ABSTRACT

Improving search interfaces and algorithms are major foci of HCI and information retrieval (IR) research respectively. However, less attention has been given to understanding how users collect, manage, organize, and share the results they find from conducting searches on the Web and designing tools to support their needs. In this paper, we present results from a study in which we interviewed 30 people in three cohorts (academic researchers, corporate workers, and people looking for medical information) about their current practices conducting, managing, and sharing information from ongoing, exploratory searches. We report results on users’ current practices, tool use, areas of difficulties and associated coping strategies with emphasis on how information seekers use a variety of “tools-at-hand” beyond search engines and web browsers as they search, process, and share results, and on the learning processes that occur as they seek and use information over time.

Author Keywords
Exploratory search, information seeking, personal information management, collaborative search

ACM Classification Keywords
H5.m. Information interfaces and presentation (e.g., HCI): Miscellaneous.

General Terms
Human Factors, Design, Experimentation

INTRODUCTION

Information seeking is a fundamental human process that manifests in many personal and professional settings. Some of the most common instances of information seeking arise from the need for specific data and these needs are well served by today’s WWW-based search engines. There are, however, important kinds of information seeking that leverage current search technology but are not well served by it. These more difficult information-seeking challenges involve information needs that are open-ended, ongoing, comprehensive, and multi-faceted; and search activities that are exploratory, discovery-oriented, possibly collaborative, and depend as much on results examination and interpretation as on query specification. These challenges are described in different terms, for example, exploratory search [17][29] or collaborative search [19][7]. This kind of information seeking also overlaps with the personal information management literature [11][12] and the study we describe here is part of our work to fill a gap between query-oriented IR and the personal/group information management systems [12][6] that support information use.

In particular, we aim to understand problem-centered searching that takes place over time (multiple sessions) in collaboration with other stakeholders in authentic settings. This paper reports results from a set of interviews that were conducted with 30 people in three different kinds of problem settings. We had four main research questions in this study: 1) how do people conduct exploratory searches on the web; 2) how do people organize, manage, and synthesize the results they find; 3) how do people recycle searches and re-find information across multiple sessions; and 4) how do people collaborate on searches and share found information? During our analysis, we observed two themes that have impact across all four research questions: 1) the extensive use of tools-at-hand (such as printers, telephones, text processors, email, and simple copy and paste) to support users’ needs, and 2) how the over-arching goal of topical learning over time influences and effects multi-session, exploratory searches.

BACKGOUND / PRIOR WORK

Several research areas are relevant to the study described here: information seeking theory, personal information management, multi-session search, and collaborative search. Most theories of information seeking consider it
as one component of human problem solving (e.g. [3][14][16][23]). People search for information objects that embody ideas, use cognitive effort to understand what they find, and employ additional effort to use these understandings to create problem solutions. Most of the models aim to be general, but tend to focus on discrete search episodes. Bates’ [2] berrypicking model emphasizes how searches evolve as the searcher explores and learns. Marchionini [16] characterizes the information seeking process with seven subprocesses (recognize need, accept problem, formulate the problem, express the need, examine results, reformulate the problem, and transition to use) that recur according to the information seeker’s ongoing sense making and reflective monitoring of progress. Kulthau’s [14] work includes an affective dimension as people seek information and learn over time. Two aspects of these views of information seeking that motivate the work reported here are results examination and sharing, and how the overall process evolves over multiple search sessions.

Theories and practices of personal information management (PIM) encompass a broad range of management functions; however, finding and refining information is particularly salient in much of this work (e.g. [5][10][4]). In the Keeping Found Things Found project, Jones et al. [10] reported on the diversity of methods and tools used to manage and re-use information found on the Web, including practices such as email to self, printing, saving copies of web pages to a hard drive, copying and pasting URLs, relying on personal memory of URLs, history mechanisms, and creating bookmarks. Aula et al. [1] conducted a study of Web search and re-access strategies and reported that: users commonly rely on memory of a URL; commonly save found documents; sometimes use bookmark, printing, history tools, and pasting URLs into emails; and rarely write down URLs or queries. Many studies have reported on bookmark use and the problems of recognizing, using, and managing large bookmark collections (see MacKay and Watters [15] for a good summary). Studies have found that users struggle to make these ad-hoc strategies work for their needs and that PIM is a challenge [1][10]. The PIM work motivates the multi-session search and results management emphases in the work reported here.

