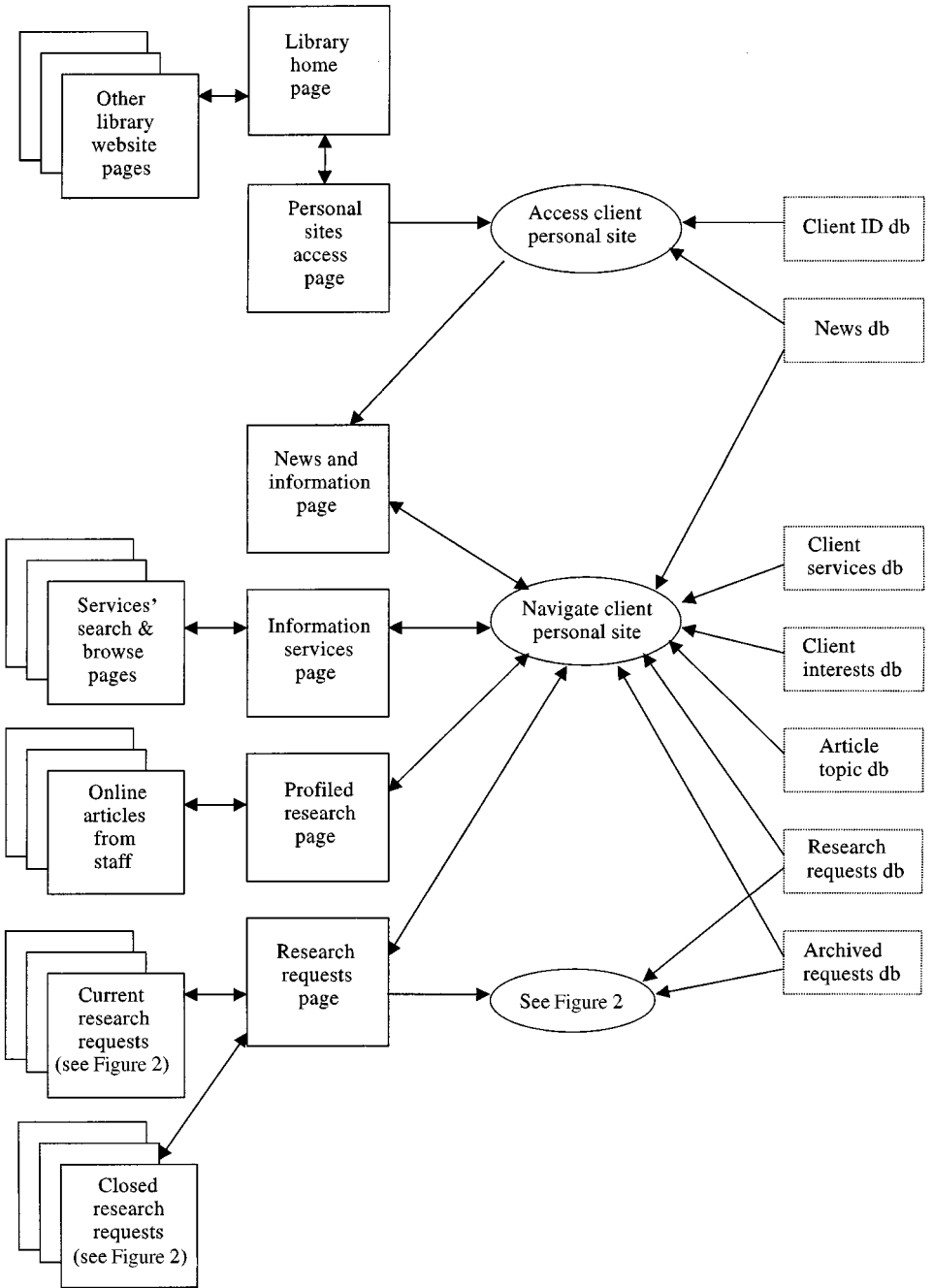


FIGURE 1. The overall architecture of the library system.

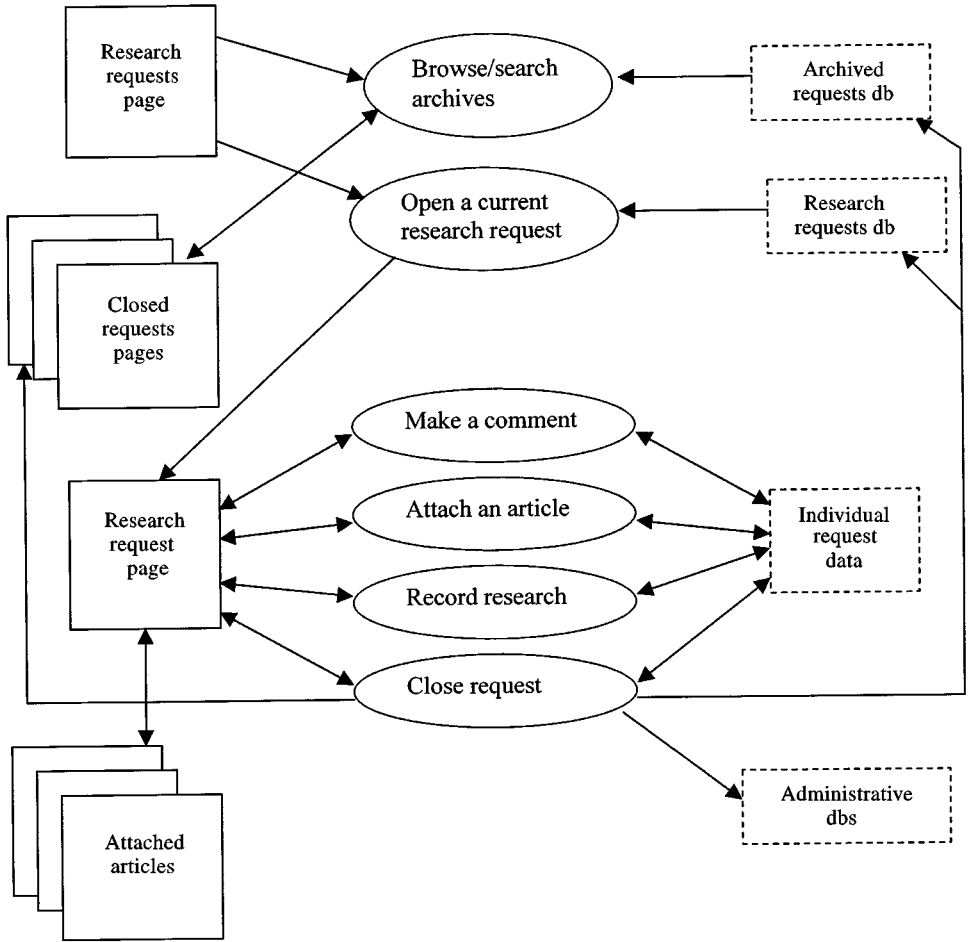


FIGURE 2. The overall architecture of the research request handling system.

