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PLANNED AND SITUATED ASPECTS IN INTERACTIVE IR:
PATTERNS OF USER INTERACTIVE INTENTIONS AND
INFORMATION SEEKING STRATEGIES

by

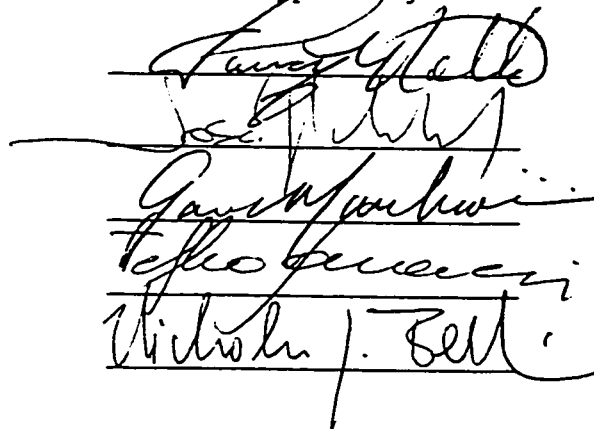
HONG XIE

A Dissertation submitted to the
Graduate School-New Brunswick
Rutgers, The State University of New Jersey
in partial fulfillment of the requirements
for the degree of
Doctor of Philosophy
Graduate Program in
Communication, Information, and Library Studies

written under the direction of

Professor Nicholas J. Belkin

and approved by



The image shows four handwritten signatures, each written on a horizontal line. From top to bottom, the signatures are: 1. A signature that appears to be 'James H. ...'. 2. A signature that appears to be 'D. ...'. 3. A signature that appears to be 'Gary ...'. 4. A signature that appears to be 'Nicholas J. Belkin'.

New Brunswick, New Jersey

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ABSTRACT OF THE DISSERTATION

Planned and Situated Aspects in Interactive IR:

Patterns of user interactive intentions and

information seeking strategies

by HONG XIE

Dissertation Director:

Professor Nicholas J. Belkin

Research in Information Retrieval (IR) demonstrates that users typically proceed through multiple iterations, involving multiple information seeking strategies within one information seeking episode. It is therefore a central problem for IR to understand how to support a variety of interactive strategies, and furthermore, to provide ways to adaptively assist users as they employ different strategies in their attempts to achieve their information seeking goals. This study addresses this issue by investigating the relationship between users' information seeking goals and their information seeking behavior. The particular focus of this study is on specifying hierarchical levels of users' goals, and the in-depth examination of one micro-goal level -"interactive intentions" - in relation to information seeking strategies. This study is based on the idea of IR as interaction, and attempts to address the relationship between planned and situated aspects of IR interaction.

The data used for this study were collected as part of an earlier study of library users. A total of 150 users from academic, public, and special libraries were recruited to participate. The investigation was designed to study the context of users' goals, tasks and

behaviors with OPAC and other library use. Multiple methods were employed to collect the data: questionnaire survey, semi-structured interview, verbal protocols, transaction logs, and unobtrusive observations. Most importantly, users were probed for their intentions associated with every behavior over the entire information seeking episode.

The analysis of these data illustrates the ways in which changes in interactive intentions are associated with patterns of information seeking behavior. From this, several intention-based interactive strategies and their dimensions have emerged. Moreover, this study also identifies users' shifts of current search goals, plans, interactive intentions and information seeking strategies in the process of accomplishing current goals. In addition, factors that lead to the change of interactive intentions and information seeking strategies are analyzed. The results of the study are further discussed within the model of information seeking behavior.

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CHAPTER 1 INTRODUCTION

1.1 The Emergence and Significance of the Research Problem

More and more Information Retrieval (IR) research demonstrates that people engage in multiple information seeking strategies within an information seeking episode. However, most existing IR systems can only support one type of information seeking strategy. In order to support the variety of users' information seeking strategies, we need to further investigate the information seeking behavior of users, to characterize these information seeking strategies, and moreover, to identify the factors that lead to changes of information seeking strategies.

1.1.1 Limitations of existing IR systems

Representation and *comparison* are usually considered as the two core processes in traditional IR. Comparison is between two representations: representation of text and representation of user need. Much of the research in IR has concentrated on indexing techniques for representing the contents of documents and retrieval techniques that compare documents to queries (Salton, 1983; Van Rijsbergen, 1979). Two underlying assumptions of the traditional IR view are: 1) the information need is static and can be specified; 2) there is only one form of information seeking behavior (Belkin, 1993).

The limitations of the standard IR model are becoming ever more evident. Theoretically and empirically, more and more research demonstrates that people can not specify their information needs, and moreover, that people engage in multiple

information seeking strategies within an information seeking episode and across a variety of contexts. (Bates, 1989; Belkin et al, 1982; Belkin and his associates, 1995; Ellis, 1984; Oddy, 1977). The idea that a single query presented by a user should be matched with document representations in the system has been criticized, and researchers have begun to study IR interactions, which include users, their problems, and the situations that lead to the selection and modification of information seeking behavior.

The standard IR view influences the way users perceive IR systems as well as the way they seek information. Oddy and his associates' (1992) research shows that both users and intermediaries are constrained by their view of current IR systems: they tend to view the system as a mechanism for the provision of bibliographic citations and not as a mechanism for assisting in the resolution of problematic situations. It is difficult to express problematic situations as concrete search terms or to apply them to search in other useful ways because of the limitation of the existing system. As a result, both users and intermediaries pay little attention to situational variables and research goals.

1.1.2 The need for adaptive IR systems

The limitations of existing IR systems call for the need for adaptive IR systems. Researchers realize a new type of IR system is required which supports users to employ different information seeking strategies in their information seeking processes. Simultaneously, researchers are suggesting new types of IR systems from different perspectives.

Brajnik, Guida, and Tasso (1987) emphasize that the major tasks in the design of an expert interface to an information retrieval system involve three aspects: supporting

the users in analyzing their information needs, formulating an appropriate search strategy, and evaluating the obtained results. Bates (1990) argues it should be possible to design search interfaces to make it easy for novice users to apply good strategies. Belkin (1993) claims that a central problem for information retrieval is designing for effective interaction. Belkin and Perez-Carballo (1996) further propose to design IR systems which incorporate a variety of IR techniques to adaptively support a variety of information seeking strategies within the course of a single information seeking episode across a variety of task environments, situations and contexts.

The adaptive IR system design raises the question regarding interactions in IR: to what degree an IR system ought to be designed to accommodate users with various tasks using different search strategies to achieve their goals. To be more specific, the question regarding system design is the degree to which an IR system ought to be designed to accommodate individual users in defining their problem, in defining their need for their information or in solving their underlying problems. Accordingly, I propose that an adaptive IR system should:

- a) support users in defining their information problem/need
- b) support users in modifying their search strategies
- c) support users in using multiple seeking strategies to achieve their goals.

However, the user-centered design paradox is that we can only build systems based on knowledge of users and how they work as we can not know how users work with systems until the systems are built (Marchionini, 1995). Therefore, we need to understand more about multiple information seeking strategies before we can actually support users to engage in variety of information seeking strategies. There are two issues

in relation to the understanding of multiple information seeking strategies: 1) how can information seeking strategies be characterized? 2) what leads to the selection and modification of different information seeking strategies?

1.2 Research problem and research questions

User goals have been identified as the most important factors in defining information seeking behavior from both theoretical and empirical studies (Zunde, 1978; Rouse & Rouse, 1982; Saracevic 1983; Weischedel, 1984; Shenouda, 1990; Belkin, Marchetti & Cool, 1993). Daniels (1985) develops a user model based on an analysis of human-human interaction. She identifies five sub-functions of the user model: 1) the status of the user; 2) user's goals; 3) user's state of knowledge; 4) user's familiarity with IR systems; and 5) user's background. According to her analysis, user's goal plays the most important role in defining user's information seeking behavior. However, she does not further explore the relationship between user's goal and his/her information seeking behavior.

This study attempts to understand the multiple seeking strategies users engage in within an information seeking episode by investigating the relationship between users' information seeking goals and their information seeking behavior. The particular focus of this study is on specifying hierarchical levels of user goals, and the in-depth investigation on one micro level -“interactive intention” in relation to information seeking strategies. Furthermore, the study attempts to discover factors that lead to users' change of interactive intentions and information seeking behavior.

In particular, this study was designed to address the following questions:

- 1) What are the *interactive intentions* users try to accomplish in the information seeking process?
- 2) How can the *information seeking strategies* users engage in to achieve interactive intentions be characterized?
- 3) What is *the relationship* between users' interactive intentions and their information seeking strategies (intention-based strategies)?
- 4) How do users *shift* their interactive intentions to fulfill their goals/tasks within an information seeking episode, and how do users change their search strategies to achieve their interactive intentions within an information seeking episode?
- 5) What are the *factors* that lead to the change of users' interactive intentions and their seeking strategies?

1.3 Research design

In order to answer these research questions, I first examine relevant literature to acquire theoretical bases and empirical evidence for my conceptual framework to understand multiple information seeking strategies (Chapter 2). I then attempt to construct my own conceptual framework of interactive information retrieval built upon three theoretical bases (Chapter 3). After I develop a methodology to test and modify my model by analyzing data from 40 cases of information seeking episodes from four different types of libraries (Chapter 4), I then discuss the results of the analysis corresponding to each of the research questions, and further apply them to evaluate and modify the model of interactive information retrieval (Chapter 5). Finally, I summarize the thesis, discuss its theoretical and practical implications and suggest further research (Chapter 6).

CHAPTER 2 LITERATURE REVIEW

The literature review consists of four sections, which are the theoretical bases and empirical evidences for my conceptual framework. First, the nature of IR and interaction in IR is the foundation of my study. Second, the “planned model” and “situated action” are two different approaches to understanding information seeking behavior. Third, search strategy studies provide sufficient evidence that users engage in multiple information seeking strategies in their information seeking processes. Fourth, user goals are both theoretically identified and empirically verified as an important factor in framing information seeking behavior. Finally, section 5 summarizes this chapter.

2.1 Nature of IR and interaction in IR

2.1.1 Nature of IR

The nature of IR is interaction. Uncertainty and interactiveness are the two major characteristics of information retrieval.

Taylor’s (1968) classic work on question-negotiation proposes four levels of need that users bring to the information seeking task. The need comes from an un-formulated question based on the user’s uncertainty. The significance of Taylor’s work is that it postulates a particular psychological state of mind of the user that may lead to an expressed request.

Wersig (1979) uses the concept of problematic situation in which knowledge and experience may not be sufficient in order to resolve the doubt. He identifies an explicit

account of precursors to information seeking behavior based on an individual's knowledge, beliefs, goals and situation.

Belkin's "Anomalous State of Knowledge" (ASK) hypothesis (1977, 1978, 1980) is an extension of Taylor's model. ASK is similar to "visceral need" and "problematic situation," which means that the user's knowledge is insufficient for the user to deal with a specific situation. ASK provides a framework in which the reasons for users to seek information could be explicitly represented and used for information retrieval.

According to Taylor's "visceral need," Wersig's "problematic situation," Belkin's "ASK," if users are not capable of recognizing their state of knowledge/problem space, they may end up in a state of uncertainty. Users try to clarify their information problems by interacting with information. Based on the above analysis, we can conclude: 1) information problem/need is dynamic, and it changes during the information seeking process; 2) information problem/need can only be clarified by interaction.

In his review article on modeling interaction in IR, Saracevic (1996) points out "IR interaction is a complex process that is very much situation or context dependent: it starts from and relates to users, their tasks or problems, competencies, knowledge states and intents on the one hand, but it also involves characteristics and capabilities of the system, the information resources, and the interface, on the other hand." Mantovani (1996) claims that understanding interaction is difficult, because what keeps changing in interaction is not just things in the world or things in the actor, but the very structure of their connection. Things change, strategies change, goals themselves change during the development of the interaction.

2.1.2 Interactive IR models

Belkin and his colleagues have worked on interaction in information retrieval over several years (Belkin & Vickery 1985; Belkin, 1993; Belkin, Cool, Stein & Thiel, 1995; Belkin & Perez-Carballo, 1996), and he further develops an episode model of information seeking (Belkin, 1996). The central process is users' interaction with information. An information retrieval episode can be considered as a sequence of interactions between the user in the system and information objects supported by representation, comparison, summarization, navigation and visualization. Interaction is determined by factors, such as user's goals, intentions and knowledge, problem at that time, and the nature of the information objects being interacted with.

Saracevic (1996) develops a stratified interaction model based on studies in human-computer interaction (HCI) and stratificational theory in linguistics and communication. User's information use involves both cognitive process and situational application. Three levels of interactions are interconnected to each other: surface, cognitive, and situational. On the surface level, investigation focuses on what users do; on the cognitive level, researchers focus on users' cognitive processes, such as relevance judgment; on the situational level, users' problems and their changes are the focus.

Both of these models present the general picture of interactive information retrieval, that is how users interact with information or system, and how users' characteristics affect the interaction. Belkin's episode model emphasizes the information seeking process while Saracevic's stratified interaction model focuses on levels of information seeking. Both of these models try to identify patterns to incorporate into system design and support effective interaction in IR.

2.2 Planned model vs. situated action

There are two different approaches to understanding human information seeking behavior in information retrieval environments. The *planned model* approach views information seeking behavior as continuous and interrelated actions, which are all part of a goal-related plan. This research attempts to understand information-seeking behavior in relation to *general* plans and goals. In contrast, the *situated action* model views information seeking behavior as a moment by moment response to elements of the current situation, and therefore as less determinant. The results of this research are usually limited to the specific situation or context under investigation.

2.2.1 Planned model

2.2.1.1 Planned model

From the cognitive point of view, Newell & Simon (1972) posit that action is a form of problem solving, where the actor's problem is to find a path from some initial state to a desired goal state, given certain conditions along the way. The *planned model* approach views information seeking behavior as continuous and interrelated actions, which are all part of a goal-related plan. This research attempts to understand information-seeking behavior in relation to *general* plans and goals.

Most of the plan recognition work tries to infer the task-related plan by: 1) analyzing speech acts, or 2) observing other non-communicative acts. These two types of work are also referred to as “intended” and “keyhole” recognition (Kautz, 1991.)

1) Inferring the task-related plan by speech act

It is fairly well accepted that people's goals affect what they say and how they say it - an underlying theme in the work on speech acts (Hayes and Reddy, 1983). Speech acts are used to infer the speaker's goals and intentions.

According to Carberry (1989), one of the most important ways in which an information-seeking dialog can be assimilated is by inferring the task-related plan motivating an information-seeker's queries. In more complex domains, the information-seeker's complete plan will consist of a hierarchy of sub-plans and sub-goals which accomplish his or her overall goal. Such a complete plan is not immediately evident from a single utterance, and individual utterances must be related to one another to build the user's plan as the dialog progresses. Grosz (1977) identifies two types of nature in information seeking dialogs: 1) Organized nature: which indicates that humans ask all questions related to one subgoal of a plan before they move to the next subgoal. 2) Cooperative nature: which means the dialogs are cooperative and both participants focus on the same knowledge in order to understand each other.

Pollack (1986) has proposed that plans be viewed as mental phenomena. She contends that, in order to comprehend an utterance and relate it to the user's plan, the system must reason about the configuration of beliefs and intentions that it should ascribe to the user.

The most popular application of plan modeling study is in handling pragmatically ill-formed queries. An utterance can be syntactically and semantically well-formed, but violate the structural properties of the listener's world model. Such an utterance is pragmatically ill-formed. A number of researchers have investigated the problem of

handling pragmatically ill-formed queries (Sowa, 1976; Kaplan 1979; Mays, 1980), but their strategies are deficient in that they consider the queries in isolation, without using a model of the preceding dialog to address the speaker's intention.

2) Inferring the task-related plan by non-communicative act.

Different from the above approaches, Schmidt, Sridharan, and Goodson (1978) propose a hypothesis and revised paradigm for inferring a user's goal by observing his non-communicative actions. They formulate a set of revision rules by changing a plan when the observed action is conflict with expectation.

Humans often use keyhole recognition in order to expand their beliefs about what the information-seeker is trying to do and how he should go about doing it, beyond what the information-seeker explicitly intended to convey. Keyhole monitoring and plan-recognition apply mostly to the diagnosis of user strategies and intelligent help systems (Desmarais, Larochelle & Giroux, 1987; Hecking, 1987).

Cohen, Perrault & Allen (1981) further distinguish intended vs. keyhole recognition. Keyhole recognition is the inference of an agent's goals and plans by unobtrusively observing his behavior, as if through a keyhole. In such cases, the agent does not directly communicate his goals to the observer. Intended recognition is the inference of those goals and plans that an agent intends to convey. Intended recognition is essential in communicative situations, since the listener must identify the intended meaning of a speaker's utterance; but it seems that keyhole recognition should also play a significant role in identifying users' intention. However, since the information-seeker may not have intended to communicate these goals and plans, they are more likely

sources of error than components which the information-seeker intended that the information-provider recognize. If we can employ these two types of recognition together, it will be more accurately to identify the information-seeker's intentions.

Planning modeling plays an essential role in assisting an information system to recognize a user's beliefs, goals, and plans. Kobsa (1989) emphasizes that for a dialogue system, assumptions about the user's beliefs are necessary, for example, to discover any misconception on the part of the user or to adapt its answers to the level of his/her expertise in the domain of discourse. Assumptions about the user's goals and plans can be used, for example, to provide better recommendations or for supplying additional information not explicitly requested by the user.

Summing up the above, plan models have three characteristics: 1) Directed by goal. A plan directs a series of actions from the initial state to the end state. 2) Interrelated actions. In planned models, actions are considered as continuous and interrelated, and they are all part of a goal-directed plan. To understand a specific action, we need to relate it to its previous and following actions. 3) Influenced by beliefs and intentions. Plans are viewed as mental phenomena, so both users' beliefs and intentions are crucial to interpret actions. That also requires the system to be able to reason users' belief and intentions.

2.2.1.2 The limitations of the "planned model"

Goal-directed information seeking behavior is often considered as part of a plan. However, the inherent uncertainty and interactiveness of IR also determines the

situational aspect of information seeking activity. The limitation of plan models can be analyzed based on the studies of the nature of IR in the previous section:

1) Uncertainty of IR

IR differs from much of the other work on planning as a good deal of the other research concentrates on plans in task-execution domains. The user is not simply executing a task or solving, for example, an algebra problem online, but is gathering information so that a problem may later be managed. In the beginning, the user probably does not have a complete plan about how to search for the information. Most importantly, he might not be clear how he is going to solve the problem because he could not clarify his information problem at the beginning of the information seeking process.

2) Interactiveness of IR

Interactiveness of IR suggests that users can only clarify their information problem by interaction. The interactiveness of IR leads to another limitation of the “planned model”: failing to take account of the impact of the environment, the interacting process and the results of the interaction. Hoppe & Schiele (1992) recognize that in the incremental retrieval process it is mostly impossible to plan or anticipate longer sequences of actions, because the semantic evaluation of intermediate results co-determines the selection of the next action. Hert (1997) claims that elements of situatedness affect users’ information seeking behaviors, such as elements associated with the respondent, elements associated with the problem or project, and elements associated with the system response.

3) The tradeoff between making a general and flexible plans

As could be expected, information encoded in task-composition rules about action ordering turns out to be more fragile than information about the various patterns of search attributes (indicating different priorities) and requested attributes that may be specified by different users. The breakdown of higher-level plans due to some unaccounted-for user action is a problem faced by any plan-recognition mechanism that works with a finite set of predefined plans. There is a tradeoff between making plans more general and flexible to account for variation in procedures at the risk of sometimes providing extraneous suggestions and making plans more specific to always warrant precise interpretations of the risk of not being able to interpret some individual action sequences at all.

2.2.2 Situated action

2.2.2.1 Situated action

In contrast to the cognitivist view represented in the plan model approach, Suchman (1987) proposes an alternative perspective, or *theory of situated action*, drawn from recent developments in the social sciences. The aim of situated action research is not to produce formal models of knowledge and action, but to explore the relation of knowledge and action and the particular circumstances in which knowing and acting always occur. This approach assumes that the coherence of action is not adequately explained by either preconceived cognitive schema or institutionalized social norms. Rather, the organization of situated action is an emergent property of moment-by-moment interactions between actors and between actions and environments of their action.

Suchman (1987) argues that plans can neither determine the actual course of a situated action nor adequately reconstruct it. The plan model treats a plan as something located in the actor's head, which directs his behavior. She argues that artifacts built on the planning model confuse plans with situated actions, and suggests that a better way to view plans is to see them as formulations of antecedent conditions and consequences that account for action in a plausible way.

She emphasizes that the foundation of actions by her account is not plans, but local interaction with our environment, more or less informed by reference to abstract representations of situations and of actions, and more and less available to representation themselves. The function of abstract representations is not to serve as specifications for the local interactions, but rather to orient or position us in a way that will allow us, through local interactions, to exploit some contingencies of our environment, and to avoid others.

Hert (1997) further develops the notion of information-seeking interaction as "situated action" in an investigation of information interactions among a sample of OPAC users. Results of her study indicate that users' goals were not greatly modified during their information interactions. Users' actions were not completely predetermined; instead, elements of the situation were utilized to influence actions. According to her results, three elements of situatedness affect information seeking behavior: elements associated with the respondent, elements associated with the problem or project, and elements associated with the system response.

Summing up the above, "situated actions" are represented by 1) Goal constancy. User's goals remain constant in the information seeking process, and users' modifications

are limited. 2) **Situatedness.** Situated actions emerge from moment by moment interaction, and unanticipated conditions always require re-planning. 3) **Influenced by situational elements.** A user's action is influenced by situational elements which are elements associated with respondents and the problem of the respondent instead of cognitive schema or social norms.

2.2.2.2 The limitations of the “situated action”

“Situated action” emphasizes the situational aspect of IR. From the “situated action” perspective, intelligent systems should be created with little or no planning and minimal representations of their environments. However, the structure of information problem/task and user's personal information infrastructures also determine the planned aspect of information seeking activity. The limitation of the “situated action” can be analyzed from the following aspects:

1) Structure of the information problem/task

It is generally considered to be difficult to identify patterns of information search strategies because of their situation-driven nature. Information seeking is not only situational, but also goal directed action. Information seeking always serves some purpose in a task or problem solving process. The task or problem itself often imposes considerable structure on the information seeking process. Every user has some kind of information problem or task which not only promotes his/her information seeking but also directs his/her information seeking to the final destination.

In Hoppe and Schiele's (1992) study, they suggest that procedural task support becomes feasible, if the system can draw on procedural and conceptual domain

knowledge about the external task for inferring user goals and plans. The study also recommends that some information about the state of the task environment could and should be used to account for the “Situatdness” of user behavior. “Situatd actions” focuses more on the situated aspects and neglects the planned aspects.

2) Personal information infrastructures

In addition to the structure of the information problem, users’ personal information infrastructures also play important roles in shaping their information seeking behaviors. According to Marchionini (1995), users’ personal information infrastructures refer to users’ general cognitive facility and special knowledge and skills, and they affect users’ information seeking behavior. Users’ special knowledge and skills consist of three types of knowledge and skills: knowledge and skills regarding the problem domain, knowledge and skills specific to the search system and setting, and knowledge and skills related to information seeking itself. In addition to these three types of knowledge and skills, relevant studies also show that users’ general knowledge, expectations, and intentions also influence how users define their situations and assist users to adapt to situations (Saracevic et al, 1988; Shenouda, 1990; Barry, 1994).

Summing up the above, while we agree with the “situated action” paradigm’s emphasis on the impacts of the situation on the course of action, we contend that users’ behaviors (if not exclusively) are controlled by their tasks/problems and their personal information infrastructures. To neglect this would mean to ignore valuable information that a responsive system could capitalize on in giving task-oriented support. Information seeking behavior is co-determined by situations and plans.

2.3 Previous search strategy studies

2.3.1 Previous search strategy studies

A number of researchers have investigated users' information seeking strategies from tactics, search process, seeking patterns to search strategies. Here are some examples:

In her classic work, Bates (1979a, 1979b) specifies a set of 29 **information tactics** grouped into four categories: 1) monitoring tactics: tactics for keeping the search on track (check, weigh, pattern, correct, record), 2) file structure tactics: tactics for navigating through the system's file structure to get to desired source or information (select, survey, cut, stretch, scaffold, cleave), 3) search formulation tactics: tactics to aid in reformulation (specify, exhaust, reduced parallel, pinpoint, block) and 4) term tactics: tactics to aid in selection of terms (support, sub, relate, neighbor, trace, vary, fix, rearrange, contrary, respell, respace).

Kuhlthau (1991) developed a model of the information search process based on a series of studies of users in information seeking situations. Her model includes both cognitive and affective aspects of information-seeking. Six stages of information **search process** are identified: initiation, selection, exploration, formulation, collection and presentation; **Actions** common to each stage are as follows: seeking background information, seeking relevant information and seeking relevant or focused information. Finally, appropriate **tasks** derived from Kuhlthau's model are: recognize, identify, investigate, formulate, gather, and complete.

Ellis (1989) developed a behavioral model of the **information seeking patterns** of academic social scientists: starting, chaining, browsing, differentiating, monitoring, and extracting. He suggests that “if researchers’ information seeking behaviors are broken down into their basic behavioral characteristics-and the retrieval system is provided with facilities that reflect those characteristics-then users should be able to recreate their own information seeking patterns while interacting with the system (p.172).”

Chen and Dhar (1991) conducted two studies which investigated the cognitive processes of users in order to construct an intelligent front end to an IR system, and they found five types of **strategies** employed by users of the system: 1) the known-item instantiation strategy, 2) the search-option heuristic strategy, 3) the thesaurus-browsing strategy, 4) the screen-browsing strategy, and 5) the trial-and-error-strategy. Markey and Atherton (1978) analyzed users’ online **search strategies**, and identified five basic types: 1) building block; 2) pearl-growing; 3) successive-fractions; 4) most-specific-facet-first; and 5) lowest-postings-facet-first. Hawkins and Wagers (1982) label a frequently used **strategy** as “interactive scanning” which requires more user interaction with the system and information based on online bibliographic study.

Marchionini (1995) tries to categorize **information seeking strategies** into two high level of categories: analytical and browsing strategies. Analytic strategies are more goal oriented and systematic while browsing strategies are more informal and interactive.

In studying interactive IR in (Text Retrieval Conference) Trec-4 and Trec-5, Belkin and his associates (1996, 1997) note that searchers attempt to employ different information seeking strategies in their information seeking process in addition to query

formulation. For instance, learning to understand the content and structure of the database, identifying good terms for a query, finding out more about the subject knowledge, and increasing precision by using negative feedback, etc. Those search strategies are not fully supported by the existing systems.

The above studies identify search strategies, tactics, and also develop patterns and models. These studies are examples of some of the work that demonstrate that people engage in multiple information seeking strategies. My research builds upon these earlier findings.

2.3.2 The limitations of the previous studies

A number of researchers have already investigated users' search strategies, such as Kuhlthau's actions and tasks in relation to stages in the information seeking process, Chen and Dhar's search strategies, Belkin and his associates' and Marchionini's information seeking strategies, Ellis' information seeking patterns, and Bates' information tactics and relationships among move, tactic, stratagem and strategy. Those studies have contributed a lot to the understanding of user information seeking behavior. However, all of these studies only answer the question what kind of search strategies are used by users, they do not further examine the hidden structure behind these search strategies, that is the next question, under what circumstances these search strategies are applied.

