Task management support in information seeking: a case for search histories

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Abstract

This paper reports the results of an extensive user study that examined information seekers' use of their memory and externally recorded search histories in searching for and using information in the legal domain. The ultimate goal of the research is to design search-history-based user interface tools to support information seeking. The results reported here focus on the management of complex information-seeking tasks. Computers can automatically record human–computer interaction events, allow the user to manipulate this information, and provide it back to the searcher through the user interface. In order to understand how this information can best support information seekers, the role of users' internal and external memory processes was examined using qualitative research methods (observations, interviews, and participatory user interface design sessions). The data collected were analyzed to identify potential task areas where search histories can support information seeking and use. The results show that many information-seeking tasks can take advantage of automatically and manually recorded history information. One of these areas is described in this paper: the management of complex tasks. Results of the study from the legal user group presented evidence of the utility of search histories and history-based interface tools.

1. Introduction

People search for information to solve many problems. With the proliferation of the World Wide Web and easy access to large amounts of information, online search tools have become very widely used. Original concerns about the decreased need for librarians and other information professionals have been quieted by the realization

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that this immense, unorganized, and confusing information store requires significant amounts of expertise and experience, and it creates a challenge for users.

Information seeking is a problem-solving task involving many steps and requiring various tools. While information-seeking tasks vary widely in complexity, many legal information problems studied here require a long and careful searching process. As with other problem-solving tasks, searchers plan, monitor, and evaluate their actions when looking for information. They often carry out multiple parallel tasks at any one time and switch between these task lines. Eventually the results of searching will be integrated with other tasks such as writing documents. All these aspects of problem solving and task management are examined in this paper, along with potential system support for them.

An extensive user study examined legal searchers' information-seeking behavior. The goal of the study was to inspect information seekers' memory use and external memory aids while looking for information. As search history information can be automatically recorded in search systems, the ultimate goal was to identify system and user interface functions built on search histories to lighten memory load for searchers. The legal information domain was selected as it often poses complex, long-term information needs, and the legal field is intrinsically history-oriented and values record keeping.

The study identified several task management strategies that can be supported by automatically and manually recorded search histories. These are described in this paper along with initial interface and system design recommendations. The results of the larger study (Komlodi, 2002a) are described in several other publications. Results related to mental model building and integrating searching with using information are described in Komlodi and Soergel (2002). Komlodi (2002b) reports the use of search histories in supporting legal searchers' knowledge sharing practices. For a full description of the search history frameworks, please see Komlodi (2002a).

Based on the findings of the study, recorded search histories can support the execution of complex tasks in the following three areas: (1) support for the planning and evaluation of actions, (2) integration of tasks, and (3) recreation of context for interrupted tasks. Participants were observed creating notes and other external memory aids to help plan actions, integrate between various steps of the search process, and capture system states to recreate context after an interruption. While the external memory aids supported many other tasks, these three areas are clustered around the management of complex information-seeking tasks. The next section of the paper will review research related to these task areas in information seeking, then a description of the methodology follows. Finally, the results on memory use and external memory support behavior by participants are described along with user interface design implications.

2. Literature review

Information seeking is a dynamic and complex process. Information seekers collect information through interactions with an information system, negotiating a

match between their information needs and the content of the information system. While searching, information seekers construct their own picture of the world by integrating knowledge extracted from the information found with their existing knowledge. As stated above, information seeking is a complex task; it is comprised of many steps and requires task domain, system, and searching expertise (Marchionini, 1995). The basic assumption of this research is that search histories can help with this complex task. This section examines literature related to the process of information seeking, with special attention to areas where search histories have a role. Analyzing information seeking as problem solving helps to understand the process from a cognitive viewpoint and identify roles for activity histories in the management of complex tasks.

2.1. Role of planning and evaluation in information seeking

When looking at stages and phases in information seeking, a problem-solving model is a helpful starting point, as it defines a generic sequence of steps. Models have been developed for both general problem solving and specific information-seeking activities. This section will review formal models of problem solving and information seeking especially to examine the role of planning and evaluation.

Many of these models have described planning and evaluation stages at the end of each problem solving cycle. Planning, monitoring, and evaluation steps are crucial to the success of problem-solving tasks. However, adequate system support for these steps is not typical in current search systems. Our data collection has shown that legal searchers create external memory aids to help them plan and evaluate searching actions.

Problem solving is widely discussed in the cognitive science literature. Solso defines problem solving as "thinking that is directed toward the solving of a specific problem that involves both the formation of responses and the selection among possible responses" (Solso, 1995, p. 440). Hayes (1989) described the steps of problem solving as follows:

1. Identifying the problem.
2. Representation of the problem.
3. Planning the solution.
4. Execute the plan.
5. Evaluate the plan.
6. Evaluate the solution.

While all these steps occur in information seeking, planning and evaluation were steps that were supported by user notes and other manually recorded search histories in the legal domain. Participants planned actions before starting a search, used these plans to monitor progress, and regularly stopped searching to evaluate their actions. In addition to the general problem-solving model, several frameworks of information-seeking tasks were proposed.

Soergel (1985) and Marchionini (1995) describe the steps of information seeking as presented in Table 1. These two frameworks mirror Hayes' problem-solving steps. Both include problem recognition and definition states, the planning and execution of actions, in this case queries, the examination of the results of the action, which are search results, and finally evaluating the process. Marchionini includes many feed-back loops and iterations among the actions emphasizing the lack of linearity in human information seeking. While query formulation, execution, and results examination have been widely studied and supported in systems, the planning and evaluation/reflection steps received considerably less attention. The results of the data analysis reported here demonstrate that these steps are crucial to information seekers and that automatically and manually recorded search history data can help searchers with these tasks.