The personal web pages are viewable by other employees, so they not only serve to deliver customized information to the client, but also reflect the client to others who may browse the pages. The contents of personal web pages, as they evolve, provide client “identities in cyberspace”. The personal websites are linked to many lists of on-line library activities and to research requests. The idea is to provide the on-line equivalent of special interest areas or ways for people who are in one part of the library website to find others whose interests or activities are related.

Visitors to the U S WEST Library website may go immediately to the “Personal Sites” page shown in Figure 4, where they enter their user ID to access their personal website. As Figure 1 shows, once clients are in their personal website, cgi scripts control the display of information as they navigate through their personal web pages.

The top page of a client’s personal website, shown in Figure 5, provides news and information. When this page is accessed, a cgi script reads contact information about the

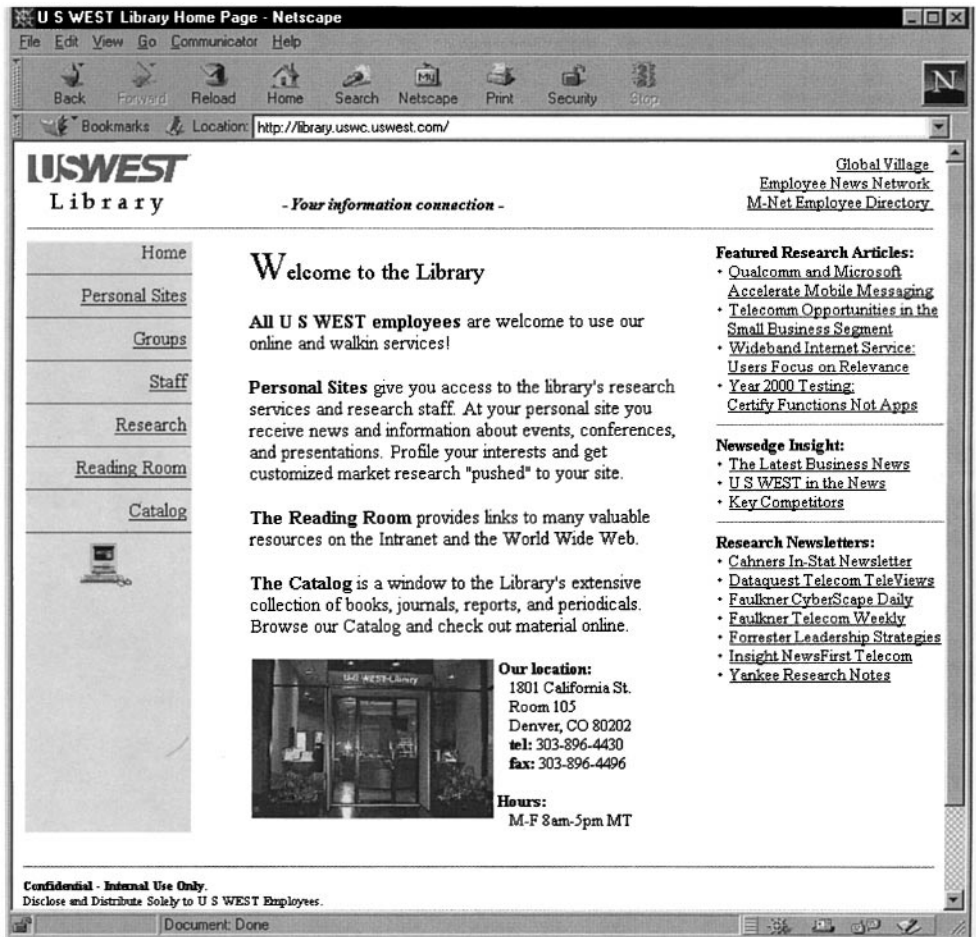


FIGURE 3. The library homepage at U S WEST. Clients use the left column to navigate throughout the website.

client from a client database and current news from a news database. The client database is kept up to date by frequent synchronization with the company's human resources database. News and information is authored by library staff through their personal websites. By displaying contact information on a personal website, it makes it easy for another employee who is browsing the site to reach the person.

A navigation bar near the top of the personal website pages allows clients to move to a "Push" page for profiling their interests and receiving pushed articles, a "Services" page for accessing research services and databases, a "Requests" page for making research requests, and a page for administering their password. In the next sections, we discuss the information services, push and research request pages. The research request functions are discussed at length since this, in many ways, is the heart of the knowledge-sharing aspect of the library system.

