Collaborative Information Behavior:
User Engagement and Communication Sharing

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Chapter 5
Collaborative Information Behavior:
Exploring Collaboration and Coordination during Information Seeking and Retrieval Activities

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ABSTRACT

Collaborative information behavior is an important and growing area of research in the field of information behavior. Although collaboration is a key component of work in organizational and other settings, most research has primarily focused on individual information behavior and not the collaborative aspects of information behavior. Consequently, there is a pressing need to understand both the conceptual features of this type of behavior and the technical approaches to support these collaborative activities. In this chapter, the authors describe current research in this area and what we are learning about collaboration and coordination during these activities. In particular, the authors present details of ethnographic field studies that are starting to uncover the characteristics of collaborative information behavior. They also discuss a preliminary collaborative information behavior model and some technical explorations that they are conducting in this space.

INTRODUCTION

Most information retrieval systems and underlying conceptualizations of information behavior are still viewed primarily from an individual user's perspective, despite the mounting evidence that collaborative information behavior (CIB) plays an important role in organizational work. Focusing solely on individual information behavior

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(IIB) has lead to processes and technologies that support individual information seeking but often constrains collaborative information behavior. However, many models and studies of information seeking behavior have focused on individual needs and behavior. For example,

- Kuhlthau's studies (1989; 1991) of high school students examined individual information seeking behavior; therefore, her model conceptualized information seeking as an individual activity.
- Ellis' model reflects his studies' (1993; 1997) emphasis on information seeking as an individual activity.
- Wilson (1981) developed his model after examining information needs and seeking studies. The model is his conception of the information needs and seeking process but also reflects the individual nature of the information seeking typified in earlier user studies.
- Leckie et al.'s model (1996) was developed from a literature survey of studies examining the largely individual information seeking behavior of engineers, physicians, and lawyers.

These studies and models focused on IIB primarily because information seeking was viewed as being embedded in individual not collaborative work. Furthermore, the focus was on the conventional pattern of interaction between a single user and technology. However, this is acutely problematic in settings where teams and team work are important. Consequently, this perspective of focusing primarily on IIB is now being challenged by a number of studies examining information seeking in a wide variety of collaborative settings (Fidel, Bruce et al. 2000; Foster 2006). These studies are starting to pave the way for both a conceptual understanding of collaborative information seeking and the improved design of collaborative information retrieval (CIR) systems.

Our research team has been exploring collaborative information seeking practices in a variety of organizational settings such intensive care units (Reddy and Dourish 2002), emergency departments (Reddy and Spence 2006), and academic research (Spence, Reddy et al. 2005) for the last ten years. We have used the term *collaborative information behavior* (CIB) in our research studies to describe these broad range of activities (Reddy and Jansen 2008). Our team's research goals have been two-fold: First, to develop a conceptual understanding of CIB and second, to gather requirements for the design of organizational CIR systems.

In this chapter, we focus our attention on some of the empirical and technical aspects of our team's research. We synthesize findings from our earlier studies and describe what we are learning about collaboration and coordination during CIB activities. In the rest of the chapter, we provide some background in this area, describe our methodology for collecting data on CIB, present a general overview of our research, discuss lessons that we are learning about CIB, and highlight future directions that we need to further explore in the CIB research space.

BACKGROUND

Even though information seeking is an important part of collaborative work (Cicourel 1990; Paepcke 1996; Hansen and Jarvelin 2005; Foster 2006), researchers have only recently begun to examine the particulars of CIB (Foster 2006). For instance, Talja and Hansen (2005) describe the important role that collaborative information seeking play in everyday work. Much of this research has been influenced by Dervin's (1992) work on sense-making and Kling's (1980) research on the role of technology in organizations. Dervin's sense-making research highlights the sense-making "gaps" and addresses how people try to bridge these gaps. Kling focuses our attention on the

importance of understanding the context in which technology will be implemented and the social interactions that impact the use of the technology.