2.2. Stages, changes, and stopping in information seeking

Researchers have looked at changes of attention and focus in the information-seeking process. Findings show that there are many attention changes during the process; often the scope and goal of information seeking change as well (Bates, 1989; Hearst, 1999; Robins, 1997). These shifts in goals and plans can distract from the original goal and plans, but histories and history-based tools can help users keep track of their goals and changes in plans and actions.

Bates' berrypicking model (1989) describes human behavior in searching as a process that starts with one feature of a topic or one reference and then traverses through a variety of sources, with each piece of new information encountered giving the searcher new ideas on how to proceed and thus changing his/her movements through the system. The query shifts, in part or whole, at every step of this process, gradually evolving in the light of the new information encountered. This process combines analytical searching and browsing in a fashion similar to berrypicking:

Table 1
Steps of information seeking

	Soergel (1985)			Marchionini (1995)
(1)	Recognize and state the need	I n	M o	Recognize, accept Define problem
(2)	Develop the search strategy	t e	n i	Select source Formulate query
(3)	Execute the search strategy	r	t	Execute query
(4)	Review search results	a	o	Examine results
(5)	Edit search results	c	r	Extract information
(6)	Check helpfulness of results	t		Reflect, stop

Furthermore, at each stage, with each different conception of the query, the user may identify useful information and references. In other words, the query is satisfied not by a single final retrieved set, but by a series of selections of individual references and bits of information at each stage of the ever-modifying search. A bit-at-a-time retrieval of this sort is here called berrypicking. This term is used by analogy to picking huckleberries or blueberries in the forest. The berries are scattered on the bushes; they do not come in bunches. One must pick them one at a time. One could do berrypicking of information without the search need itself changing (evolving), but in this article the attention is given to searches that combine both of these features (p. 409).

Reassessing goals and going off on tangents cause changes in behavior. Hearst (1999) suggests that the user interfaces of information systems should allow users to reassess their goals and adjust their search strategy while looking for information based on these shifts in direction. She describes another need when users encounter a "trigger" that leads them into a new direction (a tangent), but they will later want to return to their original goal. The system interface should support users in returning to the previous branch and continue down that path.

Robins (1997) examined the change of focus and attention to different aspects of the information problem by analyzing conversation transcripts between end users and intermediaries in information-seeking sessions. He states that even though user actions are logical and intentional, they are not necessarily linear. He found that the majority of shifts in conversation between the end user and the intermediary occured while being online in search sessions. The search history will record some of these shifts, especially the ones that are (1) reflected in actions or (2) explicitly recorded by the user. Search histories can help users bridge across these shifts. The temporal order of intentions and actions may not necessarily follow a logical order, and their reorganization in a search history interface needs to be left to the user, to reflect meaningful order.

Shifts and changes in information-seeking activities are natural and occur often, as described above. Search histories have a potential of bridging across these shifts and supporting users in keeping track of their actions.

2.3. Task integration: system support for the whole information-seeking process

As seen above, the process of information seeking includes many different steps, planned and unplanned, until an information need is satisfied or the process is aborted. Early information-seeking interfaces concentrated solely on the entry of query expressions and the display of result functions, slowly expanding to include query formulation and reformulation, search aids, examination of result sets and documents, and integration of results into ongoing work (Marchionini & Komlodi, 1998). In the design of systems that match the searcher's information-seeking process, one must support the whole flow of the process. Search histories and history-based tools can provide a continuity of actions from the first to the last stages of information seeking and help the transfer to information use.

Vigil (1986) reviews developments in the software interface of bibliographic and document retrieval systems. As a future direction for software interfaces, he describes the importance of easy and quick availability of search histories and expert searchers' ability to quickly assess the logic of what has been done so far in order to be able to formulate the next steps. He states that ''the searcher's continued effectiveness depends on his ability to reconstruct what he had done'' (p. 75). He points out that the ability to do this is related to practice in searching.

Visualizing the whole of the searching process can help users clarify their information needs by laying out the starting state, intermediate steps, and end results. It also supports the planning and evaluation stages of these activities by providing an overview as a basis for evaluation. Information-seeking actions and directions may change during a session as influenced by new information encountered through searching. Annotated search histories can help users keep track of their plans and directions.

System support for the whole of the search process is a very important though challenging task. The smooth flow of steps described in the earlier models usually progresses in parallel and in cycles during real-life information-seeking tasks. Users stop for various reasons, and their goals and tasks change along the way. Search histories can provide continuity across steps and provide system support for the whole of the search process.

2.4. Successive information seeking: interruptions in searching

Information seeking sessions can be interrupted for various reasons (Lin, 2001, 2002; Spink, Bateman, & Greisdorf, 1999), and searchers often look for the same information across several search sessions. Lin (2001, 2002) identified eight renewal reasons for continued searching in successive sessions. Spink et al. (1999) also found that many search sessions appear in succession and identified 10 reasons for continuing search sessions. As successive searching behavior has been identified by researchers, design implications are expected for search systems. Search histories can provide support by capturing the system state and allowing the user to recreate the context when returning to continue a search.

2.5. Note-taking and external problem representation

In addition to the study of information-seeking behavior, researchers have examined note-taking and external memory aids in information seeking. Searchers themselves create external memory aids even if the system does not provide any. Notes and printouts are paper-based examples of these. Spink and Goodrum (1996) describe a study on reference librarians' encoding and external storage (EES) processes during searching using a Boolean information retrieval system. They describe encoding in mediated information seeking as the

> human process of creating working notes to assist in the understanding and translation of a user's information problem into a search strategy to retrieve

relevant items from an IR [information retrieval] system. [. . .] [External storage is defined as the] human process of using recorded notes during an interaction with an IR system (p. 684).