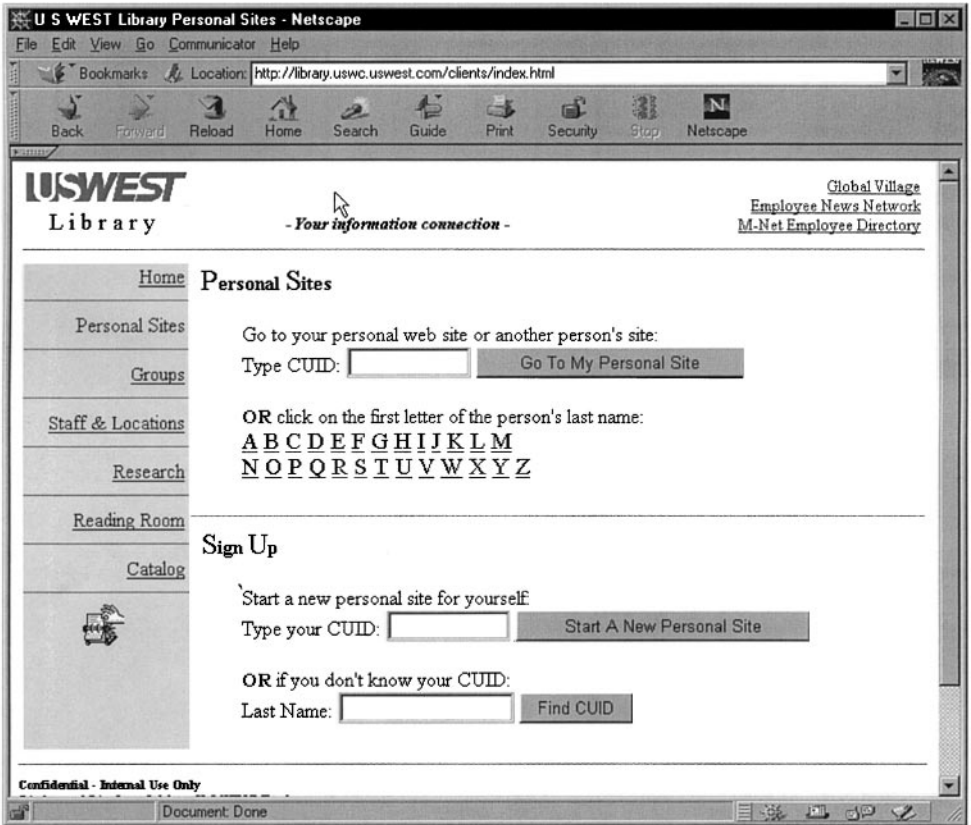


FIGURE 4. The "Personal Sites" page: portal to clients' personal websites.

2.4. INFORMATION SERVICES

Most libraries subscribe to several on-line information services. These services provide primary research and analysis in various areas including marketing, technical information, demographic trends, consumer data and business intelligence. This information is used primarily by research librarians, however, the library system also makes this information available directly to clients. Clients are thereby able to perform simple searches themselves, freeing library staff to answer more detailed research requests.

As depicted in Figure 1, when a client goes to his "Information Services" page, a cgi script checks his services profile. The profile contains information about the services to which a client subscribes. Icons providing access to only those services are returned on the client's page. When an icon is selected, the browse and search capabilities for that service appear. Clients may subscribe and unsubscribe to services as they please.

In addition to making a considerable amount of information available to all employees, the "Information Services" personal web page also serves a community-building function when someone else looks at it. The particular services to which a client subscribes reflect something about that client's interests. Finding that a client subscribes

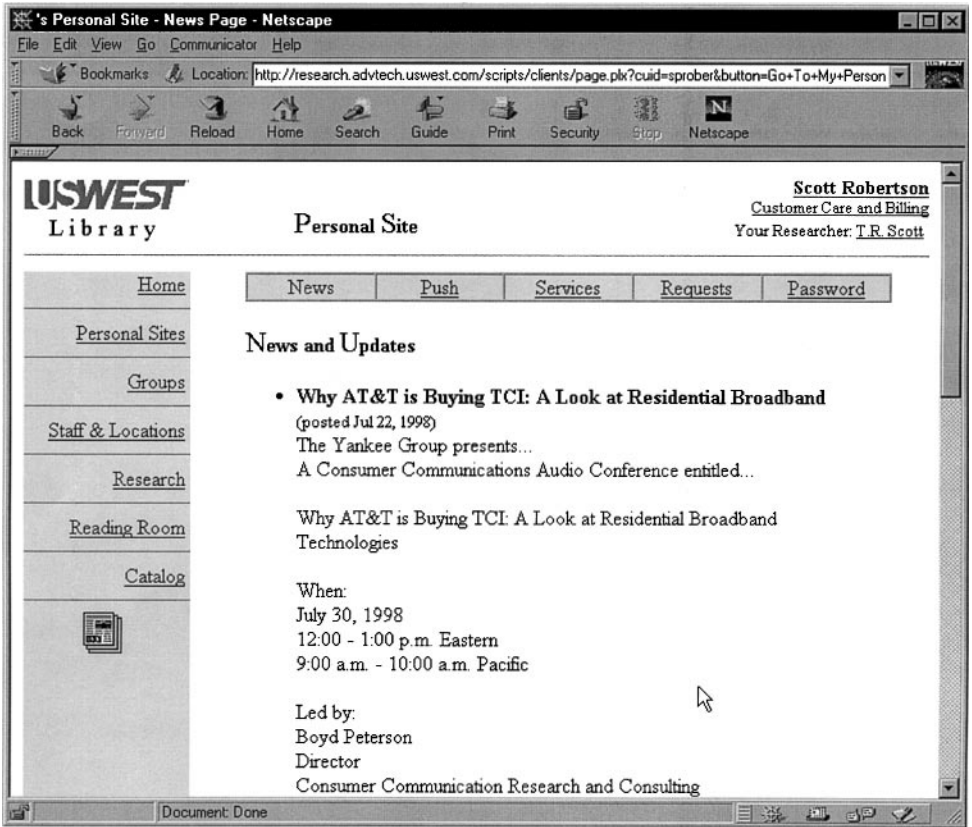


FIGURE 5. A client's "News and Information" page. The navigation bar across the top of all personal pages allows access to different parts of a client's personal website.

to the same services, market intelligence reports on European wireless for example, is a bit like noticing someone in your favorite section of the library. It serves as a interest-based point of recognition and suggests potential shared concerns.

2.5. PERSONAL INTEREST PROFILES AND PUSH

Librarians have traditionally served as informal keepers of information about the interests of their clients. Proactive librarians look for material relevant to their clients' interests, or find information in the course of their work, that they pass on to clients as a personal service. In fact, clients who find librarians that are particularly attuned to their needs soon regard them as invaluable resources. Automated "push" systems accomplish something similar by combining search agents with personal interest profiles in order to push information, but they lack the knowledge of client's goals and the contexts of clients' interests that librarians have automation for push.

Research librarians who find interesting material may send it to the system from their personal websites. They do this by copying the material to a special directory on the

library web server. Articles in this directory show up on a researcher’s personal website where they can be categorized and comments attached. The categories that are used for profiled research are derived by the library research staff using their knowledge of the business and the activities of their clients. In turn, clients may profile themselves by selecting the business categories that they are interested in. As Figure 1 shows, when a client accesses his/her “Profiled Research” page, cgi scripts compare the client’s interests with categorized articles and then return links to those articles to the client’s page. Clients may update their interests at any time.

