

Dimensions of human-work domain interaction: A preliminary analysis for the design of a corporate digital library

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The author applies the cognitive system engineering approach to investigate human-work interaction at a corporate setting. This study reports the preliminary analysis of data collected from diary analysis and interview of 20 subjects. The results present the identification of three dimensions for each of four interactive activities involved in human-work interaction and their relationships. An enhanced model and its implications for the development of a corporate digital library are further discussed.

Introduction

There is a growing recognition that the traditional corporate library model doesn't work effectively in business anymore. Information needs of corporate employees are changing, and information services in the corporate environment should change as well. Corporate libraries and information services need to address new needs and expectations in the area of content medium and deployment. Many companies start to build digital libraries that are accessible to all employees via the Intranet (Alsmeyer & Smith, 1997; Crandall, 1998; Gulliford, 1998; Harmsen, 1998; Pack, 2000). According to Stratigos & Strouse (2001), two-thirds of respondents to Qutsell's 2000 corporate information professional study reported that they were moving toward fully or nearly digital libraries. Over the past several years, there has been a tremendous increase in the amount of research on digital libraries, much of it focused on how to convert printed material into electronic format, organize different types of resources, and design system structure. Although there are a variety of user studies on digital library, little research has been done on how to design digital libraries to satisfy specific user groups in corporate settings (Baldonado, 2000; Bishop et al, 2000; Greene, Marchionini, Plaisant & Shneriderman, 2000). There is a need to understand people's information seeking behaviors within a larger context of the working environment.

End users of corporate libraries have their own unique characteristics, and they are in a typical "information rich" environment in which people are exposed to, and make use of a variety of information resources in support of their daily work (Auster & Choo, 1993; Cool & Xie, 2000). In an early study, corporate respondents reported spending about 16 hours per week on scientific and technical information activities (Mick, Lindsey & Callahan, 1980). Regardless of many technological advances, people merely

have more information, not necessarily better information (Broady-Preston & Hayward, 2000). Information seeking is never an easy task, especially for people who work in the corporate environment. Their work tasks require unique information seeking strategies (Crandall, 1998; Smith, 1999). For example, a typical information problem in corporate settings is looking for information about a competitor's products. A user might start with browsing his/her existing personal files or talking to colleagues to identify some search leads, then try to search the information from the internal resources provided by the company Intranet. After that he/she tries to find the competitor's Web site by searching Web search engines. If the user could not get all the information needed, next he/she might choose commercial online databases (e.g. Dow Jones Interactive), by first trying to learn about the coverage of databases to identify appropriate databases, then finding good terms to formulate effective queries to retrieve relevant information.

The complexity of the corporate setting requires the design of corporate digital libraries to support and enhance employees' work productivity. The cognitive systems engineering approach (Rasmussen, Pejtersen, & Goodstein, 1994; Vicente, 2000), which focuses on the human activities and work context in which an information system is used, can offer guidance to the design of a digital library by analyzing the actors, the work domain and the interactions between them.

In order to design digital libraries to understand and support users' information use at corporate environments, it is important to characterize patterns of information use and the factors affecting the use in work domain. In particular, this study is designed to address the following research question: How to characterize the actors, the work domains and the dimensions of interactions between the actors and the work domain?

Previous Research and Theoretical Framework

The cognitive engineering framework analyzes the complex interaction between activities of work domains and end users' cognitive and social activities and their subject preferences (Rasmussen, Pejtersen, & Goodstein, 1994; Vicente, 2000). It is generally done by field studies that involve systematic investigation of work domains, actors and their interactions. The cognitive engineering approach has been widely applied to the design,

development and evaluation of variety of information systems.

The cognitive engineering approach has been used in information system design and development. The Book House, an interactive multimedia online public access catalogue was designed based on cognitive engineering analysis (Pejtersen, 1992). By applying the cognitive engineering approach, the Design Explorer project, which supplements the Book House project, specified requirements for an information system that effectively enables design team members to interact more effectively in the design process. The framework is the basis for specification of a digital library system supporting access to a wide network of heterogeneous databases and resources (Pejtersen, Sonnenwald, Buur, Govindaraj & Vicente, 1997; Pejtersen, 1998). Design Browser, a software architecture intended to support designers of large software systems, was created based on principles derived from the cognitive engineering approach (Ockerman & Mitchell, 1999). In addition, the cognitive engineering approach has been used in addressing the design problems of computerized monitoring in neonatal intensive care (Alberdi et al, 2001).