Generally speaking, as these strategies and tactics are highly interactive, it is difficult to identify relations between actions in the information seeking process, so it is difficult to predict users' information search strategy use. Hoppe & Schiele (1992) claim

that as these strategies are highly interactive, flexible and underdetermined, they only impose weak constraints on the relation between the actions in a sequence, so that it is difficult to generate help and advice from them. However, if we can identify relations between seeking behaviors and goals and subgoals of users, it will be easier for an adaptive IR system to predict and suggest appropriate strategies for users to solve their information problems.

2.4 User goals – important factors in framing user information seeking behavior

User goals are not only theoretically identified but also empirically verified as important factors in defining information seeking behavior. Here I summarize some of the relevant studies.

2.4.1 Theoretical identification

Zunde (1978) argues that information value and utility only have meaning if related to a user or a class of users and to a goal or class of goals. Moreover, since information users and their goals vary with time, information value and utility are functions of time as well.

Belkin, Marchetti & Cool (1993) propose an information seeking behavior model based on the space of information seeking strategies. According to them, information seeking strategies arise from Wersig's (1979) problematic situation. The characteristics of the problematic situation, especially, the user's state of knowledge and information seeking goals affect information seeking strategies.

Saracevic (1983) studies the structure and nature of requests in information retrieval based on the ASK concept, and identifies five basic elements in information seeking: problems, internal knowledge state, intent, question, and request. Shenouda (1990) adapts Saracevic's model, and defines the following variables related to the problematic situation which affects user's information seeking behavior: level of clarity of the problem, user's expectation of obtaining potentially useful answers, user's knowledge of the general subject related to the problem, user's knowledge of the topic of the problem, and user's objectives (goal) with regard to the use of potential search results.

Based on the above analysis, we can conclude that user's goal has been theoretically identified as an important factor in affecting user's information seeking behavior.

2.4.2 Practical verification

Practically, Rouse and Rouse (1982) conducted two experiments using DBASE for two groups of students with different goals, and demonstrated that users' goals had influence on their information seeking behavior.

Cool and her colleagues (1993) conducted two studies to investigate the factors which underlie people's judgments of the relevance or usefulness of documents to particular information problems. The results showed that those factors were related to the users' situation, goals and to retrieval strategies for information retrieval system.

To develop an intelligent information system, Weischedel (1984) explored the user models of goals and plans to control the search for the intended interpretation of ill-formed input. This is a study that incorporates models of user goals and plans into a truly

intelligent system with a natural language interface. He emphasizes that user goals are the basis for an intelligent information system's ability to understand ill-formed input. Belkin and his associates (1991) describe four information system user interface products in progress at ESRIN, the establishment of the European Space Agency (ESA), Italy. Each project demonstrates a somewhat different approach to interface design, but all share the commonality of responding to user goals, tasks and characteristics. They suggest that design of information systems, including their interfaces, should be based on a multi-level analysis of user goals, tasks and domain views.

In system evaluation, Chandler (1982) claims that an information system should be evaluated with equal consideration given to both user constraints and to system constraints. This approach provides the analyst with a framework for gaining insight into information system performance from both user and system viewpoints by establishing a causal relationship between user goal achievement and system activity.

On user training, to satisfy online users' more sophisticated demands, Smith (1992) studied user goals, objectives and feedback to develop a comprehensive customer training program designed to minimize the time needed to become proficient and maximize the relevance and application of the materials retrieved in the use of the LEXIS and NEXIS databases.

2.4.3 User goals and search strategies -- pattern identification

Since 1988, Belkin and his colleagues and students have carried out a number of studies on information seeking behavior. The original data I use for this dissertation comes from those studies. I will discuss it in detail in the Methodology chapter.

Belkin, Marchetti & Cool (1993) first develop a scheme of information seeking strategies based on a small number of behavioral dimensions. After re-analyzing existing data and other research, they propose a multi-faceted classification of information seeking strategies based on four “behavioral” dimensions which are: *goal* of the interaction (learn, select), *method* of interaction (scan, search), *mode* of retrieval (recognize, specify) and *type of resource* interacted with (information, meta-information). They suggest that this could represent a space of possible information seeking strategies within an information seeking episode. A set of 16 prototypical information seeking strategies (ISSs) are presented. In addition, Belkin, Cool, Stein & Thiel (1995) also associate information seeking strategies with interaction or dialogue structure, and further apply those dialogue patterns to system design.

Chang (1995) focuses on the nature of browsing, and further identifies the underlying common dimensions of browsing: *scanning* (looking, identifying, selecting, and examining), *resource* (meta-information, whole object, part of object), *goal* (locate, confirm, evaluate, keep up, learn, curiosity, and entertain), and *object* (specific item, common items, defined location, general, and none). Based on these four dimensions, she identifies five themes and nine patterns of browsing.

However, researchers still understand very little about the range and nature of user goals and even less about how they relate to information seeking behavior, even though we are sure that the goals of users are strong determiners of their information behavior overall. More empirical data are needed to further explore the relationship between the nature of user goals and information seeking behavior.

Summing up the above, user goals are highly related to user information seeking behavior. However, those studies do not further examine how information seeking behavior is affected by different levels of user goals. In addition, they do not investigate how changes of user goals might have impact on his/her information seeking behaviors.

2.5 Summary

The nature of IR and interactive IR models suggest that information retrieval research should be discussed within the framework of IR as interaction, and furthermore, IR interaction should take both situated and planned aspects.

The inherently uncertain and interactive nature of IR determines the situatedness of information seeking activity. Users' information problems can only be clarified through interaction with information system or information. Each interaction itself may determine the selection of the next action. It is difficult if not impossible to plan or anticipate entire sequences of actions. Compared to situated action systems, planning systems have the capabilities to build simplified models of the real world, and use these models to plan actions and predict real-world responses. However, if the world does not behave exactly as the model predicts, such systems will not long survive unless they also have good capabilities for detecting and responding to the deviations.

Information seeking is situated, and it is a moment by moment change. Alternately, information seeking is also determined by planned aspects. First, the structure of the task or problem itself has impact on the information seeking process. Second, users' personal information infrastructures also guide users in developing techniques and strategies to solve information problems.

More and more search strategy studies demonstrate that users engage in multiple seeking strategies within an information seeking episode. However, these studies do not further explore what lead to the use of different information seeking strategies. User goals are theoretically identified and empirically verified as one important factor in defining information seeking behavior, but previous studies do not investigate more about the relationships between user goals and sub-goals and information seeking strategies.

Hoppe and Schiele (1992) note a clear need for task models in IR to account for both “planned” and “situated” aspects. The only way to challenge both perspectives and furthermore to contribute to the system design is to investigate the nature of user information seeking behavior, especially how different levels of user goals affect their information seeking behavior.

CHAPTER 3 CONCEPTUAL FRAMEWORK

3.1 Overview of the model of interactive information retrieval

The aim of this study is to identify patterns between users' interactive intentions and their information seeking strategies. It differs from other relevant research in the following aspects: 1) This study emphasizes how different levels of user goals, and especially, how users' interactive intentions lead to different seeking strategies. 2) This study identifies information seeking strategies as well as dimensions of information seeking strategies. 3) This study is discussed within the framework that interactive IR should take both "planned" and "situated" aspects into consideration. This study will take into account both the situated and planned aspects of information seeking behavior, which will enable us to understand not only the specific situation or context but also more general goal and plan related information seeking behaviors common to a variety of environments.

In order to examine the relationships between levels of user goals, especially interactive intentions and information seeking strategies, I construct the model of interactive information retrieval (Figure 1). The model is established on three theoretical bases discussed in Chapter 2: 1) nature of IR and interactive IR model; 2) plan model and situated action; and 3) user goal and information seeking behavior.

The model attempts to present 1) levels of user goals and their representations; 2) interactive intentions and information seeking strategies - products of plans and situations; 3) shifts of interactive intentions and information seeking strategies; and 4) factors affecting shifts of interactive intentions and information seeking strategies.

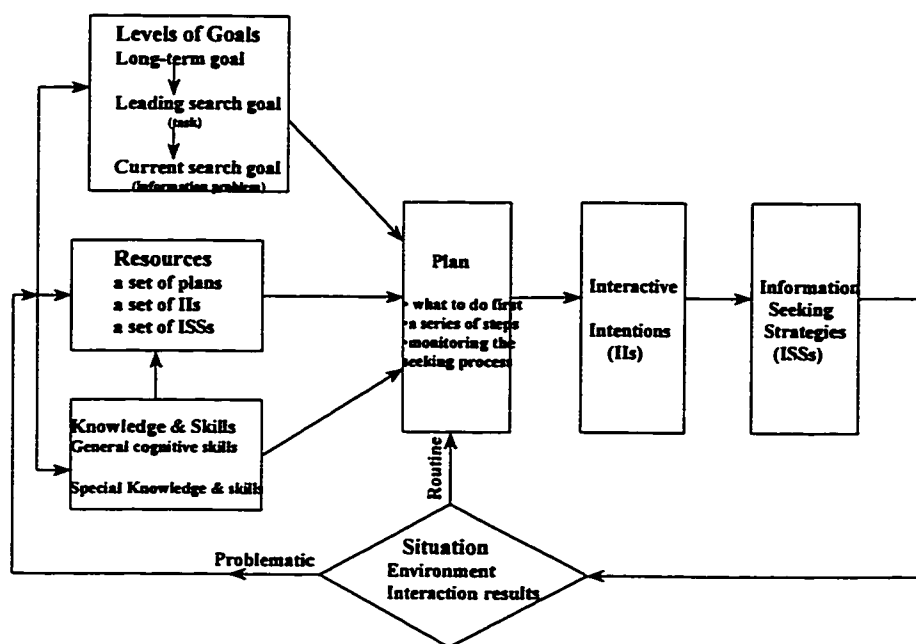


Figure 1 Model of Interactive Information Retrieval

3.2 Levels of User Goals and Their Representation

According to Heckhausen & Kuhl (1985), goals rest on three levels of endstates with an ascending hierarchical order. The first-order-level refers to an action, the second-order level to the outcome of an action, and the third-order level to consequences of that outcome. Each of these three goal levels has its own focus of attention as well as its own types of valence. Simultaneously, different levels of goals also have their interrelations: high-level overlap and lower level inclusion. In the case of higher-level overlap, the actor focuses on a lower-level endstate, and includes the valence of the higher-level goal; In the case of lower level of inclusion, lower-level goals usually borrow their valences from the higher level goals.

Daniel's (1986) user goal definition is trying to relate users' goals with users' current information problems and to their personal background and more long-term plans and objectives. She identifies four types of user goals: 1) current search goal, which refers to goals that the user is currently working on, such as obtaining a specific type of output from the search; 2) goals leading to search, that is the goal that makes the user realize that he needs a search carried out, for example, using a particular methodology or reviewing the literature; 3) specific intention, which gives rise to the above category of goal, for example, a user may have the specific intention of completing a thesis or writing a report; 4) general goal, which includes long-term goals such as personal advancement goals, e.g., obtaining a certain type of job, getting in a particular course, and idealistic goals.

Adapted from Daniel's (1986) classification of goals, for this study, I reconstructed user goals into four levels of hierarchical structure:

1. long-term goal
2. leading search goal
3. current search goal
4. interactive intention

Table 1 provides detailed illustrations of the hierarchical structure of user goals.

Table 1 Levels of User Goals

Type of User Goals	Definition	Examples
long - term goal	refers to a user's personal goals which he/she will pursue for a quite a long time, maybe most of his/her life.	profession, job, interest, etc.
leading search goal	refers to a user's current task- related goal that leads to search.	writing a paper, preparing for a class, etc.
current search goal	refers to what search results a user intends to obtain.	looking for a theory, looking for a specific book, etc.
interactive intention	refers to sub-goals that a user has to achieve in the process of accomplishing his/her current search goal.	discussed in "Results"

The differences between this structure and Daniel's classification are : 1) This classification not only covers different levels of user goals but also imposes the goal structure of these levels, that is high levels of goals have effects on low level goals. 2) This structure further investigates the micro level of user goals - "interactive intentions," which are the products of level of user goals and interaction between user and information or system. Interactive intention changes in the information seeking process, and also leads to the change of information seeking behavior. 3) This structure connects user goals to related task and information problem. Task and goal are inseparable in the

information seeking process: task, which is a leading search goal, determines the low level of user goals, and to some extent, high level of user goals, e.g. long-term goals, also influence what kind of tasks a user is going to work on and how to accomplish those tasks.

3.3 “Interactive Intentions” and information seeking strategies - products of plans and situations

“Interactive intentions” are not just products of the level of user goals, and they are also affected by other planned and situated aspects. The model of interactive information retrieval illustrates what determines the selection of interactive intentions and information seeking strategies.

Plans influence human action in two ways: first, plans may be used to establish a set of “landmarks,” sub-goals along the route to some distant goal; second, plans may be used to determine what initial (present) action will lead toward desired goals. Similarly, plans influence information seeking behavior in two ways: first, plans are goal directed, so they may be used to establish a set of intentions, sub-goals along the route to accomplish their current search goals; second, plans may be used to determine information seeking strategies that lead toward desired goals; third, plans also help in monitoring the search process.

User’s information problem determines the uncertainty of the situation. However, levels of goals impose a structure on the overall situation -- user’s information problem. Long-term goals normally define the areas users are interested in. Leading search goals are users’ tasks-related goals that motivate users to seek information. Current search goals define what users are looking for in relation to their tasks. Just as Schutz &

Luckman (1973) point out that the situation needs to be determined only to the extent that it is necessary to master it. The plan-determined interest selects the “open” elements of the situation which are to be determined in great detail. Interactive intentions are the sub-goals users attempt to achieve in the process of fulfilling their current search goals.

Interactive intentions are the products of hierarchical levels of user goals. The goal structure leads to the decision how to start and when to stop. Therefore, levels of goals define a set of interactive intentions for users to achieve in order to accomplish their current search goals.

Information seeking requires users to apply their knowledge and skills, such as their general cognitive abilities, their knowledge skills in relation to the problem/task domain, knowledge and skills in general, knowledge and skills specific to a system and knowledge and skills regarding information seeking. Users normally employ their general cognitive skills and their knowledge and skills to 1) represent their problem/task, 2) establish a set of sub-goals to fulfill the overall goal, and 3) develop techniques and strategies to seek required information. Simultaneously, users’ personal infrastructures are also developed in the information seeking process when users gain knowledge and skills in order to adapt to different situations and solve problems.

Another resource for a plan is a set of information seeking strategies. Most plans are not specifications of fixed sequences of actions, but are strategies that determine each successive action as a function of current information about the situation. Derived from users’ knowledge and skills, information seeking strategies are the sedimentation of their experiences according to relevance and typicality. Information retrieval tasks are generally considered as difficult or impossible to represent by means of goal-directed

procedures or plans because of their highly situation-driven nature. It is precisely the storage of such strategies that constitutes the readiness-at-hand tools.

3.4 Shifts of interactive intentions and information seeking strategies

The nature of an activity can be missed unless one views purposeful action as an interaction between a representation and the particular contingent details of the environment. Not only planning but also feedback from the interaction influences the information seeking process. In general, situated aspects start to affect the information seeking process after a user selects the first interactive intention and information seeking strategy. “Interactive intentions” reflect the interactions between user and information or system. To be more specific, they are influenced by the environment the user is interacting with, and the results of the interaction. For every situation, a user has to adjust his/her plan to adapt to the situation.

In order to analyze the structure of the life world, Schutz and Luckmann (1973) identify two types of determination of situations: 1) routine situation and 2) problematic situation. In a routine situation, the situation can be sufficiently determined with the aid of habitual knowledge. All “open” elements of the situation can be routinely defined, and the situation is not problematic. Because of the successful employment of these directions, users do not need to go to new solutions of the problem. Instead, they will act as they have already acted in the those circumstances before. Therefore, the plan can be carried out. Users just move to the next interactive intention, and select its corresponding information seeking strategy to fulfill the interactive intention.

Not all situations can be routinely determined. In a problematic situation, users' knowledge is not clear enough, sure enough, or sufficient enough to handle the situation. Further explication of the open elements of the situation is required. The ability to resolve problematic situations adaptively is a basic human cognitive capacity, and that is also part of a plan. Not like in routine situations, users have to either rearrange their old knowledge or acquire new knowledge and skills to clarify their present situations.

The situated aspects have impacts on which facets of knowledge and skills are brought to bear, modifications and re-arrangements of the set of interactive intentions and information seeking strategies, and a more clear definition of user goals. Accordingly, an adjusted plan is formed to select the next interactive intention and information seeking strategy. Vera and Simon (1993) emphasize that a good plan should include a general path, as well as strategies for recovery from deviations. Users not only evaluate the opportunities they discover in the various situations while coping with them, but also develop their current interactive intentions among the possibilities offered by their present situations. Users' interactive intentions are the decisions they make to adapt to the current situation. From users' change of intentions and seeking strategies, we can investigate how planned and situated aspects affect users' information seeking behaviors.

Robin (1997) analyzed transcripts of mediated information retrieval interactions to describe interaction results and concluded that users might change the focus of their attention to various aspects of their information problem. His study found that shifts focus on evaluation judgments, search strategy, terms and query reformulation.

Hert (1997) defines user goal as “what the respondent intended to accomplish during the interaction.” She claims that goals are not greatly modified by respondents during their interactions. It is not analytically possible to determine whether the additional information reflects a revision of the goal, or merely a fleshing out of the goal as it exists at the beginning of the interaction. In her opinion, the modifications tend to reflect the increasing detail of the original goal instead of a new goal, because it is impossible to determine the constancy of the goal. Not only that, the modifications are limited and tend to reflect increasing detail in the goal rather than a new goal.

My questions are: 1) whether users’ goals change in relation to their information problems; 2) whether users’ sub-goals change in relation to how to solve their information problems; and most importantly, 3) how users’ goals and information seeking strategies change.

3.5 Factors affecting shifts of current search goals, interactive interactions and seeking strategies

While a respondent has a limited number of goals, to understand why a respondent has a particular goal involves an understanding of many elements in his or her situation. From the “situated action” perspective, researchers claim situated elements affect actions, especially when the situation becomes problematic. Hert (1997) categorizes all elements of situation that affect users’ information seeking behavior into three groups: 1) elements associated with the respondent; 2) elements associated with the problem; and 3) elements associated with the system.

As actions are always situated in particular social and physical circumstances, the situation is crucial to the action's interpretation. However, situated aspects are not the only factors that affect users' interactive intentions and information seeking strategies. According to the model of information seeking behavior, users' level of goals, knowledge and skills also play important roles in shifts of current search goals, interactive intentions and information seeking strategies. Hert's study has some limitations: 1) She identifies elements of the situation, but she does not further examine the relationship between those elements and their associated shifts of interactive interactions and information seeking strategies. 2) Different levels of user goals and planned aspects also play important roles in those shifts, and furthermore, they might override the effect of some of the situated circumstances.

So far, there are very few studies investigating factors that affect the shifts of current search goals, interactive intentions and information seeking strategies. It is interesting to investigate different types of elements that lead to those shifts, and more importantly, to discover the hidden structure behind those shifts.

3.6 Summary

Interactive intentions and information seeking strategies are products of plans and situations. Levels of goals, knowledge & skills, and their resources co-determine a plan which includes what to do first, a series of steps and also monitors the search process. A plan leads to the selection of appropriate interactive intentions and corresponding information seeking strategies in order to accomplish the current search goal. If the situation is routine, users normally follow their plans until their current search goals are

achieved; if the situation is problematic, users have to adjust their plans to adapt to the current situation by employing their knowledge and skills. Situational factors are not the only factors affecting shifts of interactive intentions and information seeking strategies, in addition, levels of goals, knowledge and skills of users also have impacts on these shifts.

CHAPTER 4 METHODOLOGY

The research problem of this study is to investigate the relationships between user goals, especially the micro-level of user goal - interactive intentions, and associated information seeking strategies. It also tries to identify shifts of interactive intentions and information seeking strategies, and further to discover the hidden structure – factors that lead to user’s change of intentions and information seeking behavior. The following sections discuss the sample, data collection and data analysis of this thesis.

4.1 Sample

This data was selected from 150 cases collected in the research project “Taking Account of User Tasks, Goals and Behavior for the Design of Online Public Access Catalogs” led by professor N. J. Belkin and professor T. Saracevic from Rutgers University in 1990. I chose this data set for the following reasons:

1) large sample, heterogeneous sample

The data were collected in four different libraries, two academic, one public, and one special library to extend the generality of the search results. In each library, 50 self-selected subjects of OPAC use and Non-OPAC use samples were chosen by approaching patrons as they entered the library and asking them their purposes in coming to the library. If their activity was related to the use of the library materials, they were asked to participate in the project. To check on the results of data analysis on the first OPAC

sample, a second OPAC sample consisted of 15 subjects from each library using the same sampling technique and data collecting techniques.

2) real setting, real problem

The data were collected in three different types of libraries. Those users were real users with real problems, and they came to the library to use the library collection to solve their own problems. Compared to an experimental setting, these data are real, more representative and more useful for the understanding of user seeking behavior and, moreover, for the implications for system design.

For this study, 40 cases were selected from four libraries to represent a variety of users and their library uses. Table 2 summarizes the data corpus.

Table 2 Summary of the Data Corpus

	Academic (2 libraries)	Public (1 library)	Special (1 library)
OPAC	10	5	0
NON-OPAC	10	5	10
Total	20	10	10

Table 3 Cases for Analysis

Site	Alex Library		LSM Library		Westfield Library		Fed_Res Library	
Case Number	064	119	002	043	011	058	015	024
	068	123	004	049	032	059	019	026
	076	132	008	069	034	078	021	028
	100	143	009	072	046	084	022	033
	117	145	010	077	054	089	023	035
Total Cases	10		10		10		10	

Table 4 Summary of the Methods

	Questionnaire Survey	Semi-structured Interview	Transaction log	Unobtrusive Observation
OPAC	x	x	x	
NON-OPAC	x	x		x

4.2 Data Collection

1) multiple methods employed

In this study, data were collected through multiple methods: questionnaire survey, semi-structured interview, verbal protocols, transaction logs, and unobtrusive observations. Table 4 summarizes the multiple methods employed. Subjects were first interviewed briefly before the search and also asked to complete a questionnaire on the purpose of the library visit, on the types of information being looked for, and on the projected use of the catalog. The transaction log recorded the user's search session from beginning to the end. Then the investigator observed all subsequent collection-related behavior in the library. Immediately after his/her search session, the user was interviewed to comment on his/her search and other activities in the library. The transaction log and observation data serve as stimuli for the interview.

2) user intentions recorded

Most importantly, the data set recorded user intentions behind every move they made in an information seeking episode. The transaction log and observation data make the retrieved verbal reports more reliable. Furthermore, those data allow the investigators to ask about the intentions of every move, how their moves related to their problem contexts and intended uses, and the reasons for the evaluations of individual aspects of

the search and of the search process as a whole. The intentions recorded are the keys to investigate the research problem.

Verbal reports combined with other data, can be of great value in providing an integrated and full account of cognitive processes and structures. According to Ericsson & Simon (1993), the evidence demonstrates that verbal data are highly pertinent to and informative about subjects' cognitive processes and memory structures. Human subjects' thinking aloud protocols and retrospective reports can reveal in remarkable detail what information they are attending to while performing their tasks, and by revealing this information, can provide an orderly picture of the exact way in which the tasks are being performed: the strategies employed, the inferences drawn from information, and the accessing of memory by recognition.

Concurrent and retrospective reports are mutually consistent. Compared to the concurrent report, the advantage of the retrospective report is that it would not affect user's cognitive process. The disadvantage is that it might omit information contained in the concurrent reports. In this study, the retrospective interview occurred right after users' search sessions, and furthermore, transaction logs and observation data helped subjects refresh their memories.

4.3 Data analysis

In order to address the research problem, the data were first analyzed to identify concepts and to develop categories by open coding (Strauss & Corbin, 1990) which is the process of breaking down, examining, comparing, conceptualizing, and categorizing. Furthermore, "process" was brought into analysis to determine the relationship among

those categories (Strass & Corbin, 1990). The unit of analysis was the user's information seeking activity and associated interactive intention within an information seeking episode. Table 5 presents the data analysis plan for five research questions which include: 1) what kind of data are used; and 2) how to analyze those data.

Table 5 Data Analysis Plan

Research Question	Data Collection	Data Analysis
interactive intentions (IIs)	open-ended interview, unobtrusive observation, transaction log	content analysis taxonomy of IIs
information seeking strategies (ISSs)	open-ended interview, unobtrusive observation, transaction log	content analysis taxonomy of ISSs
patterns of IIs and ISSs	open-ended interview, unobtrusive observation, transaction log	content analysis taxonomy of IIs taxonomy of ISSs descriptive data analysis
shifts of IIs & ISSs	open-ended interview, unobtrusive observation, transaction log	content analysis graphic representation
factors affecting shifts of IIs & ISSs	questionnaire, open-ended interview, unobtrusive observation, transaction log	content analysis taxonomy of factors descriptive data analysis

4.3.1 Developing coding categories

In the process of data analysis, six types of coding categories emerged from the analysis of 40 representative cases. For easy discussion, the operational definitions of these categories with examples from data are presented in the Results and Discussion Chapter. As many quotes are ungrammatical which is the nature of recorded discourse, I added parenthetical clarifications in some places. The coding procedures were as follows:

1) Identifying categories of leading search goals

Identifying categories of leading search goals was based on the questionnaire and the transcripts of the interviews. Categories of leading search goal were embedded in the question on the questionnaire: “Specifically, what is it that brought you to the library today?” and in the interview: “Specifically what is it that brought you to the library today?” Or “what are you going to do with whatever you wanted to find in the library?” Examples of leading search goals were: writing a paper, preparing for a class/quiz, doing a project, entertaining oneself, looking for a job, etc. A table of categories of leading search goals is developed with examples and discussed in the Results and Discussion Chapter.

2) Identifying categories of current search goals

Identifying categories of current search goals was based on the questionnaire and the transcripts of those interviews. Categories of current search goals were embedded in the question: “Purpose of visit?” and the question on the questionnaire: “Could you say specifically what is it that brought you to the library today?” Examples of current search goals were: looking for general information (demography of Guyana), looking for a specific book (The Fundamentals of Organic and Biochemistry), looking for technical information (geotechnical information), looking for models (environmental models), and looking for research (clinical research), etc. A table of categories of current search goals is developed with examples and discussed in the Results and Discussion Chapter.

3) Developing the coding categories of interactive intentions

Developing the coding categories of user's interactive intentions for each information seeking activity was based on the transcription of the interview, observation log, and transaction log. The intention was embedded in the interviewer's question: "What did you intend to do here?" for every activity in the library. Those answers with corresponding observation log (for non-OPAC) or computer log (for OPAC) were identified and analyzed. Categories were developed through making comparisons. Similar answers were grouped into one subcategory and category based on their properties. The operational definitions of subcategories and categories as well as examples are discussed in the Result and Discussion Chapter.

4) Developing coding categories of information seeking strategies

Developing the coding categories of user's information seeking behavior was based on the transaction log, observation log and the transcript of interview. The observation log and transaction log recorded every activity of a subject, moreover, the transcript of an interview verified and enriched the data of information seeking behavior. Information seeking behaviors were first identified and analyzed for each activity. Methods and resources emerged as two dimensions of information seeking strategies. Similar methods and resources were compared and analyzed to develop categories of methods and resources. Types of information seeking strategies of different combinations of methods and resources were identified from the data. The operational definitions of information seeking strategies and examples are presented in the Results and Discussion Chapter.