Even more than the information services profile of a client, the personal interest profile of a client is an important knowledge source for community building. In fact, “Profiled Research” pages contain a link called “Communities of Interest” which compares the interest profile of a client to all other clients. A client’s “Communities of Interest” page, shown in Figure 6, returns information about other employees who have various degrees of match in terms of interests. A number follows each of the client’s interests, indicating how many others share that interest. When a number is clicked on, a list of employees who

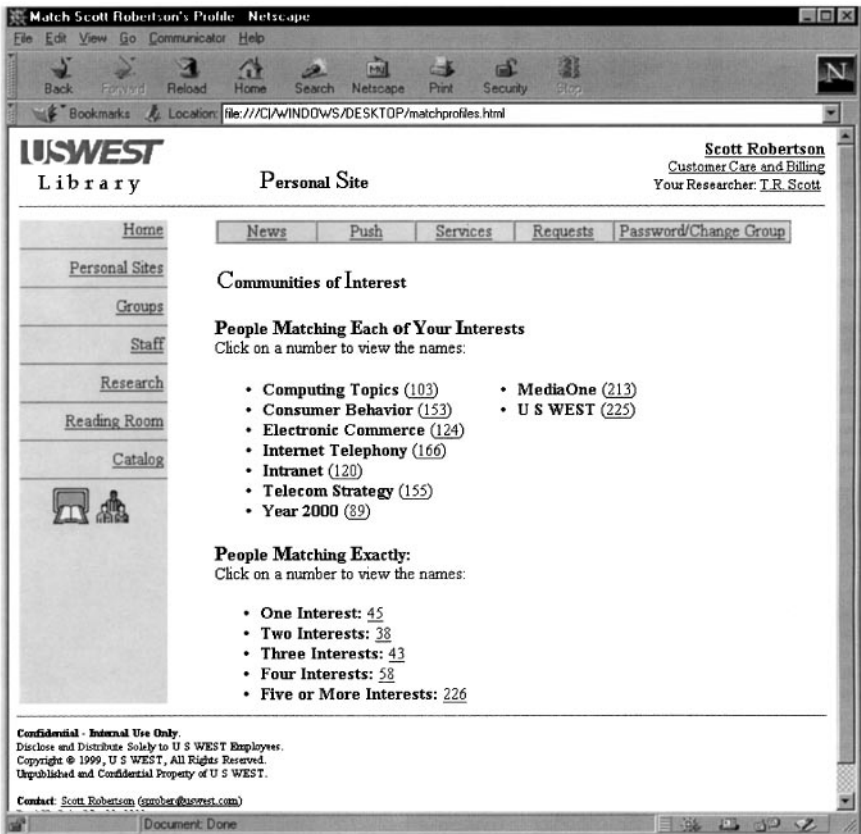


FIGURE 6. A client’s “Communities of Interest” page. Clicking a number returns a list of others with the same interest(s). The list page provide contact information and access to other people’s personal websites.

provided. The list includes contact information and, more importantly, links to each personal website so that a client can browse the personal website of other employees who share his/her interests.

2.6. RESEARCH REQUESTS

Library clients may make complex research requests of the library research staff. The staff uses a number of the relevant resources of the library to gather information in response to the request. The client is usually provided with several research articles and interpretation in a highly collaborative research interaction. Collaboration, knowledge sharing using research requests, preservation of client identity, and enabling special interest groups were at the core of the web-based research request system.

2.6.1. *Task analysis and requirements*

A task analysis of researcher–client interactions as they were performed before the system was implemented is shown in Figure 7. Research interactions were initiated by the clients, who would ask a question either by phone or in person. Regular clients of the library would contact a particular researcher who had done work for them before. New clients were assigned a researcher, usually on the basis of the group that they belonged to (researchers were assigned to particular groups).

Questions were typically short, such as “What is the future of digital libraries?” Library researchers immediately embellished questions based on their understanding of the client, his/her group and the business. For example, a research librarian might embellish the above question by saying “He really wants to know if we should be looking at digital libraries as a potential line of business”. The research librarian formulated an initial strategy for finding information at this stage, planning which sources to investigate and what types of materials to return to the client.

Researchers usually engaged the clients early on in a dialog about their request. The dialog, referred to as the “reference interview”, would set goals, scope, timetable and other parameters for the research activity. Usually, the research librarian would present options from his/her initial strategy, explaining the time payoff involved with various options. Clients explain their goals, providing a context for the request and helping the researcher to understand what they already know and what types of new information would be valuable.

After the reference interview, the researcher began searching information sources (usually online) and choosing documents that they think are relevant. The documents were sent to the clients incrementally, usually with some explanation of what is important about them. Researchers would almost always print the documents and fax them, or send paper copies via company mail to the clients. Explanations were usually provided by phone. Once some documents were delivered, the researcher and client might engage in another round of goal setting, very much like the initial reference interview, but this time being informed by the material provided.

At some point the researcher and client agreed that the task was finished. At this time, researchers were supposed to record the time spent in various activities for administrative purposes. In reality, the recording was usually done monthly with the time spent on various activities being reconstructed from memory. Administrative data were recorded

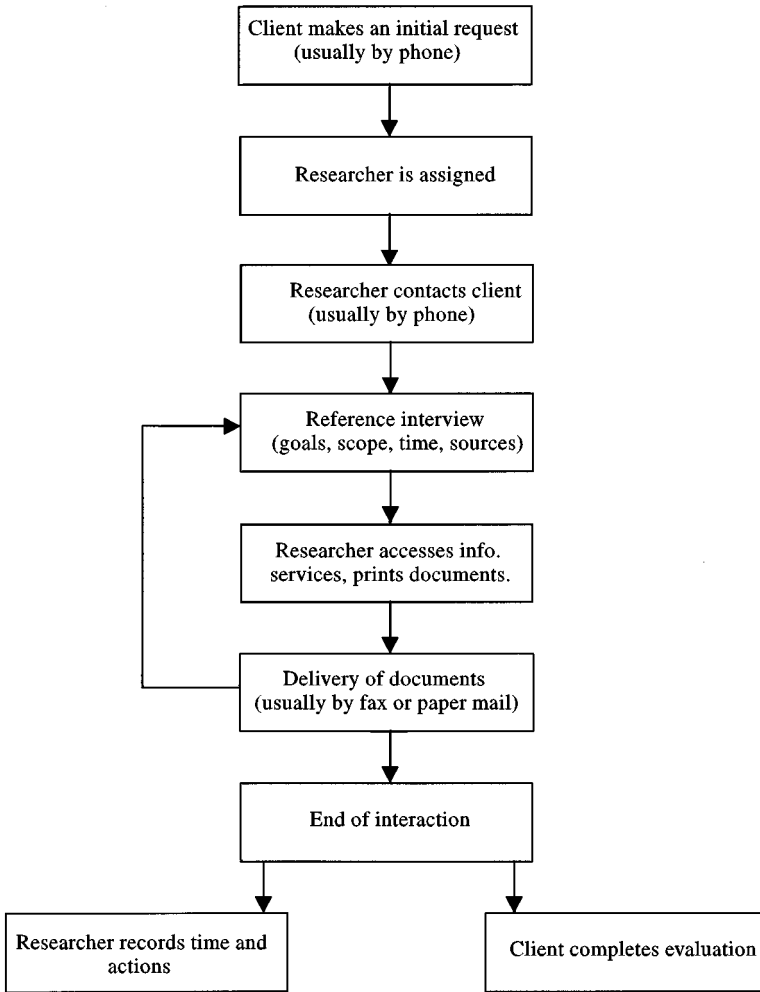


FIGURE 7. Task analysis of the research request activity as practiced before development of the on-line system.

in a stand-alone database as a separate task for the researchers. Clients filled out evaluations at the end of research interactions. Evaluations were usually sent on paper or via email.

