Lessons and Challenges for Collaborative Information Seeking (CIS) Systems Developers

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ABSTRACT

The developers of collaborative information seeking (CIS) systems face many unique challenges, above and beyond the issues raised by traditional single-user information systems. We present lessons derived from the general area of collaboration, as well as from information seeking domain, which can help one understand various design considerations for developing a CIS system. A number of challenges for system developers are listed, along with several suggestions for designing a successful CIS system.

Categories and Subject Descriptors

H.3.3 [**Information Search and Retrieval**]: Search Process; H.5.3 [**Information Interfaces and Presentation**]: Group and Organization Interfaces—*Collaborative computing, Computer-supported cooperative work*

General Terms

Algorithms, Design, Human Factors, Performance

Keywords

Collaborative Information Seeking, System Design

1. INTRODUCTION

The importance of working in collaboration has been widely acknowledged. For instance, Denning & Yaholkovsky [1] suggested that collaboration is essential for resolving "messy" or "wicked" problems. Twidale & Nichols [14] argued that introducing support for collaboration into information retrieval systems would help users to learn and use the systems more effectively. Levy & Marshall [8] noted, *"...support for communication and collaboration is as important for information-seeing activities, and ... indeed, support for the former is needed to support the latter."* However, such systems face several challenges for their design, development, and deployment. This is due to several intertwining factors that needs to be accounted for, such as social and personal interactions, group dynamics, and integration of existing practices into shared information spaces.

Many systems have been proposed and implemented to serve the collective needs of groups and/or facilitate various collaborative behaviors of the users. Some of such systems are Ariadne [15], SearchTogether [10], and Coagmento [12]. While these and many other systems have taken us closer to fulfilling the requirements for supporting a seamless collaborative information retrieval/seeking/behavior, several issues remained to be addressed. To this end, we want to bring the reader's attention to the lessons learned from works on collaboration (information seeking or otherwise), and enlist some of the major challenges and suggestions for designers of CIS systems. Our focus here will be on the kind of collaboration that is defined explicitly among the participants, interactive, and mutually beneficial.

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2. LESSONS LEARNED FROM GENERAL COLLABORATION

For designing a successful CIS system, one needs to understand what makes collaboration successful. Collaboration, in many situations, is a process that ties people of varying opinions and abilities together. However, the process may not necessarily lead to agreement on all issues. For instance, Gray [5] (p.25) acknowledged that not all collaborations lead to consensus, but added that when agreements for action are reached they are always done so by consensus. Denning & Yaholkovsky [1] also noted that it is solidarity, not software, that creates successful collaboration.

Surowiecki [13] presented four conditions for a successful collaboration.

1. *Diversity of opinion.* Each person should have some private information, even if it is just an eccentric interpretation of known facts.
2. *Independence.* People's opinions are not determined by the opinions of those around them.
3. *Decentralization.* People are able to specialize and draw on local knowledge.
4. *Aggregation.* Some mechanism exists for turning private judgments into a collective decision.

From these conditions for a successful collaboration in general, we can synthesize that in order to have a successful collaboration while seeking information, we need to create a supportive environment where:

1. The participants of a team come with different backgrounds and expertise.
2. The participants have opportunities to explore information on their own without being influenced by the

others, at least during a portion of the whole information seeking process.

3. The participants should be able to evaluate the discovered information without always consulting others in the group.

4. There has to be a way to aggregate individual contributions to arrive at the collective goal.

Let us now explore the conditions under which a collaboratively seeking information is useful. They are not very different from those of any other kind of collaborative process.

1. *Common goal and/or mutual benefits*
   This is covered in the definition of the kind of collaboration that we are interested in addressing here. Often, it is the common goal and/or the possibility of mutual benefits that brings people together for collaboration. For the most part, we believe this is not a function of a system. A system can provide a support for people with common goals who want to collaborate and reap the benefits of that collaboration, but does not typically initiate the collaboration. On the other hand, a few systems provide a functionality of connecting the visitors to the same websites in order for them to have a possible collaboration, such as the one given in [2]. These systems are based on the assumptions that the people browsing the same websites may have same information needs.

2. *Complex task*
   Morris & Horvitz [10] showed that there are not many benefits for collaborating on simple task, such as fact-finding. Denning & Yaholkovsky [1] also recognized the benefit of collaborating while solving "messy" or "wicked" problems. While listing the conditions under which it is not useful to collaborate, London [9] argued that if a task is simple enough, there is no point in collaborating. In addition to this, we believe the task should be exploratory in nature, and may span several sessions.

3. *High benefits to overload ratio*
   Often, simple divide and conquer strategy could make collaboration successful. However, such a process may have its overhead. London [9] noted that collaboration is only useful if such an overhead is acceptable for the given situation. Fidel *et al.* [3] showed that collaboration induces additional cognitive load, what they referred to as the *collaborative load*. The collaboration in question has to meet or exceed the benefits expectations for it to be viable with the cognitive load that it brings.