The study examined artifacts of EES processes, which are notes taken by intermediaries before and during searching. These notes were content-analyzed, and the researchers found that search intermediaries frequently create notes in searching, with an average of 20 entities created per search. An entity was defined as unique, independent or separate marks. Entities were categorized into textual/numerical and graphical groups with many subgroups. Some of these notes were created before and some during search sessions. This finding was confirmed in the data analysis reported here, and it points to the need of extending search history displays to include the clarification of the information need and query formulation steps before the actual searching starts. The findings of this study clearly demonstrate the need for note-taking and annotation tools integrated in search histories to help users record their own interpretation of the events and information found.

2.6. Implications of information-seeking behavior for history displays

The characteristics of information-seeking behavior has many implications for search history designs. Search history displays and user notes can help the planning and evaluation of actions. Supporting various steps and stages in the process, as well as providing continuity across these steps, can also be an important role for search histories. System states recorded in histories can help searchers recreate context after an interruption. These potential uses of search histories were at the focus of this study.

Searchers create external memory aids to support complex task management even if the system does not provide those for them. Some of these external memory aids can be replaced by automatic history recording. Thus, the user would not have to record this information manually, but it would be available to him/her automatically. An extensive user study was completed to explore information-seeking behavior areas where search histories can be useful. This study examined searchers' natural behavior using a legal information system with limited search history capability. Searchers complemented the system functionality by other external memory aids, which made the legal user group an interesting population to examine.

3. Methodology

This research project explored a new area of searcher behavior that has not been thoroughly examined before, the use of memory in information seeking. For this reason, a qualitative methodology was selected. Qualitative methodologies are especially well suited for exploring new areas of research, as they allow for the examination of unknown factors and relationships without having to define these in advance. In this study, data collection and analysis were informed by earlier theories

of cognitive and information-seeking behavior (Hayes, 1989; Marchionini, 1995; Soergel, 1985), but many of the facets involved were undefined at the outset of the research. In addition to the exploration of new areas, qualitative methods were selected as they are often used to examine human information-seeking behavior (Barreau, 1997; Kuhlthau & Tama, 2001; Marchionini, 1995; Spink & Goodrum,1996).

Table 2 presents the research questions that were at the center of the larger study (Komlodi, 2002a), and the subset reported in this paper. In Table 2, the right column describes the research questions addressed in this paper. Research questions 1.b and 2.b are fully explored in the paper. Research question 3.b is also discussed; however, much of the work in this area is proposed as future research. Descriptions of the behaviors participants exhibited often include suggestions for user interface design; however, formal user interface development and evaluation have not yet been completed.

The full study consists of three phases as presented in Fig. 1. Preceding the first phase, an initial exploration of the topic was carried out through a literature review, interviews with reference librarians in a special library, and an analysis of usability testing videos of the Westlaw legal information system. These preliminary data collection efforts led to the conclusion that search histories can enhance information seeking and that current tools need improvement to satisfy user needs. Based on these findings, an initial search history framework was developed, and an iterative methodology was designed including data collection on user behavior, search history framework development, and interface design in all three phases:

Phase 1: data collection through observations of and interviews with attorneys and law librarians;
Phase 2: iterative participatory interface design and evaluation sessions with attorneys and law librarians;
Phase 3: interface development and formal evaluation.

Table 2
Research questions

| Research questions in the larger study (Komlodi, 2002a, 2002b)	Research questions reported in this paper
1.a What user tasks can search history information support and how? For what purposes do searchers use recorded and remembered search history information? How do they use search history information?	1.b How do searchers manage complex tasks? How do they use external memory aids to help them manage complex tasks in searching?
2.a What search history information should be recorded?	2.b What search history information should be recorded to support task management?
3.a What user interface tools and functions are needed to allow the user to use the search history information in support of his/her tasks?	3.b What user interface tools and functions are needed to support task management?
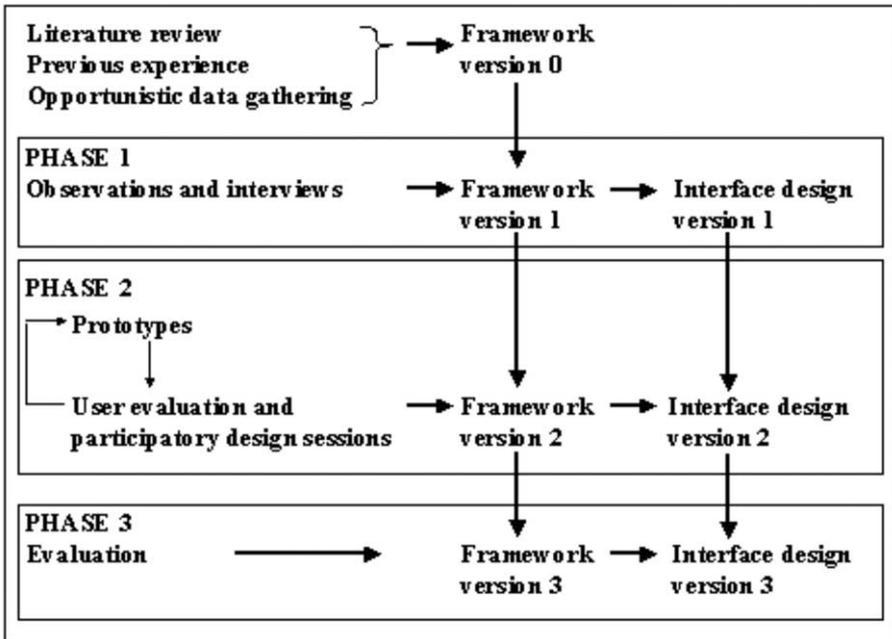
Fig. 1. Research phases.