5) Identifying factors of a given change of current search goals, interactive intentions and information seeking strategies

Identifying factors of a given change of current search goals, interactive intentions and information seeking strategies was based on the transcription of the interview, questionnaire, observation log and transaction log. There is no direct question asked about reasons that lead to different levels of shifts. However, most of the reasons were embedded in the answer of the interviewer's question: "What did you intend to do here?" and "How successful were you at this specific search? Why do you feel this way?" For every change of a current search goal, interactive intention and information seeking strategies, similar factors were grouped into one category, then those coding categories were grouped into larger categories. The operational definition of factors and examples are discussed in the Result and Discussion Chapter.

4.3.2 Identifying relationships/patterns

Strass & Corbin (1990) suggest ways to bring process in the analysis: 1) the change in conditions influences action over time; 2) the action response to the change; 3) the sequence of the results; and 4) how those consequences become part of the condition for the next action.

In order to address the research problem, for every subject, a table was established to present his/her leading search goal, current search goal, interactive intentions, information seeking behavior, outcome and the factors affecting the change of levels of goals and seeking strategies in the search process (Table 6). The following procedures were taken to analyze the data:

- 1) In order to identify the relationships between interactive intentions and information seeking behavior, every interactive intention and its associated information seeking behavior was noted within an information seeking episode.
- 2) In order to discover different levels of shifts, in every table, not only “current levels of user goals and information seeking behavior” but also the “previous levels of user goals and information seeking behavior” were presented. In a word, the table recorded the whole information seeking process of each subject.
- 3) In order to identify what factors affect the shifts of current search goal, interactive intentions and information seeking strategies and their impact on information seeking behavior, in every table, “outcome” and “factors” were also recorded for further analysis.

Table 6 Relationship Analysis

ID	Leading search goal	Current search goal	Plan	Interactive intention	Information seeking strategy	Outcome	Factor

The relationships and patterns were identified based on the comparison of interactive intentions, factors, and the information seeking behaviors within each subject's and between subjects' information search process. The results will be discussed in detail in the Results and Discussion Chapter.

Three types of relationships were identified from the data:

- 1) Patterns between interactive intentions and information seeking strategies

Patterns between interactive intentions and information seeking strategies were identified through the comparison and analysis of interactive intentions and associated information seeking strategies among subjects. Eight types of interactive intentions and corresponding information seeking strategies are discussed in detail in the Results and Discussion Chapter.

2) Shifts of current search goals, interactive intentions and seeking strategies in the information seeking process

Shifts of user's current search goals and interactive intentions in the search process were identified based on the transcripts of interviews and observation logs and transaction logs. Four types of shifts emerged: a) Current search goal shifts. A shift was detected when a subject attempted to introduce a new current search goal. b) Interactive intention shifts. A shift was recognized when a subject tried to introduce a new interactive intention. c) Information seeking strategy shift. A shift was identified when a subject tried to shift from one strategy to another to accomplish the current interactive intention. Graphic representation will be used to help us understand the structure of different types of shifts visually. Those shifts were compared for further analysis in the Results and Discussion Chapter.

3) Factor affecting the change of current search goals, interactive intentions and information seeking strategies

Factors affecting the change of current search goals, interactive intentions and information seeking strategies were identified through the comparison and analysis of the change and associated factors among subjects. The research here does not stop at identifying all the factors that affect those changes, but further investigates the

relationship between types of factors and types of shifts of user goals and information seeking strategies.

4.4 Limitation of this study and its validity and reliability

Just like any research, this study also has its limitations. In this section, I have tried to discuss the limitation of the study and further explain how this study attempts to obtain strong internal validity, external validity and high reliability.

4.4.1 External validity

First, this study focused on different library settings, so the results of this study can not be generalized to other settings. External validity refers to how well the results of a study can be generalized across populations, settings, and time. The external validity can be affected by the interaction in an analysis of variables such as subject selection, instrumentation, and experimental conditions. This study randomly selected data collected from four types of libraries. All the subjects were randomly selected, and multiple methods were used to collect the data. The data were collected in natural settings instead of experimental conditions. Therefore, the results of this study can be generalized into different library settings.

4.4.2 Internal validity

Second, as this study is the secondary analysis, some of the research questions can not be investigated because of the limitation of the data. For example, do users have plans? How are their plans formed? How do users change their plans? These are the

important research questions that can help us understand the nature of IR, but this study can not examine these questions because they were not collected directly. However, it did not affect the internal validity of this study. Validity is intimately connected to the procedures used in the analysis. If the sampling design is faulty, if categories overlap, or if reliability is low, the results of the study probably possess little validity. Operational definitions of the unit of analysis should be clear-cut and thorough; the criteria for inclusion should be apparent and easily observed. I followed up the principles of obtaining the internal validity. I tried to develop all category systems to be mutually exclusive, exhaustive, and reliable.

4.4.3 Reliability

Reliability is the consistency of measurement. The problem raises a question: if the measures were applied and reapplied under precise replication of conditions, would the same results be obtained?

To test the reliability of the above coding categories (types of interactive intentions, types of information seeking strategies and types of factors affecting different levels of shifts), two judges coded randomly selected 8 (2 from each of the 4 libraries) of the 40 cases independently based upon the coding scheme with examples. The inter-coder reliability was .91 according to Holsti's (1969) reliability formula¹. The high degree of reliability demonstrates the credibility of this study.

¹ Reliability= $\frac{2M}{N1+N2}$, where M is the number of coding decisions on which two coders agree, and N1 and N2 refer to the total number of coding decisions by the first and second coder, respectively.

Third, this study also inherited some problems of the original data, for example, people might argue that the data were a little bit old, therefore users' information seeking strategies might be limited by the information retrieval system they were interacting with at that time. Actually this study not only investigated the multiple types information seeking strategies people engage in but also explored the interactive intentions that led to the selection of different types of information seeking strategies. The adaptive IR systems should support different types of information seeking strategies as well as multiple types of interactive intentions.

4.5 Summary

This chapter summarizes the process of data collection and data analysis of this research. Furthermore, it also discusses the limitation of study and its internal validity, external validity and reliability.

Forty cases were selected from an earlier user library use study, and ten cases were randomly selected from each of the four types of libraries. Multiple methods were used to collect the data: questionnaire, transaction logs, unobtrusive observation and in-depth interview. Users were also probed for their intentions associated with each of their information seeking activity.

Content analysis was used to analyze the data. The unit of analysis is every information seeking activity and its associated interactive intention. First five types of categories were developed by open coding, that is the process of breaking down, examining, comparing, conceptualizing and categorizing. Then three types of relationships were identified from the data.

Finally, three types of limitations of this study were further discussed, and more importantly, this chapter also reviewed how the author tried to achieve strong internal and external validity and high reliability.

CHAPTER 5 RESULTS AND DISCUSSION

Based on an analysis of 40 cases, results are presented in the following sections:

1) Leading search goals, 2) Current search goals, 3) Interactive intentions, 4) Information seeking strategies, 5) Patterns between interactive intentions and information seeking strategies, 6) Shifts of current search goal, interactive intentions and information seeking strategies, 7) Factors affecting different levels of shifts, and finally 8) Summary of the chapter: re-evaluation of the model. These sections are trying to answer the five research questions raised in Chapter 1.

5.1 Leading Search Goals

Leading search goals are task-related goals that lead users to seek information. Five types of leading search goals were identified based upon questionnaire and transcripts of interviews: 1) educational assignment, 2) professional use, 3) personal information use, 4) recreational use, and 5) other. Table 7 presents all the leading search goals of 40 cases.

1) **Educational assignment** refers to those educational related assignments students have to work on as part of the degree or credit requirements. It includes dissertation, class assignment/term paper, research project, etc.

Here is an example of “**class assignment/term paper**”:

“Okay, I wanted to get enough material to, ah, just to enable me to **write the paper for a course that I’m expected to write.**” (a076)

Here is an example of “**research project:**”

“I’m **working on a project on nonverbal communication for the class.**”(a068)

2) **Professional use** refers to profession-related tasks that people have to perform as part of the job requirement. It includes research project, business use, etc.

Here is an example of “**research project:**”

“What we’re going to do is that I have a habitat assessment and **research project** to determine if the species exist on the site.” (l069)

Here is an example of “**business use:**”

“I gather information on New Jersey families and I send them to my clients. **In other words, I come here to work.** I gather information on a particular family, I draw up a report and I send it to my client.”(a132)

3) **Personal information use** refers to personal tasks that people normally do as part of their life. It includes looking for a job, buying a car, etc.

Here is an example of “**looking for a job:**”

“I’m **looking for a job** and in clinical research possibly and I want to find out more about it, what happens, what they do, where I might fit in.” (l077)

Here is an example of “**buying a new car:**”

“Well, my intention is to do some research to obtain information on automobiles, **my wife would like a new car.**” (w054)

- 4) **Recreational use** refers to entertainment-related use. In this data set, recreational use mainly refers to recreational reading

Here is an example of “**recreational use:**”

“I came to locate a couple of things to read over the vacation period. **Just for recreational reading.** (a143)

- 5) **Other** refers those tasks that are not included in the above four categories.

Here is an example of “**other:**”

“I came here to **look for a specific item for a professor.**” (f035)

5.2 Current search goals

Current search goals refer to what search results a user intends to obtain. Five types of current search goals were identified based upon questionnaire and transcripts of interviews: 1) look for a known item(s), 2) look for specific information, 3) look for items with common characteristics, 4) keep up to date, and 5) other (picking up reserved item).

Table 8 presents all the current search goals of 40 cases.

- 1) **Look for a known item(s)** refers to looking for an item(s) about which a user has bibliographic information.

Here are some examples of “**looking for known items:**”

“**There were two books that I was looking for by specific authors, I wanted to see if they were in the library.**’ (a145)

“**Well, I have a list of books I am interested in reading.**” (w084)

- 2) **Look for specific information** refers to finding something that a user needs to know that is embedded in an item.

Here are some examples of “looking for specific information:”

“Well, I was looking for a manufacturer of dual batteries in Thomas’ Registers” (w084)

“I needed to get some information from two days’ newspapers.” (f024)

“This particular visit was I want to find out the one number of the nature of the chemical I am working on and then I want to get the exact, the reference out of it.” (1002)

“Well I was looking for a particular protein enzyme and I wanted to find out about the size of the protein that’s what I want to find out. How big that protein is. And there is a handbook called “Enzyme Handbook” that I was looking for.” (1009)

- 3) **Look for items with common characteristics** refers to looking for items that share similar qualifications that a user needs.

Here are some examples of “looking for items with common characteristics:”

“I came mostly to find documentation for some environmental models and using some of the ideas from those models to develop a third model for my dissertation. There is no such thing as a simple answer to questions like that.” (1072)

“Well I came to look up some sources for my paper. Basically on population of a specific country, Guyana. (1043)

“I’m trying to **find a book that has a picture of a man** that I’m writing a report about so I can make a picture of him on the MacPaint, on the computer, so that’s what I came here for.”(a117)

“I want to **get the some information about clinical research, books about that.**” (1077)

“I was **looking for geotechnical information.**” (1049)

“(I try to) **find general background, either about the play, both about the play and about the author.** So I could make this paper a little bit more than just, you know, my reaction to the play. (a119)

“Yeah, I have to do a paper on the “The Prince” by Niccolo Machiavelli and I was just, I was basically **looking for some critical work on his book.** So I would be able to criticize him in my paper also.”(a123)

“I am going to **look for books by an author.**” (a143)

- 4) **Keep to date** refers to keeping one’s knowledge up to date on one area or field.

Here is an example of “**Keeping up to date:**”

“My intent was to **keep myself up to date** on this area.” (1049)

- 5) **Other** refers to other current search goals that are not included in the above categories.

Here is an example of “**other:**”

“I come to **pick up New York Times.**” (f023)

Table 7 Types of Leading Search Goal

Types of Leading Search Goals	Examples
Recreational use	<ul style="list-style-type: none"> • Entertainment (w034) • Recreational reading (a143) • Recreational reading (w032) • Recreational reading (w059) • Recreational use (l010)
Professional use	<p>Research project</p> <ul style="list-style-type: none"> • Research project (a145) • Research project (f024) • Research project (f002) • Research project (threatening species study) (l069) • Research project (found a gene & protein & want to know how big the protein is) (l009) • Research project (l008) • Research project (l049) • Research project (f022) • Research project (f026) • Research project (f035) <p>Business Use</p> <ul style="list-style-type: none"> • Business use (w034) • Business/occupational use (w058) • Federal Reserve Bank work (f019) • Professional genealogists (a132) • Equal opportunity matters (f033) • Photographer (w058) • Business use (chef) (w046)
Educational assignment	<p>Dissertation</p> <ul style="list-style-type: none"> • Dissertation (l072) • Dissertation (f015) <p>Class assignment/term paper</p> <ul style="list-style-type: none"> • Finance class (w078) • Write a paper on demography on a specific country (l043) • Term paper (a117) • Write a paper for theatre history class (a1119) • Do a paper on Niccolo Machiavelli's "The Prince." (a123) • Write a paper of voice of America for communication theory (a100) • Write a paper for a course (a076) <p>Research project</p> <ul style="list-style-type: none"> • Term project (l004) • Term project (a068)
Personal information use	<p>Look for a job</p> <ul style="list-style-type: none"> • Look for job in sales (w011) • Look for a clinical job (l077) • Look for a job (a069) <p>Buy a new car</p> <ul style="list-style-type: none"> • Buying a new car (w054) <p>Personal information use</p> <ul style="list-style-type: none"> • Personal information use (w089)
Other	<p>Get information for somebody else</p> <ul style="list-style-type: none"> • Look for a specific item for a professor (f035)

Table 8 Types of Current Search Goals

Types of Current Search Goals	Examples
Looking for specific item	<ul style="list-style-type: none"> • Look for a book (f019) (l010) • Look for a particular book (f058) • Look for some books (l004) • Look for a journal (l009) • Look for a reference (l009) • Look for a book (a143) • Look for two specific books (a145) • Look for a list of books (w084) • Look for a specific item for a professor (f028) • Look for a specific issue of a magazine (f035)
Looking for specific information	<ul style="list-style-type: none"> • Get specific information on banks (f024) • Get specific information on one of the nature of the chemical (l002) • Look for information in a handbook (l009) • Look for advertisers in Standard & Poor's Directory (a069) • look for a picture of a man in a book (a117) • Look for specific information in Thomas Register (w084) • look for specific information in a journal (f022) • Look up information from a particular book (w058) • Get data from a book (f026)
Looking for items with common characteristics	<ul style="list-style-type: none"> • Check want ads in papers (w011) • Information on a particular subject of interest (w034) • Look for some environmental model idea (l072) • look for data for a paper (w078) • Information about clinical research (l077) • Background information on endangered turtles (l069) • Information on population of a specific country (l043) • look for general overview on a area. (a068) • look for geotechnical information (l049) • get automobile information (w054) • Get some background material on the play. (Either about the play or the author) (a119) • Look for books by an author (a143) • Look for some critical work on Niccolo Machiavelli's work. (a123) • Find some books for special project (l008) • Find primary sources on female friendship in 19th century (a064) • Find some background information on female friendship on 19th century (a064) • find Information on a particular family (a132) • Find books on housing (f015) • Look for books about Voice of America (a100) • Look for information on environmental policy (a076) • Look for recreational reading books (w059) • Look for recreational reading books (w032) • Look for information under a specific heading (w046)
Keeping up to date	<ul style="list-style-type: none"> • Keep up to date (l049)
Other	<ul style="list-style-type: none"> • Pick up New York Times (f033)

5.3 Interactive Intentions

5.3.1 Types of Interactive Intentions

Eight categories and sub-categories of interactive intentions emerged from the data. The following briefly defines and discusses each of these categories. In the following examples, “I” and “U” refer to the “interviewer” and “user” respectively.

- 1) **Identifying:** this intention refers to identifying information as search leads. It includes two types of sub-intentions: a) identify information to get started, or b) identify more information to search. “Identify information to get started” often occurs when a user tries to consult personal sources before starting to search while “identify more information to search” happens when a user needs more search leads in the search process. In the first type of intention, users emphasize what to start with, and examples of this type of intention are “identifying an author to start with,” “identifying a reference to get started,” “where should I start,” “what to start with, ” or “what my priorities are,” etc. In the second type of intentions, users are more interested in getting more information to continue their searches, so they more likely use phrases “identifying more information (for search)” or “looking for some more information (to search), etc.”

Here is an example of “**identifying information to get started:**”

I: The first thing that you did was after you sat down you took out a notebook and looked at (a) set of handwritten papers, I couldn’t see exactly, what did you intend at that time?

U: I had written a preliminary paper, a proposal and I was going over my ideas that what I wanted to look at, and also I handed the proposal in to the professor and she made comments on it and I wanted to look at those comments and see **where I should start and what was most important and what my priorities were.** (a064)

Here is an example of **“identifying more information to search:”**

I: I saw you looked your notebook, what did you intend to do?

U: I was **looking for some more information to search out of my notebook.**
(1049)

- 2) **Learning:** this category refers to learning: a) system function, b) system structure, c) database content, or d) domain knowledge. Users might use “learn,” or “figure out” to express their learning intentions. Here, system includes any IR system in the library, such as, OPAC, card catalog, infomaster, etc., and the library itself is also considered as an IR system. Learning system function is learning how to use the system and its features, and examples include how to go back to the index in OPAC, how to sign out the newspaper, etc. Learning system structure is to learn how the system is organized, and examples could be to figure out the floor plan of a library, or what does a specific call number mean, etc. Learning database content is to know about the coverage of a database/area, or the content of a database/area, and examples of that are: what are the items in a database/area? what is the time range of the publications in a database/area? Learning domain knowledge is to know about the

relationship of terms, and examples of this intention are learning the synonyms, broad, narrow or related terms of a specific term, etc.

Here is an example of **“learning system function and structure:”**

U: And obviously this is the system you want to **learn** to use considering the amount of time it is used but it was difficult for me to adjust at first to find books. It drove me crazy trying to find something here because I would wander through floor after floor after floor trying to **figure out where everything** was until I managed to **figured out how to use the wall charts and everything to find books.** (lsm0069)

Here is an example of **“learning database content:”**

I: Okay, you typed in forward, right? What did you intend here?

U: I basically wanted to **scan all the population and demography information in this database.** (l043)

- 3) **Finding an item(s)/information** consists of four types of sub-intentions: a) finding a known item(s), b) finding items with common characteristics, c) finding specific information, and d) finding something without pre-defined criteria. Here “finding” means to find the existence or availability of the information or an item(s).

Finding a known item(s) refers to finding an item(s) about which a user has bibliographic information. Normally, a user would use words like “get,” “look for” or “find” to express his/her intention to find an item(s) that he/she has some

bibliographical information, such as title, author, publisher, volume number, page number, etc.

Here is an example of **“finding a known item:”**

I: for the first screen we can see you chose a partial title search, what was your intention at this point?

U: I tried to **get a book. The person gave me the name of the book**, but I didn't think she was right so I figured I used the first three words and I found out that she was wrong. (west058)

Finding items with common characteristics refers to looking for items that share similar qualifications that a user needs.

The commonly used terms for “finding” are “looking for” or “getting.” Examples of “finding items with common characteristics” are “finding publications on the same subject,” “publications of the same author,” “publications in the same journal,” “publications published by the same publisher,” etc.

Here is an example of **“finding items with same subject:”**

U: I didn't find the book I was looking for in the room.

I: Okay, and you also browsed spines?

U: Yeah, because I didn't find the book I was looking for so I was just **looking for other books because it was the same material.** (lsm004)

Finding specific information refers to finding something that a user needs to know that is embedded in an item, such as stock quotes of a company, sports statistics,

picture of a man, etc. “Looking for,” “finding,” and “getting” are the commonly used terms for this intention.

Here is an example of “**finding specific information:**”

I: what was your intent of that activity?

U: Um, I was **looking for stock quotes for a particular company on a given day.** (f024)

Finding something without pre-defined criteria: this intention refers to exploring to find something that might be interesting or useful while users do not have a very clear idea what specifically they are looking for. Normally users would use phrases like “find or look for something that would 'hold my interest',” “satisfy my curiosity,” or “find or look for something useful.” Examples of this type of intention are finding something interesting, finding something to satisfy curiosity, and finding something useful.

“Here is an example of “**finding something without pre-defined criteria:**”

I: Were you specially looking for a book about art?

U: No, No, when I come in here I never really know what I’m going to read.

I: Okay, so you don’t have anything in mind?

U: No, I just thought, to **find something that would hold my interest.** (west0032)

- 4) **Locating:** this intention refers to finding out where an item(s) is located. Generally, users have already known the availability of the item(s) when they try to locate it/them. Examples of “locating” are “locating a specific journal,” “finding out the

location of a book I saw before,” “asking the librarian for the direction/location of a magazine,” and “finding out where a book recommended by my professor is located in this library,” etc.

Here is an example of “**locating an item(s):**”

I: OK, after you spent a few minutes looking through the shelves then you went over to see Kathy at the reference desk and you consulted with her. What was the intent with that activity?

U: Just to ask her to point me in the right direction to find the magazine.

(f035)

- 5) **Accessing:** this intention refers to getting an item(s) based upon the location of an item(s). “Accessing an item(s)” is neither to check whether the item(s) is available nor to find out where it is located, instead, it is to get access to the item(s) after a user has/finds the location of that item(s). Frequently used terms for accessing are “looking for,” “getting,” “checking,” etc. Examples of this type of intention are going to the shelf to get an item after finding the call number of that item, going to one area to get an item used before, etc.

Here is an example of “**accessing an item(s):**”

I: Then the next thing that you did you went to the government document stacks and I saw you browse, the first stack you kind of just stopped there and pulled out one volume, what did you intend?

U: Okay, in addition to the electronic searching and all the other searching that I did came loaded with several shelf catalog numbers so I was, at that point, just

going through the shelves to **pick out the things which I knew where they were.**

(1072)

- 6) **Evaluating:** this intention refers to evaluating a) correctness of an item(s), b) specificity of an item. c) usefulness of an item(s), d) fitness of an item(s), or e) duplication of an item(s).

As “evaluating” is to make sure different types of “finding” intentions are satisfied, “evaluating” is highly correlated to “finding.” “Checking” and “making sure” are the alternative terms for evaluating.

“Evaluating correctness of an item(s)” is often a follow-up of “finding a known item(s)” to make sure the item is the one a user is looking for. “Evaluating specificity of an item(s)” is normally related to “finding specific information” to double check whether the item has the specific information a user is looking for. “Evaluating usefulness of an item(s)” is more related to “finding items with common characteristics” and “finding items without pre-defined criteria” to check whether each item is worth keeping. Examples of this intention are to see whether the book/article includes the topics of information of interest, whether the item has enough details, whether the item is interesting to read. However, users do not always stop at evaluating each of the finding results, sometimes, users have to further select one or several items from all the useful items. “Evaluating the fitness of an item(s)” is to pick up the best item(s) from a groups of items based upon certain criteria. In addition, in the evaluating process, users have to also evaluate to see whether that item was read or used before when they suspected that they might read it before, and

that is “Evaluating duplication of an item(s).” Table 9 further distinguishes these five types of “evaluating” by comparing their relations to types of “finding” intentions, evaluation criteria, examples, etc.

Here is an example of “**evaluating correctness of an item(s):**”

I: You took the issue off the shelf, flipped through the front and the back a little bit. What was the intent with that activity?

U: Uh, just needed to **make sure it was the exact issue that (I) needed.** (f035)

Here is an example of “**evaluating specificity of an item(s):**”

I: So, then when you pulled out this book, you kind of browsed it, scanned the text, what did you intend at the time?

U: **To see if it had the picture that I’m looking for.** That’s basically it. (a117)

Here is an example of “**evaluating an useful item(s):**”

I: I saw you select a book, you looked at the jacket at the inside of the book and then you kept it. What were your intentions at that point?

U: It **held my interest.** That’s all, ah.

I: That’s why you kept the book?

U: Yeah, that’s why I kept the book, I think it was this one right here. (1049)

Here is an example of “**evaluating fitness of an item(s):**”

I: You pulled out green books, flipped through them and kept them, what did you intend?

U: **They were four of the exact same book, I was checking to get the newest printing of it,** in case there were any additional authors’ prefaces that they added on, say in second or third edition of the book. I wanted to get all of the additional

authors' notes too. So I ended up going through, I found one new edition, but I ended up taking up the original edition of the book.

I: Why didn't you take the new edition?

U: Because from what I looked through it was missing, it was shorter than the origin which made me think that the prefaces and stuff might be missing. (a068)

Here is an example of "**evaluating duplication of an item(s):**"

I: I saw you browse the shelves, select a book, flip through it, replace it. What was your intention at that point?

U: **I wanted to make sure it is book that was not the book I had taken out before.** I realized it was same after I seeing (the) book. (w046)

Table 9. Types of Evaluating

	Relations to types of "finding" intentions	Individual vs. group evaluation	Evaluation criterion	Examples
Evaluate correctness of an item(s)	<ul style="list-style-type: none"> Find a known item(s) 	Individual	Correctness	<ul style="list-style-type: none"> To check to make sure it is the right newspaper he is looking for Exact book Exact article
Evaluate specificity of an items(s)	<ul style="list-style-type: none"> Find specific information 	Individual	Specific information	<ul style="list-style-type: none"> To see the picture of a man is in there The size of a particular protein
Evaluate usefulness of an item(s)	<ul style="list-style-type: none"> Find items with common characteristics Find items without pre-defined criteria 	Individual	Usefulness	<ul style="list-style-type: none"> To check whether the book /article includes the topics of information of interest Whether the item has enough details Whether the item is interesting to read
Evaluate fitness of an item (s)	<ul style="list-style-type: none"> Find a known item Find items with common characteristics Find specific information Find items without pre-defined criteria 	Group	Most fit one(s)	<ul style="list-style-type: none"> To check to get the best of same edition Most recent one(s) of a topic Most comprehensive of topic
Evaluate duplication of an item(s)	<ul style="list-style-type: none"> Find a known item Find items with common characteristics Find specific information Find items without pre-defined criteria 	Individual	Read or used before	<ul style="list-style-type: none"> To make sure the book was not read before The article was not used before

7) **Keeping record:** this intention refers to keeping a record of the bibliographic information of an item before accessing it. Commonly used terms for keeping

recording are “writing down,” “taking notes,” “copying,” “getting,” etc. Examples of keeping a record are keeping record of author, title, call number, publisher, publication year, page number, etc.

Here is an example of “**keeping record:**”

I: ...What’s your intention here?

U: I just wanted to **write down the author name and title. I wanted to get the call number also** because that way I can go straight to the stack, so when I go over to Kilmer I don’t have to go punching up their computer and running around the library. (lsm010)

- 8) **Obtaining an item(s):** this intention refers to obtaining a) specific information/part of an item, b) an item, or c) a set of items. Here “obtaining” means writing down, taking notes, downloading, saving, copying, photocopying or checking out information or an item(s). Examples of obtaining an items(s) are writing down stock quotes of a company, photocopying an article or part of an article, checking out videotapes, signing out newspapers. Here is an example of “**obtaining part of an item:**”

I: You went to photocopy machine, what did you intend to do?

U: I copied two pages of statistics on NBA players 1988 season. So rather than copying that down I just **photocopied two pages.** (w078)

Here is an example of “**obtaining an item:**”

I: what was your intent with that activity?

U: I **take the book out of the library.** (f19)

9) **Combination of interactive intentions.** Not all the interactive intentions can be clearly defined. Sometimes, users try to combine several interactive intentions together. There are several cases that users try to find both the availability and the location of an item(s) at the same time. Here is an example of **combining “finding a specific item,” and “locating a specific item:”**

I: The first activity I observed you doing, after I met you downstairs was you came right upstairs and you went to the reference librarian and spoke to her. What was your intent here?