A related body of research has examined current practices to deal with information seeking over multiple sessions. Morris et al. [18] surveyed information workers and reported common multi-session search resumption strategies: memory (36%), written or typed notes (30%), browser bookmarks (26%), leaving the browser open (14%), and browser history (7.6%). Saving web pages locally as a file (5.3%) and email to self (2.4%) had low percentages. MacKay and Watters [15] reported on diary and field studies of multi-session Web search and found that copy and paste, bookmark use, saving and printing Web pages were common actions in multi-session searches. They suggest features to support multi-session search: a task reminder feature, support for working on multiple tasks simultaneously, and tools to help manage and return to information found during multi-session tasks. Kellar et al. [13] studied how people monitor information on Web pages and found that bookmarks were “the most common navigation mechanism” [13, p.383] across a variety of monitoring purposes.

A recent thread of research that builds on these literatures aims to create support for collaborative information seeking. Morris [19] has reported on the collaborative Web search behaviors of technology workers, and with his colleagues has built and evaluated tools to support collaboration and search (e.g. SearchTogether [20] and SearchBar [18]). Commonly reported sharing behaviors from her survey of collaborative search [19] were: email links (86.3%), show personal display (85.3%), email a summary (60.3%), call on phone (49.0%), print page (41.2%), and create a document (34.3%). Other work on collaborative information seeking such as Twidale et al.’s [28] framework of collaborative search activities, Golovchinsky et al.’s [9] taxonomy of collaboration, Evans and Chi’s model of social search [7], and Pickens et al.’s [22] framework of collaborative search activities demonstrate the growing attention to collaborative information seeking and motivates the broad kinds of collaboration examined in this paper.

One additional important area of background research is medical/health information seeking. Recent studies have found that 74%–80% of U.S. Internet users have searched for health information on-line [8][25], that people often start with Web search engines [8], commonly look for information about specific diseases, conditions, or treatments [8][25], and that searches are often done for someone else [8]. Studies have also reported that users assess accuracy of found information by factors including endorsements by recognized agencies or groups [25][27] and “the understandability of the information” [25, p. 39]. These prior studies inform our analysis and provide a basis for situating and evaluating our findings.

**METHOD**

We interviewed 30 people about their current practices conducting, managing, and sharing information from ongoing, exploratory searches. Participants were recruited from a university and the surrounding metropolitan area by posting messages to a campus-wide opt-in mass email service and to local professional organizations. In our recruitment, we screened for people who had done exploratory, multi-session searches and had shared the results of their searching with others. We recruited into three cohorts as described below.

**Academic researchers** [denoted by A] all worked on ongoing research projects in roles as faculty, post-doctoral researcher, Ph.D. candidate (post-proposal), or research
scientist, had a mean age of 40 years (s.d.=14), and consisted of five men and six women from a variety of departments. Corporate workers [C] all worked in roles that required them to conduct exploratory searches for business purposes (i.e. corporate research, marketing, product development, research and development). They had a mean age of 34 (s.d.=9) and consisted of three men and six women. Medical information seekers [M] were all university faculty or staff members who had conducted ongoing searches for medical information for themselves or a family member. This group had one man and nine women with a mean age of 46 (s.d.=11). Participants in this group searched for information on a wide variety of conditions including a childhood birth defect, an autoimmune disease, a heart condition, and insomnia. Participants in all three groups had substantial on-line search experience (mean of 14 years, s.d.=4). In the statistics above, we note that age and search experience data was missing for three participants, one in each group.

**Semi-Structured Interview Session**

We developed a semi-structured interview form with 16 questions based on our research goals and knowledge of prior research. The questions were designed to inquire about specific situations of interest, but also to be open enough to allow participants to describe their variety of behaviors and practices. The complete interview form is available for download from http://www.ils.unc.edu/resultsspace/. Interviews were conducted mainly in participants’ private offices or in quiet conference rooms to avoid disturbing co-workers. Some participants chose to be interviewed in a conference room in our department and one was held at a local coffee shop. Some participants showed us artifacts such as their bookmark collections, searches they had conducted, and tools they used. However, these were not available in all cases. The interviews typically lasted about one hour.