In Phase 1, eight attorneys were involved in the observations and interviews conducted by the author. Another eight interviews with expert legal information specialists from Halvorson (2000) were generously made available for this study by T. R. Halvorson. Members of the first group were asked to search the Westlaw databases for a topic of their choice. The problem had to be subject-oriented and involve several linked questions. While searching, participants were asked to think aloud. After the search, they were interviewed about the search session and about their memory and history use in general. In the Halvorson interviews, participants were interviewed about their information-seeking practices, many of which involved the use of history mechanisms. Transcripts of think-aloud sessions, and interviews, and observation notes were coded using the search history framework and analyzed; the results then informed the design of interfaces.

In Phase 2, participatory design sessions with attorneys and law librarians took place. The interfaces developed based on the results of the interviews and observations in Phase 1 were used in the participatory design sessions, and further interfaces were designed by participants. The main outcomes from these sessions were the user interface designs and functions. However, the transcripts from these sessions were also analyzed, and they informed the framework. The user interface recommendations presented in this paper were presented to participants and feedback collected on them.

Although the attorneys in the study worked at several different firms, the general context of their work is similar. The law firms studied are all large, multi-office, multi-regional law firms with establishments in the Washington, DC area. They employ hundreds of attorneys and have offices all over the US and, in some cases, the world. Attorneys usually work in large teams comprising of both junior and senior attorneys. The teams litigate large cases often spanning months and years. Attorneys share tasks and knowledge amongst each other and collaborate in litigating cases. The attorneys interviewed and observed were early in their careers (up to the seventh year of practice); at this stage they still perform many informa-tion-seeking tasks in their work. More senior attorneys often delegate these tasks to junior attorneys, and thus were not studied. All the participants used the Westlaw legal information system for their searching tasks.

Phase 3 of the research involves formal testing of the user interfaces implemented. The interface tools proposed will be implemented and tested through more rigorous methods to examine whether the integration of search history interface tools will result in improved user performance and satisfaction. Whether the flexible availability of historical information changes the nature of information seeking can be examined if tools are available. The results from the first two phases of the research are described in the next sections along with some design implications.

4. Results and discussion

The results of the user observations, interviews, and participatory design sessions provide a rich description of how information seekers manage complex tasks with the help of external memory aids. Recording search actions and information can support task management in many ways. The following sections will describe user behavior identified related to planning and evaluation of actions (Section 4.1), task integration (Section 4.2), and context recreation for successive search episodes (Section 4.3), as well as the implications for interface design.

4.1. Search task management: planning and evaluation

Managing the search task requires steps similar to those involved in managing other tasks: plan, review what was done, and evaluate. The role of these steps in problem solving and information seeking has been described earlier. Search history can support many of these steps. Short, known-item-finding tasks usually do not require extensive task management actions, as they are completed through simple steps in a brief time period. The tasks used in this study were complex topical ones, which can benefit from task management techniques.

4.1.1. Planning
Searchers usually undertake planning before they start searching; legal searchers are often taught to do this in legal research courses. Several of the participants came

to the sessions with notes handwritten on paper and used those while searching; they reported similar activities in every-day searching. It is important to provide support for systematically recording the planning notes in order to help users capture what it is they are looking for. Keeping this information on the screen while searching, or making it easily available to searchers, can help them focus on the task and evaluate search results more efficiently. On the other hand, search goals shift continuously, and allowing the user to update plans can help them keep track of newly emerging avenues of information seeking.

Since end users have less knowledge about the different information sources and search tactics, it is harder for them to plan actions. While law librarians are expert searchers, attorneys are domain experts, but often they are not search experts. However, even though they cannot specify queries, sources, or accurate steps, they have a generic idea about topics, keywords or names of people and organizations. Creating plans with even minimum information before starting the search helps with the management of the process.

Planning usually starts before the searcher logs into the search system. The information problem arises, usually along with some indication of the topic and other attributes. Depending on the context, searchers often create notes or otherwise document their planning. Best (2003), at her Website on legal research methods for law librarians and attorneys, suggests that searchers think about their topics and goals and write down keywords and subject headings to search on; these can include synonyms and variations on words. During the planning phase, expert searchers consider sources to check and directions in the search. Professional searchers would often familiarize themselves with a topic, as an introduction to the search, and collect keywords. This may not be conducted in the search system, but serves as a preparation for the search. The results from it need to be used in searching.

Keywords are often part of pre-search notes. These are very characteristic of the user and his/her areas of interest, and they have a role in guiding the search, as in the following example:

Participant 6: Keywords, very important, all along, because those are the guiding, organizing principle.
Interviewer: Notes?
Participant 6: You saw my notes.
Interviewer: Yes, it's usually not continuous text, it's keywords, reminders.
Participant 6: Yes, I usually go into searches with keywords. That's the one thing I try to think of because searches are all keyword, or mostly keyword-organized. Phrases, or concepts, sometimes citations, but it's really the keywords or the subject matters will narrow down to get the closest thing of what I'm looking for.

These keywords will become the basis for queries when searching starts. They can be used to create task representations and monitor progress against them. Systems should support this transfer from notes to task representations and queries. The

keywords not only serve as the conceptual basis for queries, but also as the anchor cues for the different search process phases. In the following example, the searcher describes how she uses her notes in keeping track of topics and uses keywords when refining these through the searches. In this case the needs clarification is strongly linked to the search plan, as the searcher looks for the information right away:

Halvorson: How much planning do you do before logging on to QuickLaw?

Best: I do a fair amount. I always make a list of keywords, synonyms and alternate words, and think about which words should be truncated. I think about what databases to search and make a note of them. Then, as I do the search, I refine it and check off what I've searched. Depending on how complex the search is and how many alternate terms it includes, my search plan is more like a diagram, with several columns of alternate terms separated by the appropriate connectors (Halvorson, 2000, p. 129).

Continuous monitoring and evaluation feed back into planning through the creation of reminders for actions while conducting the search. Based on the plans and the history of the actual actions and outputs (often search results), the user continuously re-evaluates his/her situation and what needs to be done in order to reach his/her goals. In order to capture this rethinking of plans, the searcher needs to be able to change his/her checklists and other plan representations in the system. Creating reminders, thus updating the plan of action, is one way to do this.