The cognitive engineering approach has also been used to study information use and system use for potential system design. Building on concepts from cognitive engineering, Te'eni (1991) examined how computer-generated feedback enhances the user's decision consistency. Sonnenwald and Pejtersen (1994) developed a conceptual representation of the information space based on field studies of relationships in cognitive work dimensions and communication networks for the design of information retrieval systems. The cognitive work analysis framework has guided the field study to investigate situations where members of a work team are seeking and using information collaboratively to further design systems to support collaborative information retrieval (Fidel, et al, 2000).

Guided by the cognitive systems engineering approach, Pejtersen & Fidel (1998) developed a model (figure 1) that

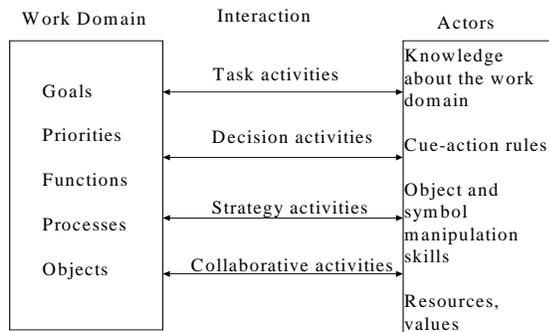


Fig. 1. Model of Human-Work Interaction (Pejtersen & Fidel, 1998)

shows the invariant properties of human-work interaction in which technology is embedded to support work. These invariant properties highlight the stability and regularity of

dynamic work environments, and they will greatly help designers to characterize and further predict actors' information seeking behaviors. They did a case study of high school students searching the Web for their homework to illustrate the model and its application for the improvement of Web design. The following components and their properties are the essential parts of the model: 1) work domain, 2) actors, and 3) interaction activities. Work domain analysis is to identify the current and future means and ends of a working place, which includes the goals, priorities, general functions, work processes and physical objects. Actor analysis focuses on the knowledge and preferences that are related to information seeking which consists of knowledge about the work domain, cue-action rules, object and symbol manipulation skills and resources, values. Interaction analysis examines interactions between work domain and actors. Task activities, decision activities, strategy activities and collaborative activities are the main products. Adapted from this model, the author further examines the dimensions and relationships of these interaction activities to study people who work in a corporate setting and its application for the design of a digital library. For better understanding the context of this study, these activities are discussed in the results part of this paper.

Methodology

A company, Case Corporation, located in Milwaukee, that has already provided partial electronic or virtual library service and is planning to create a digital library, was selected. It started to provide Case Virtual Library, which includes both internal and external information resources, to its employees via Intranet since 1998. The Case Virtual Library offers the following services: NewsCenter, SearchCenter, Reference Desk, Research Department, Reading Room, and Special Focus Corner. Case Corporation recently merged with New Holland and plan to establish its integrated digital library. In order to address the proposed research questions, the investigator conducted non-experimental studies with people as they engaged in a variety of information seeking tasks, in their working environments. This methodological matrix combines Web survey, diary method and open-ended interview.

At the beginning of the project, a *Web-based survey* was posted on the digital library page as well as company homepage. The survey asks about 1) demographic information, 2) general patterns of variety of information resource use, 3) evaluation of current CNH Virtual Library. A total of 263 employees filled in the survey. Among all the respondents, the average time they have worked in the company is 3-5 years. The majority of them are male (82.6%), and their average age is 41-50. Their average education level is graduate with the majority of them preferring to use a digital library (68.2%) over a physical library (31.8%). About half of them (53%) were not aware the existence of the CNH Virtual Library.

Within the Web survey, one of the questions asked is whether the respondent is willing to be a participant for further study. Twenty subjects were chosen from the respondents who agreed to be part of the second phase study. Participants were asked to keep an "information interaction diary" for two search tasks within a two-week time frame. Participants were asked to use the diary to keep track of their information seeking interactions in the order in which they take place. The diary requires participants to record the following information: a) search tasks, 2) time spent, 3) information resources/systems used, 4) types of people consulted/databases/publication selected, 4) queries asked/used/search process went through, 5) outcome of using each information resource, and 6) factors leading to the success or failure of each of the resource or system used. The diary methodology has long been used in other fields, such as mass communication, in order to measure the TV and radio listening behaviors of audience members. The diary data provide a record of all the information interactions related to two search tasks a participant engaged in, over an extended time period. Ten subjects returned their diaries before the interviews.