At the start of the session, participants signed an informed consent form and completed a short questionnaire with demographic and background information. The interviewer then started a digital voice recorder and began the questions. To help ground the interview, we asked participants to describe a particular collaborative exploratory search project they had worked on recently to be the primary focus. However, we encouraged comments about their information management behavior in general, and many participants described experiences from several different projects. Twenty of the interviews were conducted by one author, and two other authors conducted the remaining 10 interviews to help balance any potential interviewer bias.

**Analysis**

After the interviews were completed, we transcribed and analyzed the data. We used a content-analytic approach that drew upon concepts from several qualitative analysis techniques, adapted to our specific research goals. Rather than starting with verbatim transcriptions, we generated paraphrased transcriptions of each interview. By paraphrasing, we were able to generate the transcriptions quickly, while still maintaining the richness of the data. These paraphrased transcriptions then formed the basis for our qualitative analysis coding. After coding, we went back to the audio and extracted verbatim quotations to illustrate key points.

The three authors who conducted the interviews met as a group and reviewed each question. For a few questions, we determined that a small number of closed codes would cover a majority of the responses. We analyzed saving behaviors using a set of closed codes rooted in findings from PIM studies (e.g. [10][1]). In our analysis of methods for sharing information, we used a set of codes similar to a subset of the results of Morris [19]. We also used closed codes for note taking behaviors. However, for most questions, there was great variety in the responses and we used an open coding approach. We divided the interviews into three groups and each independently coded a group such that each participant’s responses were coded by one coder. We then met again over several days and, for each question, merged and collapsed our open codes by a process of consensus. The results we present here are based on the common themes that emerged from this process of analysis.

**RESULTS**

In this section, we summarize the main findings from our qualitative analysis of the interviews, organized by our main research questions.

**How Do People Conduct Exploratory Searches?**

**Common Strategies for Searching**

Many participants (67%) described starting exploratory searches by going to one of the major Web search engines and entering keyword queries. The academic and corporate searchers mentioned a mixture of starting points including databases such as ISI, PubMed, and specific known sources, but the medical group overwhelmingly (100%) reported using a Web search engine as part of their initial exploration (although they often later learned of authoritative sources). Participants described a variety of subsequent behaviors to refine and continue their searching: keyword refinement, changing the scope of the search, and reference chaining were all common behaviors in all three groups. These behaviors largely confirm results from other studies (e.g. [26]).

**Issues and Challenges of Searching**

**Keywords** – When asked about problems they faced when searching, over a third (37%) of our participants mentioned figuring out what keywords to use, indicating that people still have trouble with query formulation, despite advances in search algorithms and interfaces.
Finding “good” results – Over a third of our participants (37%) talked about difficulties in finding information that was “good” along some dimension such as accuracy, credibility, or timeliness. The medical group was especially attuned to finding relevant and trustworthy information, a process that involved learning about information sources:

> Personal web sites are popped up between legitimate web sites... somebody’s personal blog... where they... say, oh, this is what you need to do [M9]

> You start to know what are the reputable sources... and then I would begin to go directly, instead of entering my symptoms,... to those sources. [M11]

Across all three groups, we noted four criteria as influencers about the relevance/trustworthiness of a search result: name recognition, the content of the text snippets on the search results page, recommendations from other people, and the readability and language used in the source (e.g. too much technical or medical jargon – consistent with the findings of [25]). Name recognition differed based on the domain. For the medical group it often involved recognizing a major research center such as the Mayo Clinic or a national organization such as the American Cancer Society (consistent with prior studies [25][27]). Academic researchers knew the names of authors, universities, and research groups of interest. The corporate group referred to known organizations, trusted sites, established magazines and popular blogs.