4.1.2. Monitoring and keeping track

As mentioned above, lists of actions created by attorneys while planning were often used to monitor progress in the observed searching sessions. Monitoring, reviewing, and evaluating previous steps can help users understand the current system state and how they got there. While the searcher is executing his/her search actions, he/she needs to constantly monitor the inputs and outputs. Search history tools can help with this task, as they keep track of what has been done, and as indicated in the previous sections, they make it easier for the user to follow progress. Monitoring forms the basis of evaluation of the process, which in turn influences planning. Monitoring answers questions such as: what has been done, what the result was, and what needs to be done. Showing the sequence of steps can help users comprehend the relationships of actions and can promote system learning as well as problem solving and planning.

One way to monitor the progress of a search is to follow the checklist created before the search started, mark the steps that were completed, and then create reminders of new action items. Following the checklist guides the searchers' actions, helps him/her avoid repeating actions or leaving areas uncovered, and also helps with focusing on the main task. Displaying the sequence of actions in a search history can help users monitor past actions without having to remember them. In interrupted searching situations, this is a very important orienting factor for searchers in recreating context as will be discussed in the next section. Search

histories can automate this task to a great extent by matching actions carried out with planned actions. Queries that have been completed and identified by keywords and other query parameters can be checked off on the planning list. When entering a query, planned similar actions can be shown to the user to select and enter planned actions.

4.1.3. Evaluating action

The goal of monitoring actions is to evaluate them. The evaluation of actions happens after each step, when the user reviews and interprets results from queries, reads documents, and judges the relevance of information found. If he/she is not satisfied with the results, he/she takes remedial action. One of the law librarians described how he, in his legal research class, encourages his students to constantly evaluate and check what they have done and found. The goal of this constant evaluation is to verify that searchers are clear on what they found and that they searched everything they planned to search. This concern highlights the importance of recording actions and information for review by searchers:

Halvorson: What general warnings do you give your students?

Jackson: The most important thing is to be really sure what they've got when they find something. With electronic sources, when something pops up on your screen, it's easy to feel a sense of accomplishment or reward and think, "Oh, I got what I need." You might have gotten something, but you need to be sure what you've searched, and hence what you've gotten. You need to be sure you've searched everything you thought you searched. You have to observe the scope of the database. You need to know whether it's really full text or selected full text. You need to know the date range of a file's coverage. You need to know which source documents are included in the file. I see students do a lot of searches in the wrong database. They think they have included tax advice memoranda that were really in a different file. I see them not go back far enough in time (Halvorson, 2000, p. 163–164).

In addition to verifying the results of actions, knowing when to stop searching requires constant evaluation. This involves reviewing search steps, interpreting results, checking to see what actions have been completed and what have not. While the decision to stop searching is complex, and more often an art than a science, a view of what has been accomplished can help:

Participant 5: I guess at this point I might stop and review my Word document [i.e., manually-created search history] and see if I have enough information to at least get started, to stop and read.

The quantity and quality of the information and the presence of an adequate answer are all signs for searchers to stop. Search history displays can help users evaluate this by making the information available on the screen and thus providing an external memory aid. Stopping can happen for other reasons as well, such as

budget constraints or interruption. This last cause for stopping calls for the context recreation function described in Section 4.3.

4.1.4. Managing multiple tasks

Attorneys are often juggling multiple cases simultaneously and may have to manage multiple searching tasks related to various legal issues. Keeping track of multiple parallel tasks may also be necessary for billing purposes, because time spent on different searches may need to be billed to different clients. Recording search history associated with different tasks can support this need. In order to accomplish this, the user must identify the task he/she is working on to the system, and the system state has to be saved and provided when switching to a new task. When saving results and search histories, it is important to note what task they were relevant for. Later the attorney may want to retrieve or organize them by the task they were carried out for.

4.2. Task integration

Search histories can provide continuity across tasks and steps that have been previously segmented by the various tools. As described earlier, many search systems focus on the query formulation and execution stages, with additional tools addressing results examination and relevance judgments. Integration with pre- and post-searching activities is often minimal. The availability of a record that can stretch across steps and tasks can support integration across search steps. Integration between planning and execution has been described in previous sections. Integration between finding information and using it in document writing or other tasks can be supported by recording not only the documents found, but also allowing the user to capture relevance judgments and notes. Thus, the first step of integration between seeking and using information is the capture of relevance judgments, described next.

When evaluating results, searchers make relevance judgments about documents. This involves a decision about the usefulness of the information found to the user's problem. These relevance judgments are based on reading and interpreting the results and relating them to the searcher's own knowledge and problem at hand. The results that were deemed relevant enough are saved for future analysis or use.

Recording relevance judgments helps the searcher in using the information for his/her task. Often only those documents are selected and saved that are found to be relevant for some reason. This involves some kind of marking within the system and then a customized list or group of documents on the user's own computer. This is the simplest selection and recording of relevance. If a document is saved by the user, it was found relevant; thus, saving a document expresses a binary acceptance decision:

Participant 4: Acceptance/rejection?
Interviewer: Whether you liked it or not.
Participant 4: That's irrelevant. What do you mean liked it or not?
Interviewer: So you found an article and ...
Participant 4: Oh, I'm only going to keep it if I liked it, so it's very important.