Conceptual Perspective

Researchers are starting to lay a conceptual foundation for understanding CIB. Karamuftuoglu (1998) outlined the beginnings of a theoretical framework for understanding the collaborative nature of information seeking. The core of this framework is that information seeking is just as much about producing new knowledge, a creative and inventive activity, as it is about finding extant information. Karamuftuoglu addresses two knowledge functions of information retrieval (IR) systems. These IR systems should support transferring and creating new knowledge, where new knowledge creation is dependent on social networks. This ties in with work on social intelligence (Cronin and Davenport 1993) and with attempts to subsume support for information seeking in the broader area of group support (Romano, Roussinov et al. 1999; Hyldegard 2006). Cross et al. (2003) point to five categories of benefits of collaboration during information retrieval. These benefits range from people turning to each other to get specific information to people validating each other's search plans.

The collaborative information retrieval (CIR) project undertaken by the researchers at the University of Washington (Fidel, Bruce et al. 2000; Bruce, Fidel et al. 2003; Poltrock, Dumais et al. 2003; Fidel, Pejtersen et al. 2004) has helped lay an important foundation for understanding CIB. Their cognitive work analysis approach highlighted the important interactions that took place between team members as they sought, retrieved, and used information. They examined the collaborative information retrieval activities of design teams in Boeing and Microsoft. The researchers found that team members collaborated when developing information seeking and retrieval strategies to address an information problem within the team. Their research revealed factors such as communication patterns and work activities that influence the need for information and for collaboration during information searching. Similarly, Hansen and Jarvelin (2005) discuss CIR practices of information workers in patent offices. They found that awareness workers have of each other's work activities plays an important role in the success of the CIR activities. They also state that there has been very little empirical work on collaborative information seeking and retrieval.

Sonnenwald and Pierce's (2000) study of information behavior in a hierarchical work environment (i.e., a military command and control) highlights the collaborative nature of the activity. They described collaborative information seeking (CIS) as a dynamic activity in which "individuals must work together to seek, synthesize and disseminate information". They placed collaborative information seeking within the wider context of the group communication process. Sonnenwald and Pierce examined how team members maintained awareness of each other's information activities and how this awareness influenced their information sharing with each other.

In educational settings, Hyldegard (2006; Hyldegard 2009) looked at collaborative information seeking from the perspective of extending Kuhlthau's (1989) Information Search Process model. She was interested in examining how well the model explained CIB activities in students. Hyldegard (Hyldegard 2006) found that the model needed to be extended to support collaboration. In a survey of CIB activities among academic researchers, Spence, Reddy, and Hall (2005) found that researchers used a variety of tools ranging from e-mail to video-conferencing to support their collaboration during information seeking activities.

In the medical domain, Reddy and Dourish (2002) described the role that work rhythms played in team members' collaborative information seeking practices in an intensive care unit. The rhythms provided team members with information about

each other, which allowed them to plan their search for information accordingly. Therefore, when team members understood the rhythms of the unit, they also knew when information was needed. Team members could then collaborate for needed information in a "just in time" fashion (not too soon and not too late) based on the rhythms of the unit. In a study of a patient care team, Forsythe et al. (1992) examined information needs of the team. Their focus was on the questions that these members asked to satisfy their needs. In another study of an intensive care team, Gorman et al. (2000) looked at how team members worked together to find and share needed information. They discussed the importance of tying different sources of information together to answer team members' questions.

Researchers in the computer-supported cooperative work (CSCW) community have also provided useful insights into collaborative aspects of information and work. For instance, CSCW researchers have highlighted the importance of people maintaining "awareness" of each other's activities to coordinate their work (Dourish and Belotti 1992a; Symon, Long et al. 1996). Clearly, this concept of awareness applies to CIB. Similarly, CSCW researchers have also discussed the impact of distance and time on collaboration (Ackerman 2000; Olson and Olson 2000; Mark, Abrams et al. 2003). Through these and other studies (Ackerman 2000), CSCW research has informed our understanding of collaborative information behavior.