Finally, *telephone interviews* were conducted after they finished their diaries. The interviews focus on general information related to a) typical work related tasks and goals which precipitate information seeking behavior, b) typical information interactions associated with these tasks and goals, c) reasons for interacting with specific information resources or items, d) typical information-seeking problems encountered, and e) typical ways of solving the problems. These interviews also attempt to verify and enrich the diary content; more importantly probe more information related to their information seeking process. For the ten subjects who did not return their diaries, the interviewer asked questions about the two search tasks and related information as stated in the diaries. This method is frequently used by cognitive psychologists in order to understand what people are thinking while they are engaged in some task. All interviews were tape recorded and transcribed.

Quantitative as well as qualitative methods were employed for this study. Quantitative methods concentrate on descriptive data analysis of the data. For this study, Strauss & Corbin's grounded theory (1990) is the basis for qualitative analysis that include content analysis (open coding); the development of taxonomies of dimensions of interaction activities. To avoid repetition, the discussion of the open coding and the development of taxonomies are presented in the "Results" section.

Results

The results of this study were summarized to answer the research question proposed in the first section: How to characterize the actors, the work domain and the

dimensions of interactions between actors and the work domain?

Dimensions of work domain

Before the discussion of the dimensions of interactions between actors and work domain, we need to examine the work domain and characteristics of actors. Work domain of CNH is summarized based on the interviews with 20 subjects from different departments, and information gathered from company reports and the company Web site (Table 1).

Table 1. Dimensions of Work Domain

Dimensions	Descriptions
Goals	Become the number one manufacturer of agricultural tractors and combines in the world, the top maker of construction of equipment, and has the industry's largest equipment finance operations.
Priority	Consolidate the standards and resources from Case and New Holland and establish unified databases since CNH was created in November 1999 through the merger of Case Corporation and New Holland N.V. CNH had targeted technology and people development as a key corporate strategy.
General function	Design and manufacture agricultural equipments, construction equipments; provide financial services; market and sale CNH products; develop/purchase technology; manage employees and their benefits.
Work process	Identify search task, look for information from external or internal information resources; evaluate/ validate information; apply relevant information to achieve working tasks.
Physical resources	Colleagues; experts; computers; Internet; Intranet; printed material.

Based on the analysis of the CNH work domain, the results show the merger of Case and New Holland largely impact the interactions between the actors and the domain, to be more specific, it greatly affects people's information seeking strategies, especially their uses of information resources. The main problem is there are no authorized and complete internal databases for all the internal information. One subject described the situation in detail, "The problem we have is there have been a lot of changes and there is still change going on. So sometimes it's very hard to find the owner of a standard. There should be one repository for all the standards. I've got one of those situations now, I want to find some standards with the company and actually I found multiple owners which isn't

a good thing because only one person should be from the Intranet.” Another subject complained, “When I prepare a report to find employees in certain race, I have to search for two databases (new Holland and Case), and they have different fields, different designs and different ways to organize things.” Another subject explained why he first used human resource in finding a better human resource supporting system, “I would start with talking to the HR community because you know we just merged in the last couple of years and were still trying to put it together especially from a system standpoint were just not there yet. That’s why it’s a real continuum to have to talk to the people what the former Case would have as an expectation, what the former New Holland would have as an expectation for systems.”

Company philosophy and business cycle also have impact on employees’ choices of information seeking strategies. One subject discussed his strategy, “I may choose to focus on certain pieces of the results that become more or less important depending on the business climate, depending on my company philosophy. We’re shifting our focus a little bit this year to rewarding and recognizing improvement in loyalty.” Another one clarified why she discontinued using some of the resources, “It’s just a very cyclical of the business and when there’s money to be spent but then all of sudden there is no money in using some of the paid information resources.”