In reality, a relevance judgment is not simply a yes-or-no decision. Some cases and documents are more relevant than others. Some speak to one aspect of the topic, while others speak to a different aspect, or even a different topic or task. Some cases are supporting the attorney's cause, while others are against it, but should still be collected and studied. Some cases are relevant because they consider the same legal issue, while others are important because the defendant was involved in them. These different shades and colors of relevance can be recorded when the user thinks they are important. Attorneys in the study generally described these decisions while searching, and they sometimes recorded them in annotations on results printouts or in a Microsoft Word file. The following participant described the importance of recording why the searcher thought something was relevant and whether the document saved was for or against their argument:

> Participant 8: A lot of times you can see, as a young associate or junior associate, you go to the partner and they'll say why did you pull this case? And you'll have to explain what caused you to think that this was relevant. And it's difficult to do that if you looked at a hundred cases without a road map.

Recorded relevance judgments will provide a bridge to information use. Other task integration methods to help the user transition from finding to using information are described in Komlodi and Soergel (2002). Creating functionality within the search system with strong integration into other applications where the saved information will be used should be a consideration in designing search systems. Providing interaction history information across various applications can also help with shortening the distance between applications and de-emphasizing the separation of user task environments in different computer applications.

4.3. Successive searching episodes and context recreation

The previous descriptions of information-seeking behavior show that recording and providing search histories can be useful in search task management. What information to save and how to represent it to searchers are the next natural questions in designing support. Monitoring search history while searching is important, but it may not require very detailed search history information, as searchers can remember details of recent actions. Other scenarios can require more detailed information. Interruptions, sharing search history with others, and evaluating actions from a long time ago will all require more detailed contextual information. The following sections describe the role of search histories in preserving and recreating context for any of these scenarios.

4.3.1. The need for recreating context

Context is operationally defined here as a representation of the state of the system and the user at a given point in the execution of a search or other task. The context is a time slice of the search history (only the last and several previous steps) along with the objects and actions represented on the screen and their relationships. Users

need to understand what they had done and why: what they thought, what they saw, and what they need to do next. Presenting the history right before the last system state can help, as shown in this example:

> Participant 7: Yes, I'd like to know exactly where I left off. I guess I would certainly like to know what my search query was, I'd probably like to see the queries right before that, I would like to see what databases I looked at before that too. For example if I stopped and came back and I saw, ok I'm in fedall or all feds [name of Federal case law database] and I have this search query, I might look and see, gee, did I look at the 8th circuit first and then expanded it because I didn't find anything? I might look and see if I did a date narrowing at some point so that's still an option for me if I haven't done it. Oh, I'd want to go back to at least three or four operations before where I left off, and that will help me reconstruct what I had done.

Personalization features are also very important, since the goal of saving the context is to put the searcher back into the same situation and mind set in order to help him/her continue exactly where he/she left off or to help him/her understand why a document was found and how the document should be interpreted.

The context recreated should help the searcher to understand:

- what he/she did and why,
- what he/she thought about what he/she had seen, and
- what he/she needs to do next.

Recreated context can be helpful in various situations such as interrupted tasks that are continued and collaborative tasks where searchers share information with others. Task interruption can be voluntary or involuntary. A user may need to stop working on a specific task because a colleague, a phone call, or other external effect interrupts him/her. He/she can also decide that he/she will follow a tangent and then return to the main task line some time later having forgotten about what he/she has been doing. This latter scenario will be described in Section 4.3.3.

When the user returns to his/her task after an interruption, he/she needs to remember what he/she was doing and why, where he/she left off the task, and what needs to be done next. He/she usually needs to review several recent steps in order to recreate the flow of steps and the reasons for taking them. In this example, the participant described how she uses reminders created in notepad files:

> Interviewer: And how do you use those? If you want to later use those little notepad files?
> Participant 1: Then I go back and I'd copy the URL and I go to that. Or it would remind me that I found this out, but I didn't find X, Y, Z out so I still need to go back and look at that rather than this.

In other cases, the searcher can save certain elements of a task for future follow up, in this case he/she needs to document what has been done so far and how to

proceed to have a reminder when he/she returns. This saving for future review happens often when coming up to tangents in searching and deciding to follow the main task line, or when time limitations do not allow one to examine promising, but only marginally relevant results.

Attorneys are often working on the same case for a long time period, often months or years, in which circumstance they may have to stretch out their searching over some time as well.

> Interviewer: What would be that thing that it would be helpful for in the future? Like you would do similar searches?
> Participant 5: If I wanted to search the same thing, or if I know I'm going to want to look at this again, but I don't have time to look at it right now, but I might have time a month from now.

In this situation, they will have to come back to the same search task group and continue on a different tangent. They will need a larger search context that shows several branches of the search and their status because the longer the time that passed, the harder it will be for the user to remember details.

In collaborative team circumstances, where junior and senior attorneys work together, a searcher may have to document the context of a search in order to pass it on to a colleague to continue the process. In this case it is important to record the preceding steps, current situations, plans, motivations, and rationale for actions in a way that is understandable for another person, not just the creator of the record. This is also related to the scenario when the user has to recreate the context or review the search history to understand his/her steps in order to explain actions and decisions to others, as in the next example:

> Participant 4: Oh no, I wouldn't recreate. Just whatever is... it's more just a history record. It could be that, if I have to justify a decision, which I haven't had to do, but I could see it happen, something like, why did you give that opinion, and if it wasn't apparent from what I created, then I would have to do more search. I would have to try to recreate why I did it, why I said what I did.

4.3.2. Information displayed to show context

In order to allow the user to recreate the context of his/her work, search history information, such as user and system steps, and information exchanged should be recorded. The search history records should be comprehensive; relationships between actions and information should be indicated clearly, and searchers should be allowed to enter user notes and annotations.

The comprehensiveness of search histories is crucial to a searcher's ability to recreate context. For example, showing a screen of text from a document may not tell the user why he/she was looking at it, but scrolling to a specific section of the text, highlighting the area of interest, and pointing out the keywords searched would give a much clearer picture of the process. This is also useful because it allows the

searcher to continue the action right where he/she left off, instead of having to recreate the smaller details of the actions, as demonstrated by the following participant:

> Participant 1: I guess what I should have done when I found textbook, see I can't go back now and find it either. I guess it would be helpful to somehow be able to highlight terms once you found them so that you could go back to them and click on ... if I didn't find another reference to textbooks, so I want to go back to that one that I did find and then maybe to click on those cases, but I don't see a way to do that.