Technical Perspective

Researchers are also beginning to explore CIB from a technical perspective. Twidale and Nichols (1998), in their study focused on designing interfaces to support CIR, suggested that support tools must provide a visualization of the search process which can be changed and talked about by the users. Furthermore, they believe that collaboration can improve the users understanding of the search process. Based on their observations in conventional and electronic libraries, they developed ARIADNE, one of the earliest collaborative retrieval tools. The system provides features for saving and sharing the search process and visualization of the search. ARIADNE highlights the significance of supporting collaboration by allowing users to share views and knowledge with each other during the search process. Similarly, Blackwell et al. (2004) describe the design of a tangible interface that allows multiple users to collaborate to refine a query. They found that it can improve relevance rankings when compared to single-user interfaces.

Another system that supports collaborative information retrieval is FoRSIC (Ertzscheid 2001). This system attempts to address the issue of information overload by devising a dynamic means of supporting connections between information seekers, information trainers, information tools, and information sources. The research team looked at neglected social factors such as communication and collaboration in information retrieval systems. A research team at Microsoft has explored supporting collaboration in general Web searching and have developed SearchTogether (Morris and Horvitz 2007). This tool is designed to support collaborative Web-based searching. It allows remote users to share searches and results with each other.

A few commercial systems have implemented functionality which supports some aspects of CIB. For example, IBM offers many products which allow collaborations among colleagues, customers, business partners and suppliers. These products offer presence awareness, instant messaging, and Web conferencing. In addition, the latest Netscape browser allows a team leader to share their Web page with multiple users. Although not specifically focused on CIB, there are several project team environments, such as Microsoft's Groove. Lastly, Enlista's Chat in Context allows users to browse and share information while chatting.

RESEARCH METHODS

In our field research examining CIB, we have primarily been utilizing qualitative methods (Reddy and Spence 2008). Although we have also utilized quantitative methods such as surveys to examine CIB (Spence, Reddy et al. 2005), our primary empirical approach is ethnographic fieldwork. Ethnographic observation is designed to provide a deep understanding and support rich analytical description of a phenomenon, as part of an iterative cycle of observation and analysis (Strauss and Corbin 1990). It seeks not just to document actions, but to examine what is experienced in the course of these actions.

Studying CIB requires careful observation and questioning. Multiple people need to be interviewed, and only with sufficient observation can we identify different CIB practices and their effects on daily work activities. Since people often cannot tell a researcher what they actually do in practice (rather than what they are supposed to do), it has been found more useful to both interview and observe study participants. For instance, in an example of tacit understandings, people may tell a researcher that they "officially" ask the unit pharmacist when seeking information about a particular medication. However, in practice, they may be observed to bypass the unit pharmacist and directly ask a pharmacist outside the unit about the medication. It is probable that many other tacit understandings about how people collaborate when seeking information exist (e.g., assumptions about the quality of the information, background of individuals, individual's knowledge); only a field study can reveal them. Indeed, only a field study can uncover CIB practices, can tell us what issues are important for which groups of people, and most importantly, can tell us *why* these issues are important.

To analyze data, we have used grounded theory (GT) (Strauss and Corbin 1990). The underlying assumption of GT is that a deep understanding of social phenomena can only occur from real-world observations. It is a set of methods for analyzing qualitative data such as interviews and observations. GT foregrounds this data and helps create an evolving hypothesis through systematic data coding. In the course of this coding, patterns become visible giving rise to hypotheses that in turn are strengthened or dismissed through further coding of the data and, in some cases, additional data collection. The strength of GT lies in the interaction between the data collection and the coding. The coding is a continual process that occurs not at the end of the data collection but during it; categories (e.g. themes) *emerge* from the data and are strengthened, modified, or discarded as more data is collected. We are using a qualitative data analysis software, NVivo7 (QSR International), to assist in this analysis. All the data is imported into the software as documents. Artifacts (e.g., forms) can be captured as "external" documents with a rich description of their use and contents. Then, as data is reviewed and compared, categories will emerge and nodes are created. The text will be "coded" on the respective node(s). This allowed for easy comparisons of text coded on the same node and across nodes. As analysis progresses, memos of emerging hypotheses will be documented by the software at both the document and node level. As these hypotheses were tested and strengthened, nodes were modified (e.g. ordered, combined, and collapsed). The software provides this functionality without any loss of coding ability. GT will help us identify categories of team information seeking interactions and practices as they emerge from the data.