Filtering search results is time consuming – About a quarter of our participants (23%) mentioned that searches would return too many non-relevant results, or “too much junk” in the words of one person. Often, the “junk” were search results that did match their query, but took time to determine the relevance of:

> It just takes longer to sift through all that information... you know, reading different sites and deciding if you are going to get anything out of it. It’s just the length of time it takes to get very little information. [M8]

Information may be unavailable – Participants (23%) also described situations of not finding information, due to the information being unavailable because of: 1) access issues such as not being able to log in to a publication database from an off-campus location, or 2) the information may not exist or may not be on the Web.

How Do People Organize and Manage Search Results?

Common Strategies for Organizing

Participants reported printing (43%), creating bookmarks/favorites (43%), saving to disk (37%), and copying and pasting text (33%) as the most common saving behaviors. Printing was especially prevalent among the medical and academic groups, but interestingly, was not mentioned at all by our corporate participants. When saving documents found from searches, three participants (10%) talked about renaming the files based on meaningful metadata such as the author, source, or topic.

Generally, participants reported using bookmarks for two main reasons: 1) to create an easy way to get back to a commonly visited site, and 2) to save a page that had been difficult to find:

> [Q: What sites would you bookmark?] Sites that I couldn’t find easily... There’s no need to bookmark the Johns Hopkins Center... but... information that was hard to find, I bookmarked. [M11]

These two distinct uses of bookmarking are important for different aspects of ongoing search. Bookmarking commonly used sites is a kind of personal information seeking infrastructure development that recognizes reuse (similar to Keller’s [13] findings on bookmark use for a variety of monitoring purposes). Bookmarking hard to find pages is likely to be much more problem-centric.

The Multi-Purposed Role of Note Taking

Many participants took notes about the information they found from their exploratory searches. For example, across all three groups, copying and pasting found information into a text, word processing, or email document was mentioned by a third (33%) of our participants. In the academic group, six of eleven participants reported using a reference manager such as EndNote, but no other groups reported using these. Participants also reported relying on hand-written and mental notes (more details in the section on resuming searches and refining results).

Note taking often played a multi-purposed role, helping participants organize and synthesize (i.e. learn) the information they found, keeping track of sources of information, and acting as an important aid for sharing information with others. In this section, we focus on note taking in its organizational role, but revisit the practice again in our discussion of collaboration and sharing.

If I find something that is really interesting, what I’ll do is right-click it and open it in a new tab. So in this way, I’ll have maybe 10 tabs open, maybe up to 15 tabs. And then I’m going to look at all of this and then take some notes into a Word file. [A3]

Copying and pasting found information into a text document is a simple, but powerful technique. Participants often described adding their own notes to these documents and using them to organize and annotate the results they found. By reducing the information to simple text, complexity is removed, there is a low barrier to use, and it is easy to share with others. However, information may be lost in the process – table formatting is removed, metadata structure is eliminated, and source information is not automatically kept with copied data.
Additional work may be required to preserve or re-create structure and linkages after pasting (e.g. copying metadata fields for citation, or copying text from a Web page and then copying its URL in a separate step).

This simple practice of copying and pasting found information and annotating/summarizing in text documents is perfectly logical, but we were surprised by its prevalence and the importance it played in many participants’ exploratory search and collaboration process. In one sense, it is a great adaptation of tools-at-hand to fill a need. In another sense, it highlights the need for better tools to extract information pieces, re-use them, annotate them, and share them with others.

One university professor used an especially innovative approach to note taking using a somewhat heavyweight but familiar tool-at-hand:

> It’s a system that I came up with a couple years ago... I organized it in PowerPoint... I’m old enough to have had to use 3x5 file cards... you know, you write your quotes down on it, or you write your references down on it... well, that’s what PowerPoint does for you. You create slides... and then you can organize it and just move stuff around... until you get the flow that you want. [A1]

Several participants described entering found information into template documents. For example, one participant worked as an intern at a consulting company and her job involved developing profiles of their clients for business development. She developed a template document for each client that served several purposes: it helped guide her searches and make them more efficient, it helped her resume her work (she knew what she had done and what was left to do), and the completed templates were her finished work product. Thus, she created a simple tool to reuse for each client search.