The new system is designed to maintain the task structure, but at the same time to bring the interaction, document delivery and record keeping, together in a single, web-based system.

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Figure 2 provides an overview of the pages, process and data used to support research requests. Figure 8 shows a mapping of the task analysis of a typical research request scenario onto the system design. It will be helpful to refer to Figure 8 while reading the ensuing discussion. Note that Figure 8 shows only client and researcher interactions, however, other clients can browse ongoing research request pages and participate in the question/comment activities.

When a client accesses his “Research Requests” page, shown in Figure 9, cgi scripts use databases of current and archived requests to generate a personalized list of requests. From this page, a client may browse or search his own (or all) archived requests. The client may also go to any ongoing research request or open a new research request.

The “New Request” link brings up a form on which a client enters the research request and some other details such as the due date. It is not necessary for the client to enter any personal information on the form since the form is retrieved from his personal website and his/her information has already been bundled with it. As Figure 2 suggests, when the form is submitted a data file for the specific request is created. This file will hold all information about the request while it is open and is used to generate a unique “Research Request” web page. A researcher is automatically assigned and notified by email of the impending request. The request also shows up in a pending list on the staff member’s personal website.

2.6.2. The research request

During requirements gathering for the system, library researchers described the research request as if it were a “first class object” in an object model of the task. They described properties of the request such as its dates (start date, close date, due date), its client (a person and/or organization), its content (the research question itself), and so on. Consequently, when each research request is made, a new “Research Request” web page is created. The “Research Request” page reflects all of the properties of the request and operates as the focus for all interactions involving the request. As Figures 2 and 8 show, these include making comments, attaching articles, recording research and closing the request.

Figure 10 shows a “Research Request” page after the request has been submitted but before any activity has taken place. The request is identified by the number in the page header. Relevant dates also appear in the page header. The request itself, which consists of a title and description provided by the client, appears in the main portion of the page.

At the bottom of the main portion of the “Research Request” page is information about the client and the researcher. This personal information is always kept with the request and reinforces the fact that the request is an interaction between two people. The personal information about the client and researcher is linked to their respective personal website. Thus people browsing the request can find out what other interests the client may have by going to his/her personal website and looking at other current and past requests and at other aspects of the client’s personal website. A client can also skip to his/her researcher’s personal web page and look at other work being done by that researcher.

At the top of every research request page are links for posting comments, posting actions and research activities, uploading articles and closing the request. These support the various types of interactions that take place around a research request. When any of these links is followed, a form appears in which the appropriate information is entered.

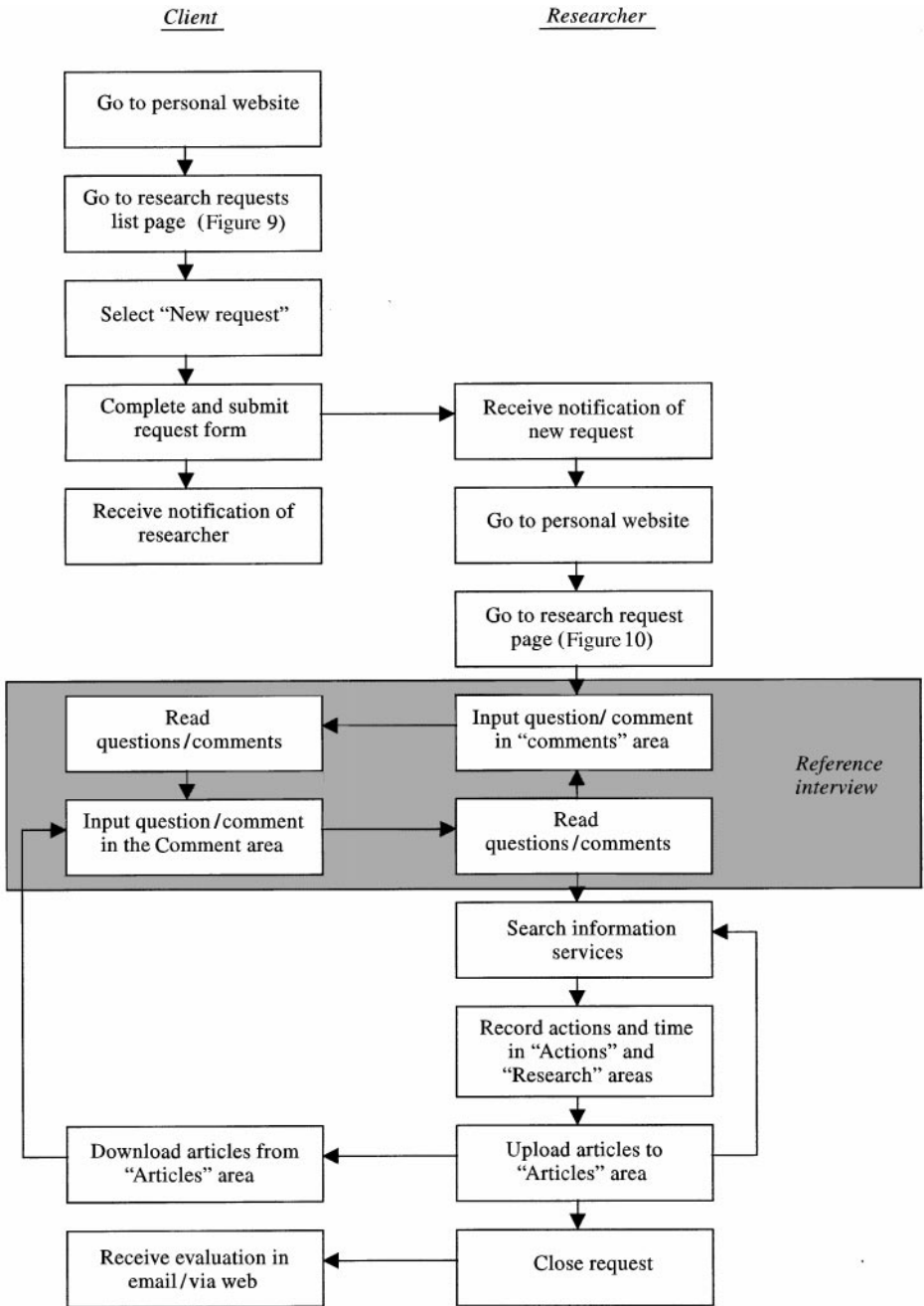


FIGURE 8. A typical scenario for completing a research request interaction using the system.