RESEARCH FINDINGS

We have been investigating CIB through empirical fieldwork using the methods described in the last section. The early results have been both enlightening and promising. In this section, we highlight our important findings from our team's prior work.

Fieldwork: CIB in Medical Work

We have been investigating how team members collaborate when seeking, retrieving and using information in the healthcare domain. In particular, we have examined patient care teams in the surgical intensive care unit (SICU) of a large urban teaching hospital and the emergency department (ED) in a small rural non-teaching hospital (Reddy and Dourish 2002; Reddy and Spence 2006).

Previous studies of information seeking in medical settings have focused primarily on individual information behavior (Dee and Blazek 1993; Detlefsen 1998). However, as our fieldwork highlights, medical care is a highly collaborative endeavor (Reddy, Dourish et al. 2001). In information-intensive environments such as the SICU and ED, information is available from a variety of different resources. The goal of providing all these resources is to allow people to easily find needed information. Yet, at the same time, the increasing number of information resources and systems has created a problem of *information fragmentation*. Therefore, patient care team members in both settings have to gather information from different sources to make appropriate patient care decisions (Spence and Reddy 2007). What our fieldwork shows is that team members in the course of their work collaborate when seeking and retrieving information to ensure that they get the right information. The focus of our analysis has been on how this happens.

We found that CIB often occurs when there is a breakdown in the information flow. We have identified three reasons for information flow breakdowns in the two units. First, the information was not available when anticipated. For instance, a lab result was not ready when the physician expected it and he had to ask another team member about the results. Second, the information was either incorrect or incomplete. Therefore, team members had to ask questions to find the correct or complete information. Finally, the information was delivered to the wrong person. These breakdowns lead to team members collaborating to find needed information.

To understand why team members collaborate during information seeking and retrieval activities, we utilized the analytical concept of *triggers - an event or situation within the environment that initiates CIB amongst a formal or informal group of people* (Reddy and Spence 2008). Triggers are key events or situations in initiating a shift from individual information behavior to CIB. In particular, we have identified four triggers for CIB.

- **Complexity of information need:** Complex information problems often with multiple components lead to the need for collaboration.
- **Lack of immediately accessible information:** When information is not easily accessible, people often had to collaborate to find the information.
- **Lack of domain expertise:** When an individual does not have the prerequisite knowledge she will turn to people with the necessary knowledge to help him or her find the needed information.
- **Fragmented information resources:** Work environments where information resources reside in multiple and dispersed systems can often necessitate collaboration.

When these triggers occurred, team members turned to each other for help in seeking information.

A key element of CIB is communication. During information seeking activities, team members followed an iterative pattern of information seeking-sharing-seeking. This pattern highlights two important aspects of communication during CIB activities. First, when team members were verbally communicating, turn-taking was involved. One team member would present some information followed by another team member's presenting what she found. Second, sharing information was an essential part of CIB. The turn- taking and

information sharing allowed team members to collect pieces of information that they put together to resolve their information need.

We also found information retrieval technologies played a different role in IIB than in CIB. In the two units, there are a number of such technologies ranging from the electronic patient record to Web-based systems. Team members used them constantly to find needed information. However, unlike in IIB where interacting with the IR technologies is the last step in the process of the information seeking, it was often the *first* step in a CIB activity. Team members often used the information found in the systems as a starting point for their collaborative activities. The fieldwork in the SICU and ED reveal the complex nature of collaborative information behavior and lead to the development of a preliminary CIB model.