**Issues and Challenges of Organizing**

**Saving and managing found information** – Organizing found information is often complicated in exploratory search by the lack of context early in the process (similar to Jones’ discussions in [12]). One participant described this in terms of what would make organizing easier:

> If I knew more in advance about what categories... what pigeonholes I am going to need. [A1]

Participants described interesting uses of tools at hand to support specific goals and challenges in saving information. For example, one participant, apparently in an effort to preserve details of found web pages, described saving web pages by “printing it to Adobe”, and “taking a picture of it in Adobe”, meaning that she would print the file to PDF, look at the print preview to make sure everything was there, and then save the PDF to her hard drive using a descriptive name. By saving in this way, she was able to preserve the web page exactly as she saw it, and to have it saved into a single file with a recognizable name. Another participant made sure he had easy access to articles by keeping multiple copies – one copy in each project folder for which it was used.

Managing bookmarks also presented challenges. For example, two participants expressed how over time their bookmark collections became unmanageable:

> For a long time I think I was putting everything into Delicious, but I realized that was too much. [C29]

> Bookmark... I did in the beginning, but it turns out to be too long... In the very beginning I sorted them into... different folders... But then later it mixed up with my own personal collection of my own web sites. So in the end, I gave that up. [A3]

In addition, participants expressed both real and perceived barriers to adopting tools to organize found information:

> I just downloaded... Zotero... which I've never really used yet, but hopefully I’ll start... My wife tried to get me to [use it], but it seemed to me it was more work getting it set up than it was just dealing with the 15 citations. [A4]

> There’s lots of software, I just generally tend to use whatever our IT guy loads and we use. [M2]

The quotes above about bookmark use and tool adoption illustrate an HCI design principle that is especially important for information management tools – the user’s primary tasks (e.g. information seeking, learning) need to be supported without overwhelming them with secondary tasks (information management). Using well-known tools-at-hand may help in this regard.

**Criteria for when to save/print/bookmark** – Deciding whether or not to save a found result is what Jones refers to as a “keeping decision” [12] and can also be applied to printing and bookmarking decisions. One of our participants described the saving decision based on how much effort they put into finding the information:

> If it is something that I know I can get to easily again, like something on WebMD, then I don’t save it... if I had to read through... a lot of abstracts... I thought well, this will take me longer to get back to that again, so that would be one I would save. [M2]

When deciding whether or not to print a result, participants described three main criteria: “important” items, sharing with others, and portability.

> If it’s really really good, I print it. If it is the latest, or a well-done research study... I also print it because my mother-in-law does not have email access or Internet, so if it is something medically related to her... then I print it so she can have a hard copy to read. [M2]
Re-finding Search Results
Re-finding results that have been seen before can be a particularly tricky problem. The searcher may or may not have saved the information, may not remember where it was seen, and the information may have moved from its original location on the Web [4].

Forty three percent (43%) of our participants talked about relying on memory when trying to re-find information found in earlier searches, including efforts to re-create the query that they had used to originally find the information, and making use of recalled details such as an author name to shortcut the original search process:

I try to remember what search or a little bit more about where it was, what the source was [M11]

I remember a lot of the keywords, so I have to retry all of the combinations of the keywords [A3]

About a quarter of our participants (23%) described looking for information they needed to re-find from earlier searches in their personal information collections. Re-finding from within a personal collection requires that: 1) the information was saved, and 2) that the user remembers that they saved it to their personal collection. Jones [10][12] has described these “forgetting” problems and they were mentioned by our participants as well:

Sometimes when I find something I forgot to bookmark it. But maybe a day or two later I need to turn to that web page again...[A3]

I have to think about it again, I’m like, “Oh gosh, how did I get there?” and “Did I save that one or not?”... I may have decided not to save it... [M2]

Two participants described using “Desktop Search” tools (e.g. Windows Desktop Search, Google Desktop, Apple Spotlight) to re-find information they had saved. One additional participant seemed to know about this feature but had not used it:

I'm kind of assuming that Windows Vista has a search function where I can look for certain words... to do the equivalent of a keyword search... but on my own hard drive... would be helpful. [A1]

Twenty percent (20%) of our participants described using browser history and auto-complete mechanisms to help them re-find information from earlier searches, but noted that these tools have limitations:

With, you know, auto-complete in the form field, I can easily recall which keywords I've used. [C29]

I tried to use the history function just to look at all the web pages... But since I was doing searches everyday... so many pages... it's just really hard to go through all of them one by one [A3]

Interestingly, only two participants talked about using bookmarks when they encountered re-finding difficulties.