Showing relationships between user steps and information in the search history record also enhances understanding. Searchers can more easily remember why certain steps were taken if the relationships between actions are clearly identified, and they may remember what they thought of the results at the time, although this is better represented through user notes and annotations. In most cases, the ultimate goal is to recreate the user's thinking and rationale, which is based on the steps he/she had taken and the results he/she had found. The following participant tries to recreate his thinking from a series of steps he completed:

> Participant 7: It seemed like a nice idea at the time. Now I have to figure out what I was doing before I got distracted with the picture. Oh, I know, I was looking at the... is this that expert.. yes, this is the XY tire company, I was going to look at this and see, I know what I was thinking, if, as I suspect, a lot of cases here 118 cases, if they relate to prior testimony by expert and whether that's admissible in subsequent case, which I know this case touches upon, at least in part, and that's not what I'm interested in. If it is, what I'll probably do is exclude expert from my search query and hopefully narrow the number of cases. Oh, so I was just looking this quickly to see where are my search terms. Actually that didn't really tell me that much about it at all. Oh, I'll just check out the next case to see if...

In saving search history information to recreate context, it is important to allow the user to enter notes, annotations, and highlights, and thus personalize the history. When returning to the task, his/her own thinking may be the most important factor in helping to understand the process. Personalizing the history helps the queries and documents the searcher's problems. If the searcher started the information seeking process by creating a plan, it is necessary to show progress against this plan. This may be very helpful in recreating context, as it not only shows the past, but also the future steps. Integrating planning into search histories is especially important, as the main purpose of recreating the context of an interrupted task is to continue the information seeking.

4.3.3. Keeping track of tangents

An important issue in task management is the question of tangents. A tangent is a line of activity not closely related to the main task, but emerging out of it.

Information seeking (especially in hypertext environments representing highly interconnected literatures) is an inherently non-linear activity. Following tangents is often part of the search strategy through weak relevance, serendipity, or checking the validity and citation history of legal cases (this is referred to as Shepardizing, defined below). Documents with weak relevance are not judged to be important for a searcher right away, but could show some promise for further investigation. Searchers may follow a lead to check a document, but later realize that it was not relevant, and the searcher has to return to the original task. Serendipity may lead searchers to unexpected findings that may not be relevant to the task at hand, but important for a different reason, such as relevance for a different case the attorney is working on. These documents also need to be examined, but the searcher often returns to the original task afterwards.

One form of potential distraction in legal research is the need to Shepardize cases. Shepardizing in the legal information context means to check the later history of a case. Shepard's Citations is a citator tool in legal information that

> lists later sources that cited earlier sources. A later source is a ''citing source''; the earlier source (the one you have located and plan to rely on) is the ''cited source.'' ... Shepard's Citations, published by Shepard's/McGraw-Hill, Inc., are the most commonly used legal citators. Shepard's case citators serve four primary functions:
>
> (1) They provide parallel citations to your cited case.
>
> (2) They trace its history.
>
> (3) They help you determine the treatment of the case by leading you to other cases that have cited it.
>
> (4) They provide references to commentary sources that discuss the case (Kunz, 1996, pp. 152–153).

Attorneys often Shepardize documents while searching, which can distract them from the original goal and entice them into browsing by following citations from the original case. Tools to support searchers in returning to the original task line can be helpful with this task, as described in the next example:

> Interviewer: You mentioned that you would go multiple levels down and just Shepardize cases, would you ever want to go back to your original results?
> Participant 7: Yes, almost always I do. Because typically, when I get sidetracked like that, I'm on case 8 out of 15. And so I'll Shepardize 8, 8 will be helpful, I'll Shepardize 8, I'll find another case that's helpful, I'll Shepardize something there, I'll find another case that's helpful, and then I want to go back to 9 out of 15. Once I've sort of explored that tree to its fullest extent, I want to go back to number 9, because usually at that point I haven't read it, sometimes I would write it down, 8

is very helpful and put a little star by it and go to no. 9 to 15, see if there is anything of interest there and then go back, but it depend on the amount of time that I had. If I'm really short on time, which I typically do, what I do is 8 looks great, Shepardize it, I'll print it, I'll look and see if there are any cases that cited that, that are either very good or very bad for me, and just use it, and maybe not even go through 9–15, depending on my time. If I had more time, I'd more likely just put down, I'd write down, maybe on a scrap of paper, you know 8, and then go through the rest of them and then come back to it, so it depends, but in a perfect world, I'd always want to go back.

Following tangents involves the introduction of subgoals into the task, more or less related to the main task; weak relevance and serendipity described above are examples. These can be distracting. The more distracting the tangent is and the longer it takes, the harder it will be for the user to remember to return and continue the main task. One way to remind the searcher that the direction being pursued is only peripheral to the problem is to attach some kind of reminder to the search history representation at the time of the branching of actions. Another way is to create a reminder in a checklist format or a highly visible sticky note on the screen. In either case, the reminder should also take the user directly back to the branching screen so that continuation of the original task is easy.

Participant 8: Upon reflection I really used my search results. A lot of times, it would keep me from going off on a tangent.

In the physical sense, following tangents often leads users far away from the system location where the entry point to the tangent was or where they need to return to continue the main task line. It often involves navigating to a different part of the system, following many links that causes problems with orientation in general and getting back to the tangent in particular. Allowing the users to create landmarks or bookmarks in the system will help them easily return to a previously visited scene when continuing the main task.