U: **To find, to locate “Thomas’ Registers.”** (w084)

5.3.2 Coding Category Comparison

In this study, I also tried to compare the coding categories on interactive intentions I developed with the coding categories developed by Belkin and his associates (1990) on the same data. Table 10 presents two types of categories of user intentions in the library developed by current study and Belkin and his associates (1990), and similar categories are put in the same row for easy comparison.

Most of the categories are similar in two groups, and differences are not critical. The differences between the two coding schemes are as follows: 1) On a general level, the current study comes up with the same categories for both OPAC and non-OPAC data while Belkin and his associates have different categories for OPAC and non-OPAC data. 2) On categories related to “finding,” the current study emphasizes the differences between the different types of finding, especially among specific, common and general while Belkin and his associates focus on the differences between “search” and “retrieval.”

3) For some categories, current study explores a deeper level, for example, “getting instruction” is one of the category in Belkin and his associates’ classification, but current study identifies another category ‘learning” which further expresses the purpose behind “getting instruction.” In addition, “learning” covers more than “getting instruction.”

Table 10. Comparison of categories of user intentions in the library

Current study	Belkin and his associates (1990)
identify	identify
a. something to get started	get started
b. something more to search	
find	find (searching)
a. a known item(s)	a. identifiers of the items
b. items with common characteristics	b. types of items
c. specific information	c. source of search characteristic
d. items without pre-defined criteria	d. purpose of search
	satisfy curiosity
locate	locate
a. an item(s)	a. item(s)
b. items with common characteristics	b. class of item(s)
c. an area/location	c. orientation in general
access	retrieval (get something)
a. a specific item	a. for a known item(s)
b. items with common characteristics	b. by serendipity
c. an area/location	
evaluate/judge	judge
a. relevance of an item(s)	a. relevance of an item(s)
b. correctness of an item(s)	b. correctness of an item(s)
c. duplication of an item(s)	confirm
d. fitness of an item(s)	a. availability of item(s)
	b. accuracy, correctness, completeness of bibliographic information
	c. completeness of some intention
	read
	a. general information
	b. specific information based on topic or other specified criterion
	c. something of interest non-specified
learn	get instructions
a. system feature	
a. system structure	
b. domain knowledge	
c. database content	
Keep record of bibliographical information	record
	a. for location and retrieval purpose
	b. for non-specified purpose
	c. for bibliographic record
Obtain	
a. specific information	
b. Part of an item	
c. A whole item(s)	
	OPAC specific intention

5.4 Information seeking strategies

In Chapter 2, section 4.3, the identification of dimensions of information seeking strategies was discussed. Belkin, Marchetti & Cool (1993) developed a multi-faceted classification of information seeking strategies based on four “behavioral” dimensions. Chang (1995) identified the underlying four common dimensions of browsing. These studies also classified prototypical information seeking strategies derived from the dimensions.

Both of these studies consider user goal as one of the dimensions of information seeking strategies. In this study, I try to characterize information seeking strategies that users engage in to achieve their interactive intentions. Therefore, interactive intentions are not conceived as one of the dimensions of information seeking strategies. The identification of dimensions of information seeking strategies is based on users’ information seeking behaviors, and patterns of interactive intentions and information seeking strategies are further discussed in the next section.

Most of the research on information seeking strategies has focused on search related strategies. Therefore only one type of information seeking strategy is identified. This study demonstrates that people do engage in multiple information seeking strategies to achieve their multiple interactive intentions within their information seeking processes.

Two types of components of information seeking strategies emerged from the data: 1) methods and 2) resources. The integration and combination of these two types of components represent variety of information seeking strategies employed by users.

5.4.1 Types of Methods

Eight types of methods were identified from the data based upon observation data and questionnaire. They are: 1) scanning, 2) searching, 3) tracking, 4) selecting, 5) comparing, 6) acquiring, 7) consulting and 8) trial & error. Table 11 summarizes these eight types of methods.

- 1) Scanning refers to looking through an item or a series of items, for example, pages of an item, list of citations in OPAC or card catalog, a stack of newspaper, shelf, an area, etc. Examples of “scanning” are looking at, looking through, reading, reading through, flipping through, etc. Strictly speaking, reading and reading through can not be considered as “scanning,” but in this study interviewers described the behavior of looking at or glancing through as reading or reading through in some of the cases. This should be clearly defined for further studies.
- 2) Searching refers to finding item(s)/information matching certain criteria. Examples of searching are specified searching, such as, author searching, title searching, subject searching, keyword searching, etc.
- 3) Tracking refers to following meta-information to get to specific location, specific information, etc. Examples of tracking are following call numbers, following signs, turning to page # after searching the index, etc.
- 4) Selecting refers to picking an item among a series of items/location, for example, books on the shelf, citations in OPAC, a stack of newspaper, etc. Examples of selecting are entering a number, picking up, pulling out, choosing, etc.
- 5) Comparing refers to identifying some information and making a comparison. Examples of comparing are making a comparison, comparing, etc.

- 6) **Acquiring** refers to writing down, copying specific or meta-information or checking out items, etc. Examples of acquiring are taking notes, copying, checking out, etc.
- 7) **Consulting** refers to asking questions to a human. Examples of consulting are asking questions, consulting, etc.
- 8) **Trial & Error** refers to figuring out something, especially system functions or system structures by trying different possibilities/approaches without specific instructions. Examples of trial & error are wandering around, trying, etc.

Table 11. Types of Methods

Methods	Scanning	Searching	Tracking	Selecting	Comparing	Acquiring	Consulting	Trial & Error
Examples	Looking at, looking through, reading, Reading, Flip through	Specified search (author, title, subject, author/title) Modifying identifiers, Semantic structuring (narrow terms, broad terms, synonyms), Look for something in index and turn to page #	Direct accessing, Following a link, Following a sign, Going to	Selecting, Choosing, Picking up, Entering a number, Pulling out	Comparing, making a comparison	Writing down, Taking notes, Copying, Checking out, signing out	Asking, consulting	Wander around, Trying,

5.4.2 Types of resources

Resources are the information, information object and human that users are interacting with. Seven types of resources were identified from the data. Table 12 summarizes these six types of methods.

1) Meta-information

Meta-information is information about information. Examples of meta-information are:

- citations in OPAC or card catalog
- citations in secondary resource
- table of contents in a book or a journal
- index at the back of a book or a bound journal
- index of a newspaper
- descriptors of an item

- signs and floor plan in the library

2) Part of an item/specific information

This resource refers to sections of an item, pages of an item or specific information embedded in the item. Examples of part of an item/specific information are:

- Chapter(s) of a book
- Columns of a newspaper
- Articles in a magazine
- Stock quotes on a given day newspaper
- A picture of a man in a book
- A piece of news on a given day newspaper

3) Whole item

A whole item refers to an information object that contains information. Examples of a whole item are:

- a book
- a newspaper
- a journal
- a magazine
- a videotape

4) A series of items/one location

A series of items are several items bound together or in a specific location. One location refers to one area or location in the library. Examples of a series of items/one location are:

- bound journals
- a stack of newspaper
- microfilms
- fiction or nonfiction area
- index table
- HG area

5) One system/multiple databases

One system/multiple databases refers to one system that contains more than one database.

- OPAC
- card catalog

6) human

Human refers to human serving as a resource. Here are some examples:

- a librarian
- a friend
- a classmate
- a colleague

- a professor

Table 12 Types of Resources

Resource	Meta-Information	Part of an item/specific information	Whole item	A series of items one location/	One system/multiple databases	human
Examples	citations in OPAC or card catalog, citations in secondary resource, table of contents in a book or a journal, index at the back of a book or a bound journal, index of a newspaper, descriptors of an item, signs and floor plan in the library	Chapter(s) of an book Columns of a newspaper Articles in a magazine Stock quotes on a given day newspaper A picture of a man in a book A piece of news on a given day newspaper	a book a newspaper a journal a magazine a videotape	bound journals a stack of newspaper microfilms fiction or nonfiction area index table HG area	OPAC card catalog	a librarian a friend a classmate a colleague a professor

5.4.3 Dimensions of information seeking strategies

Methods and resources are two dimensions of information seeking strategies (table 13). Different types of information seeking strategies are different combinations of methods and resources. Here are some examples of the most popular information seeking strategies derived from the data:

- 1) scanning meta-information
- 2) scanning part of an item/specific information
- 3) scanning a whole item
- 4) scanning a series of items/one location/one database
- 5) searching one system

- 6) searching a whole item
- 7) tracking meta-information
- 8) selecting an item
- 9) selecting meta-information
- 10) comparing meta-information
- 11) comparing specific information
- 12) acquiring meta-information
- 13) acquiring specific information
- 14) consulting a human

These dimensions of information seeking strategies are further discussed with dimensions of interactive intentions by applying real examples from the data.

Table 13 Dimensions of Information Seeking Strategies

Methods	Resources
Acquiring	Meta-Information
Comparing	Part of an item/specific information
Consulting	Whole item
Scanning	A series of items/ one location
Searching	One system/multiple databases
Selecting	Human
Tracking	
Trial and Error	

5.5 Patterns between interactive intentions and associated information seeking strategies

5.5.1 Types of entities

Just like information seeking strategies, interactive intentions can also be characterized. After analyzing eight types of interactive intentions, four types of entities were identified from the data. As part of interactive intentions, entity refers to types of information or information objects users intend to acquire or work on.

1) Specific

Specific refers to specific information or a specific object. Examples of specific are:

- A citation
- A book
- A datum
- A picture
- A system feature
- A synonym

2) Common

Common refers to information or information objects with similar characteristics.

Examples of common are:

- A topic
- A format

- A method
- An author
- Different versions of a book

3) Area/location

Area/location refers to a defined area/location of an item or in the library. Examples of area/location are:

- preface of a book
- back of a bound journal
- non-fiction area
- reference desk

4) General

General refers to general knowledge on something or something without pre-defined criteria. Examples of general are:

- content of a database
- general knowledge of a system structure
- content of a book
- something holding my interest
- something to satisfy my curiosity

5.5.2 Dimensions of Interactive Intentions

Eight types of interactive intentions can be further characterized based upon four types of entities. Table 14 presents dimensions of interactive intentions.

Table 14 Dimensions of Interactive Intentions

Interactive intentions		Entities
Identify	Identify something to get started Identify something more to search	Specific
Learn	Learn system feature Learn system structure Learn domain knowledge Learn database content	Common
Find	Find a known item Find specific information Find items with common characteristics Find items without pre-defined criteria	Area/Location
Access	Access a specific item Access items with common characteristics Access an area/ location	General
Locate	Access a specific item Access items with common characteristics Access an area/ location	
Evaluate	Evaluate correctness of an item Evaluate specificity of an item Evaluate usefulness of an item Evaluate fitness of an item Evaluate duplication of an item	
Keep Record	Keep record of bibliographical information	
Obtain	obtain specific information obtain part of the item Obtain a whole item(s)	

5.5.3 Relationships between Interactive Intentions and Information Seeking

Strategies

The results show that each type of interactive intention has its own associated information seeking strategies. Simultaneously, several types of information seeking strategies also apply to different types of interactive intentions. Table 15 presents patterns of interactive intentions and information seeking strategies.

Table 15 Relationships between Interactive Intentions and Information Seeking

Strategies

Intentions	Entities	Methods	Resources
Identifying Learning Finding Accessing Locating Evaluating Keeping obtaining	Specific Common Area/location General	Scanning Searching Tracking Selecting Comparing Acquiring Consulting Trial and Error	Meta- Information Part of an item/specific information Whole item A series of items/ one location/ one database

Eight types of interactive intentions and their associated information seeking strategies are as follows. For easy explanation, I selected some of the examples I used to illustrate the types of interactive intentions. In all the examples, dimensions of interactive intentions and information seeking strategies are underlined. In addition, dimensions of information seeking strategies are also italicized:

- 1) **Identify** includes identifying information to get started and identifying more information for searching. According to the data, *scanning a whole item (28%),*

scanning meta-information (19%), and scanning part of an item/specific information (19%) were the most popular seeking strategies used for this type of interactive intention. Here *scanning a whole item, scanning meta-information and scanning part of an item/specific information* mostly refer to scanning personal materials. Users bring their personal materials to the library to help them identify a search topic or specific search items, and that includes “reading notes,” “looking at bibliography,” and “scanning reading list,” etc. Sometimes, users *also searching a system & scanning citation list (14%)* from the OPAC search to identify search leads. Occasionally, users *consult with human (10%)* to identify some information to get started or to search. Figure 2 presents the frequency and percentage of information seeking strategies applied to “identifying.”

Here is an example of **identifying something in general** to get started by **scanning a whole item**:

I: The first thing that you did was after you sat down you took out a notebook and looked at (a) set of handwritten papers, I couldn't see exactly, what did you intend at that time?

U: I had written a preliminary paper, a proposal and I was going over my ideas that what I wanted to look at, and also I handed the proposal in to the professor and she made comments on it and I wanted to look at those comments and see where I should start and what was most important and what my priorities were. (a064)

Here is an example of **identifying something specific** to get started by **scanning meta-information**:

I: The first thing you did you went to the computerized catalog and you took *out a sheet to look at?* Right?

U: I had *a list of about 5 books* that I was going to start with. I was checking these authors and titles. (a068)

Here is an example of **identifying something common to search by scanning specific information**:

I: I saw you *flipped through several pages* of your notebook, what did you intend to do?

U: I was looking for some more information like that out of my notebook to search. (1049)

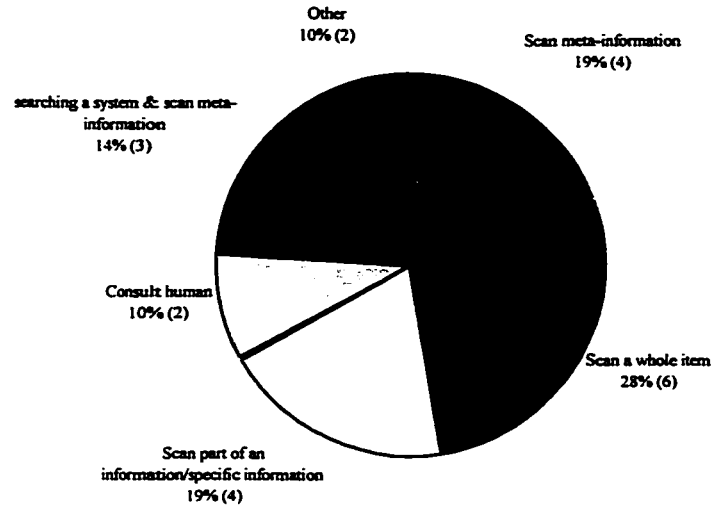


Figure 2. Information Seeking Strategies Applied to "Identifying"

- 2) **Learning** covers learning about system function, system structure, database content, and domain knowledge. “*Consulting a human*” (39%) is the most frequently used strategy in this category, and it includes *consulting experts and peers*. Here “*consulting peers*” refers to consulting classmates, friends, etc. In addition, *scanning meta-information* (32%) and *trial and error* (19%) are the important information seeking strategies to learn about system function, system structure, database content, and domain knowledge. Figure 3 presents the frequency and percentage of information seeking strategies applied to “learning.”

Here is an example of **learning structure in general by consulting an expert**:

I: You *talk with* the *librarian*, what did you intend to do?

U: I'm not familiar with the library or where they keep everything. I wanted to know about that. (f033)

Here is an example of **learning system function/structure in general by trial and error meta-information**:

U: And obviously this is the system you want to learn to use considering the amount of time it is used but it was difficult for me to adjust at first to find books. It drove me crazy trying to find something here because I would *wander through floor after floor after floor* trying to figure out where everything was until I managed to figured out how to use the wall charts and everything to find books. (lsm0069)

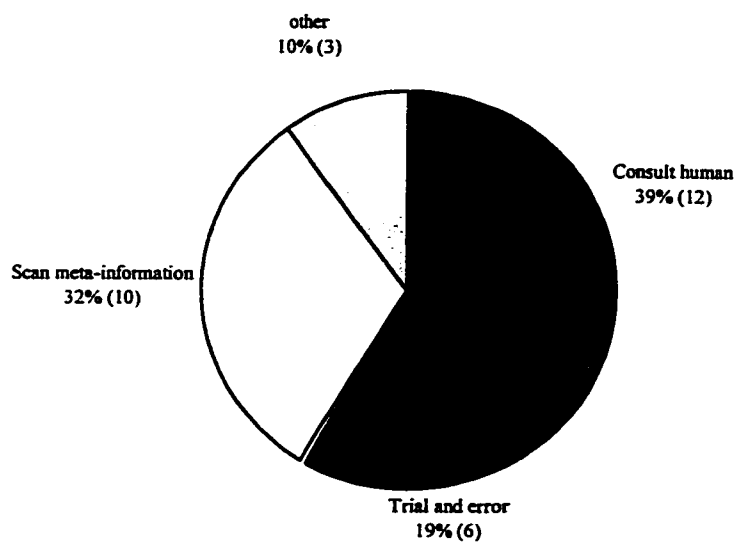


Figure 3. Information Seeking Strategies Applied to "Learning"

3) **Finding** includes finding a known item, finding specific information, finding items with common characteristics and finding items without pre-defined criteria.

Finding a known item(s) refers to finding an item(s) that a user has bibliographical information. *Searching a system & [scanning meta-information] & [select]* (48%) and *scanning an area/location & [selecting specific]* (27%) were the most frequently used search strategies for this intention. "[]" represents an option. In addition, users also *consulted expert* (16%) to find a known item. According to the data, users did not always have the complete information of a known item, therefore, they had to try different versions of a title or an author to search. Figure 4 presents the frequency and percentage of information seeking strategies applied to "finding a known item."

Here is an example of **finding a specific item by searching a system & scanning meta-information** :

I: You went to *IRIS* and *searched*, what did you intend to do?

U: I knew the complete title so I simply *typed it in* and *move forward and backward* of the *list* to look for the book. (1010)

Here is an example of **finding a specific item by scanning an area/location and selecting the specific item**:

I: You *browsed* the *TD section* and *selected a red book*, what did you intend to do?

U: I tried to find that book I could not find in OPAC. (1049)

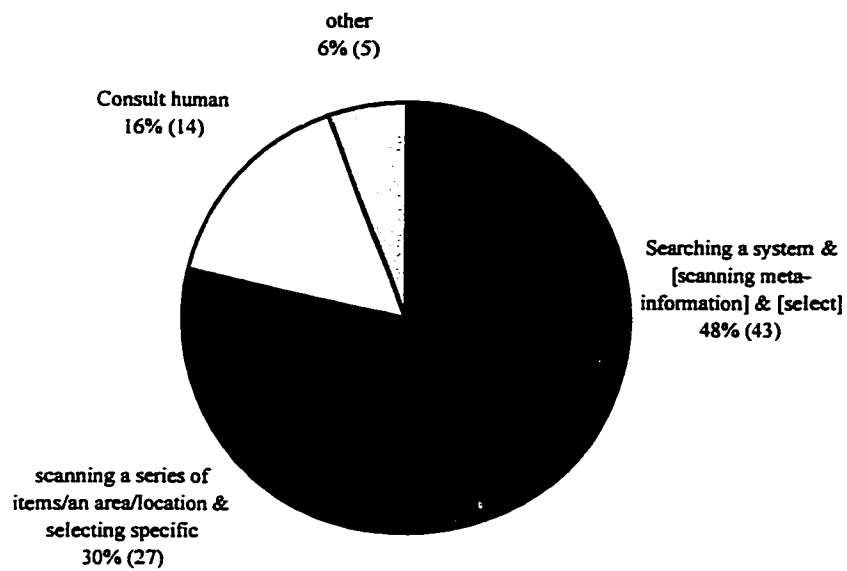


Figure 4. Information Seeking Strategies Applied to "Finding a Known Item"

Finding items with common characteristics refers to finding items with something in common. *Scanning a series of items/an area/location* (50%), *searching a system & scanning meta-information* (38%) and *tracking meta-information* (7%) were the three types of most popularly employed information seeking strategies for this type of interactive intention. In order to find items with common characteristics, users might scan an area of shelf to check items with the same call number, try subject search and scan the results or trace the citation of a relevant item to find documents more like this. Figure 5 presents frequency and percentage of information seeking strategies applied to “finding items with common characteristics.”

Here is an example of **finding items with common subject by scanning an area/location**:

U: I didn't find the book I was looking for in the room.

I: Okay, and you also *browsed spines*?

U: Yeah, because I didn't find the book I was looking for so I was just looking for other books because it was the same material. (Ism004)

Here is an example of **finding items with common subject by tracking meta-information**:

I: What are you going to do next?

U: I will go for a specific, see that's a handbook, it is a compilation of data that came out in other journals so I will look for the main sources by checking the citations of the handbook. (109)

Here is an example of **finding items with common author** by searching a system and scanning meta-information:

I: Okay, this is the author from your reference. Okay, Here comes the next screen, what did you intend when you move forward and backward to look at the list?

U: To look for Brownwell which is not there, so I was trying to know if I could find him in the list... (76-82, 1049)

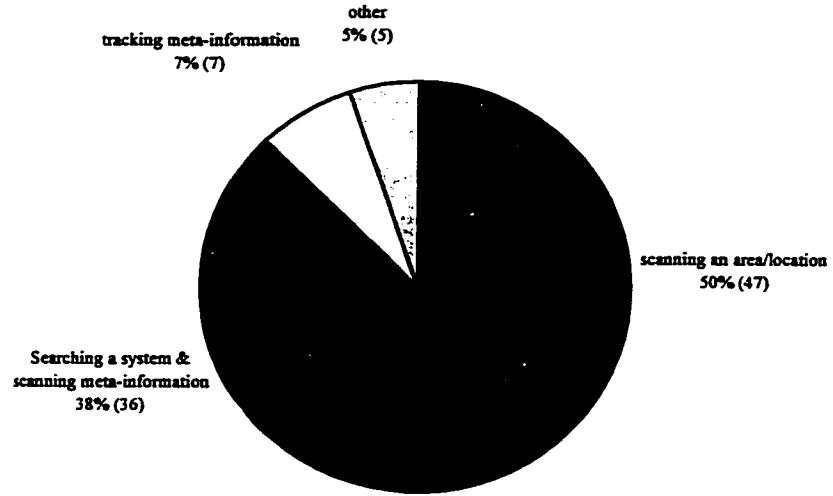


Figure 5. Informaton Seeking Strategies Applied to "Finding Items with Common characteristics"

Finding specific information refers to finding specific information embedded in an item that a user needs to know. *Scanning a whole item* (38%), *scanning part of an item/specific information* (27%) and *Searching meta-information & [tracking meta-information]* (23%) were the most frequently used information seeking strategies. Sometimes, searching meta-information occurred without tracking meta-information when users could not find what they needed from the meta-information. Users also employed *consulting human* (8%) to find specific items. Figure 6 presents frequency and percentage of information seeking strategies applied to “finding specific information.”

Here is an example of **finding specific information by searching meta-information and tracking meta-information:**

I: It looked like you page through the back of that bound book, and turn to middle of the book, what was the intention there?

U: Well, to find where the car was being reported and turn to page 660 which had to do with that car model. (w054)

Here is an example of **finding specific information by scanning a whole item:**

I: Ok, then you took the two microfilm boxes that you selected over to the microfilm reader and you put one in, um, I think it was the March 1989 first, and you advanced until you got to the quotes that you were looking for and you wrote down some information. What was your intent of that activity?

U: Um, I was looking for stock quotes for a particular company on a given day. (f024)

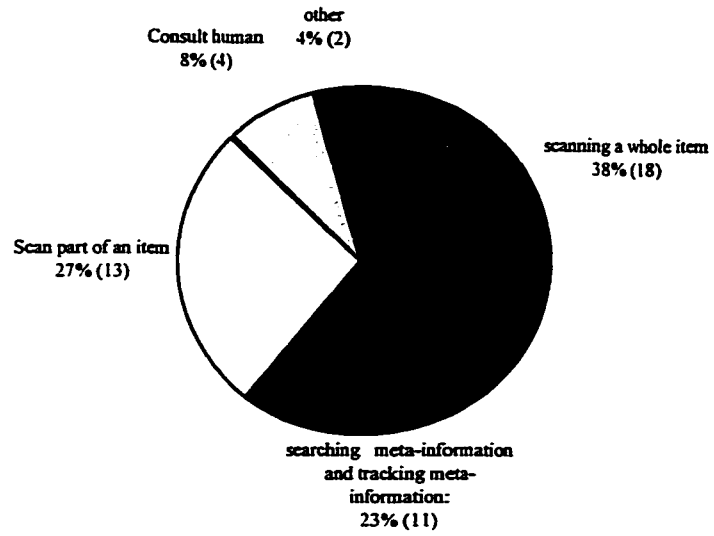


Figure 6. Information Seeking Strategies Applied to "Finding Specific Information"

Finding items without pre-defined criteria refers to exploring to find something that might be interesting or useful while users do not have a very clear idea what specifically they are looking for. *Scanning an area/location* (89.4%) was the most frequently applied information seeking strategy for this intention. When users did not know what specific to search, they normally scanned an area, a location or some meta-information to find something interesting. Figure 7 presents frequency and percentage of information seeking strategies applied to “finding items without pre-defined criteria.”

Here is an example of **finding items in general by scanning an area/location**:

I: After I talked to you by the door, you went right over the new nonfiction area, that’s where I found you. I saw you *browsed* that *area*, selected a book, you looked at the jacket at the inside of the book and then you kept it. What were your intentions at that point?

U: It held my interest, that’s all, ah. (w032)

I: Were you specially looking for a book about art?

U: No, No, when I come in here I never really know what I’m going to read.

I: Okay, so you don’t have anything in mind?

U: No, I just thought, to find something that would hold my interest. (w0032)

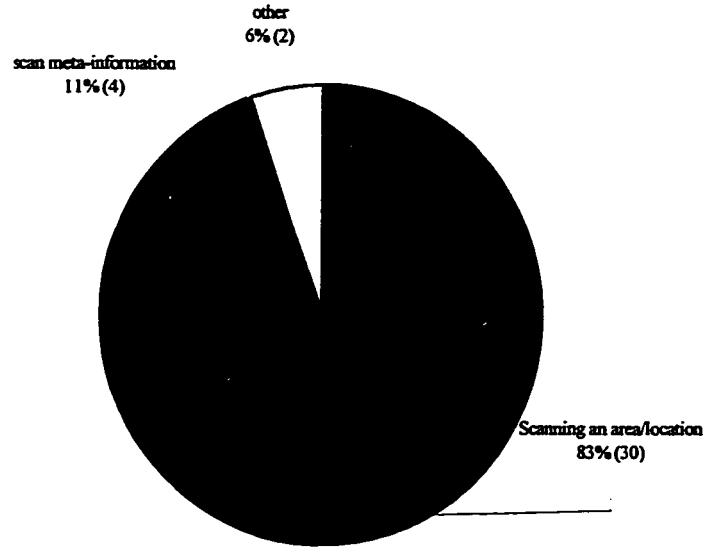


Figure 7. Informaion Seeking Strategies Applied to "Finding items without Pre-defined Criteria"

4) **Locating** refers to finding out where an item(s) is located. As locating and finding is highly correlated to each other, information seeking strategies that are used for "finding" also apply to "locating." The results showed that *searching a system & scanning meta-information & [select]* (68%) was the most popularly used information seeking strategy for this type of interactive intention. Users also applied *consulting a human* (13%) and *scanning an area/location* (11%) to locate an item(s). Figure 8 presents frequency and percentage of information seeking strategies applied to "locating."

Here is an example of **locating a specific item by searching a system and scanning meta-information and selecting a whole item**:

I: I saw you entered a particular subject, what was your intent at this point?