4. *Insufficient knowledge or skills*
   A common reason to collaborate is the insufficient knowledge or skills an individual possesses for solving a complex problem. In such cases, the participants can collaborate so that they can achieve something bigger or better than what they each could do individually. In other words, the whole can be bigger than the sum of all.

3. LESSONS LEARNED FROM COLLABORATION IN INFORMATION SEEKING

In addition to what creates a successful collaboration, one needs to understand the cost for achieving that success when it comes to using a CIS system. There are several costs associated with using a system that supports CIS, some of which are listed below. Understanding these costs is vital for a good system design, and it is possible that each system designer may have to address these costs in different ways.

1. *Cost of learning.* This is the cost associated with learning a new system. A CIS system is likely to be complex and one may needs to be educated about the functionalities and scope of each of its components.

2. *Adaptation/adoption cost.* Knowing how to use a system does not necessarily mean the users will adopt it in the long run. During the pilot runs of our experimental CIS system Coagmento, we found [12] that the subjects failed to see why someone would use such a system instead of using Google, IM, and email. The subjects successfully learned the system, but they did not see how they could adopt it, leaving more familiar and already adopted systems such as Google, IM, and email. There is a cost associated with such adoption or adapting to such a new system.

3. *Cognitive load.* Many works have attempted to address the issue of cognitive load induced by a system. Specific to many CIS systems, part of the cognitive load is in learning and then adapting to the system, which are presented before. The other aspect of cognitive load for a CIS system will be induced during the actual usage of it. As presented in the guidelines of a successful CIS system, four kinds of awareness are essential to provide. While such awareness is useful, it can also be overwhelming.

4. *Collaborative cost.* Often referred to as the collaborative load, this is a kind of cognitive load that is unique to the CIS environment, and comes from being a part of a group. For instance, a participant of collaborative project may have to pay attention to the group's history in addition to the personal history, inducing additional cognitive load.

In addition to dealing with these costs, a CIS system developer faces several challenges. Grudin [6] recognized eight challenges for designing groupware systems.

1. *Bringing a balance in work and benefit.* More than often, the users of a groupware system do not all get the same benefits for the amount of work they have to do. The designer has to address the needs and the work distribution for all the users.

2. *Building a critical mass.* If a groupware cannot achieve "critical mass" of users to be useful, it can fail as it is never to any one individual's advantage to use it.

3. *Entertaining to normal social processes.* A groupware system may sometimes hinder the social and political norms that its users have. A good system design adapts to an existing social structure rather than imposing one.

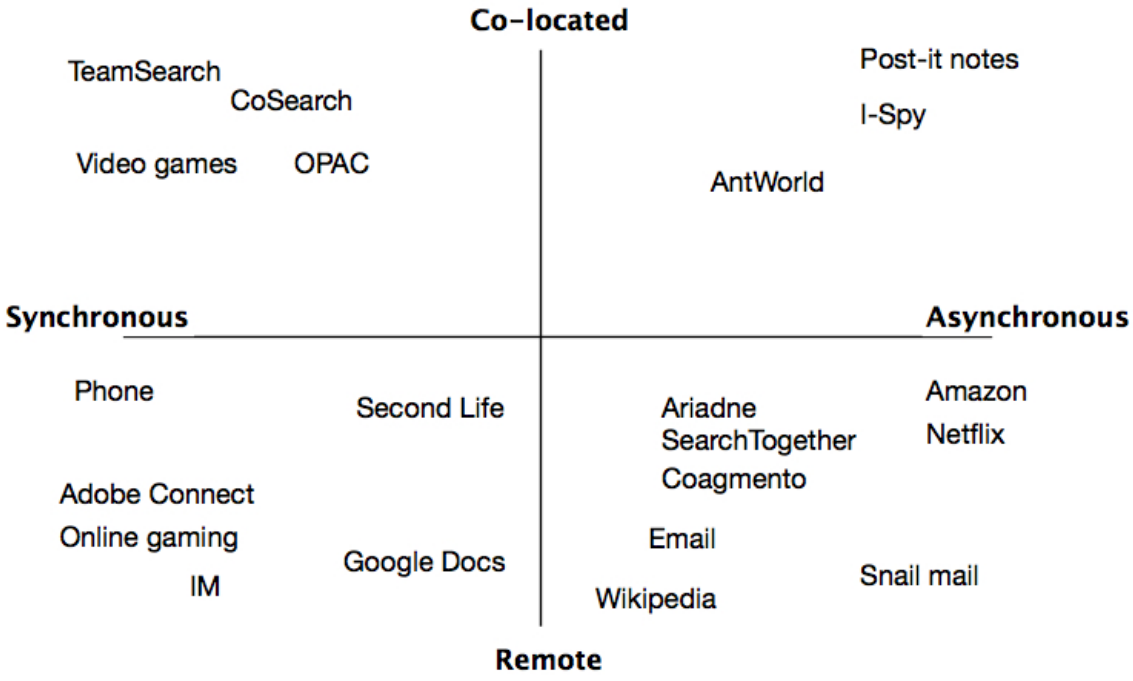

Figure 1: CIS systems organized according to time and space aspects.