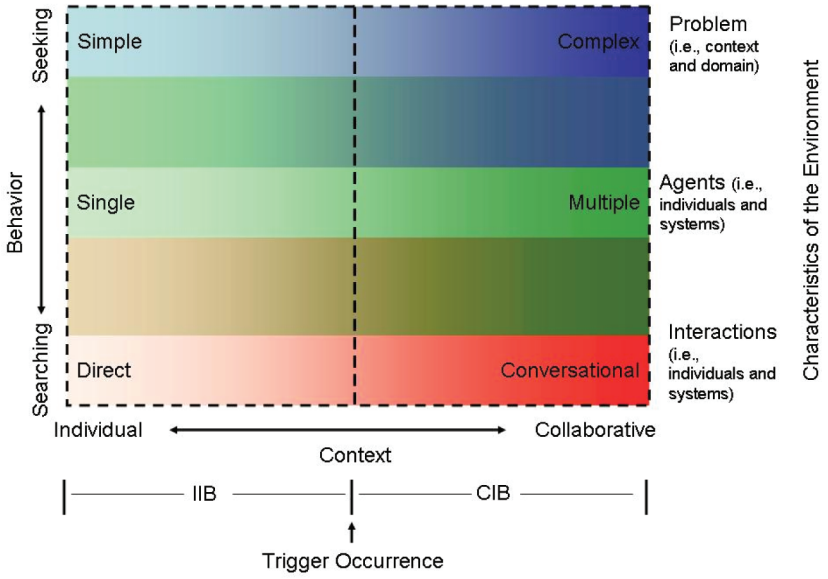
Collaborative Information Behavior Model

Based on the fieldwork, we have been developing a preliminary CIB model (Figure 1) (Reddy and Jansen 2008). One can view information environments along two axes: (1) Behavior axis: ranging on a spectrum from information searching to information seeking and use and (2) Context axis: ranging on a spectrum from IIB to CIB. Both axes affect the environmental characteristics of interactions (at the information searching level), agents (at the information seeking level), and problems (at the information behavior level). Naturally, these levels are not precisely bordered; there is a degree of overlap among the three. These two factors (behavior and context) interplay simultaneously across problems, agents, and interactions. The interplay of the complexity of the problem, the number of agents interacting, and the nature of these interactions initiates a trigger that transforms the context from IIB to CIB. At the individual level, the information problem is relatively simple when compared to the collaborative level. As the information problem becomes more complex and nuanced, the need to seek out other information sources becomes more pronounced. This is especially true in domains where multiple areas of expertise are needed to address the information problem. In these domains, several agents must interact. Problem complexity occurs at many dimensions, including number of sources to be consulted, closed or open problem, non-routine/unusualness of the information need, etc. Interactions include those involving systems and people. At IIB, these interactions are direct, even when interacting with people. With CIB, the interactions are much more conversational such as "query/question – response from agent – refinement of query/question", with shifts in the information need at each iteration. This model points to *triggers* (discussed earlier) as a key event that separates IIB from CIB. However, the model is still very preliminary and requires a great deal more fieldwork to further develop it. For instance, we need to investigate issues affecting CIB such as trust, rhythms, oral versus written sources, and coupling of work tasks.

Technology Prototyping

One characteristic of our research is that it involves not just the collection and analysis of ethnographic field data but also the development of prototype collaborative information retrieval (CIR) system. The development of information systems can benefit from ethnography's detailed, open-ended style of investigation. However, despite the broad recognition of both the value of ethnographic techniques as a basis for understanding working settings and the critical need to ground system development efforts in empirical detail, the question of just *how* ethnographic findings can be turned into design recommendations is still a challenge. Although no one systematic method has been developed, CSCW and HCI researchers have developed effective methods for developing recommendations and designing systems (Ackerman and McDonald 1996; Moran and Carroll