U: Well, that was I put in the subject for which I was looking.

I: You went through the list and entered a number, what was your intention?

U: Well, I, now I wanted to find out whether the book was in the library at this point.

I: And after you entered the particular number, you got some more information on that one particular book, when you saw this screen, what was your intention?

U: Ah, just to continue on to find the location of the book. (w046)

Here is an example of **locating a specific item by consulting a human**:

I: OK, after you spent a few minutes looking through the shelves then you went over to see Kathy at the reference desk and you consulted with her. What was the intent with that activity?

U: Just to ask her to point me in the right direction to find the magazine. (f035)

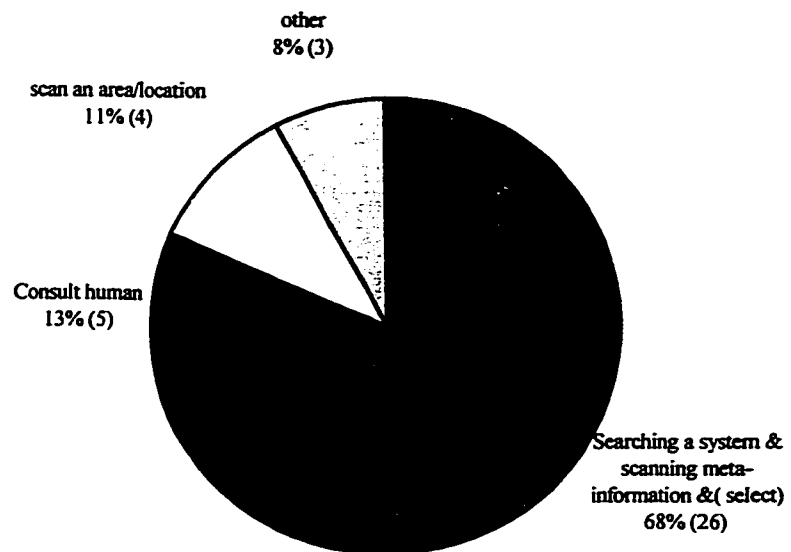


Figure 8. Information Seeking Strategies Applied to "Locating"

5) **Accessing** refers to accessing an item, an area based upon the location of an item(s).

Tracking meta-information (80%) was the first choice to access a specific item, items with common characteristics, or an area/location. Here *tracking meta-information* refers to following call numbers or floor map, etc. Figure 9 presents frequency and percentage of information seeking strategies applied to “accessing.”

Here are two examples of **accessing items with common characteristics by tracking meta-information and scanning an area/location:**

I: Right, then you were looking at the floor map, right? What did you intend at that time?

U: I intended to go straight to where the book was located instead of making another mistake? (a143)

I: Then the next thing that you did you went to the government document stacks and I saw you browse the first stack you kind of just stopped there and pulled out one volume, what did you intend?

U: Okay, in addition to the electronic searching and all the other searching that I did came loaded with several shelf catalog numbers so I was, at that point, just going through the shelves to pick out the things which I knew where they were.

(1072)

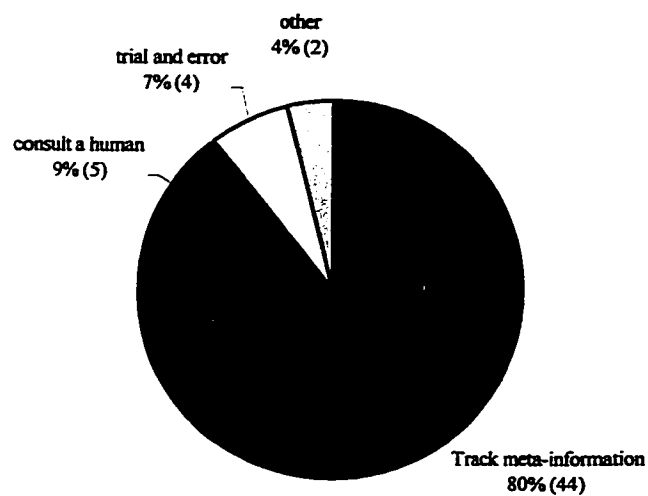


Figure 9. Information Seeking Strategies Applied to "Accessing"

6) Evaluating consists of five types of evaluation: usefulness of an item(s), correctness of an item(s), specificity of an item(s), duplication of an item(s), and fitness of an item. The results showed that major information seeking strategies employed in “evaluating” were *scanning meta-information* (47%), *scanning a whole item* (30%), *comparing meta-information/specific information* (11%), *searching meta-information & tracking meta-information* (7%) and *scanning specific & selecting specific* (3%). *Comparing meta-information* and *specific information* were the essential information seeking strategies for evaluating correctness and specificity of an item/information. *Scanning meta-information* and *scanning whole item* were two approaches for the evaluation of usefulness and duplication of an item. *Searching meta-information & Tracking meta-information* was the major information seeking strategy applied to the evaluation of the specificity of an item(s). *Selecting specific* was used in the evaluation of fitness of an item. Figure 10 presents frequency and percentage of information seeking strategies applied to “evaluating.”

Here is an example of **evaluating a series of items** by ***scanning meta-information***:

I: The clinical trials. Here comes the citation list. What did you intend here?

U: Well, I was reading the titles to see what fit with my intentions (be)cause I was looking for basic information really. (1077)

Here is an example of **evaluating a specific item** by ***comparing meta-information***:

I: When you saw this and you typed in “FUL”, what did you intend?

U: I wanted to know if the publishing company was the same. We have New York but McGraw Hill is not from New York, it is from Washington. (1049)

Here is an example of **evaluating specific information by comparing specific information**:

I: You talked on the phone and I noticed that you kind of flipping through a book had brought in with you and you were also writing a few things down. What was the intent with that activity?

U: I just asked them to give me the number, and I compared the number with the issue to see whether the number is comparable. (f026)

Here is an example of **evaluating specific item by searching meta-information and tracking meta-information**:

I: You look at the index and then you turn to middle of the book and look at the text? What was your intention?

U: I tried to see whether it has the information I need. (l049)

Here is an example of **evaluating specific item by scanning a whole item**:

I: I saw you browse the shelves, select a book, flip through it, replace it. What was your intention at that point?

U: I wanted to make sure it is book that was not the book I had taken out before. I realized it was same after I seeing book. (w046)

Here is an example of **evaluating items with common characteristics by scanning a specific part of each item and selecting a specific item**:

I: You pulled out green books, flipped through them and kept them. Then you look at front pages of each book and pick up one book, what did you intend?

U: They were four of the exact same book, I was checking to get the newest printing of it, in case there were any additional authors' prefaces that they added

on, say in second or third edition of the book. I wanted to get all of the additional authors' notes too. So I ended up *going through* all the *prefaces* of all the editions, I found one new edition, but I ended up taking up the original edition of the book. (a068)

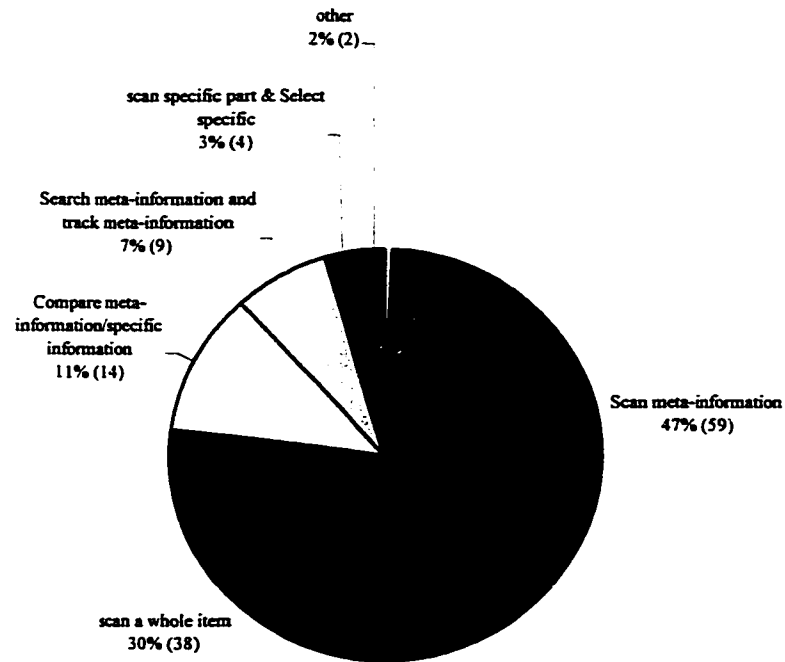


Figure 10. Informaiton Seeking Strategies applied to "Evaluating"

- 7) **Keeping record** refers to recording bibliographic information of a specific item, items with common characteristics or an area/location. The best way to accomplish this type of intention was “*acquiring meta-information*” (89%). Normally users just wrote down title, author and call number of an item to keep a record for further accessing. Figure 11 presents frequency and percentage of information seeking strategies applied to “keeping record.”

Here is an example of **keeping record of a specific item by *acquiring meta-information***:

I: I saw you daring around at the beginning, and then you wrote down something on a piece of paper. What’s your intention here?

U: I was trying to find something to write down the author name and title. I wanted to get the call number also because that way I can go straight to the stack, so when I go over to Kilmer I don’t have to go punching up their computer and running around the library. (lsm10)

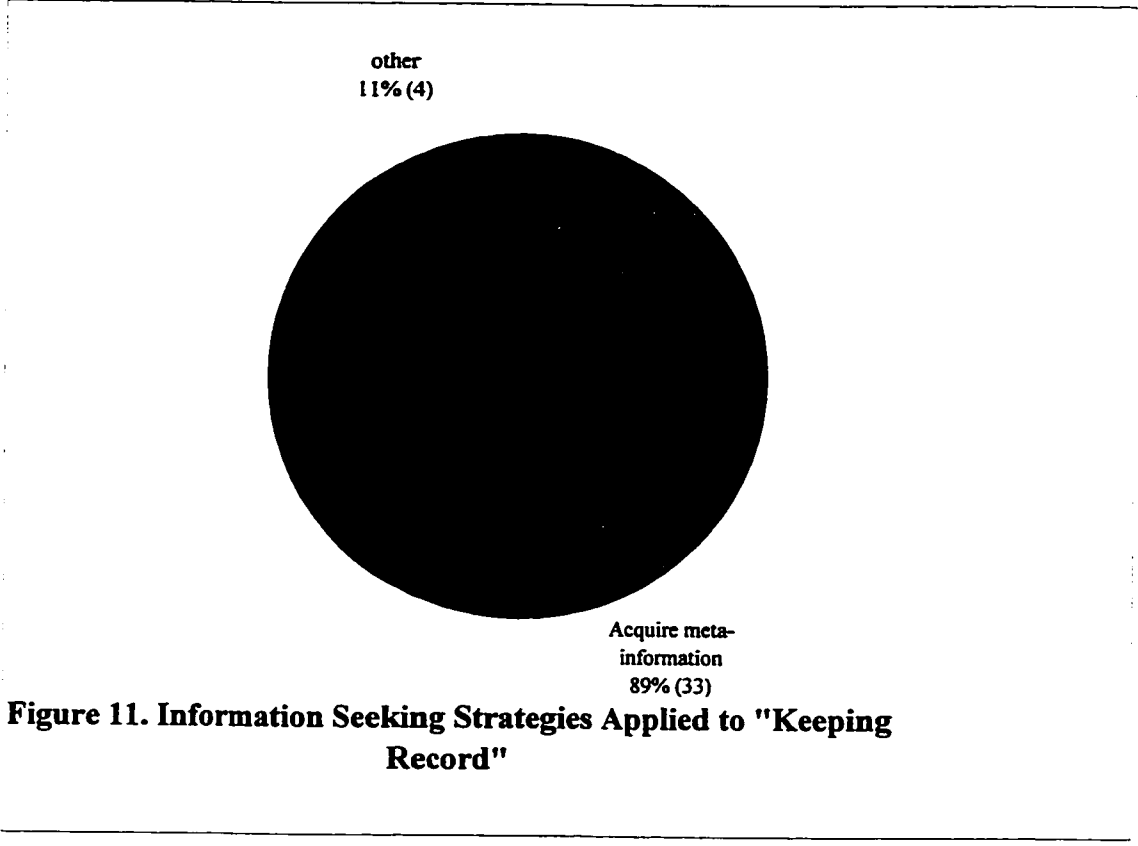


Figure 11. Information Seeking Strategies Applied to "Keeping Record"

8) **Obtaining** refers to obtaining part of an item, an item or a set of items. *Acquiring part of an item/specific information* (38%), *acquiring whole item(s)* (26%) and *acquiring a series of items* (26%) are the major information seeking strategies applied to obtain part of an item, an item or a set of items. Acquiring here refers to write down, photocopy, check out, etc. Figure 12 presents frequency and percentage of information seeking strategies applied to “obtaining.”

Here is an example of **obtaining specific part of an item by acquiring part of an item:**

I: You went to photocopy machine, what did you intend to do?

U: I copied two pages of statistics on NBA players 1988 season. So rather than copying that down I just *photocopied two pages*. (w78)

Here is an example of “**obtaining a specific item by acquiring a whole item:**”

I: I saw you went to circulation desk, what was your intent with that activity?

U: I take the book out of the library. (f19)

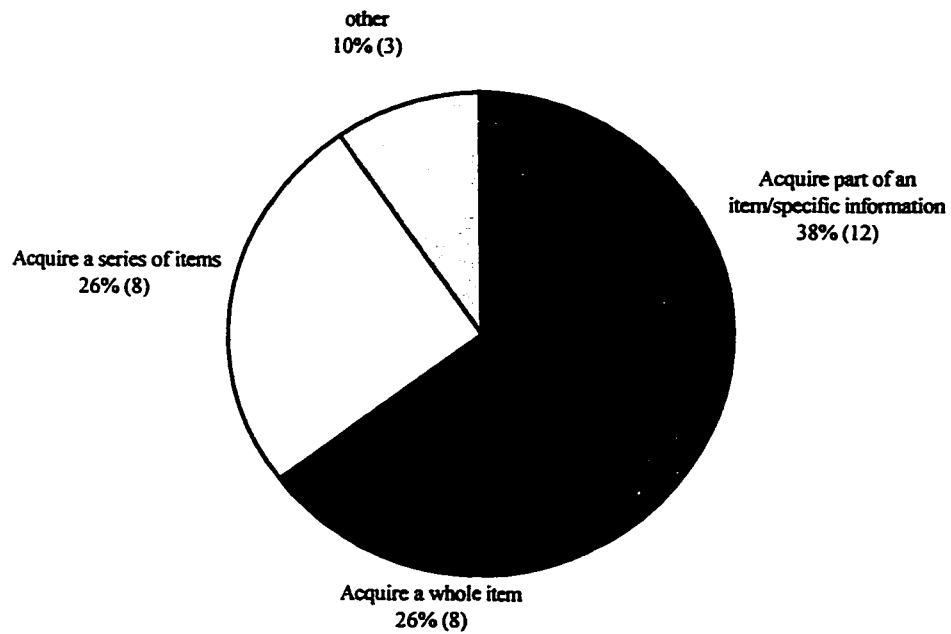


Figure 12. Information Seeking Strategies Applied To "Obtaining"

5.6 Shifts of Current Search Goals, Interactive Intentions and Information Seeking Strategies

According to the data, in the information seeking process, users' long term goals normally did not change. Rarely their leading search goals that led them to search might change. However, the results showed that users changed quite often their original current search goals, interactive intentions and information seeking strategies within an information seeking episode. Three levels of shifts emerged from the data: 1) current search goal shifts, 2) interactive intention shifts, and 3) information seeking strategy shifts.

5.6.1 Overview of levels of shifts

In order to understand the nature of these shifts, we have to first review the relationships among long term goals, leading search goals, current search goals, plans, interactive intentions and information seeking strategies.

According to the model of information seeking behavior, levels of user goals are interrelated. Current search goals are what users attempt to obtain in order to achieve their leading search goals. Therefore, current search goals are mainly determined by leading search goals, sometimes, current search goals are also affected by long-term goals. Plans are sequences of a set of interactive intentions and their associated information seeking strategies that users apply to achieve their current search goals. Plans are subject to modifications and inherently adaptive. Interactive intentions are the sub-goals users have to accomplish in order to fulfill their current search goals. Users have to move from one interactive intention to the other to not only follow their plans but

also adapt to the situation to achieve their current search goals. At the same time, the changes of interactive intentions might also have impacts on shifts of current search goals. In the information seeking process, users might also shift plans to complete their current search goals. Information seeking strategies are employed to achieve interactive intentions, and users might change information seeking strategies in order to fulfill an interactive intention. Factors that affect the changes of these shifts are discussed in detail in Section 5.7.

5.6.2 Four types of shifts

All these current search goals and interactive intentions are interrelated, because some of the shifts are just follow-ups, while the others are the results of hierarchical structure of user goals and interactions between users and systems. I further classified those shifts into four types based upon whether a problem occurred in the current search goal/current intention and whether a user continued, discontinued or just finished his/her current goal/intention after his/her new goal/intention was accomplished. Table 16 presents four types of shifts:

Table 16 Types of Interactive Intention Shifts

Current search goal/ Interactive Intention	*Finishing/Discontinuing	Continuing
No Problem	type I (planned shift)	type II (opportunity shift)
Problem	type IV (assisted shift)	type III (alternative shift)

* In a type I shift, users finish their current goals/intentions, while in type IV shift, they just discontinue their current goals/intentions.

In a type I shift/transition, a current search goal/interactive intention is achieved without any problem, so the user just starts a new goal/intention, and this new goal/intention is normally a follow-up. Strictly speaking, a follow-up shift is just a planned transition. Therefore, type I shifts can be called **“planned shifts.”**

In a type II shift, in the process of accomplishing his or her current search goal/current interactive intention, a user shifts to another goal/intention temporarily, and then comes back to the original goal/intention. As this generally happens when a user sees something by serendipity, type II shifts can be called **“opportunistic shifts.”**

In a type III shift, a user can not accomplish his or her current search goal/ current interactive intention because of a problem, but the user does not abandon this goal/intention. In this type of shift, the new goal/intention is introduced quite often to assist in solving problems. Type III shifts can be called **“assisted shifts.”**

In a type IV shift, a user starts a new current search goal/ interactive intention after abandoning the previous one because of a problem. An alternative goal/intention is normally generated to make up for the failure of the previous one. Type IV shifts can be called **“alternative shifts.”**

Among these four types of shifts, type III and type IV occur when users encounter problems in the process of fulfilling the current search goals/intentions. These two types of shifts need to be analyzed further in detail to see whether there are patterns between types of problems and these shifts.

5.6.3 Current search goal shifts

Shifts of current search goals were identified from the data. The results demonstrated that four types of shifts applied to current search goal shifts.

Planned shifts occur quite often when a user has two current search goals, especially when these two goals are interrelated under one leading search goal. When the user finishes one current search goal, he/she moves to the next current search goal. For example, one user was interested in finding some books for recreational reading. His two intentions were to look for a book whose title he knew and to look for books written by an author. Looking for books written by a known author is the planned shift of finding the book that he knew the title (a143).

Opportunity shifts occur when a user sees something by serendipity, so he or she temporarily changes to a new current search goal. The user will go back to his/her original current search goal after he/she finishes the new search of current search goals. These types of shifts happen quite often in relation to “keeping up to date.” “Keeping up to date” is not always the users’ original current search goals when they come to the library, instead, it often occurs when users accidentally see something that they are interested in. For example, on his way to look for geotechnical information, a user passed by his favorite isle. Therefore, he shifted from original current search goal – “finding geotechnical information” to a new current search goal “keeping up to date his knowledge on ground water,” and then changed back to his original current search goal after he finished “keeping up to date his knowledge.” (l049)

Assisted shifts occur when a user has problems to achieve his/her current search goal, so he/she switches to another current search to assist himself/herself to fulfill his/her previous current search goal. For example, one user tried to write a paper for class on female friendship in the 19th century. First she tried to find primary sources of that topic, but the topic was too complicated, so she decided to find some background information first to help her to find primary sources. After she found enough background information, she continued to look for a primary source of female friendship in 19th century (a064).

Alternative shifts normally emerge when a user can not accomplish his/her original current search goal, therefore he/she has to introduce a new alternative current search goal to achieve his/her leading search goal. For example, in order to write a report on “women and jobs,” one user came to the library and tried to “find a book” of which she knew the title and author. However she could not find this book either in the OPAC system or in the card catalog, so she decided to “find some other books” about “women and jobs,” and finally she found some for her report (a145).

5.6.4 Interactive intention shifts

Four types of shifts also apply to changes of interactive intentions. The differences between shifts of interactive intentions and current search goals are: 1) Shifts of interactive intentions are identified from one type of interactive intention to the other while shifts of current search goals are identified from one current search goal individually to the other; 2) If a user introduces a shift to achieve the same current search

goal, this shift is an interactive intention shift; if a user introduces a shift to achieve a different current search goal, then this shift is a current search goal shift. In figure 13 to figure 16, each arrow represents a shift, and it starts from the original interactive intention to the current interactive intention. Oval with an arrow represents shifts happening within that type of interactive intention.

1) Four types of shifts

Planned shifts occur while an interactive intention is achieved without any problem, so the user just starts a new interactive intention, and this new intention is normally a planned shift. For example, one user found several books on the nature of the chemical he was working on from the OPAC system, then he located them on shelves, after that he started to evaluate them to see whether they were relevant to his research. In this case, **“locating” is a planned shift from “finding items with common characteristics,” and “evaluating” is a planned shift from “locating” (1002).**

Planned shifts happen among different types of interactive intentions except "learning," because "learning" normally serves as an assisted interactive intention. Table 17 presents frequency and percentage of planned shifts among eight types of interactive intentions. Figure 13 illustrates examples of planned shifts among eight types of interactive intentions.

“Finding,” “locating,” “accessing,” “evaluating,” “keeping records” and “obtaining” follow the logical sequences of search process, for example, “finding” might be after “identifying” (2.5%), “locating” was after “finding” (3.4%), “keeping record” followed “locating (2.7%), “accessing” came next to “keeping record” (2.3%),

“evaluating” was after “accessing” (1.8%), and “obtaining” followed “evaluating” (2.5%). “Evaluating” followed “finding” (17%) when users evaluated citations of the OPAC search, or when users directly found items on the shelf, so they skip the process of “locating” and “accessing.” Sometimes, users move to find another item after he/she finished finding this one (12%). In some cases, “finding” and “locating” occurred together, therefore, “accessing” went after “finding” (3.4%). Also when users identified information for a search, they might find some items they used before (pretty sure about the existences or availability of these items), just needed to locate (1.3%) or access (0.9%) them.

Planned shifts not only occur among different types of interactive intentions, but also appear within several types of interactive intentions. In “finding” and “locating,” users normally first find or locate common or an area/location before they find/locate a specific item. Therefore, finding or locating a specific item is the planned shift of finding/locating common or an area/location. In “evaluating,” “evaluating fitness of an item” (evaluating items in common) can only happen after “evaluating each specific item.”

Table 17 Frequency and Percentage of Planned Shifts among Eight Types of Interactive Intentions:

To From	Identify	Learn	Find	Access	Locate	Evaluate	Keep record	Obtain
Identify			2.5% (11)	0.9% (4)	1.3% (6)			
Learn								
Find	0.4% (2)		12% (53)	3.4% (15)	3.4% (15)	17% (75)	3.4% (15)	3.6% (16)
Access			2.9% (13)			1.8% (8)		0.9% (4)
Locate			0.9% (4)	1.1% (5)	1.3% (6)	1.1% (5)	2.7% (12)	
Evaluate	0.4% (2)		8.8% (39)	3.6% (16)	0.9% (4)	8.4% (37)	2.3% (10)	2.5% (11)
Keep record			4.1% (18)	2.3% (10)	1.3% (6)			
Obtain			4.3% (19)					

Figure 13 illustrates examples of planned shifts among eight types of interactive intentions:

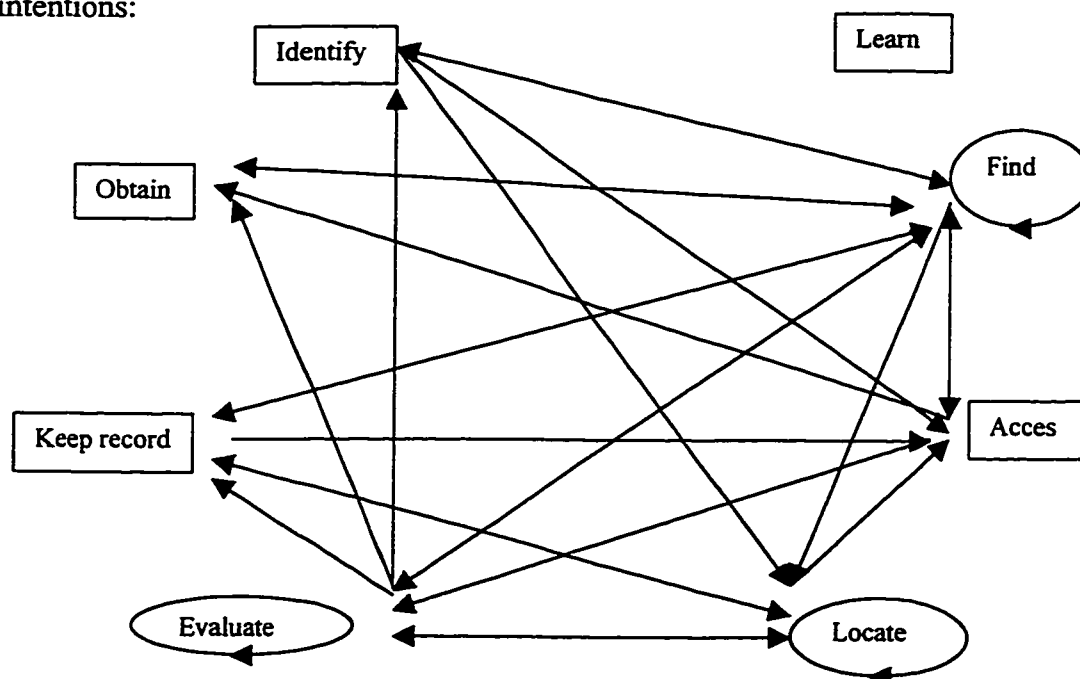


Figure 13. Examples of Planned Shifts of Interactive Intentions

Opportunistic shifts occur while users shift to other interactive intentions temporarily by serendipity in the process of accomplishing their current interactive intentions, then users come back to their original interactive intentions. For example, when one user was “evaluating the usefulness of an article,” he accidentally saw the editorial board of the journal, and one name caught his eye, so he went through the rest of the names, just interested to see who was on the editorial board. **After he “found specific information,” he continued to “evaluate” the article (1009).**

Opportunistic shifts do not happen as often as planned shifts do. "Seeing something by serendipity" is the cause of this type of shift. According to the results, in the process of "accessing," "evaluating" and "finding," users saw something by serendipity, and that "something" led users to "find." Table 18 presents frequency and percentage of opportunistic shifts among eight types of interactive intentions. Figure 14 illustrates examples of opportunistic shifts of interactive intentions.

“Accessing” to “finding,” “evaluating” to “finding” and “finding” to “finding” accounted for 40.9%, 27.2% and 22.7% respectively of all the opportunity shifts. In addition, “accessing” to “learning” held about 9% of the opportunity shifts.