Tangents need to be represented on the search history record, but should show that they are digressions from the main task line. After a tangent has been completed and proved pointless, the user may want to delete it from the search history record in an easy way. Another solution can be to keep the tangent, but with a comment that explains its role. Even though this seems laborious, several participants expressed their willingness to edit or annotate search histories to remove tangents, especially when the history record is shared with others.

As described earlier, often before a searcher starts following a tangent, he/she has a good idea of what he/she wants to do after returning, but by the time he/she returns, part or all of the plan may have been forgotten. It is advisable to create a short reminder in the search history at the place where the searcher needs to return to. Showing the reason for going off on a tangent is also helpful in search histories. It can inform the searcher about not only why he/she left, but also what he/she was doing before following a tangent and what the natural next step is in the main task.

This section concludes the results related to the management of complex tasks in information seeking. The user behavior descriptions presented provide ample evidence for the need for automated search history recording. User interfaces of search systems should include history-based functions to support users.

5. Conclusions

Automatically and manually recorded search histories can support information seekers in finding and using information. In answer to the first research question, it has been found that legal information seekers do use external memory aids to help them manage complex tasks. They create these memory aids to plan and evaluate search actions, integrate activity over separate steps, and create context for interrupted and successive search sessions. With the decreasing cost of processing power and storage space, more complete search history information can be recorded and provided to searchers. In response to the second research question, the amount and type of search history recorded depends on the user, task, and context variables of the system.

Information seekers in the legal domain create manual search histories and external memory aids when these are not provided by the system to support their planning, evaluation, task integration, and context preservation. New interface tools building on search histories should be developed to automatically support these functions.

The third research question (3.b) has been partially addressed in this paper through user interface design recommendations integrated with the behavior descriptions. Proposals for three search-history-based user interface tools have been made in Komlodi (2002a) and Komlodi and Soergel (2002). These tools are: (1) user-manipulable search history displays, (2) a scratchpad interface to allow users to take notes and to save various granules of information and the search history, and (3) an organized collection tool to allow searchers to bridge the gap between finding and using information. All three of these user interface tools include functions to support planning, monitoring, evaluation, task integration, and context preservation. Development and formal evaluation of these interface designs are proposed for future research. The results of this research describe the legal information field. Other knowledge-intensive fields, such as medicine, may also benefit from search history features in user interfaces; however, further empirical evidence is needed.

The results presented here point to the importance of recording search history information and providing this information along with history-based tools to the searcher. System designers should consider applying search history information to user interface tools that will allow searchers to manage complex tasks, evaluate and plan actions.

References

Barreau, D. K. (1997). *Information systems for organization and the problem of ephemeral information*. Unpublished doctoral dissertation, University of Maryland at College Park, College Park, MD.

Bates, M. J. (1989). The design of browsing and berrypicking techniques for the on-line search interface. *Online Review*, *13*(5), 407–431.

Best, C. (1995–2003). *Best guide to Canadian legal research*. Retrieved 10 September 2003, from the World Wide Web: http://legalresearch.org/essential.html.

Halvorson, T. R. (2000). Law of the super searches: The online secrets of top logal researchers. Cyberage Books, 360 p.

Hayes, J. R. (1989). *The complete problem solver* (2nd ed). Hillsdale, NJ: Erlbaum.

Hearst, M. A. (1999). User interfaces and visualization. In R. Baeza-Yates, & B. Ribeiro-Neto (Eds.), *Modern information retrieval*. New York: Addison Wesley Longman.

Komlodi, A. (2002). *Search history for user support in information-seeking interfaces*. Unpublished doctoral dissertation, University of Maryland, College Park, MD.

Komlodi, A. (2002b). The role of interaction histories in mental model building and knowledge sharing in the legal domain. *Journal of Universal Computer Science*, *8*(5), 557–566.

Komlodi, A., & Soergel, D. (2002). *Attorneys interacting with legal information systems: tools for mental model building and task integration*. Paper presented at the American Society for Information Science and Technology, Annual Meeting, Philadelphia, PA.

Kuhlthau, C. C., & Tama, S. L. (2001). Information search process of lawyers: a call for "Just for me" information services. *Journal of Documentation*, *57*(1), 25–43.

Kunz, C. L. (1996). *The process of legal research*. Boston, MA: Little, Brown.

Lin, S.-J. (2001). *Understanding successive searches across multiple sessions over the Web*. Paper presented at the International Conference on Information Systems.

Lin, S.-J. (2002). *Design space of personalized indexing: Enhancing successive Web searches for transmuting information problems*. Paper presented at the Americas Conference on Information Systems.

Marchionini, G. (1995). *Information seeking in electronic environments*. Cambridge: Cambridge University Press.

Marchionini, G., & Komlodi, A. (1998). Design of interfaces for information seeking. In M. E. Williams (Ed.), *Annual Review of Information Science and Technology* (Vol. 33, pp. 89–130). Medford, NJ: American Society for Information Science.

Robins, D. (1997). *Shifts of focus in information retrieval interaction*. Paper presented at the American Society for Information Science Annual Meeting.

Soergel, D. (1985). *Organizing information: principles of data base and retrieval systems*. San Diego, CA: Academic Press.

Solso, R. L. (1995). *Cognitive psychology*. Boston, MA: Allyn and Bacon.

Spink, A., & Goodrum, A. (1996). A study of search intermediary working notes: implications for IR system design. *Information Processing and Management*, *32*(6), 681–695.

Spink, A., Bateman, J., & Greisdorf, H. (1999). Successive searching behavior during mediated information seeking: an exploratory study. *Journal of Information Science*, *25*(6), 439–449.

Vigil, P. J. (1986). The software interface. In M. E. Williams (Ed.), *Annual review of information science and technology* (Vol. 21, pp. 63–86). Published for the American Society for Information Science by Knowledge Industry Publications, Inc.