Figure 1. Individual vs. collaborative information behavior



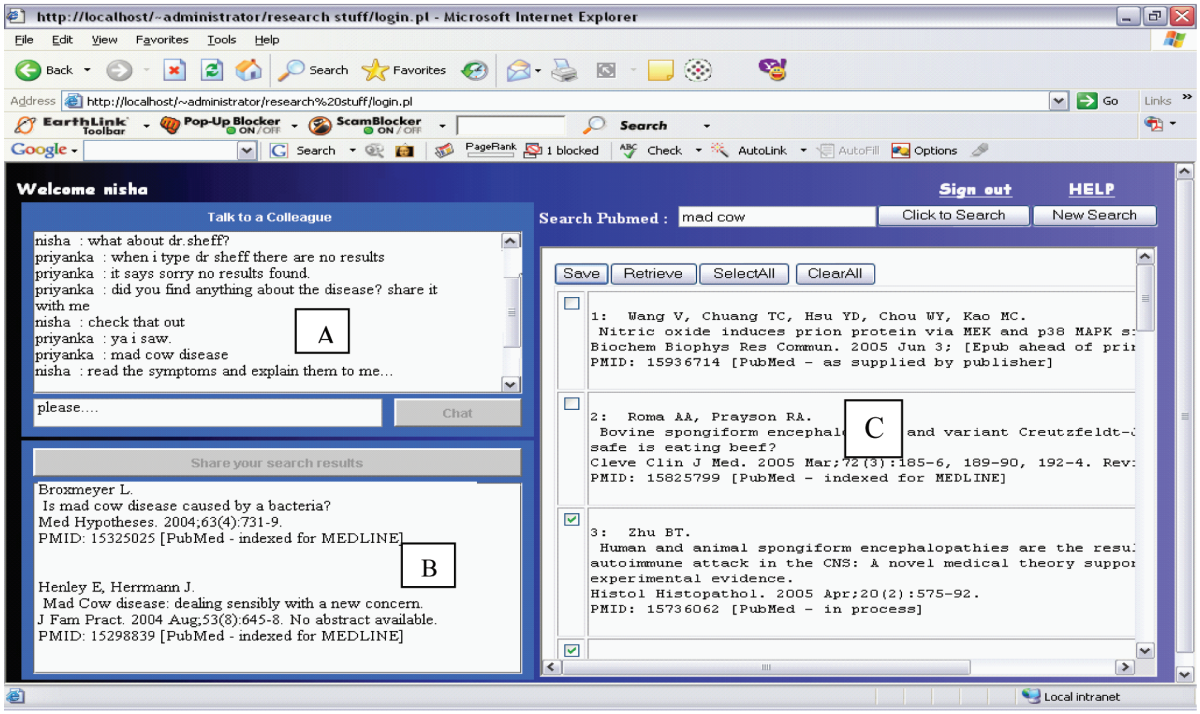
1996; Twidale, Nichols et al. 1997; McDonald and Ackerman 1998). Our intention, in this research, is to use ethnographic analysis as a means to systematically question the assumptions behind traditional technology designs of conventional IR systems, and through this questioning, generate design recommendations for CIR systems.

Consequently, drawing on our ethnographic fieldwork, we developed a CIR prototype. Along with our fieldwork, the CIR prototype helped us examine collaborative information behavior. We explored how features identified through the fieldwork are utilized by users. For instance, our preliminary fieldwork has begun to uncover the central role that collaboration plays in information seeking and retrieval activities. However, issues such as communication amongst collaborators has largely been ignored in current information retrieval tools (Reddy, Jansen et al. 2008). Developing a CIR prototype allowed us to explore whether incorporating features such as peer-to-peer and group communication along with other collaborative features can better support multi-user collaboration during information seeking and retrieval.

The CIR prototype allowed us to examine how team members who may not be physically co-present interact while collaboratively searching for information. The development of the CIR prototype builds on and extends our ethnographic fieldwork and provides us with another venue to investigate CIB. To initially explore technical approaches to supporting collaborative information behavior, we focused on communication and searching through the development of a simple CIR tool – Multi-User Search Engine (MUSE) (Figure 2).