How Do People Search and Share Collaboratively?
People reported using a variety of methods to communicate, collaborate, and share information found from searches with each other, including: email (80%), face-to-face (67%), telephone/conference calls (37%), and printouts (37%). Other methods for information sharing included blogs/webpages (17%), shared network hard drives (13%), and instant messaging (10%). These findings are similar to those of Morris [19].

Collaboration Styles
Several styles of collaboration were apparent in our interviews and are summarized below.
Directed collaboration – In the academic and corporate groups, collaborative search was often directed, with one person leading the work and other team member(s) conducting the searches. This was typically the case with a graduate student working on the research project of a faculty member, or a corporate worker looking for information as a task assigned by their supervisor.

Tightly coordinated collaboration – In coordinated collaboration, the collaborators work together to divide the search task into parts. One university professor described an example of this with students working on a class research project.

Actually, what we did in class was, a couple students bring a computer, I bring a little projector, and one of them would log into Blackboard and... we could all look at it... these are the articles I found, who wants to go find this one, who wants to read this one, who wants to do the summary. [A1]

Loose/Informal collaboration – This type of collaboration commonly occurred among the medical information seeking group. For example, family members or friends might do searches and share information on an ad-hoc basis. Although informal collaboration can be opportunistic and beneficial, one corporate participant described how shared information can be lost:

We don’t have a good way of creating and sharing a list of resources... So... that kind of collaboration can be very informal... via IM or email... But there’s no place that I can go and easily reference those links... there’s no one place to go and find that information once it’s been shared. [C29]

Sharing Results
First, we note as a general observation that our participants often described sharing information in aggregated sets with their own annotations and commentary provided as part of a “value-added” package to be shared. Although browsers and other software have added capabilities such as emailing a web page, our interviewees were using tools-at-hand (largely text documents and email messages) to aggregate, annotate, and document results found from both single session searches and across multiple search sessions.

Much of the information sharing that was described by our participants occurred after the information was found and synthesized/aggregated to some degree. Participants rarely reported sharing “raw” lists of results. More often, they reported sharing summarized / filtered sets of results.

I don’t share the raw materials that I have found... the team doesn’t have time to read all the web sites... When I share all of this information with them it’s not the original information, but the integrated information into our project. [A3]

Note taking played a key role not only in helping participants organize the information they found, but also in creating summaries to share with others. For example:

I put it into a Word document and I cut and paste... and I email myself so that I can review it before I send it to somebody... I copy the direct link so that that person can go to that web site and read the whole thing if they want. Either that or I’ll give them a summary... I’ll say okay, here’s the link, but this is really what the research found. [M2]

An interesting example from the corporate group involved two co-workers using tightly coordinated collaborative searches to conduct a literature review for a project in which the deliverable product was an annotated bibliography. They wanted to organize, annotate and share their results with the client on an ongoing basis. To do this, they used a tool at hand, posting their bibliography entries to a blog:

We opened the WordPress blog to the client from day one, so she could check-in daily and get a feel, see the directions we were pursuing. [C12]

In some cases, participants did describe sharing “raw” lists of results. An example mentioned separately by two unaffiliated participants involved conducting a literature review in two parts: an initial searching stage in which promising looking citations were collected and a second stage in which the citations were reviewed in more detail. The collaborators shared their lists of raw citations because they were being added to an overall shared list.

Sharing “raw” results was also mentioned as a way to quickly send a link of interest to a colleague with little annotation:

We share links back and forth, saying, ‘You should check this website out, it’s got good examples.’ [C29]

Another dimension of collaboration and sharing deals with the roles of the collaborators. For instance, the medical cohort was usually characterized by a central figure – either the patient themselves or the primary care giver. This central person disseminated information to others, i.e., family members, friends, and medical professionals, with less information transmitted in the other direction (except for receiving information from doctors). Anecdotally, many participants across all groups identified themselves in a “central” searching role, even in cases where they were not the leader of the project. While it is likely that people in these central searching roles self-selected for our study based on our stated recruiting goals, we note that even participants who were working under the direction of a more senior team member (e.g. a Ph.D. student working on an advisor’s project, a corporate worker doing assigned work) placed themselves in this central searcher role. In an example of how roles can influence collaborative search behaviors, one of our medical participants described how she (the
Learning in Exploratory Search

Exploratory search is characterized by learning and investigation [17]. Knowledge acquisition, comprehension, interpretation of ideas, analysis, synthesis, and evaluation are all components of an ongoing learning process supported by exploratory searches.