Actor’s knowledge structure

In addition to personalities, people’s knowledge of the domain, system and information seeking skills play an important role in determining their choices of information seeking strategies. Here is an example of a subject who discussed her strategies when she did not have enough topic knowledge, “When I’m not successful in finding information, it’s usually because of insufficient knowledge about a topic. If I’m having trouble understanding the topic, I’ll go back to the person who made the request and get more background information on it. Then I’ll go to the Web search engine and look up more information on this topic. If that doesn’t work, I will call and set up an appointment with an analyst, I always get information when I talk to an analyst.” In terms of system knowledge, here is an example, “I use either MSN search engine or the one many others like - Google. Typically you use whatever you’re best, you’re most comfortable with. It’s the things that I’m just familiar.” One subject talked about his information seeking skills and related search problems, “When I’m not successful it’s due to not narrowing my search query enough. Myself-rating is a 2.5 (on a 1-5 scale) for information seeking skills. I believe the information I need is out there, I just don’t always know how to narrow my query.” Finally, personality comes to play a role, “I generally don’t spend much time, maybe it’s short attention span or whatever I just usually if I haven’t come up with what I’m looking for in first half hour, I’ll

stop and say we need to reevaluate and start over again,” explained one subject.

Types of interactions

Dimensions of task activities

Table 2 presents the dimensions for the four types of interactions in the corporate setting: task activities, decision activities, collaborative activities and strategy activities. Task activities refer to current search goal related activities, that is what specific search results a user intends to obtain. Three dimensions of task activities emerged from the data: 1) whether the nature of task is routine or new. 2) whether the type of task is to update information, look for specific information, a known item, items with common characteristics, or to verify information. 3) whether the time frame of the task is urgent or non-urgent. These dimensions affect the decision and strategy activities.

It is essential to know whether the task is routine or new, and this is also identified by MacMullin & Taylor (1984) as one of the problem dimensions. This study found majority of the tasks that the participants work on were routine ones, and they developed certain information seeking strategies for each type of the routine tasks. For example, here is an example of how a subject worked on routine information seeking tasks. “The majority of what I would look for I already have found some information and bookmarked those sites and I would just go back there for additional. I have categories for different topics and then underneath that I have specific sites.” Moreover, these information seeking strategies become part of their plans in decision activities. Here is an example of a subject’s plan and information seeking strategies which include information resource selected, behavior presented and intention embedded, “If I’m looking for technical information on COBOL, I usually go out to the Internet, to a specific site and look up books. If I’m looking for information from a particular vendor, I’ll go out to the vendor site and search for a particular product. If I’m looking for business information then I usually establish or setup a meeting with our clients to discuss how they are doing a project, doing the process.” Furthermore, different tasks determine different level of planning. Here is an example, “It doesn’t really require a real lot of planning when I look for the syntax because I’ve already narrowed down what I’m looking for to a pretty specific area. If I look for technical information, I will do a little more background check and be ready for that call because that is person to person usually. I want to list all the questions I want to ask.”

In addition to looking for specific information, known item and items with common characteristics, updating information is another common task. It normally takes different information seeking strategies. Scanning and reading electronic and printed information are the typical information seeking strategies applied for this type of task. One subject illustrated his strategies for updating information, “Part of my job is to update agriculture

Table 2. Dimensions of human-work interaction

Types of interactions	Dimension I	Dimension II	Dimension III
Task activities	Nature of task Routine/ new	Types of tasks Update information/ look for specific info./ look for known item/ look for items with common characteristics/ verify info.	Time frame Urgent/ non-urgent
Decision activities	What to do Level of domain knowledge/ Level of system knowledge/ Level of information seeking skills	How to do Plan oriented/ Situation oriented	When to stop Obtain all/ enough information to accomplish the task/ quit
Collaborative activities	Types of resources People within the project team/ People within dept./ experts within the company/ experts outside the company	Types of interactions Acquire guidance/ Work together/ Obtain direct answer	Types of channels Face to face/ Phone/ Email/fax
Strategy activities	Types of intentions Identify/ find/learn/ evaluate/ keep record/ obtain	Types of behaviors Scan/Search/ Acquire/ Compare/ Consult/ Select/Track/ Trial and error	Types of resources Human/ electronic/ printed

information. I signed up for the types of information I'm interested in and I receive daily updates. I look at these updates every day. I scan the first paragraph of an article to confirm whether it's relevant to me. If it is, I'll print out a hard copy that I can read at my leisure. Most of the information I need is in rural locations and can be difficult

to find because it isn't 'front page' information. I have to really drill down."