MUSE (Reddy, Jansen et al. 2008) allows two users to search independently for information while sharing that information at the same time communicate with each other through a built-in chat feature. MUSE is a fully functional prototype developed using JAVA and JAVA Swing. An Apache server was used to enable networking between different computers. MUSE has features to support communication and sharing of the search results between two users. The front-end interface consists of three distinct features: search, share, and chat.

Figure 2. MUSE interface with three windows: (a) chat, (b) share, and (c) search



- **Chat:** MUSE supports text based messaging between two users. (Figure 2a)
- **Share:** Users can share the search results with each other in the share window. The users selects the results they want to share from the results in the search window and then clicks the 'share the search results' button. The results will appear in the share window of the other user. (Figure 2b)
- **Search:** Users type in a keyword to search for information. The search engine retrieves the available results from the database and displays the first twenty results. (Figure 2c)

To evaluate MUSE, we conducted a user study with ten teams (two participants per team) (Reddy, Jansen et al. 2008). We asked the participants to use MUSE to find information about *mad cow disease*. For this search, MUSE was connected to the National Institute of Health's Pubmed database. We observed the teams in a controlled environment. We provided the participants with two computers at opposite ends of the room. The participants were unable to see each other, and were instructed to communicate with each other only through the chat feature. We captured data through chat logs, query logs, observations, and interviews. We found that the chat feature played a prominent role in supporting the collaboration between team members during their information seeking and retrieval activities. For instance, participants used the chat feature to consult with each other during the search process. The participant would then ask the other team member for information that she could use in her own search. One participant noted that

"I have never used a system that allowed me to chat with others when looking for information and I have used forums that support topic specific discussion, where there are a lot of people

who post their ideas and views, lot of consulting goes on too, but that is again not synchronous. I have made phone calls when needed and email also helps communicate. This is nice to do both chatting on one side and searching on one side."

MUSE was intended to explore the feasibility of incorporating simple collaborative features such as chat into a search tool. Although it provided useful insights, it also had some significant limitations. For instance, it did not support complete sharing of search results, integration of search with the communication aspects, and multi-user (e.g. more than 2 users) interaction.

DISCUSSION

People connected by technology enable active examination of data, information sharing, and the creation of new knowledge, permitting teams, groups, and organizations to make more informed decisions. Many of these needed information processes are collaborative in nature. However, prior work has shown that these collaborative information seeking processes are extremely nuanced. At the individual level, there are a variety of factors that influence information seeking (e.g., domain expertise, temporality, technological expertise). At levels above the individual, these factors also affect the collaborative information seeking process. In addition, in collaborative information seeking, group and organizational factors also come into play of which we currently have little understanding.

Researchers have examined aspects of collaboration (e.g., CSCW), decision-making (e.g., business), and problem-solving (e.g., cognitive science). However, in each of these domains, we are just starting to examine information seeking within collaborative processes in any great detail. Previously, information seeking has been subsumed into larger issues of collaboration, decision-making, and problem-solving. Therefore, an understanding of CIB is needed to sustain the 'network effect' and leverage the expertise of group members. The development of processes and technology that support CIB can increase cooperation and leverage of collaborative skills, services, and information by leveraging current lessons learned.

Lessons Learned

Through our fieldwork and prototyping, we are beginning to learn a number of interesting lessons about potential users of CIR systems. We highlight some of the lessons below.

- **Communication is a key element for synchronous CIB:** Communication is essential for successful collaboration. This is especially true when searching for information. Team members continuously exchanged information about the *search process* as they collaborated during information seeking and retrieval activities. Exchanging information about the search process allowed team members to stay on track and alerted other team members when they may be taking a wrong search path.
- **Targeted vs. general information search:** Team members most often collaborated to find information in order to answer specific questions. The information seeking was targeted and specific. This is not to say that team members knew what they were looking for (or where to look for it). This highlights the issue that the collaboration in these settings was not for general knowledge acquisition but rather for specific purposes.
- **Formal and informal sources:** Information in these organizational settings (especially in the healthcare domain) is scattered across a number of different resources including electronic, paper, and

human. Therefore, it was not the simple task to find the source of information.