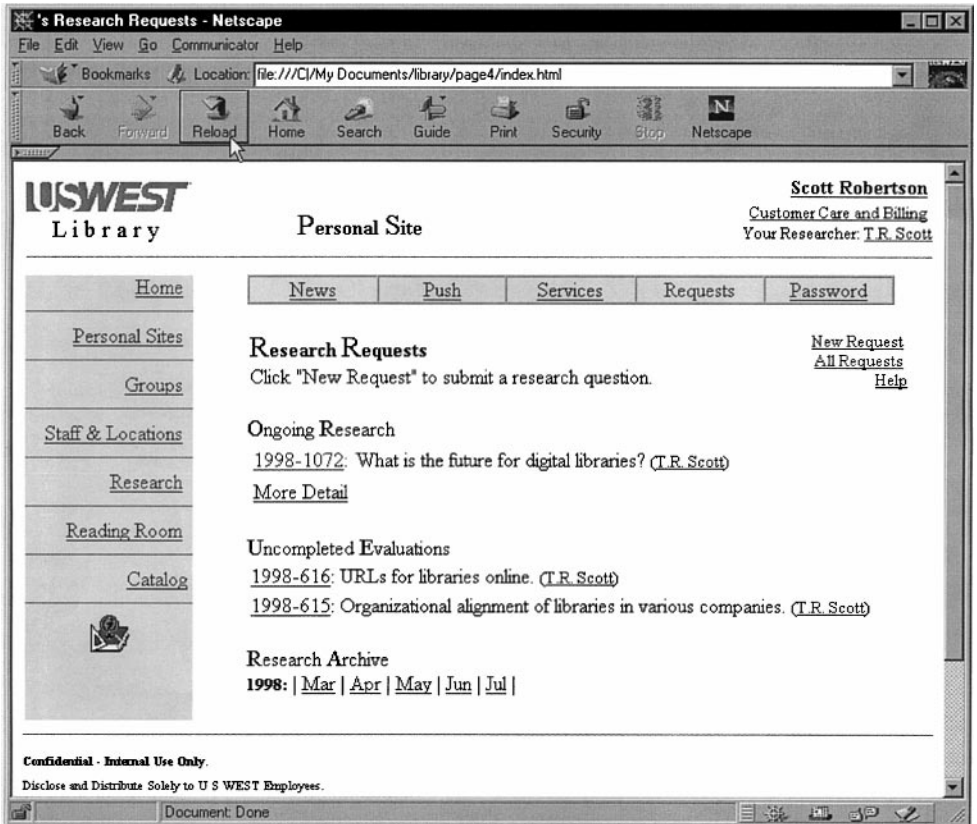


FIGURE 9. A client's "Research Requests" listing page. Clients initiate new requests and access ongoing and archived requests from this page.

As Figure 2 suggests, when a comment, attachment, research record or close request form is submitted, the request data is updated and the "Research Request" page changes. These actions are discussed in detail in the following sections.

2.6.3. Comments

Observation of the activities of library researchers during system development revealed that one of the first things that happens when a research request comes into the library is that the researcher contacts the client for clarification and elaboration. Research librarians describe this as the "reference interview". It is during the reference interview that researchers try to determine the underlying goals of their client in order to better target their research activities and tailor their response.

Information revealed during the reference interview is critical for understanding the request. It is also highly transient and ephemeral in that interview information is only maintained in the researchers' memories as they interact with their clients. The comment capability is intended to capture some of the reference interview material.

The comment feature supports asynchronous interaction. In order to use the comment capability, the user clicks the "Comments" link at the top of the "Research Request"

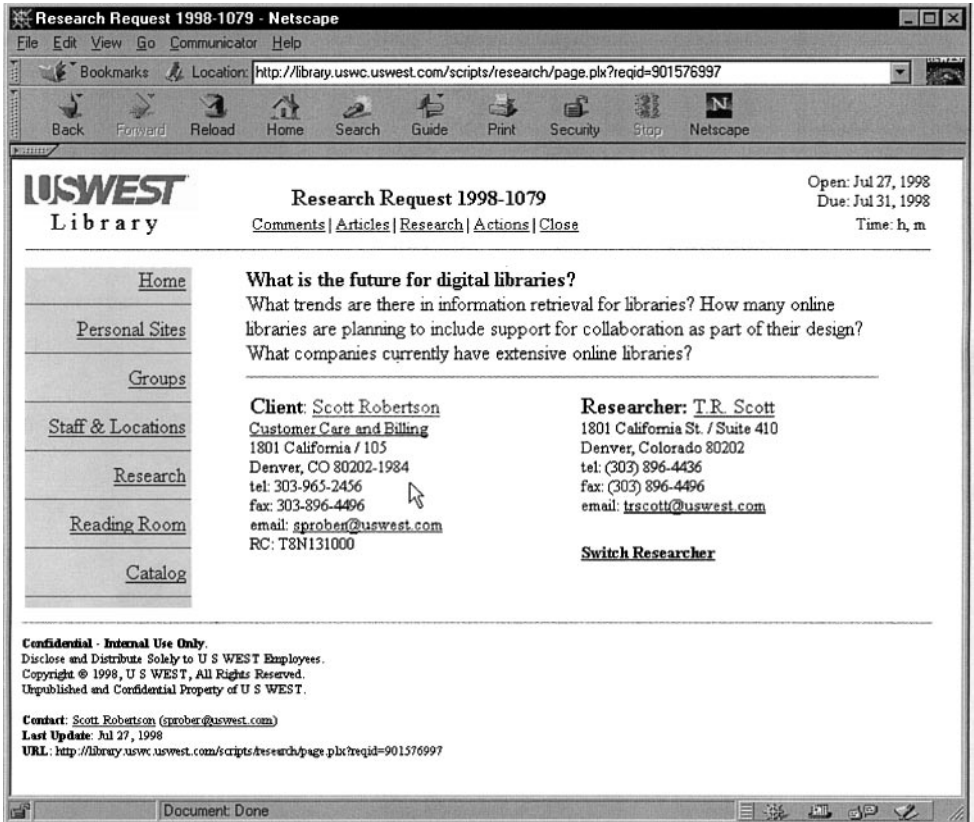


FIGURE 10. A “Research Request” page before any actions have been taken. The client and researcher information link back to the respective personal websites. Users may make comments, record research and actions taken and post or retrieve articles from this page.

page. Comments are entered in a text box and are subsequently posted in a “Comments” area on the research request page. Figure 10 shows an example of how comments appear on the “Research Request” page.