Table 18 Frequency and Percentage of Opportunistic Shifts among Eight Types of Interactive Intentions:

To From	Identify	Learn	Find	Access	Locate	Evaluate	Keep record	Obtain
Identify								
Learn								
Find			22.7% (5)					
Access		9% (2)	40.9% (9)					
Locate								
Evaluate			27.2% (6)					
Keep record								
Obtain								

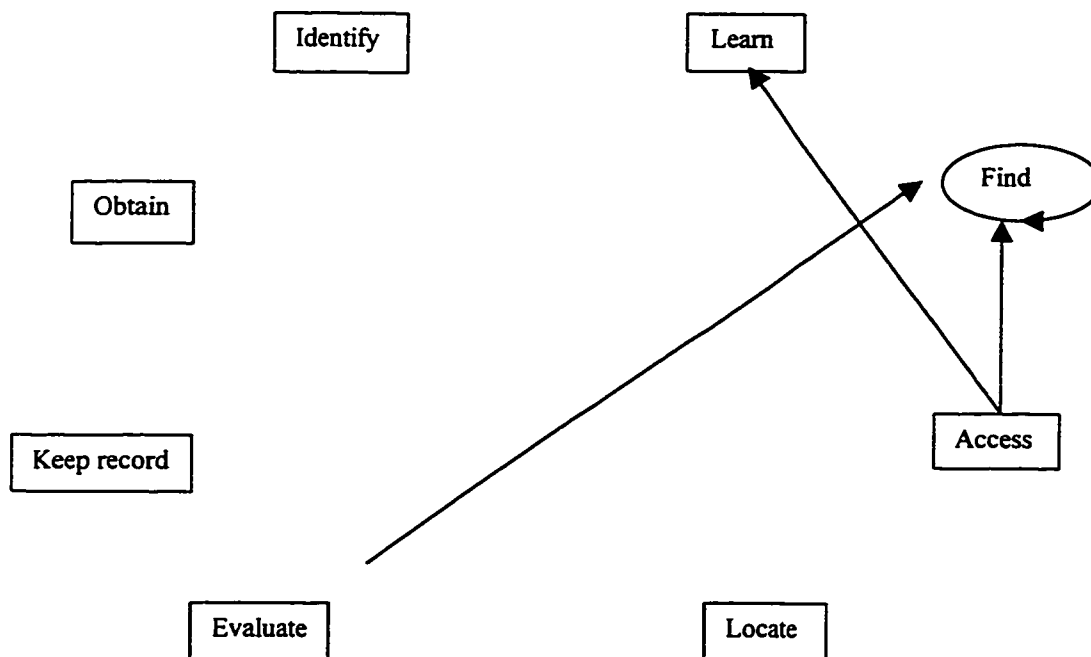


Figure 14. Examples of Opportunity Shifts

Assisted shifts occur while users can not accomplish their current interactive intentions because of problems, but they do not abandon their current interactive intentions. Instead, new intentions are introduced quite often to assist them solving problems. For example, one user tried to “locate one book,” and the system showed it was in “DANA,” so he introduced a new intention “learning.” He consulted tools first, but did not figure out what “DANA” meant. Finally, he consulted the librarian, and found out that the book was in DANA library in Newark. **After “learning,” he went back to “locate” the book (1008).**

Compared to other types of shifts, assisted shifts occur quite focused. As assisted shifts happen because users need help, “learning” is the leading interactive intention for assisted shifts. Table 19 presents frequency and percentage of assisted shifts among eight types of interactive intentions. Figure 15 illustrates examples of assisted shifts among eight types of interactive intentions.

“Learning system function, structure, domain knowledge and database content” might be required in the process of achieving “finding” (28.2%); “learning system structure and system function” were needed in “accessing” (12.8%) and “locating” (15.4%); “learning system function” might be used to “obtain an item(s)” (10.2%). In addition to “learning,” “identifying” could also serve as assistant for “finding” (12.8%).

Table 19 Frequency and Percentage of Assisted Shifts among Eight Types of Interactive Intentions:

To From	Identify	Learn	Find	Access	Locate	Evaluate	Keep record	Obtain
Identify								
Learn								
Find	12.8% (5)	28.2% (11)	20% (8)					
Access		12.8% (5)						
Locate		15.4% (6)						
Evaluate								
Keep record								
Obtain		10.2% (4)						

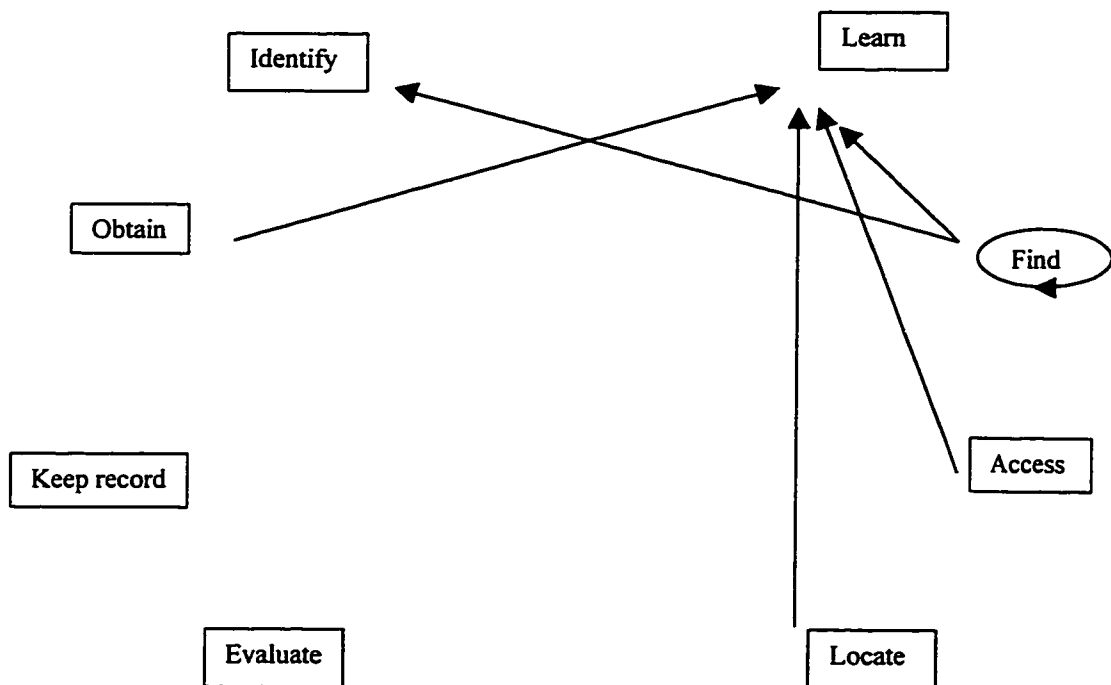


Figure 15. Examples of Assisted Shifts

Alternative shifts occur while users start new interactive intentions after abandoning the previous ones because of problems. Alternative interactive intentions are normally generated to make up for the failure of the previous ones. For example, a user was trying to find a specific book called "Enzyme Handbook," but he could not find it. As he was really interested in a particular protein enzyme, and he wanted to find out about the size of the protein, so he gave up **"finding a specific item,"** instead, he tried to **"find items with same topic -- a particular protein enzyme"** (1009).

Table 20 presents frequency and percentage of alternative shifts among eight types of interactive intentions. Figure 16 illustrates examples of alternative shifts among eight types of interactive intentions.

The typical example of alternative shifts occurred within interactive intention was "finding" (79.6%). It seems from specific to common or general is the pattern of alternative shifts. "Finding items with common characteristics," "finding items in one area/location" and "finding items in general" were the alternative choices for "finding specific" which includes "finding a known item" and "finding specific information." Alternative shifts also occurred from "accessing" to "finding" (20.3%), when users could not access an item(s) that they need, they just tried to find another item or find items with common characteristics.

Table 20 Frequency and Percentage of Alternative Shifts among Eight Types of

Interactive Intentions:

To From	Identify	Learn	Find	Access	Locate	Evaluate	Keep record	Obtain
Identify								
Learn								
Find			79.6% (47)					
Access			20.3% (12)					
Locate								
Evaluate								
Keep record								
Obtain								

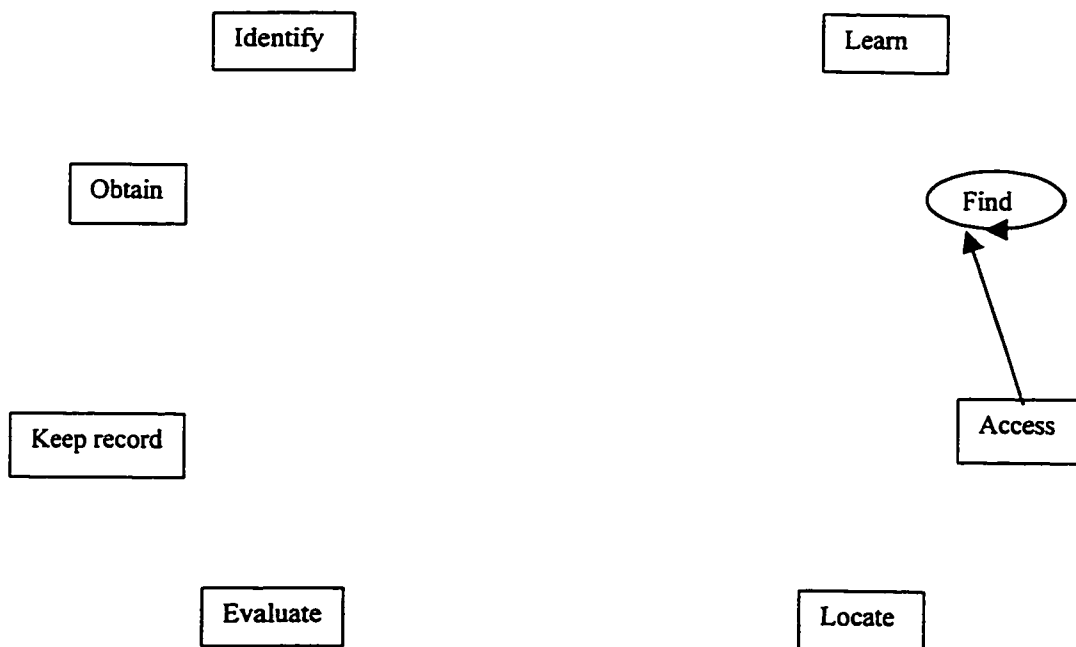


Figure 16 Examples of Alternative Shifts

5.6.5 Information Seeking Strategy Shifts

In addition to intention shifts, users have to change information seeking strategies to fulfill their current interactive intentions. I further classified those shifts into three types based upon whether the outcome of the original information seeking strategy was successful, partially successful and unsuccessful and whether a user continued or discontinued or just finished his original information seeking strategy (Table 21). Here the outcome of the original information seeking strategy refers to to what extent the interactive intention is achieved by applying the information seeking strategy, because the objective of using any information seeking strategy is to accomplish a specific interactive intention.

In a type I shift, a user's information seeking strategy works but is not fully successful, but he/she needs to enhance the original information seeking strategy to better fulfill the interactive intention, therefore, type I shifts can be called **“supplemented shifts.”**

In a type II shift, a user's original information seeking strategy does not work, but the user does not abandon this information seeking strategy. Instead, he/she tries to modify it to achieve the interactive intention. Type II shifts can be called **“improved shifts.”**

In a type III shift, a user starts a new information seeking strategy after abandoning the previous one. An alternative information seeking strategy is normally generated to make up for the failure of the previous one. Type III shifts can be called **“alternative shifts.”**

In the data set, information seeking strategy shifts occurred quite often, and they appeared almost in every type of interactive intention, particularly, in “finding” and “evaluating,” such as “finding a known item(s),” “finding items with common characteristics,” “finding specific information,” and “finding items without pre-defined criteria.”

Table 21 Types of Information Seeking Strategy Shifts

Continuing/discontinuing Original ISS	*Finishing/Discontinuing	Continuing
Outcome of Original ISS		
Successful	N/A	N/A
Partially successful	N/A	type I (supplemented shift)
Unsuccessful	type III (alternative shift)	type II (improved shift)

Table 22 Types of Shifts and Associated Dimension Changes

Types of shifts	Supplemented shifts	Improved shifts	Alternative shifts
Changes of Dimensions			
Change of methods	x		
Change of resources	x	x	
Change both methods and resources	x		x

Shifts of information seeking strategies occur at two levels: 1) methods and 2) resources. Therefore, three types of shifts of information seeking strategies can be further discussed in the change of dimensions: 1) change of methods, 2) change of

resources, and 3) change both methods and resources. Table 22 presents types of information seeking strategy shifts and their associated dimension changes.

Supplemented shifts happen when users can only partially achieve their interactive intentions by applying their information seeking strategies, so they like to enhance their information seeking strategies to further accomplish the other aspects of their interactive intentions. In evaluating the “usefulness of an item,” a user *looked at the cover and thought it was a relevant item, but was not sure how in-depth the item covered the subject that she was interested, then she further looked at index and turned to page of that topic*, and confirmed that it is the right item. In this case, the user **changed her information seeking strategy from *scanning meta-information to searching meta-information & tracking meta-information* (1049)**. Here is another example of a supplemented shift: In the process of finding a known item, a user first searched the OPAC system by author, and she got a list of citations, therefore the user **shifted from *searching a system to scanning meta-information to find that item* (1008)**.

Supplemented shifts could change both methods and resources. Table 23 presents frequency and percentage of supplemented shifts among eight types of information seeking strategies. Figure 17 illustrates examples of supplemented shifts of information seeking strategies.

One typical example of method change is from *searching a system to scanning meta-information* (39.4%). Another frequently occurred supplemented shift was from *scanning to selecting* (18.3%). Supplemented shifts could change either methods or resources, such as *searching meta-information to tracking meta-information* (9.4%), from *scanning meta-information to searching meta-information* (5.2%). Some of

supplemented shifts occurred by changing resources of some of the methods, such as from *scanning meta-information* to *scanning the whole item* (12.2%), from *comparing* one type of meta-information to *comparing another type of meta-information* (3.7%).

Table 23 Frequency and Percentage of Supplemented Shifts among Eight Types of Information Seeking Strategies

	Acquire	Compare	Consult	Scan	Search	Select	Track	Trial & error
Acquire								
Compare		3.7% (8)						
Consult								
Scan				12.2% (26)	5.2% (11)	18.3% (39)	0.9% (2)	
Search		3.3% (7)		39.4% (84)			9.4% (20)	
Select								
Track				7.5% (16)				
Trial & error								

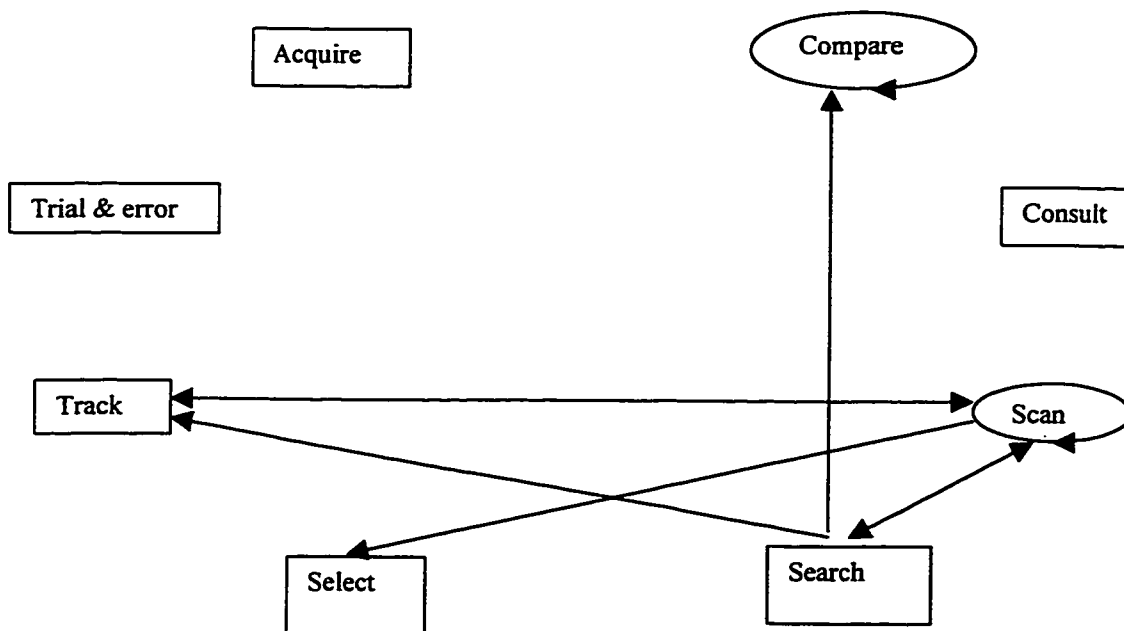


Figure 17 Examples of Supplemented Shifts of Information Seeking Strategies

Improved shifts occur when users can not fulfill their interactive intentions by using the information seeking strategies, so they try to refine their information seeking strategies as improved shifts. A user tried to find a specific book, he decided to search the OPAC system. First, he tried to search an author, but it was unsuccessful, hence he refined his strategy to search title, but it was not successful either. Finally he tried to search the publisher to find that known book. In the process of achieving “finding a known item,” he **improved his information seeking strategy from *searching author* to *searching title* and *searching publisher* (1049)**. Here is another example of improved shift: a user intended to “find a known item,” he first used *specified search* to look for a book of which he knew the title, but he could not find it in the system. Then he tried to improve the information seeking strategy, that is, to apply different versions of the title he thought the system might use, from the original title ‘Do Androids Dreams of electric sheep’ to “Androids,” because he thought “do” is a short verb and that might affect the result. Then he **changed his information seeking strategy from *searching one form of the title* to *another* several times to see whether one of them was used by the system.**

Users only change resources not methods to improve their original information seeking strategies. Table 24 presents frequency and percentage of improved shifts among eight types of information seeking strategies. Figure 18 illustrates examples of improved shifts of information seeking strategies.

From the data, “*searching*” (70.7%) was the most frequently applied information seeking strategy that served as an improved shift to “*searching*.” Furthermore, in improved shifts, “*searching*” mainly referred to “searching a system,” and users changed meta-information, such as from title to author, from one version of title to the other, etc.,

to improve their information seeking strategies to achieve their interactive intentions.

Occasionally, users also changed their resources in *acquiring* (17.1%) or *consulting*

(12.2%) when they could not access their resources.

Table 24 Frequency and Percentage of Improved Shifts among Eight Types of Information Seeking Strategies

	Acquire	Compare	Consult	Scan	Search	Select	Track	Trial & error
Acquire	17.1% (7)							
Compare								
Consult			12.2% (5)					
Scan								
Search					70.7% (29)			
Select								
Track								
Trial & error								

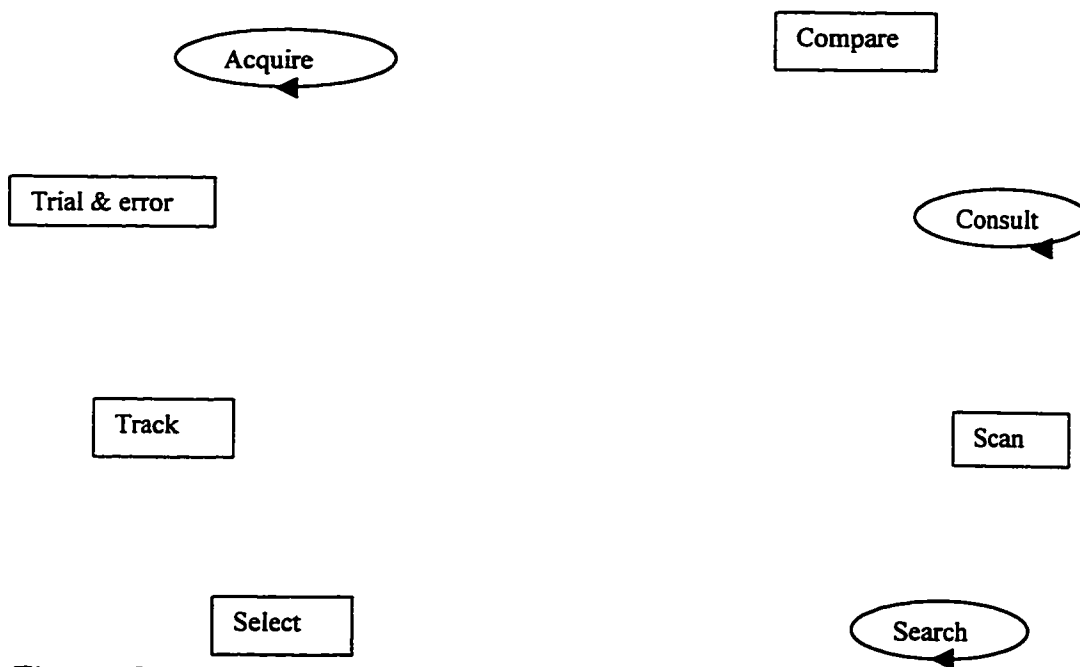


Figure 18 Examples of Improved Shifts of Information Seeking Strategies

Alternative shifts occur when users can not accomplish their interactive intentions by applying the original information seeking strategies, consequently, they have to introduce new information seeking strategies as alternatives. A user originally tried to find and locate a known magazine by *scanning the shelf*, but he could not find it. Therefore he decided to find and locate the known magazine by *consulting a librarian*, but that librarian only provided some direction. After he *consulted* another *librarian*, he finally found and located the magazine. During that process, as his original information seeking strategy did not work, he **shifted his information seeking strategies from *scanning a location to consulting a human as an alternative shift* (f035)**. Here is another example of *alternative shift*: When a user tried to learn how to use infomaster, he first played around the system by trial and error, but still could not figure out how to use the system, so finally he consulted the librarian about the use of the system. The user **shifted from *trial and error of the system to consulting librarians to learn system functions***.

The results showed that users normally changed both methods and resources in their alternative shifts. Table 25 presents frequency and percentage of alternative shifts among eight types of information seeking strategies. Figure 19 illustrates examples of alternative shifts of information seeking strategies.

Consulting a human was the most frequently used alternative information seeking strategy of *scanning an area/location* (27.5%), *searching meta-information* (20%) and *trial and error a system* (7.5%). In addition, *scanning an area/location* (30%) often served as an alternative information seeking strategy for *searching a system* while

sometimes *searching meta-information* (10%) also used as an alternative information seeking strategy for *scanning meta-information*.

Table 25 Frequency and Percentage of Alternative Shifts among Eight Types of Information Seeking Strategies

	Acquire	Compare	Consult	Scan	Search	Select	Track	Trial & error
Acquire								
Compare								
Consult								
Scan			27.5% (11)		10% (4)			
Search			20% (8)	30% (12)				5% (2)
Select								
Track								
Trial & error			7.5% (3)					

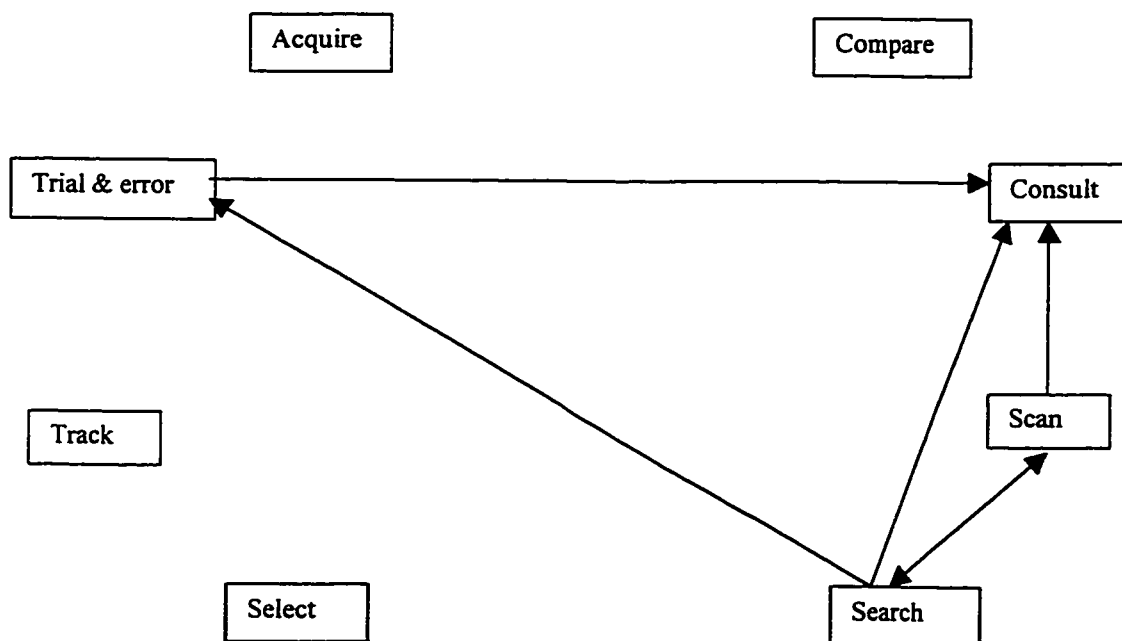


Figure 19 Examples of Alternative Shifts of Information Seeking Strategies

5.7 Factors Affecting the Change of Current Search Goals, Interactive Intentions and Information Seeking Strategies

According to the previous section, there are patterns of shifts of interactive intentions and information seeking strategies. The shifts of current search goals, interactive intentions and information seeking strategies do not occur randomly, moreover, they are led by the factors that affect those changes. As discussed before, both situated and planned aspects influence the selection of interactive intentions and information seeking strategies, therefore, they are responsible for the shifts of current search goals , interactive intentions and strategies. The following section analyzes what these factors are as well as how those elements direct the change of interactive intentions and information seeking strategies.

5.7.1 Factors Affecting Different Levels of Shifts

Eight types of major determinants of different levels of shifts emerged from the data: 1) outcome of previous result, 2) leading search goal, 3) current search goal, 4) system knowledge, 5) domain knowledge, 6) information seeking knowledge, 7) environment, and 8) interaction results.

1) Outcome of previous result

In a current search goal shift and an interactive intention shift, outcome refers to whether there is problem in the process of achieving the current search goal and the interactive intention, In an information seeking strategy shift, outcome refers to what extent the interactive intention is accomplished by the application of the information

seeking strategy. Outcome of previous result is the most important factor leading to different levels of shifts. Three types of outcomes emerged from the data: successful, partially successful, and unsuccessful. As each shift happens under one type of outcome, outcome itself might lead to different types of shifts. In most cases, outcome combined with other factors determined the types of shifts. Opportunistic shifts of current search goals/interactive interactions are the only shifts that have nothing to do with the outcome. In general, **successful outcomes** might lead to the planned shifts of both current search goals and interactive intentions, but they do not lead to the change of information seeking strategies. **Partially successful outcomes** normally lead to supplemented shifts of information seeking strategies. **Unsuccessful outcomes** often cause assisted and alternative shifts of current search goals/interactive intentions, and they also bring improved and alternative shifts of information seeking strategies.

Here is an example of **partially unsuccessful** outcome leads to the **change of information seeking strategies (supplemented shift)**:

“I look at the cover of the book, but I am not sure how in-depth the book covers my topic, so I check the index, and turn to page ...(1009)” In this case, the user changed from **scanning meta-information to searching meta-information & tracking meta-information.**

Here is one example of the **unsuccessful** of the outcome that leads to **shift of interactive intentions (alternative shifts)**:

“I didn’t find anything that seemed appropriate in fiction, so I went to find something to read in new non-fiction area.” In this case, the user shifted her

interactive intention from finding items without predefined criteria in fiction area to finding items without predefined criteria to new non-fiction area (w032)

2) Leading search goal

Leading search goal refers to a task-related-goal that leads a user to search. As current search goals are directed by leading search goals, leading search goals play important roles in influencing alternative and planned shifts of current search goal.