We observed a common learning-seeking progression described by the medical information seekers that moved from looking for information about symptoms, to possible diagnoses, through treatment options, and for some, to living with a chronic condition. These progressions often followed the initial stages of Kuhlthau's [14] model of the information search process: initiation, selection, exploration, formulation, collection, and presentation.

During initiation and selection, participants described the need to learn basic information about a medical condition and often expressed a lack of background or context (e.g. What is this? How do I treat it?):

I Googled it... I was just looking for general information... I'd never even heard of this before so I needed to get all the background information. [M9]

Participants also described using the web to supplement information from their doctors:

She [participant's mother] doesn't get that much [information from her doctor]. I think I give her more than she gets from her doctor. She will also send me lab results... to explain them... [M8]

In exploration, participants echoed the frustration and uncertainty of this stage described by Kuhlthau as they found information that was contradictory or unreliable:

There is just a lot of... people putting information out as if it’s a fact and it is wrong... it would be nice if there was... some quality control... [M11]

There were these weird little ramshackle websites that would come up, that I totally didn’t trust... once you’re outside... your WebMDs and your journal articles, it’s hard to know really what to trust. [M7]

Another reported source of frustration was that although there is often general background information for specific conditions, the same basic information may be repeated in different many sources, including from their doctors.

The same, sort of ‘cookbook’ information, gets put all over the place. And also, even you can tell that your medical doctor has that same information. That’s what people know. [M11]

Q: What was the biggest obstacle? The repetitive information... finding something new. [M8]

After learning the basic background information, detailed intermediate level information may be hard to find. In many cases, advanced information exists, but it may be beyond the technical level of laypeople.

No middle ground between technical journals and a sea of crap. [M7]

Despite this, some patients searched databases such as PubMed and read the latest journal articles. Several participants with chronic conditions described reaching a point where they were monitoring sources, looking primarily for new treatments or breakthroughs:

At the beginning I was just trying to get a wide range and basic information. Now I’m looking for breakthroughs... and recent information. [M11]

Kuhlthau’s later stages, formulation, collection, presentation, were described by some of our participants when they reached a point where they had explored a large amount of information regarding their condition and treatments. In a few cases (mostly people with rare or difficult to treat conditions), the participant became an “expert” on the condition and begin presenting and informing their doctor of new information.

People learn at many levels. They do so by adapting systems and themselves, by understanding their collaborators’ needs and abilities, and by spending time learning/reflecting on content. Quintana et al. [24] have used scaffolding theory as a basis for designing systems that support learners. Scaffolding techniques provide temporary supports that evolve and dissolve as learning takes place. Ongoing searches will benefit from these kinds of flexibility. Quintana and his colleagues have found over multiple studies with several different systems and domains that adding even simple supports such as note taking to instructional materials leads to improved performance. Designers of systems to support multi-session search should keep learning progressions in mind and use scaffolding techniques to support different stages of the information-seeking process.

DISCUSSION

Our study found that users are still dealing with many of the same issues (e.g. how to save/organize/manage/re-find found information) and are using many of the same strategies (e.g. printing, saving to disk, bookmarks) reported by Jones et al. [10] and Aula et al. [1] despite evolutions of technology, tools, operating systems, and the emergence of Web 2.0 and cloud computing since their studies were conducted. Our results compare and support the recent findings of Morris et al. [18], Morris [19], and MacKay and Watters [15] in the behaviors and practices found for multi-session and collaborative search (e.g. note taking, sending email summaries with URLs, use of memory to resume searches) even though we used different study methodologies and user populations. The consistency of these results across studies and time helps
us understand the challenges in designing tools to support users’ needs in these areas. The use of computer tools-at-hand such as simple text editors and email persist as commonly understood, frequently used tools for a variety of tasks, despite their limitations. Users experience real and perceived barriers to learning and adopting new, specialized tools, but will adapt existing tools to meet their evolving needs (such as using Powerpoint as a “note card” organizer, and using a blog to generate an on-going “report” for a client).