- **Simultaneous levels of information engagement:** People engage simultaneously in tactic and strategic information searching at both the individual and collaborative level. The results are that collaborative tasks and actions are interwoven with individual information seeking.
- **Contextual aspects:** There are some information tasks, even in team environments that are individual; however, as information problems become more complex, people begin to collaborate with others in order to address these complex issues. As the information problem becomes more complex and nuanced, the need to seek out other information sources becomes more pronounced, especially domains where multiple areas of expertise are teamed.
- **Interaction characteristics:** Commonly, in domains where CIB is common, both people and technology must interact. In these CIB situations, interactions are conversational with aspects of give and take between group members as they find, share, exchange, and process information. This highlights the aspects of *triggers* and *common ground* as key events in CIB. Consequently, we need to understand these events when designing technologies to support CIB.

Future Research Directions

Through our team's and other's research, we know that CIB is composed of a complex set of interactions involving people and technology. Yet, there are still some important questions that must be answered to strengthen our understanding of this area.

1. How does CIB differ from individual information behavior?
   a. What are the characteristics of CIB?
   b. Why do people collaborate when seeking information?
   c. What techniques/methods do people use to collaborate when seeking and retrieving information?
2. What role do current information retrieval technologies play in supporting CIB?
   a. What are the limitations of the current information retrieval technologies?
3. What are the design requirements for collaborative information retrieval (CIR) systems?
4. In what ways does the introduction of a CIR tool impact CIB?
   a. What combination of technical features best support CIB?

To answer these questions, we plan on using a variety of research methods including ethnographic fieldwork, survey research, technology prototyping, and technology evaluation. Our aim is that this work will lead to both a better conceptual understanding of CIB and the development of enhanced technologies to support CIB.

From a prototyping perspective, there are at least six areas of particular technical interest based on our research (Reddy, Dourish et al. 2001; Reddy and Jansen 2008).

- **Asynchronous collaboration:** There has been a great deal of focus on supporting synchronous collaboration during information seeking and retrieval activities (Twidale, Nichols et al. 1997; Morris and Horvitz 2007). Yet, supporting asynchronous collaboration is also vital in CIB (Edwards, Mynatt et al. 1997). Therefore, we need to incorporate features that best support this type of collaboration during these activities.
- **Awareness:** Knowing what other people are doing is an important during CIB activities. Therefore, the system should provide presence awareness information for

the group members (e.g., letting the user know if the person she wants to collaborate with is or is not busy).

- **Chat:** Clearly, one of the most important functions that CIR systems need to support is communication. A chat function allows collaborators to interact with each other and will play an important role in enhancing the information-seeking and retrieval process.
- **Conferencing**: Chatting is typically viewed as a mechanism for communication between two users; the system should provide mechanisms for communication amongst many users. This would be especially useful for members of geographically dispersed groups.
- **Privacy:** With any kind of system that supports awareness, communication, and information sharing, there is concern about user privacy. This issue raises the questions about what information users may or may not want to share. The system should support the user's ability to control how much information that she wants to share.
- **Visualization:** Users need a robust visualization of not only their search process and results but also of their collaborators' search processes and results. Providing this feature will help facilitate users discussion of each other's searches and how to improve these searches. In order to provide the appropriate visualizations, we need to explore what and how much information to present.

The challenge in designing these and other features identified through the fieldwork lies in not only developing the individual components but also effectively *integrating* them together in order to ensure that the system seamlessly supports CIB.

CONCLUSION

Through our team's research, we are starting to understand CIB in different settings. We have, for instance, identified some work features that trigger CIB (Reddy and Spence 2008). We have also identified features through the fieldwork that we believe are essential for effective CIR systems; in particular, awareness and communication. We are exploring these features in our CIR prototypes (Reddy and Jansen 2008). While this preliminary work has promise, what researchers and practitioners critically need are more granular models of CIB to form the basis of investigations of information behavior in collaborative contexts and to help design processes, organization structures, and technologies to support these contexts. This is the aim of our continued work in this area.

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