Here is an example of **shifts of current search goal (alternative shift)** led by the **leading search goal**:

“Now I was considering another topic that had to do with, since we are very open ended on the kind of things we are allowed to analyze, I was looking for something in sports, sports statistics, like teams or individuals or something like that (pp 69-73, w078).” In this case, the leading search goal is writing a paper for statistics class, and current search goal is finding statistics of company. As the **leading search goal has some flexibility (writing a paper about statistics)**, so the user **changed his current search goal from finding statistics of companies to finding sports statistics.**

3) Current search goal

Current search goal refers what a user tries to obtain from the search. Sometimes, current search goals, especially when a user has two interrelated current search goals, also has impact on assisted shift of current search goals.

Here is an example of **assisted shift of current search goals** led by **current search goal**:

One user tried to write a paper for class on female friendship in 19th century. First she tried to find primary sources of that topic, but “the topic was too complicated, so I decided to find some background information first (36-7, a064).” In this case, she **changed to find some background information first to assist her to find primary sources.**

4) System knowledge

System knowledge refers to users’ knowledge about the information retrieval system that they are interacting with, such as system functions, system structure, etc. System knowledge, especially knowledge of system structure is the key factor affecting assisted shift and alternative shift of interactive intentions and information seeking strategies. In addition, system knowledge might also lead to improved and alternative shifts of information seeking strategies.

Here is an example of **shift of information seeking strategy (alternative shift)** led by **system knowledge**:

“I had not found the book that I was looking for but I had found the office of some people that had published it, so I copied the beginning of the reference number, catalog number down, so it would get me to the right section of the stacks and I could browse through there (45-49, l072).” In this case, **system knowledge** of the user (structure of the system) helped her to **change from finding a specific items by searching a system to finding a specific item by scanning an area/location.**

Here is an example of **shift of interactive intention (assisted shift) from “learning system structure” to “finding/locating/accessing a known item** because of lack of system knowledge:

The user started with learning system structure “I have not been in this library since it was built, so it was new to me; otherwise I would probably have gone directly to the place I had to go” (13-16, w054). In this case, the user **started with “learning system structure” and then changed to “finding/locating/ accessing a known item.”**

5) Domain knowledge

Domain knowledge refers to knowledge of the subject area that a user tries to search for information/item(s), such as expert in one subject area, key publications of one subject area or specific terminology of one subject area, etc. Domain knowledge normally leads to assisted and alternative shifts of interactive intentions. It might also produce a supplemented shift of information seeking strategies.

Here is an example of **shift of information seeking strategies (supplemented shift) led by domain knowledge:**

In evaluating the usefulness of items, a user **changed his information seeking strategy from scanning the meta-information to scanning a whole item to make sure it is the useful item**, because “the previous one was an author I knew so I felt confident in just grabbing it and taking it, but I am not familiar with this author” (w034).

Here is an example of **shift of interactive intentions (alternative shift) led by domain knowledge:**

The user tried to find a known item “Value Line,” but he could not find it. Therefore he **changed from “finding a known item” to “finding items with common characteristics,”** “just to kind of look through and see if they had anything similar to (Value Line), I am familiar with the way Value Line does things by industry where they will have a page an industry grouped together (w078).”

Here is an example of **interactive intention shift (assisted shift) led by domain knowledge:**

The user **changed from “finding one type of specific information to another type”** to assisted him to find the information in Thomas Register. “ Lightalarm Electronic Corporation who in turn may be able to lead me to the dual batteries (pp25-6).” “I found the Lightalarm and they can led me to the dual battery I think since they utilize that piece of equipment in their emergency lights (w084).”

6) Information seeking knowledge/style

Information seeking knowledge refers to users’ experience and knowledge of how to search for information. It includes users’ past experience of information seeking, their information seeking style, etc. Information seeking strategy is demonstrated to be an important factor in determining planned shifts of interactive intentions and supplemented & improved shift of information seeking strategy.

Here is an example of **shift of information seeking strategies (improved shift) led by information seeking knowledge/style:**

In the previous example, a user tried to find a specific book, he decided to search the OPAC system. First, he tried to search an author, but it was unsuccessful, hence he refined his strategy to search title, but it was not successful either. Finally, he thought "maybe I did not input the right form of the author and title, I can also try to search the publisher to find this book. I always try different search options to search for a book (1049)." In the process of achieving "finding a known item," he **changed his information seeking strategy from *searching author* to *searching title* and *searching publisher*.**

Here is an example of **shift of interactive intentions (planned shift) led by information seeking knowledge/style:**

As the user thought she "had the previous knowledge that it (the item) was present (1002)," so she **went directly to "locate the known item" not to "find the item."**

7) Environment

Environment refers to the surrounding and settings where the user is interacting with the information retrieval system. Environment is the most crucial factor that influences the opportunistic shifts of current search goals and interactive intentions.

Here is an example of **shift of current search goals from find items with common characteristics to keeping up to date (opportunistic shift):**

"That is my favorite aisle it is related with my profession so I want to find new developments of ground water (1049)." Therefore, the user **changed from finding technical information to keeping up to date new developments of ground water.**

8) Interaction results

Interaction results refer to the specific results of the interaction between the user and the system. Examples of interactive results are: a list of citations from OPAC search, a specific book pulling out from the shelf, etc. Interaction results are the key factors that lead to opportunistic shifts of interactive intentions/current search goals. Furthermore, they are also determinants of improved and supplemented shifts of information seeking strategies.

Here is an example of **shift of interactive intention (opportunistic shift)** led by **interaction results**:

In the previous example, when one user was “evaluating the usefulness of an article,” he saw the editorial board of the journal, and one name caught his eye, so “I go through the rest of the names, just interested to see who was on the editorial board.” **After he “found specific information,” he continued to “evaluate” the article (1009).** Therefore, he changed his interactive intention **from evaluating the usefulness of an item to finding specific information and back to evaluating the usefulness of an item.**

5.7.2 Factors Affecting Different Levels of Shifts under Three Circumstances

Table 26, 27 & 28 and Figure 20, 21 & 22 summarize the relationships between types of factors and types of shifts. As the outcome of previous result is the pre-condition for all types of shifts, these figures illustrate how different types of factors affecting different types of shifts under three types of circumstances: 1) the outcome is successful; 2) the outcome is partially successful; and 3) the outcome is unsuccessful. In a current search goal shift and an interactive intention shift, outcome refers to whether there is

problem in the process of achieving the current search goal and the interactive intention, therefore, these shifts occur under two types of circumstances: successful outcome and unsuccessful outcome. In an information seeking strategy shift, outcome refers to what extent the interactive intention is accomplished by the application of the information seeking strategy, hence, these shifts happen under three types of circumstances: successful, partially successful and unsuccessful.

When the outcome is successful, planned and opportunistic shifts of current search goals and interactive intentions are the major shifts which emerged from the data. Environment or interaction result are the determinants of opportunity shifts of both current search goals and interactive intentions. In addition to outcome of previous result, leading search goals or domain information seeking knowledge are responsible for planned shifts of current search goals and interactive intentions accordingly. Table 26 presents frequency and percentage of factors affecting types of shifts on successful outcome. Figure 20 illustrates the relationships between types of factors and types of shifts when the outcome is successful.

In current search goal shifts, the successful outcome was the pre-condition for planned shifts. At the same time, the successful outcome (75%) was the major factor that led to planned shift of current search goals while sometimes leading search goal (25%) also defined the planned shift. Environment (71.4%) and interaction results (28.6%) were the dominant factors that were responsible for the opportunity shifts.

In interactive intention shifts, the successful outcome was also the pre-condition for planned shifts. The successful outcome (88%) and information seeking knowledge (12%) accounted for the planned shifts. Users did not mention any other factors in

former cases while they cited information seeking strategy as their reasons to change from one interactive intention to the other in latter cases. Same as opportunity shifts of current search goals, environment (50%) and interaction results (50%) are the primary elements for the opportunity shifts of interactive intentions.

Table 26 Frequency and Percentage of Factors Affecting Types of Shifts on Successful Outcome

Factors \ Shifts	Outcome	LSG	CSG	SK	DK	ISK	E	IR	Total
CSG Planned shift	75% (3)	25% (1)							100% (4)
CSG Opportunistic shift							71.4% (5)	28.6% (2)	100% (7)
CSG Assisted shift									
CSG Alternative shift									
II Planned shift	88% (388)					12% (53)			100% (441)
II Opportunistic shift							50% (11)	50% (11)	100% (22)
II Assisted shift									
II Alternative shift									
ISS Supplemented shift									
ISS Improved shift									
ISS Alternative shift									
Total	391	1				53	16	13	474

When the outcome is partially successful, supplemented shifts of information seeking strategies are the shifts occurred in the information seeking process. Outcomes of

previous results are the most important factors for supplemented shifts of information seeking strategies. Table 27 presents frequency and percentage of factors affecting types of shifts on partially successful outcome. Figure 21 illustrates the relationships between types of factors and types of shifts when the outcome is partially successful.

In information seeking strategy shifts, partially successful outcome (55%) was the primary factor for the supplemented shifts of information seeking strategies. In addition to outcome, information seeking knowledge (17.8%), interaction results (14.5%) or domain knowledge (12.6%) were the major components that affected supplemented shifts of information seeking strategies.

Table 27 Frequency and Percentage of Factors Affecting Types of Shifts on Partially Successful Outcome

Factors	Outcome	LSG	CSG	SK	DK	ISK	E	IR	Total
Shifts									
CSG Planned shift									
CSG Opportunistic shift									
CSG Assisted shift									
CSG Alternative shift									
II Planned shift									
II Opportunistic shift									
II Assisted shift									
II Alternative shift									
ISS Supplemented shift	55% (117)				12.6% (27)	17.8% (38)		14.5% (31)	100% (213)
ISS Improved shift									
ISS Alternative shift									
Total	117				27	38		31	213

When the outcome is unsuccessful, assisted and alternative shifts of current search goals and interactive intentions, as well as improved and alternative shifts of information seeking strategy are the shifts happening in information seeking process. Unsuccessful outcome plays an important role in leading assisted and alternative shifts of current search goals/interactive intentions as well as improved and alternative shifts of information seeking strategies. In addition to unsuccessful outcome, current search goal and leading search goal define the assisted and alternative shifts of current search goals respectively. System knowledge and domain knowledge are responsible for assisted and alternative shifts of interactive intentions. Table 28 presents frequency and percentage of factors affecting types of shifts on unsuccessful outcome. Figure 22 illustrates the relationships between types of factors and types of shifts when the outcome is unsuccessful.

In current search goal shifts, current search goal (60%) and unsuccessful outcome (40%) were the components leading to assisted shifts. Leading search goal (85.7%) as well as unsuccessful outcome (14.3%) was responsible for alternative shifts.

In interactive intention shifts, unsuccessful outcome (36%), system knowledge (46%) and domain knowledge (18%) played important roles in leading assisted shifts. Domain knowledge (39%), system knowledge (32.2%) and unsuccessful outcome (28.8%) were the determinants of alternative shifts.

In information seeking strategy shifts, improved shifts were produced by system knowledge (29.2%), information seeking knowledge (19.5%), interaction results (9.8%) or unsuccessful outcome (41.4%). Simultaneously, alternative shifts were determined by system knowledge (35%) or unsuccessful outcome (65%).

Table 28 Frequency and Percentage of Factors Affecting Types of Shifts on Unsuccessful Outcome

Factors	Outcome	LSG	CSG	SK	DK	ISK	E	IR	Total
Shifts									
CSG Planned shift									
CSG Opportunistic shift									
CSG Assisted shift	40% (2)		60% (3)						100% (5)
CSG Alternative shift	14.3% (1)	85.7% (6)							100% (7)
II Planned shift									
II Opportunistic shift									
II Assisted shift	36% (14)			46% (18)	18% (7)				100% (39)
II Alternative shift	28.8% (17)			32.2% (19)	39% (23)				100% (59)
ISS Supplemented shift									
ISS Improved shift	41.4% (17)			29.2% (12)		19.5% (8)		9.8% (4)	100% (41)
ISS Alternative Shift	65% (26)			35% (14)					100% (40)
Total	77	6	3	63	30	8		4	191

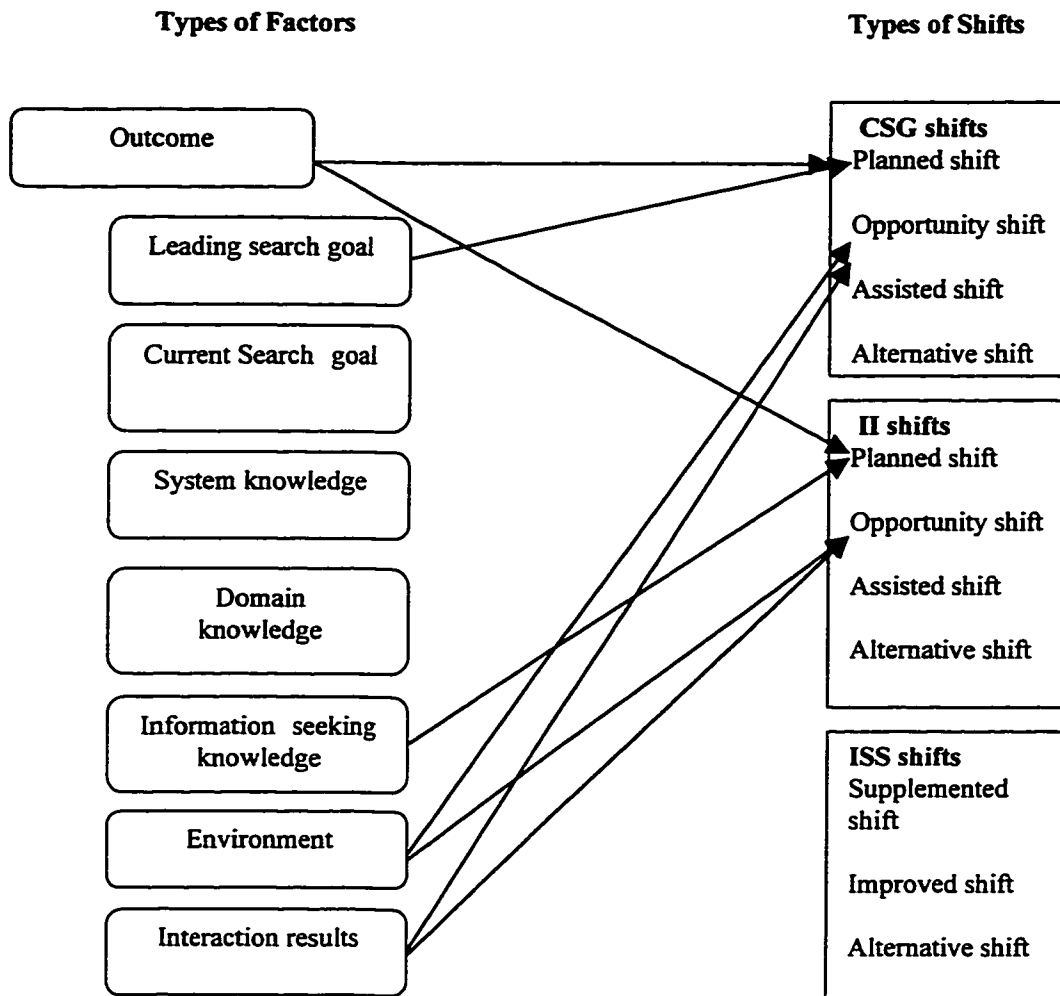


Figure 20 Relationships between Types of Factors and Types of Shifts on Successful Outcomes

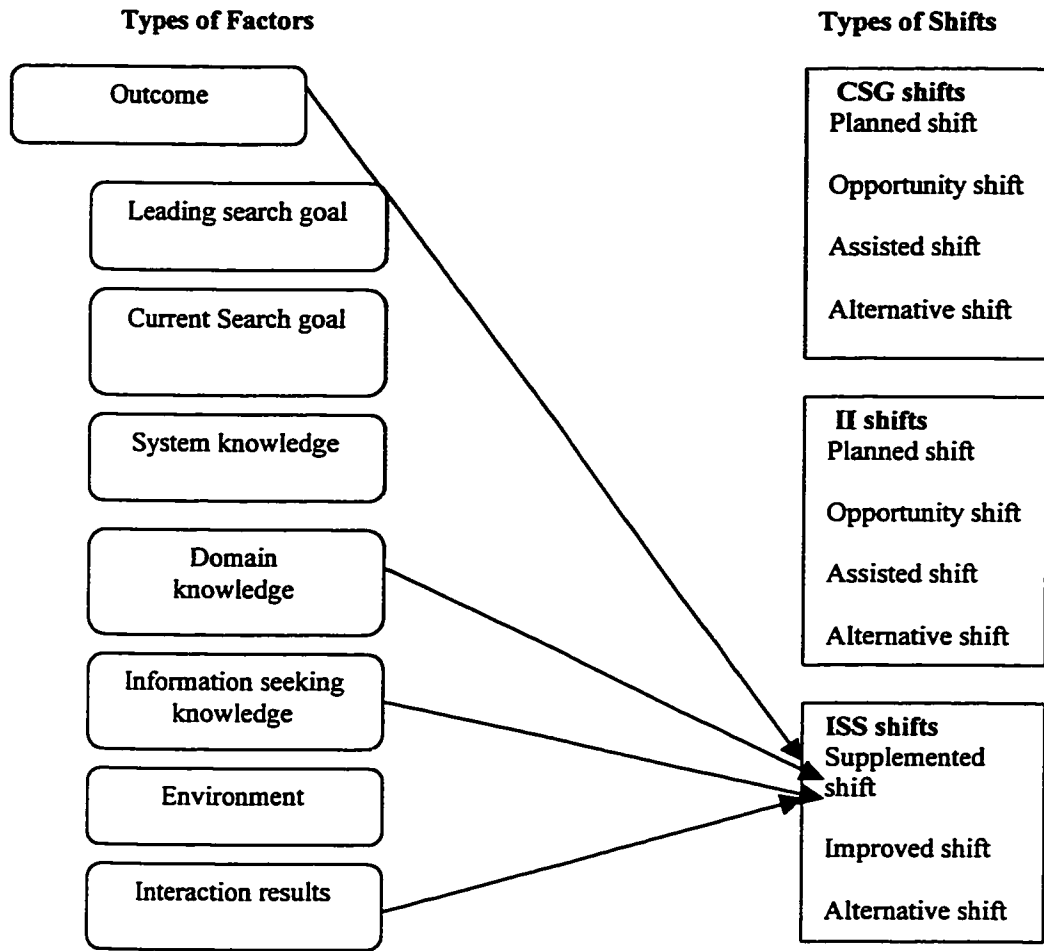


Figure 21 Relationships between Types of Factors and Types of Shifts on Partially Successful Outcome

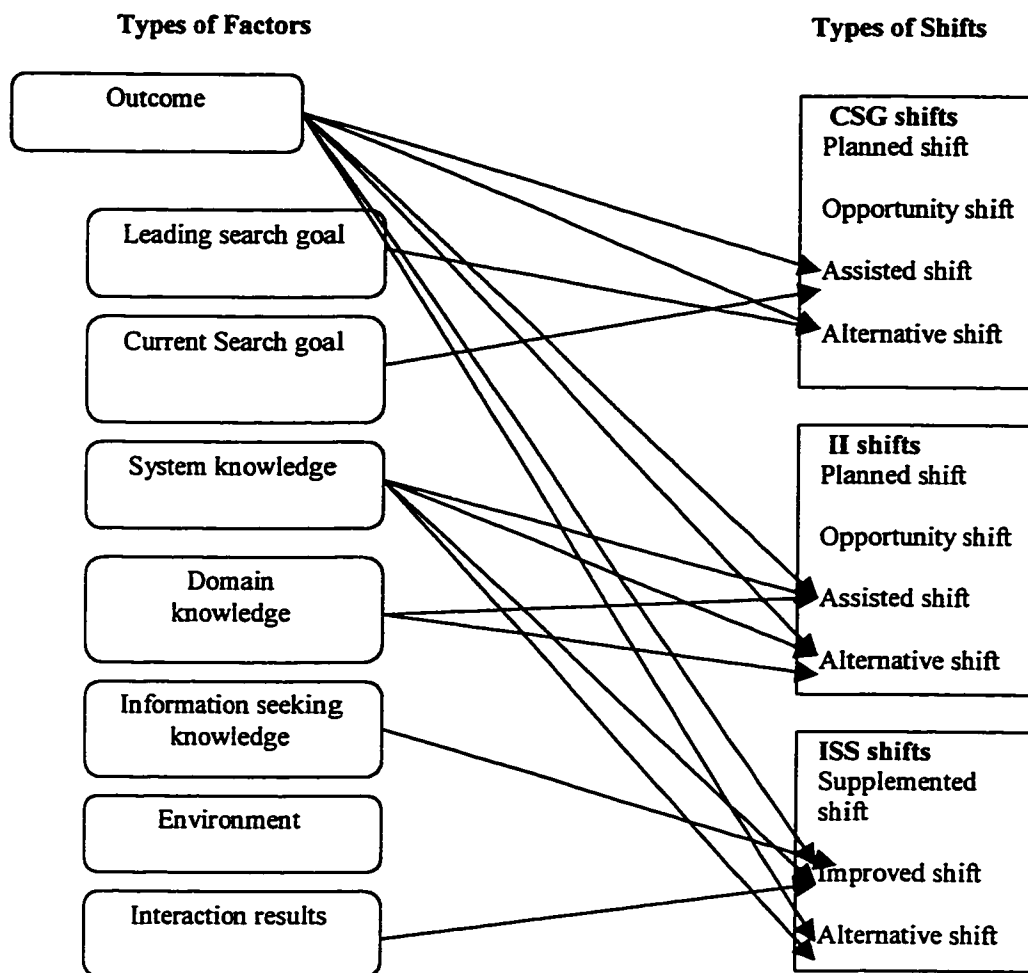


Figure 22 Relationships between Types of Factors and Types of Shifts on Unsuccessful Outcome

5.8 Summary of the Chapter: Re-evaluation of the Model of Interactive

Information Retrieval

This section summarizes the results of analysis corresponding to each of the research questions, and further evaluates the Model of Interactive Information Retrieval. In Chapter 3, I discussed the conceptual framework for this study. The model of interactive information retrieval was constructed based on three types of research: 1) nature of IR and interactive IR model, 2) planned model and situated action, and 3) user goal and information seeking behavior. This model illustrates the information seeking process by taking both planned and situated aspects into consideration. **This study demonstrates that interactive information retrieval is the product of plans and situations, moreover, interactive information retrieval can be characterized in different forms.** This can be further analyzed through the following sections: 1) levels of user goals and information seeking behavior, 2) Interactive Intentions, 3) Information seeking strategies, 4) patterns of interactive intentions and information seeking behavior, 5) shifts of current search goals, interactive intentions and information seeking, and 6) factors affecting different levels of changes.

5.8.1 Levels of user goals and information seeking behaviors

Levels of user goals and information seeking behaviors are interrelated. Levels of user goals define each sub-level of user goals and information seeking strategies employed to achieve interactive intentions. Simultaneously, information seeking strategies also influence the changes of different levels of user goals. All these changes do not happen by chance, instead, they have their own patterns that can be characterized.

Information seeking behaviors are determined by levels of user goals. Users' leading search goals lead to their current search goals, and interactive intentions are the sub-goals of current search goals, furthermore, interactive intentions also decide the types of information seeking strategies that can be employed to achieve these interactive intentions.

Information seeking behaviors also have impacts on different levels of user goals. Information seeking behaviors might not work, or only partially work, then users have to change either interactive intentions, plans, or current search goals to adapt to the situation. However, those changes do not randomly occur, and they fall into four types of goal shifts and three types of information seeking strategy shifts under three types of circumstances (successful, partially successful and unsuccessful outcome).

5.8.2 Interactive Intentions

This section attempts to answer the first research question: what are the interactive intentions users try to accomplish in the information seeking process? The results show that users engage in multiple types of interactive intentions in the information seeking process. According to the results, eight types of interactive intentions and sub-intentions emerged from the data: identifying, learning, finding, accessing, locating, evaluating, keeping record and obtaining. In order to fulfill their current search goals, users have to select and accomplish these interactive intentions in the information seeking process. These interactive intentions can be further characterized into four types of entities: specific, common, area/location and general. Table 29 presents the eight types of interactive intentions sub-intentions:

Table 29 Types of Interactive Intentions

Interactive intentions	Sub Interactive Intentions
Identify	Identify something to get started Identify something more to search
Learn	Learn system feature Learn system structure Learn domain knowledge Learn database content
Find	Find a known item Find specific information Find items with common characteristics Find items without pre-defined criteria
Access	Access a specific item Access items with common characteristics Access an area/ location
Locate	Locate a specific item Locate items with common characteristics Locate an area/ location
Evaluate	Evaluate correctness of an item Evaluate specificity of an item Evaluate usefulness of an item Evaluate fitness of an item Evaluate duplication of an item
Keep Record	Keep record of bibliographical information
Obtain	obtain specific information obtain part of the item Obtain a whole item(s)

5.8.3 Information Seeking Strategies

This section attempts to answer the second research question: how can the information seeking strategies that users engage in to achieve interactive intentions be characterized? The results showed that information seeking strategies can be characterized by different integration and combination of eight types of methods and six types of resources. Methods refer to the techniques users apply to interact with

information, information object and human. Resources are the information, information object and human that users are interacting with. Table 30 presents dimensions of information seeking strategies and examples.

Table 30 Dimensions of Information Seeking Strategies and Examples

Methods	Resources	Examples
Acquiring	Meta-Information	scanning meta-information
Comparing	Part of an item/specific information	scanning part of an item/specific information
Consulting	Whole item	scanning a whole item
Scanning	A series of items/ one location	scanning a series of items/one location/one database
Searching	One system/multiple databases	searching one system
Selecting	Human	searching an item
Tracking		tracking meta-information
Trial and Error		selecting an item
		selecting meta-information
		comparing meta-information
		comparing specific information
		acquiring meta-information
		acquiring specific information
		consulting human

5.8.4 Relationships between interactive intentions and information seeking behavior

This section attempts to answer the third research question: what is the relationship between users' interactive intentions and their seeking strategies? Intentions and entities can characterize interactive intentions while information seeking strategies can be summarized by methods and resources. Eight types of interactive intentions can be further classified into four types of entities; eight types of methods associated with six types of resources represent different types of information seeking strategies employed in the information seeking process. Intentions, entities, methods and resources constitute

the patterns of interactive intentions and information seeking strategies. Even though some of the information seeking strategies can be applied to several types of interactive intentions, each type of interactive intention has its own corresponding information seeking strategies. Different users might not use the same information seeking strategy for a specific interactive intention, but they normally employ information seeking strategies that are associated with that interactive intention. Table 31 presents each type of interactive intention and its associated information seeking strategies.