Time frame of a task also influences people's information seeking strategies. Here is an example of a subject's alternative plan for information that is not available within the required time frame. "I work in the Technical Service Group and I take phone calls from external dealers who have concerns about equipments sold by CNH. Most of the questions that I get the dealer needs to resolve a problem within 24 hours or maybe sooner, so I can't really say I'll have the information in a week or two from now because the person who manages the archives is gone. The existing archives are paper-based and managed by a retired employee who works part-time. I needed information from the archives and was told I'd have to wait two weeks because the archivist was on vacation. I tried to get information within 5-10 minutes while the dealer was on the phone. Therefore, I turned to people who've been here for quite some time and know the older equipments."

Dimensions of decision activities

Decision activities focus on the following questions: 1) what to do? 2) how to do? 3) when to stop? What to do is related to the analysis of information needs: that is how to convert information needs to something that can be expressed or presented to the human or information retrieval systems. How to do is more related to whether information seeking behavior is plan-oriented or situation-oriented, and what are included in a plan. When to stop is related to users' decision whether they obtain enough information or just quit.

Many of the participants have problems in converting their information needs to queries. One subject gave her version of the problem when she was asked what the reason might be when she could not find information, "that's because I don't know how to ask for it, how to phrase the term." Domain knowledge, system knowledge and information seeking skills all contribute to the problem. One subject discussed her insufficient system knowledge, "I am knowledgeable what I am trying to find. I would say semantics. The wording I'm using to inquire versus how you how it's really filed." Another one further illustrated his problem, "The query was structured incorrectly. My difficulties are in the way that how you pose the queries to the search engine. I'm having trouble doing this. But often times you know when someone else maybe comes up with an answer and you finally see it, you see how it was obtained, you go yes, my goodness, that makes sense except for when you ask the question you don't phrase it that way."

Most of the participants thought they did not plan before they started to search. However, even those claimed that they did not plan, they did plan in a certain way. The following is an example of high level of plan, "I tend to be a shoot from the hip kind of guy. I generally don't plan it out very much at all. I just start and let the tool kind of

guide my thoughts. You tend to form a normal strategy that you would employ. So always do this first, if don't find anything, go to the next one." Here is an example of following the known procedure, "I don't plan, but I always have certain kind of known procedure I normally do either go for MSN or for Excite or talk to people. By doing the same thing over and over again, you know I basically have a process." The typical plan includes resource selection, especially the first resource to use. "It's very ad hoc. But I do follow a set pattern- go to team members, then the Internet. I tend to use AltaVista unless I know the URL/specific web site I want. But if I don't have luck with Altavista I'll go to Yahoo. When I don't get any results I try to modify my search – either broaden search or use alternative terms/synonyms," one subject explained. Some of them have more detailed plans, for example, "I plan the topic to search and then some search terms, as well as resources to use. I also think about what to do for a backup plan, for example, different resources, different search terms." Almost all the participants' information seeking behaviors are driven by both plan and situation. Here is a typical example, "I generally have a game plan in mind but not very detailed, because depending on what I find it may change what I do next. Like any problem-solving process, it builds on the results of the last step – you know where you want to end up but you may have to take some turns along the way."

Participants have their own views of when to stop. Some of them make the decision on time. For example, "If it's a normal problem, if I don't get what I want in the first 10, 15 minutes, I'm going to give up and go to a different source." That normally is affected by time frame of their tasks. Most of them determine it's time to stop when they get enough to achieve their tasks. One subject said, "Like if I'm searching software for instance, I would stop searching after I think that's going to give me a good analysis."

Dimensions of collaborative activities

Three dimensions of collaborative activities emerged from the data: 1) types of sources (clients, people within the project team, people within the company, experts within the company, experts outside company, consultants affiliated with the company), 2) types of interactions (guide, obtain direct answer, verify) 3) types of channel (face to face, phone, email, fax).

There are several interesting findings derived from this study in terms of collaboration. First, clients are important information resources since the real task is to support them. Here is an example of talking to clients to obtain background information, "I think the biggest thing we do here is trying to talk with people that we're trying to support, because the problem with me is I was a HR generalist and haven't been an HR generalist since probably 1998 and that doesn't mean at least in my opinion leave me in the dark ages. But I don't know all of their