4. *Handling the errors.* A system needs to be prepared to handle a wide range of exceptions and support improvisations that characterize much of the group activities.
5. *Providing unobtrusive accessibility.* Features that support group processes may be used relatively infrequently, and one needs to design a system that provides unobtrusive accessibility and integration of them with more heavily used features.
6. *Evaluation.* Due to its often-complex design, multifaceted and multi-user interface, and a variety of user and system interactions, evaluating a groupware system can be a huge challenge.
7. *Addressing the intuition.* Decision makers in a production environment rely heavily on informed intuition. Most product development experience is based on single-user applications, and transferring it to a multi-user groupware application can be a challenge.
8. *Adoptation.* Groupware systems require more careful implementation and introduction in the workplace than product developers usually confront.

4. DESIGNING A NEED AND PROCESS DRIVEN CIS SYSTEM

The guidelines for building a successful CIS environment, derived from our discussion earlier, are given below.

1. A CIS system should provide effective ways for the participants to communicate with each other.
2. A CIS system should allow (and encourage) each participant to make individual contributions to the collaborative.
3. A CIS system should coordinate participant actions, information requests, and responses to have an active and interactive collaboration. This collaboration could be synchronous or asynchronous, and co-located or remote.
4. Participants need to agree to and follow a set of rules to carry out a productive collaboration. For instance, if they have a disagreement on the relevancy of an information object, they should discuss and negotiate; they should arrive at a mutually agreeable solution rather than continuing to dispute it. The system needs to support such a discussion and negotiation processes among the participants.
5. A CIS system should provide a mechanism to let the participants not only explore their individual differences, but also negotiate roles and responsibilities. There may be a situation in which one participant leads the group and others follow (cooperate), but the real strength of collaboration lies in having the authority vested in the collective.

CIS systems have a wide spectrum in terms of functionalities, the environment in which they are implemented, and desired usages. While the above guidelines are useful almost any CIS system, the designer needs to be considerate about specific needs and expectations of a particular system. Let us explore this design spectrum to understand specific design considerations for various CIS systems.

The classical way of organizing collaborative activities is based on two factors: location and time [11]. More recently Hansen & Jarvelin [7] and Golovchinsky, Pickens, & Back [4] also classified approaches to collaborative IR using these two dimensions of space and time. Inspired by a similar illustration by Twidale & Nichols [14] incorporating several

library-related activities, we present a depiction of various CIS systems/tools in Figure 1.

The placement of a CIS system on this figure has implications for its implementation, functionalities, and evaluation. For instance, Adobe Connect[1] facilitates online meetings where the participants can share and discuss information. Such an environment will fall under Synchronous-Remote collaboration in Figure 1. Thus, this environment needs to have (1) a way to connect remote participants in real-time, (2) a shared space for exchanging information, and (3) a communication channel to provide real-time message passing among the participants.

5. CONCLUSION

Based on the costs and challenges presented above, following five design suggestions can be useful for the CIS system developers.

1. *Understand the real needs.* Just because some software has the supportive tools for CIS, does not mean it will actually be used to help a user's CIS. The designers need to understand various aspects of the target domain, educate the users and managers, and design the system that can provide a good balance of costs and benefits to each user.

2. *Keep it simple.* The design of the interface needs to be very intuitive and easy to use. As we saw before, there are costs associated with learning a new system as well as adopting it. The users may feel more comfortable if the system appears very user friendly. This will help in lowering the costs for learning and continual usage of the system.

3. *Make it accessible.* Similar to Grudin [6], the CIR group of University of Washington [3] recommended that instead of designing a collaborative system that the users have to get used to, one should design a system that fits the way the users are used to working. While several of the components of a CIS system may be new to a typical user, we should try to minimize imposing a rigidly structured system on a new user. Instead, the system should have many familiar components that the user is already familiar with and know how to use, and allow the user to explore other innovative tools provided.

4. *Provide the right tools.* CSCW literature shows that support for control, communication, and awareness (group, workspace, contextual, and peripheral) are very crucial to a good CIS system. It is important to provide the tools that implement these features in an unobtrusive manner. Often, it may be useful to extend a single-user application that is already adopted and add collaboration features to it.

5. *Allow private working.* One of the requirements of a successful collaboration is independence [13]. The participants should be able to work by themselves without having to worry about being "watched" or requiring anyone's opinions. Eventually, of course, we expect the participants to share their findings and have interactions that can lead to better solutions, but one should have the ability to work on his/her own at times. This can help in reducing the cost of cognitive load induced by the system as well as the collaboration, and bring in the benefit of individual contributions.

[1] http://www.adobe.com/products/acrobatconnect/

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