Any client or library staff member can contribute to the comments on any current research request. This makes it possible to extend the dialog beyond the dyad of the researcher and his/her client. The contributor’s name appears before each comment with a link back to the contributor’s personal website. In this way it is possible to learn about who has made a comment, examining what organization they belong to, what research they have requested, what their interest profile looks like, and so on. Thus, the comment feature not only supports the reference interview, but also other interactions that arise while the request is open. When a research request is ultimately closed, the comments become part of the permanent archive and are indexed along with other material in the request.

2.6.4. *Research and actions performed*

Once a researcher is satisfied that he/she understands the research request, he/she begins working with various information services and internal collections to formulate a

response. Usually, the researcher begins incremental delivery of results to the client and provides feedback about how the searches are going and what is being found. This allows the client to reformulate the request as necessary.

Part of the administrative overload for researchers involves keeping track of the amount of time spent using various research tools and databases and allocating the time among client organizations. Prior to development of the system, this time was recorded monthly in a database, usually from recollection. The current system allows researchers to post research activities as they happen to the “Research Request” page. This supports both informing the client of ongoing research activity and keeping track of the time at the moment research activities are posted.

Two types of activities are tracked. One, called “research”, is the time spent with information services. The other, called “action”, is the time spent in a variety of the other activities related to the request such as making phone calls, talking with people, making copies, and so on. The “Research” and “Action” links at the top of the “Research Request” page present forms on which time and progress can be recorded.

The researcher can select the research sources or activities that he/she has performed, indicate how much time was spent, and provide a comment. As Figure 11 shows, once

The screenshot shows a Netscape browser window titled "Research Request 1998-1079 - Netscape". The address bar shows the URL "http://library.uswest.com/scripts/research/service.plx". The page content includes the USWEST Library logo, the title "Research Request 1998-1079", and navigation links for "Comments", "Articles", "Research", "Actions", and "Close". On the right, it shows "Open: Jul 27, 1998", "Due: Jul 31, 1998", and "Time: 0 h, 45 m". A left sidebar contains a menu with "Home", "Personal Sites", "Groups", "Staff & Locations", "Research", "Reading Room", and "Catalog". The main content area has a section titled "What is the future for digital libraries?" with a description of the request. Below this is a "Comments" section with two entries: "Terrance Scott: Do you want academic as well as corporate libraries?" and "Scott Robertson: Just corporate for this round, thanks!". A "Research" section follows with three entries: "Periodicals Collection (0h,15m - T.R. Scott)", "Several ACM articles related to digital libraries.", and "Gartner Group (0h,30m - T.R. Scott)", with a note "Found some references to corporate knowledge centers." At the bottom, it identifies the "Client: Scott Robertson" and the "Researcher: T.R. Scott".

FIGURE 11. A “Research Request” page showing comments and research activities that have been added.

posted these activities appear on the main portion of the “Research Request” page under the “Research” heading. The total time spent on the request is presented under the dates the top of the “Research Request” page. In this way the client, and anyone else browsing the page, can keep track of ongoing activities. Research activities can be posted incrementally as long as the research request is open.

2.6.5. Uploading and downloading articles

The primary deliverable of the researchers in the library is reports pulled from the various information sources that they use. A major goal of the system was to eliminate printing of these reports and move to electronic delivery. Thus in the current system researchers can post electronic documents on the “Research Request” pages and clients can pick them up by simply clicking on their titles.

Reports from information services can be saved in a variety of forms. Tables are often sent as spreadsheet files, documents can be text files or sets of web pages. Each library researcher has a directory on the library’s web server on which they can drop documents. Single documents such as spreadsheets or text files are dropped directly onto a researcher’s directory. Web pages that consist of multiple files are placed into their own unique folders.

In order to attach documents to a particular research request, the research librarian clicks the “Articles” link at the top of the “Research Request” page. This provides a page showing all of the articles that currently reside in the researcher’s directory on the library web server. For HTML files the title of the article is automatically displayed. A title that is not found can be provided by the researcher. The researcher can also provide comments about each article. The researcher selects the articles that are to be attached to the current research request, selects if they wish the client to be notified about the articles, and submits the form.

When the form is submitted, the article titles and associated comments are posted on the main part of the “Research Request” page, as shown in Figure 12. If the researcher has selected the option for client email (the default is “yes”), then the client also receives email that the articles have been posted. The email contains hyperlinks to the posted article(s), so the client may go directly to the article(s) if he/she uses a web-enabled email system. Alternatively, the client may download an article by clicking on its title on the “Research Request” page.

Articles can be posted incrementally as long as the research request is open. Others browsing research requests also have access to the articles. Thus, inadvertent discovery of interesting material is enabled by publicly posting the articles in the context of ongoing research requests.

2.6.6. Closing and archiving the request

When all relevant research has been conducted and delivered to the client, the request can be closed and the “Research Request” page archived. At that point, the “Research Request” page contains all of the information about the progress of the research activity. For reasons of copyright, the links to posted articles are removed, however the titles and their sources remain on the archived pages.

Researchers close the request by clicking the “Close” link at the top of the “Research Request” page. A form appears on which the researcher may provide keywords and text