Our results, considered with those of prior studies, have both general and specific design implications. Generally, tools for managing, organizing, and sharing search results may benefit by leveraging existing work practices involving tools-at-hand and by minimizing changes to existing systems. Specifically, tools are needed to support tasks within the Web browser (as plug-ins, extensions, and cloud applications) for collection of results, note taking, summarization, search resumption, and sharing of results. Steps in this direction include the ability to save the current set of open browser tabs and have them automatically reloaded next time the browser starts and automatic display of a user’s query history (e.g. Bing!’s “Search History” feature). Tools such as SearchBar [18] provide a hierarchical query history and the ability to organize search results by user-defined topics.

One of the most common activities reported by our participants was taking simple text based notes (which often included URLs) about the results they found and then sending summaries to themselves and/or other people. Morris et al. [18] also reported this type of note taking as a common behavior in multi-session search. Currently, this activity is not well supported by browsers, email, or websites. Many websites provide “email this page” links, but these only work for a single page, whereas our participants described situations that involved summarizing across several Web pages. Tools such as SearchBar [18], Zotero (http://www.zotero.org/), and sparTag.us (http://spartag.us/) support note taking, and more research is needed to understand users’ integration of electronic note taking tools into their workflows.

Renaming downloaded files as they are saved locally is part of broader set of behaviors to save important metadata with files. When saving found information to local files, participants described renaming the files based on authors, journal titles, topics. One participant also described renaming files for version tracking. These behaviors suggest the need for better support for metadata to be stored with files and transferred across systems.

We also note that users still deal with issues of keyword selection and understanding search domains, especially for exploratory searches and situations in which the user may be unsure if the information being sought exists on the Web. Search interfaces and tools need to help users better acquaint themselves with unfamiliar domains and terminology so that they may make well-informed next search steps (or decisions to stop searching). Search engine features such as “Related Searches”, auto-completion of search terms, and results filters are examples of efforts to help in this area.

**Tools-at-Hand**

Although web browsers and search services are the primary tools that people use for information seeking, our interviews make clear that people employ a variety of other tools and techniques that go beyond the functionalities offered by today’s search engines and web browsers as they seek and process information over time. Although many of the interviewees noted that they depend on their memory over sessions, there were many examples cited of using tool-based cues in the browser (e.g., link color changes, auto-complete for previous entries) and memory functions (e.g., bookmarks, history, various saving functions). These tools were not sufficient for results management and collaboration and many examples of using tools beyond the browser were discussed as people added value to results for both personal and collaborative purposes. It is clear that people leverage well-learned and familiar tools and techniques for multiple purposes while searching. This illustrates Norman’s notion of information appliances [21] that are so comfortably at hand that they become invisible. Using email as a way to remind oneself or to store notes are just two examples of how people adapt tools to their needs. Additionally, people make satisficing decisions that take into account personal effort as well as the needs or preferences of collaborators when choosing these tools at hand (e.g., printing vs emailing). These examples demonstrate what may be low-hanging fruit for new kinds of functions that might be added to browsers (e.g., as plug-ins, extensions, or iPhone/Android apps) to support the many aspects of exploratory information seeking.

**CONCLUSION**

The interview data for these three cohorts of information seekers demonstrate how multisession and collaborative searching occurs in different settings. The data show that people use a variety of tools-at-hand to augment what search engines and current browsing software support. Additionally, they take into account the needs of collaborators when choosing these tools. A key challenge for designers is how to leverage this tension between users’ reliance on familiar tools at hand and features that can be incorporated into web browsers and other information-seeking support tools. In this paper, we have provided insights into users’ current practices and designs that we believe are useful in this design process. As people learn more about the topics they investigate, different accompanying support tools are needed. Designs that accommodate this evolution over time and that allow people to seamlessly integrate the examination, use, and sharing of results represent the next generation of information-seeking support systems.
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