current processes as well as what they do or what they would like to see or what their real business requirements are to date. So the first is always has to be talking with those people." Second, it is a very effective approach to consult experts who are working on the same area in another company. The following is an example of how the subject consults experts outside the company to get guidance in finding relevant information, "I do have a number of colleagues working for another firm that are very nearby and certainly when something unusually happens you can use them as a resource. Often times it just gives you a different perspective. So even though the person may not have had an answer, they provide different ways of looking at the problem and can help you use the electronic source effectively. Like we were talking about point of view before, in terms of structuring your query." Third, participants need to collaborate to get guidance and obtain direct answer as well as verify information. Here is the example by talking to people with the company to verify information, "I looked at a female employee and her name is Jane Johnson, so I made the presumption that female is correct. But she is listed in the database as Hispanic and I know the individual. So I have seen her and by appearance she doesn't appear to be Hispanic. Her name is Johnson and she doesn't look Hispanic. So you know basically what I did is rather than call the individual directly I asked around to find out whether her background is Hispanic."

Dimensions of information seeking strategies

Three dimensions of strategies emerged from the data: 1) information resources (electronic, human or printed), 2) information seeking behaviors (scan, search, acquire, check, compare, consult, select, track, trial and error) and their interaction intentions (identify, find, learn, evaluate, verify, keep record, obtain). Here interactive intention refers what participants intend to achieve in the information seeking process. The information seeking behavior and interactive intentions identified in this study are pretty much same as the ones identified from another study in the library setting done by the author (Xie, 2000, Xie 2002). However there are other interactive intentions, such as verify, etc. and other information seeking behaviors, such as check, emerged from the data.

Dimensions of information seeking strategies have been mentioned in the discussion of task activities, decision activities and collaborative activities. Considering the space limitation, the author is not going to present the examples for all the information resources, information seeking behaviors and interactive intentions. Instead, the author tries to present some examples of interactive intentions and information seeking strategies identified from this study. The example of consulting people with the company to verify information about an employee's race is discussed in the collaborative activities. Here is an example of checking the URL to evaluate the authority and

relevance of the results. “I look at the matched results and then I look at the URL to determine whether the results is a company or organization that is relevant to me. I look at the top 10 results.” Here is an example of scanning printed material to identify some information and keep a record “I skim the magazines and tear out pages that have interesting information for me.” The following is an example of narrowing down the search, “I start with ‘privacy’, then get too many hits, and retry as ‘customer privacy’.” A subject well summarized his information seeking experience, “You get clues where you can trace things down kind of like a private detective, take leads and go with them.”

Discussion: the enhanced model and the implication for digital library design

This study examined human-work interaction in a corporate setting. The author enhanced the model of human-work interaction based on the results. First, the author identified three dimensions for each of the interaction activities that are essential in people’s information seeking process in a corporate environment. Second, the author illustrated the relationships among these interactions, especially how strategy activities are affected by other interaction activities, and 3) The author highlighted characteristics of actors in three types knowledge structure and personal preferences. Figure 2 presented the enhanced model.

The dimensions of interaction activities and their relationships clearly portray what/when users need support in their information seeking process, furthermore, how a digital library can best support them for effective information retrieval. Each work domain and its human-work interaction are unique; therefore designers need take the context into consideration in the development of a corporate digital library. Since majority of the tasks are routine ones, it is important for the corporate digital library to support these routine tasks. This study show that people normally have a certain information seeking strategy in their plan for their routine tasks, which include information resources selected, actions might be taken, and even backup plans. One way to support the routine task is to create a personal portfolio for each of the employees, which consists of categories of their routine tasks and having resources linked, queries used/phrased, previous results presented, and alternative plan listed under each of the task. In addition, the time frame for each task should also be considered in the backup plan, for example, for these urgent tasks, if a certain information resource is not available temporarily, another one should be suggested. For new tasks, information seeking strategies (interactive interactions, information resources, actions) can be recommended based on the types of tasks. One way to do that is to create templates for different types of tasks, such as updating information, looking for specific information, known item and items with common characteristics and verifying information.