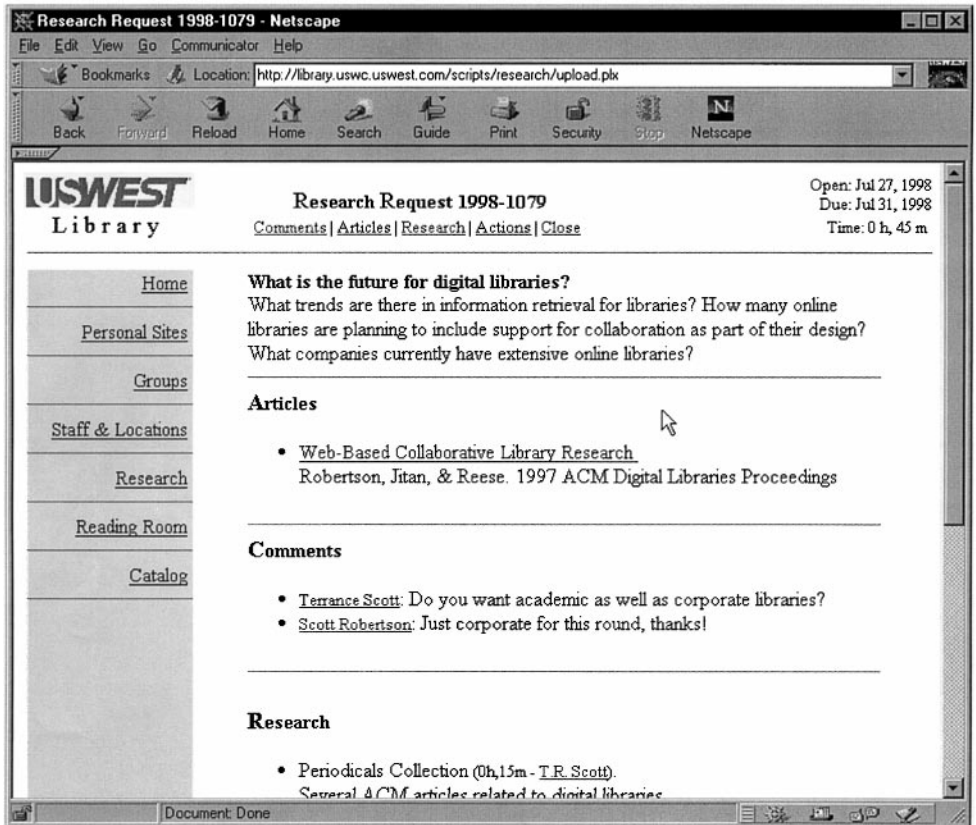


FIGURE 12. A “Research Request” page showing an attached article.

describing are outcome or summary information. When this form is submitted, the keywords are bundled into a keyword metatag and the page is saved in an archive. Several other useful metatags, such as the client and organization, are also generated and saved with the page.

The saved page is picked up by the library web server’s site indexing tool and by the corporate intranet web crawler. It can then be found by searching both within the library website or from the company-wide intranet search page. Client and staff personal web pages and group pages, have filtered views of the research request archive so that they can retrieve their archived requests (see Figure 9). Since personal and group pages are public, it is also possible to browse all of the research done for an individual or group.

In addition, when a request is closed the administrative data about time spent in various activities and associated comments are recorded. This data can be subsequently retrieved by group, by individual or by source. In addition, the client receives a web-based evaluation form in email. Alternatively, uncompleted evaluation forms may be accessed from the clients’ “Research Request” list page (see Figure 9). When an evaluation form is submitted, the data are recorded in a database which can be viewed by group, individual client or individual researcher.

3. Knowledge sharing

Significant knowledge management projects include at least some of the following features.

- Capture of “ephemeral” information that is usually lost (e.g. conversations).
- Explicit relationships and easy navigation among related pieces of information in disparate sources.
- Widespread availability of information.
- Enabling connections between people who would otherwise never find each other.

The system described here accomplishes all of these goals.

A client’s “intranet identity” consists of all the information presented on the personal website. Unlike many customizable or personalizable websites, the library’s personal websites are public. That is, anyone on the corporate intranet can see another person’s personal website. In fact, several processes are available which direct clients to other client’s sites. These are the connection processes that mimic community-building practices in real libraries.

Interactions between library researchers and their clients were previously lost but can now be captured and archived with the requests that they are part of. The research request aspect of the system also allows others to provide comments, an occurrence that would have been serendipitous and rare before. This supports the formation of informal networks and the discovery of others with similar interests, important activities that take place in real libraries (Hinds & Kiesler, 1995; Bishop & Star 1996; Constant, Sproul & Kiesler, 1996).

By linking material such as research requests back to client pages, group pages and researcher pages, relationships can be traced through the entities to which they are relevant. For example, someone from Research & Development might search the research archive for requests about wireless technology. After finding a request, they might jump to the client’s personal web page and discover that the client is part of the Internet Services organization. By browsing the Internet Services organization’s research, the employee from Research & Development might discover that the organization has also made many requests about studies of home users of the internet. These requests also have links to the individuals who originally made the requests. The Research & Development employee can then hook up market researchers or social scientists in the Research & Development organization with interested parties in the Internet Services organization. Along the way they might notice several interesting articles that have been attached to research requests or pushed to other clients.

All research requests conducted by the U S WEST Library are now available on the corporate intranet. (Clients may mark a request “confidential”, which makes it available only to the client and researcher and keeps it out of the archive. However, a minority of requests are marked this way!) This is a resource of over 1300 requests in 1997 and over 1600 requests in 1998. Anyone can browse this material to form an overview of what questions were of interest to the corporation and various business units. This facilitates cross-organizational communication and knowledge sharing, bypassing the usual boundaries and organizational obstacles (Hinds & Kiesler, 1995).

Willingness to share knowledge is one of the most basic changes in culture and technology that can lead to effective use of an organization's information resources (Davenport, 1997; Davenport & Prusack, 1997). Knowledge sharing involves breaking organizational boundaries and undermining traditional lines of control. One resource for this purpose that is appearing in some organizations in the corporate "knowledge center," a clearing house for diverse sources of information staffed by professionals who keep track of cross-organizational goals and needs (Davenport & Prusack, 1997; Marshall, 1997; Williams & Bukowitz, 1997; Chase, 1998). Knowledge centers are natural outgrowths of forward-looking libraries, and tools such as the system described in this article will be at the center of successful knowledge centers.

4. Conclusion

Many articles in the library literature stress the importance of converting libraries into "knowledge centers" (Davenport & Prusack, 1997; Chase 1998). Many of the current jobs for librarians, such as organizing and finding materials in structured and localized collections, will be replaced by automated indexing and retrieval tools that operate on unstructured documents in many (electronic) locations (Marshall, 1997). The value of librarians in the future will be in their ability to understand their clients' and organizations' needs and dynamically provide material culled from a multitude of sources (Williams & Bukowitz, 1997).

Considerable energy is spent on developing tools for indexing and retrieval, which will ultimately serve a knowledge center's clients. Less attention has been paid to enable librarians, their clients and their organizations to relate to one another in valuable ways, e.g. to facilitate the development of knowledge centers of the future.

This project supports some of the intangible, relationship-related aspects of a corporate library. It builds a structure for information from research interactions and personal interest profiles. It encourages knowledge sharing and seeks to enable in cyberspace some of the serendipitous interactions that arise in information-rich landscapes such as libraries and bookstores. Hopefully, the system described here can serve as a foundation for development of other tools that use information-related interactions and activities to build knowledge-rich virtual environments.

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