Decision activities are the most needed activities to be supported, and at the same time, the most difficult activities to be supported. In the process of supporting tasks with different nature, we need to discuss how to support decision activities in more detail. Most of the participants in this study express their concerns in query formulations. In order to help people to convert their visceral information needs to an expression that an information retrieval system/human resource can understand and effectively assisting the retrieval of information, the digital library needs to offer help in domain knowledge, such as description of one topic or synonyms for key terms in one area, system knowledge, multi-dimensional help mechanisms, especially examples of different ways to form a query, and information seeking knowledge, such as suggestions for different information seeking strategies. This study demonstrates that people do plan to certain extent even though they don’t think they do. Simultaneously, situations do affect their information seeking strategies in the retrieval process. That suggests that the digital library needs to be flexible in supporting people’s plan, considering some of the frequently occurred situations, for example, unavailability of some of the information resources, unsuccessful search results, etc. Another way to support that is to characterize shifts of information seeking strategies and further support those shifts. Each individual has his/her own way of determination of when to stop looking for information. One way to support this dimension of decision activity is to support the evaluation activities, that is to assist people to effectively evaluate their results, so they can make a quick decision about whether they have enough information. For each of the routine tasks, people are pretty clear what to look for in the results, if the system can presents the summary and highlight these information, that will greatly help them to make the decision.

Although collaborative activities are essential in assisting information retrieval process, some of the collaborative activities can be avoided or improved. One reason for the increase occurrences of collaborative activities is because most of the internal data are located in different places and owned by different people. One way to solve this problem is to construct integrated databases for variety of internal data, furthermore the digital library should also offer search capability to enable people to search for internal information. The availability of internal data in the digital library will greatly reduce some unnecessary collaborative activities, and moreover to make collaborative activities efficiently. Some of the interactions of collaborative activities focus on providing guidance in locating the right information. As an alternative way to support that, the most frequently asked guidance/questions can be incorporated as part of the help mechanism. Among all the human resources, experts play an important role in guiding people in finding the relevant information. Simultaneously, it is not an easy task for an individual to name all the

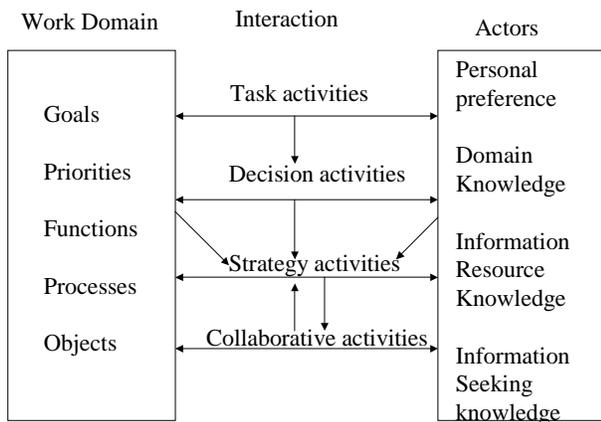


Fig. 2. Enhanced Model of Human-Work Interaction

experts within and outside the company. The most effective way to support collaborative activities is to identify the contact information of experts within and outside the company and make them available through hyperlinks since they normally know their clients and consultants but don't have all the information about experts. The availability of online chat, especially streaming video online chat will help considerably for face-to-face interactions.

The design of the digital library should support patterns between interactive intentions and information seeking strategies, and further support shifts of information seeking strategies which have been discussed in author's another study in the context of using different physical libraries (Xie, 2000; Xie2002). There are patterns between interactive intentions and information seeking strategies emerged from the preliminary analysis of data. More important, this study also demonstrates that information seeking activities are affected by task activities, decision activities and collaborative activities. Further diary and interview analysis of the data will enable the researcher to identify the pattern between interactive intentions and information seeking strategies, and most importantly, to illustrate how interaction activities affect the shifts of information seeking strategies.

Conclusion

This study investigates human-work domain interaction in a corporate setting by using the cognitive engineering approach. It systematically analyzes the work domain, the actors and interactions between the two. Three most important dimensions emerged from the data for task activities (nature of task, type of task, and time frame), decision activities (what to do, how to do and when to stop), collaborative activities (types of resources, types of interaction and types of channels), and seeking strategies (types of interactive intentions, types of behaviors and types of resources). The dimensions of task activities,

decisions activities and collaborative activities all have impact on dimensions of information seeking strategies. The discussion of dimensions for each interaction activity and their relationships highlights the most important areas that people need support in using a corporate digital library, and they contribute to the essential knowledge required to design digital libraries that enable users to effectively access a variety of information resources in a corporate setting.

Considering time and space limitation, this paper reports the preliminary analysis of the study that focuses on the analysis of interviews of CNH employee's general information uses. Further analysis will concentrate on the diary analysis and the interviews of specific information seeking tasks to further identify how dimensions of human-work interaction impact not only the information seeking strategies but also shifts of information seeking strategies in both qualitative and quantitative way.

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