Table 31 Type of Interactive Intentions and Their Associated Information Seeking Strategies

Interactive intentions	Information Seeking Strategies
Identify Identify something to get started Identify something more to search	<i>scan a whole item</i> <i>scan meta-information</i> <i>scan part of /specific information</i> <i>search a system & scan meta-information</i> <i>consult human</i>
Learn Learn system feature Learn system structure Learn domain knowledge Learn database content	<i>consult human</i> <i>scan meta-information</i> <i>trial & error</i>
Find Find a known item Find specific information Find items with common characteristics Find items without pre-defined criteria	<i>search a system & scan meta-information</i> <i>search meta-information & track meta-information</i> <i>consult human</i> <i>scan an area/location</i> <i>scan a whole item</i> <i>scan part of an item</i> <i>track meta-information</i>
Access Access a specific item Access items with common characteristics Access an area/ location	<i>track meta-information</i> <i>consult human</i> <i>trial & error</i>
Locate Locate a specific item Locate items with common characteristics Locate an area/ location	<i>search a system & scan meta-information</i> <i>consult human</i> <i>scan an area/location</i>
Evaluate Evaluate correctness of an item Evaluate specificity of an item Evaluate usefulness of an item Evaluate fitness of an item Evaluate duplication of an item	<i>scan meta-information</i> <i>scan a whole item</i> <i>compare meta-information</i> <i>search meta-information & track meta-information</i>
Keep Record Keep record of bibliographical information	<i>acquire meta-information</i>
Obtain Obtain specific information Obtain part of the item Obtain a whole item(s)	<i>acquire part of an item/specific information</i> <i>acquire a series of items</i> <i>acquire a whole item</i>

5.8.5 Shifts of Current Search Goals, Interactive Intentions and Information

Seeking Strategies

This section attempts to answer the fourth research question: how do users shift their interactive intentions to fulfill their goals/tasks within an information seeking episode, and how do users change their search strategies to achieve their interactive intentions within an information seeking episode?

According to the results, current search goals, interactive intentions and information seeking strategies do change in the information seeking process. However, all the changes do not happen by accident, instead, these changes can be classified and represented, for example, planned shift, opportunistic shift, assisted shift and alternative shift of current search goals/interactive intentions, and supplemented, improved shift and alternative shift of information seeking strategies. Table 17 to Table 20 present frequency and percentage of four types of interactive intention shifts. Table 23 to Table 25 present frequency and percentage of three types of information seeking strategy shifts. Figure 13 to Figure 19 illustrate examples of four types of interactive intention shifts and three types of information seeking strategy shifts.

5.8.6 Factors Affecting Different Levels of Changes

This section attempts to answer the final research question: what are the factors that lead to the change of users' intentions and their information seeking strategies? Both planned and situated aspects determine shifts of current search goals, interactive intentions and information seeking strategies. Furthermore, the factors that lead to these shifts can also be traced and identified, and each type of shift is led by associated planned

and situated aspects. Different types of shifts have their own leading factors that are either just outcomes of previous results (successful, partially successful, and unsuccessful) or outcomes and their combination with other factors, such as leading search goals, current search goals, system knowledge, domain knowledge, information seeking knowledge, environment and interactive results. Factors of different types of shifts can be identified and grouped into levels of goals, personal information infrastructure (system knowledge, domain knowledge, information seeking knowledge) and situated aspects (outcome, environment and interactive result). This study not only identified the factors that led to different levels of shifts but also examined relationships between types of factors and types of shifts. Table 26 to Table 28 present frequency and percentage of factors affecting four types of interactive shifts and three types of information seeking strategy shifts on three circumstances: successful, partially successful and unsuccessful. Figure 20 to Figure 22 illustrate relationships between eight types of factors and seven types of shifts on three circumstances: successful, partially successful and unsuccessful.

5.8.7 Modifications of the Original Model of Interactive Information Retrieval

The results of this study enriched our understanding of the nature of interactive information retrieval. After re-examining the original model of interactive information retrieval, I realize the original model needs to be further improved on the following aspects:

1) Emphasizing the structure of levels of user goals.

As long term goal, leading search goal, current search goal, plan, interactive intention, and information seeking strategy are all part of the hierarchical structure, high level goals lead to the low level goals, it is better to present them in a vertical structure. Therefore, the relationship of this structure can be illustrated in a more meaningful way.

2) Separating levels of goals

Leading search goal and current search goal also need to be separated from levels of goals, because, similar to plan, interactive intention and information seeking strategy, leading search goal and current search goal have their own ways of changes in the information seeking process.

3) Identifying types of shifts

As the results not only demonstrate the existences of shifts but also identifying different types of shifts in the information seeking process, it is necessary to further mark these types of shifts of current search goals, interactive intentions and information seeking strategies to the model.

4) Differentiating problematic and non-problematic shifts with associated factors

In order to differentiate problematic and non-problematic shifts, planned and opportunity shifts of current search goals/interactive intentions and supplemented shift of information seeking strategies are positioned on one side with assisted/alternative shifts of current search goals/interactive intentions and improved shift/alternative shifts of

information seeking strategies on another side. Moreover, factors affecting different types of shifts are also linked to these different types of shifts.

Figure 23 depicts the in-depth representation of the interactive part of information retrieval process based upon the result of this research.

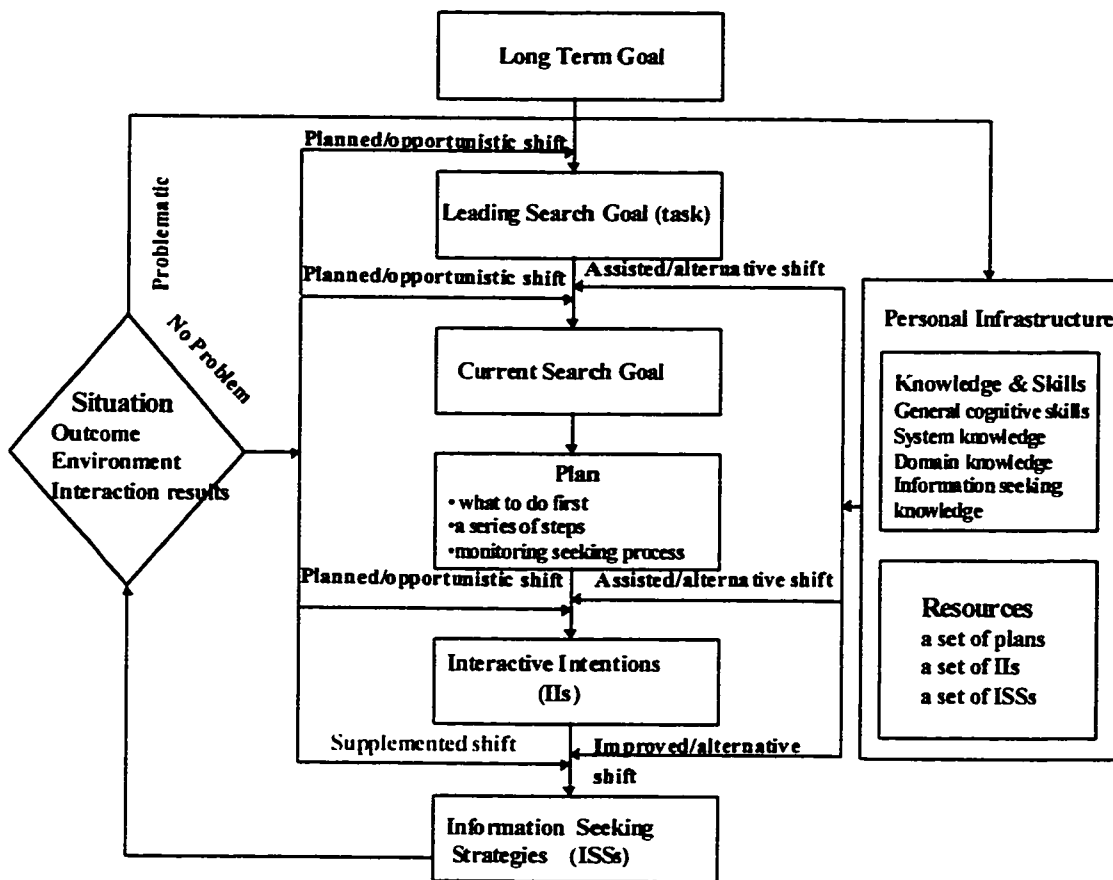


Figure 23. Model of Interactive Information Retrieval

CHAPTER 6 CONCLUSION

6.1 Conclusion

6.1.1 Conclusion

This study demonstrates that users do engage in multiple types of interaction within an information seeking episode. The limitation of existing IR systems that supports only one form of interaction raises the issue of how to support users to perform multiple types interactions in their information seeking process. It is crucial to analyze levels of user goals and their information seeking strategies, especially interactive intentions which are the products of hierarchical levels of user goals, user plans and interactions between users and information or systems. By identifying patterns between interactive intentions and their associated seeking strategies, different levels of shifts and their associated factors, we can take both planned and situated aspects of IR into consideration. It helps us understand more about the nature of interactive information retrieval, and further implement these results into system design.

The results suggest that interactive IR is the product of plans and situations. Interactive IR appears to proceed as planned behaviors, selected or modified according to the specifics of a situation. IR is highly situated because of the uncertainty and interactiveness of IR. Problematic situations and the environment a user is interacting with often require the rearrangement and modification of users' current search goals, their original plans, interactive intentions, information seeking strategies, sometimes even leading search goals. Within an information seeking episode, a user changes intentions and search strategies to fulfill his current search goal. There is no general search strategy

that can be applied to the entire search process. Simultaneously, IR is also largely determined by plans, to be more specific, by the structure of levels of goals and associated information seeking strategies. Levels of goals, resources and personal information infrastructures play important roles in defining different levels of user goals, plans and further selecting appropriate interactive intentions and information seeking strategies. For every type of intention, there is a set of specific search strategies employed by users. Although there are different levels of shifts, those shifts can be characterized into planned, opportunistic, assisted and alternative shifts of current search goals/interactive intentions and supplemented, improved and alternative shifts of information seeking strategies. Moreover, the factors that lead to those shifts can be traced and classified into outcome, user's task and problem (leading search goal and current search goal), personal information infrastructure (system knowledge, domain knowledge and information seeking knowledge) and situational factor (environment and interaction results).

6.1.2 Variables related to the five research questions

Here are the five research questions, in this section, I try to identify the variables associated with the five research questions and further provide some explanations of the results of this study.

- 1) What are the *interactive intentions* users try to accomplish in the information seeking process?

Eight types of interactive intentions emerged from the data. Just as expected, users not only try to “find something,” but also attempt to “identify,” “learn,” “locate,”

“access,” “keep record,” “evaluate,” and “obtain” within information seeking process.

Even though users do not always strictly follow the sequence of these interactive intentions, these are the major interactive intentions users have to engage in within an information seeking episode. Users can not achieve their current search goals by only taking one step because of the complexity of information seeking. Within an information seeking episode, some of the interactive intentions emerged as the products of plans while others are brought by situations. Therefore, they have to fulfill their interactive intentions that are the interrelated sub-goals users have to accomplish in order to complete their current search goals.

2) How can the *information seeking strategies* users engage in to achieve interactive intentions be characterized?

Information seeking strategies can not be characterized within one dimension. It seems that different types of information seeking strategies all fall into two dimensions, that is type of method and type of resource users employ to achieve their interactive intentions. Each type of information seeking strategy is constituted by one of the eight types of methods (scanning, searching, tracking, selecting, comparing, acquiring, consulting and trial & error) and one of the six types of resources (meta-information, part of an item/specific information, whole item, a series of items/one location, one system/multiple databases and human).

3) What is *the relationship* between users' interactive intentions and their information seeking strategies (intention-based strategies)?

This is one of the very few studies that explore the structure behind information seeking strategies. Users' interactive intentions lead to the selection of information

seeking strategies in general. Each information seeking strategy is employed to achieve a specific interactive intention, at the same time, every type of interactive intention has its corresponding information seeking strategies. The relationships between types of interactive intentions and types of information seeking strategies need to be further confirmed statistically.

- 4) How do users *shift* their interactive intentions to fulfill their goals/tasks within an information seeking episode, and how do users change their search strategies to achieve their interactive intentions within an information seeking episode?

This is the first study that investigates different levels of shifts (current search goal, interactive intention and information seeking strategy) within an information seeking episode. Each type of shift (planned shift, opportunistic shift, assisted shift and alternative shift of interactive intentions and supplemented shift, improved shift and alternative shift of information seeking strategies) has its own ways of change, and the results identify the specific patterns of each type of shift. The relationships between types of shifts and types of interactive intentions/information seeking strategies need to be further tested statistically.

- 5) What are the *factors* that lead to the change of users' interactive intentions and their seeking strategies?

This study identified the following factors/variables affecting the change of users' levels of user goals and information seeking strategies: outcome, levels of user goals (leading search goal, current search goal), knowledge structure (system knowledge, domain knowledge and information seeking knowledge), interaction environment and interaction results. The results show that outcome is the most important factor determining different

levels of shifts while other factors and the outcome co-determine the direction of these shifts. The possible explanation is that all the information seeking activities are interrelated, and the successful outcome, partially successful outcome and unsuccessful outcome of the previous information seeking activity indicate the change. The outcome itself can not define the situation, so other variables along with the outcome help users determine different levels and types of shifts.

This study is rather exploratory because of the small sampling of the users. The results of this study could serve as hypotheses for further investigation of IR research involving the above research questions.

6.2 Theoretical implications: interactive information retrieval – product of plans and situations

Chapter 5 summarizes the results of this study, in this section I will focus on the theoretical implications of interactive information retrieval, that is the nature of information retrieval. I will follow the original sequence of Chapter 5 to further discuss its theoretical implications.

6.2.1 Levels of User Goals and Their Representations

User goals have been theoretically identified and empirically verified as important elements in defining the structure and nature of information retrieval.

Theoretically, Zunde (1979) claims users' goals determine the value and utility of information across time. User goal is considered one of the elements in information seeking (Saracevic, 1983) and one important variable of problematic situation in

Shenouda's (1990) model of problematic situation. Belkin, Marchetti & Cool (1993) proposed that information seeking goals affect information seeking strategies. According to Hert (1997), the first component of information retrieval interaction is goal, and she defined "goal" as goal of the interaction," that is what the respondent intended to accomplish with the interaction.

Practically, Rouse & Rouse (1982) found user goals had influence on information seeking behavior in two experiments using DBASE with two groups of students of different goals. Cool and her colleagues (1993) discovered that user goals were highly related to the relevance of documents to specific information problems. Weischedel (1984) explored the user models of goals and plans to control the search for the intended interpretation of ill-formed input. Smith (1992) studied user goals, objectives and feedback to develop a comprehensive customer training program designed to minimize the time needed to become proficient and maximize the relevance and application of the materials retrieved in the use of the Lexis/Nexis databases.

The results of this study agree with previous research on this area that the user goal is one of the important elements of information retrieval. However, previous studies define user goal only at one level, that is what search results a user tries to obtain. This study goes beyond the previous ones, explores the levels of goals involved in the information seeking process to further clarify the relationship among goal, intention and information need.

Information need, "problematic situation," "anomalous state of knowledge," and goal or user goal have been widely used in IR literature, but the definition of these terms are still ambiguous. The structure of levels of goals might help us clarify the relationship

among information need, goal and interactive intention. The structure of levels of goals demonstrate one level of user goals can not account for the nature of information retrieval. Interactive intention is the product of levels of user goals. User's information need can not be discussed on one abstract level, instead, it corresponds to user's levels of goals. Long-term goal and leading search goal define the tasks that lead users to seek information, therefore, information need comes from long-term goal and leading search goal. Information need is represented by current search goal and further enriched, modified or changed by a set of interactive intentions emerging in the information seeking process.

Although interactive intention is the focus of this study, the results demonstrate we will miss the nature of information retrieval if we only examine one level of user goals without paying attention to other levels of user goals that lead to this level of user goal. In one word, levels of user goals define the nature of information retrieval.

6.2.2 Patterns between Interactive Intentions and Information Seeking Strategies

Researchers have examined information seeking strategies from different levels: 1) tactics/moves, such as Bates' information tactics (1979a, 1979b), Fidel's operational and conceptual moves, etc. 2) patterns, such as Ellis's (1989) information seeking patterns of academic social scientists, etc. 3) information seeking strategies, such as Chen and Dhar (1991)'s five types of strategies, Markey and Atherton's (1978) five basic types of online search strategies, etc.

Most of the studies on information seeking strategies focus on what strategies users apply in the information seeking process. They did not further investigate the

structure behind these strategies. In general, information seeking strategies are considered as interactive and undetermined, and that is why it is difficult to offer users guidance and help.

Some researchers started to explore the structure behind information seeking strategies. Kuhlthau (1991) developed a model to identify actions and tasks in relation to stages in the information seeking process. Belkin, Marchetti & Cool (1993) developed a scheme of information seeking strategies based upon four behavioral dimensions. Chang (1995) identified the common dimensions of browsing. **This study attempts to further investigate what leads to the selection of information seeking strategies, and tries to answer the question under what circumstances information seeking strategies are applied.**

Interactive intentions are the essential parts of levels of user goals. They are the sub-goal of current search goals, and the determinants of information seeking strategies applied. In terms of their interactivity, current interactive intention is not only the result of previous intention but also the cause of the next intention. A set of interactive intentions and their corresponding information seeking strategies constitute information retrieval process. Eight types of interactive intentions emerged from the data, and they could be further characterized into four types of entities.

In order to identify patterns of information seeking strategies, methods and resources were identified as the two dimensions of information seeking strategies. Different types of information seeking strategies are the combination of eight types of methods and six types of resources. Each type of interactive intention has its own associated information seeking strategies. Therefore, eight types of interactive intentions,

four types of entities, eight types of methods and six types of resources constitute patterns of interactive intentions and information seeking strategies. The results demonstrate that information seeking strategies can be characterized, and furthermore, there are patterns between interactive intentions and information seeking strategies.

6.2.3 Shifts of Current Search Goals, Interactive Intentions and Information Seeking Strategies

Compared to the traditional view of user goals, more and more researchers take user-centered approaches, and start to accept the view that users' information needs/goals do change in the information seeking process. Bates (1989) "berrypicking" process, Belkin's (1996) episode model of information seeking, Saracevic's (1996) stratified interaction model and Mantovani's (1996) discussion of social context in human-computer interaction all point out that user goals change during the interaction process. Robin (1977) concluded users changed the focus of their attention to various aspects of their information problem based upon his analysis of transcripts of mediated information retrieval interactions. According to his results, evaluation judgments, search strategy, terms and query reformulation were the focuses of shifts. Among all the shifts, operational and conceptual shift types constituted 89% of all shifts.

However, not all the researchers agree that user goals change in the information seeking process. Hert (1997) claimed that goals were not greatly modified by respondents during the course of the interaction based upon her empirical study. One possible reason is that this study analyzed both OPAC and Non-OPAC data while Hert's study used only OPAC data and OPAC does not offer sufficient insights to enable users

to change their goals. Another reason might be that this study investigated user goal change in different levels while Hert's study focused on one level of user goal change.

The results of this study demonstrate that users' goals not only change but also change on several levels. Although users' tasks do not change quite often, their goals in relation to their information problems (current search goals), users' sub-goals in relation to how to solve their information problems (plans and interaction actions), and most importantly, their information seeking strategies do change in the information seeking process. Furthermore, this study identifies patterns of different levels of shifts, and proves that these shifts do not happen randomly. **The discussion of shifts of current search goals, interactive intentions and information seeking strategies enable us to understand what constitutes the information seeking process.**

6.2.4 Factors Affecting Different Levels of Shifts

In the planned model perspective, the information seeking process is directed by goals, all information seeking activities are considered as continuous and interrelated, and users' beliefs and intentions affect actions (Newell & Simon, 1972; Pollack, 1986; Carberry, 1989; Kautz, 1991). In contrast, from the situated perspective, user goals remain constant in the information seeking process, situated actions emerge from moment by moment interaction, and they are influenced by situational elements (Suchman, 1987; Hert, 1997). Hert (1997) further identified three categories of elements of situations that affect interactive IR: elements associated with the respondent, the problem and the system.

Very few studies have investigated different levels of shifts and elements of these shifts within an information seeking episode. In order to understand the nature of interactive information retrieval, it is very important to identify elements or factors that influence the information seeking process. The results of this study show that both planned and situated aspects have an impact on different levels of shifts. Not only the environment and interaction results, but also users' levels of goals and their personal information infrastructures are determinants of different levels of shifts. In addition, this study did not stay at the level of identification, it further examined the relationships between factors and different levels of shifts under different circumstances. These factors can be characterized and classified into different groups.

The study of levels of goals, patterns of interactive intentions and information seeking strategies, shifts of different levels and factors affecting different levels of shifts helps us understand what leads to the interactive information retrieval process. More importantly, it helps us understand the relationships of levels of user goals and information seeking strategies, relationships among information seeking activities within an information episode, and relationships between planned and situated aspects and interactive information retrieval. This study will set up a foundation for researchers to further work on planned and situated determinants of interactive information retrieval. These results can be further implemented into system design to guide users through their information seeking process.

6.3 Practical Implications: Adaptive IR system design

6.3.1 Planned Model

Planned model ties successful interaction to each participant's success at anticipating the actions of the other, and recommends a system based on a preconceived model of the user that supports the prediction of actions, the specification of recognition criteria for the actions predicted, and the prescription of an appropriate response.

As information retrieval is much more complicated than other activities, and information retrieval is the product of both plans and situations, therefore it is very difficult to design an IR system to predict users' information seeking activities. Most of the plan recognition work tries to infer the task-related plan by either analyzing speech acts or observing other non-communicative acts, and these two types of work are also called "intended" and "keyhole" recognition (Kautz, 1991). The most popular of "intended recognition" application is handling pragmatically ill-formed queries (Sowa, 1976; Kaplan, 1979; Mays, 1980). Keyhole recognition applies mostly to the diagnosis of user strategies and intelligent help systems (Desmarais, Larochelle & Giroux, 1987; Hecking, 1987).

6.3.2 Situated Action

Situated action focuses on the ways in which interactional success comprises responses that are occasioned by, and responsive to, unanticipated actions of the other. This focus recommends a system that maximizes sensitivity to actions actually taken, by minimizing predetermined sequences of machine behavior.

As situated action is moment by moment action, it is almost impossible to provide any implications for a complete system design. So far there is no IR system designed based upon this theory. Most of the works try to make suggestions for part of system

design or system evaluation. Feedback design is the main application of this perspective. Suchman's (1987) work mostly focused on programmable photocopiers. Hert (1997) identified three types of feedback to design into a system: 1) expression of the identity or nature of particular entity or of the information as a whole, 2) provide information about how it worked, and 3) provide advice about how to search better. Another application of exploiting contingencies of the environment is the design of browsing mechanisms. These suggestions provided useful recommendations to enhance the feedback and browsing mechanisms, but they did not offer any recommendations for the general design of an adaptive IR system.

6.3.3 Interactive Approach

The former recommendation is constrained by limitations on the designer's ability to predict any user's actions, the latter by limitations on the system's access to and ability to make sense out of the actions that a particular user takes.

The interactive approach takes account of both planned and situated aspects of interactive IR. This approach recommends an adaptive IR system to support users' multiple types of interactions, and furthermore, support different levels of shifts within an information seeking episode.

6.3.3.1 Support multiple types of interactions

The results showed that searchers cared about not only how systems effectively support them to formulate queries but also how systems support them to perform other forms of interaction. Users need IR systems that enable them to:

- identify information to get started or search from their own personal leads
- learn system features, structure, database content or domain knowledge
- find items/information without pre-defined criteria, to find a known item with or without complete information, to find specific information, or to find items with common characteristics
- access a specific item, access items with common characteristics, or access an area/location
- locate a specific item, locate items with common characteristics, or locate an area/location
- evaluate information/item in terms of its usefulness, correctness, specificity, duplication or fitness
- keep a record of bibliographical information
- obtain specific information, obtain part of the information, or obtain a whole item
- keep them informed about their search status and problems, etc.

Based upon the pattern of interactive intentions and information seeking strategies, I further make some suggestions for the design of an adaptive IR system to support users' multiple types of interactions:

- *Scanning different types of personal materials* is the information seeking strategy used for “**identifying.**” **Suggestion:** set up a personal working space, provide access/link to their personal leads and allow users to browse these

personal leads, such as a URL suggested by an expert, a disk containing the paper written by the author himself/herself, etc

- *Consulting experts/peers, scanning meta-information and trial & error* are the most popular used information seeking strategies for “**learning.**” **Suggestion:** provide context sensitive help mechanism to assist users to get “right to the question” answer for their problems of system function, system structure, database content, and domain knowledge. In addition to regular help arranged by table of content or index, the help mechanism should also offer hyperlinks of information and examples of different commands of the system so that users can just click that to get more information about how to use different system features. The system should offer immediate access to the location information of an item as well as information about general system structure and structure of the database. The above information should be communicated to users via visualizations. Identifying terms can be supported through offering vocabulary tools, such as browsing index terms and thesaurus to help users select terms, etc.
- *Searching and scanning* are used for “**finding known items.**” The problem of this interaction is that users do not always have the complete information of a known item. **Suggestion:** provide a browsing mechanism of partial search, such as partial title, partial author, etc.; provide other options of characteristics of a known item, such as with or without image, data range, long or short, etc. *Tracking meta-information* is a frequently applied information seeking

strategy for **“finding items with common characteristics”** that is not supported from the existing IR systems. **Suggestion:** provide positive feedback mechanism, such as offering “documents like marked,” etc. *Scanning a whole item and searching meta-information & tracking meta-information* are the information seeking strategies employed to **“finding specific information.”** **Suggestion:** in addition to full text search, display is another option to assist users to identify the specific information efficiently, such as key word in context (KWIC). *Scanning an area/location* is the most frequently used information seeking strategy for **“finding items without pre-defined criteria.”** **Suggestion:** provide browsing mechanisms of different subjects, different formats, different authors, etc. is the efficient way to help users find what they are interested in.

- As locating and finding is highly correlated, information seeking strategies in “finding” can also apply for “locating.”
- *Tracking meta-information* is the first choice to **“access an item(s)/location.”** **Suggestion:** provide direct links or instructions to guide users easily access the item(s)/location. An alternative approach to support this type of interactive intention is to provide visualized links to direct users to their locations.
- *Scanning meta-information, scanning a whole item, comparing meta-information and comparing specific information* are the major information seeking strategies employed for different types of **“evaluating.”** **Suggestion:**

provide multiple formats of display for different types of evaluating with meta-information and search terms highlighted in the text, furthermore, allow finding key terms within the text displayed, etc.

- *Acquiring meta-information, acquiring part of an item, acquiring a whole item* and acquire a series of items are the frequently used information seeking strategies for “**keeping record and obtaining.**” **Suggestion:** provide easy to access search history and results as well as copying, downloading, printing, email functions for users to keep track of their searches and obtaining information/item(s), and integrating these features and their personal working space into one entity.

6.3.3.2 Support Different Levels of Shifts

Shifts of current search goals, interactive intentions and information seeking strategies do not occur randomly. Four types of shifts of current search goals, plans, interactive intentions and three types of shifts of information seeking strategies emerged from the data. Users need adaptive IR system to offer them guidance through the following shifts of current search goals and interactive intentions:

- Planned shift
- Opportunistic shift
- Assisted shift
- Alternative shift

Shifts of information seeking strategies:

- Supplemented shift
- Improved shift
- Alternative shift

Based upon different levels of shifts and factors affecting these changes, I further make some suggestions for the design of an adaptive IR system to support users' different levels of shifts:

- As **planned shifts** are part of plans, each level of a planned shift has its own structure. In addition, they are highly related to the success of the outcomes. **Suggestion:** incorporate user's leading search goal and current search goal into system, embed the frequently occurring planned shifts into the system as default conditions for design, guide users smoothly through their planned shifts when the previous outcome is successful.
- As **opportunistic shifts** occur when users see something by serendipity, "environment" and "interaction results" are the major factors that lead to the shifts. **Suggestion:** it is difficult to predict types of opportunistic shift, but it is the responsibility of the adaptive IR system to allow users to explore their new current search goals/interactive intentions, most importantly, to take them back to their original goals/intentions after finishing their opportunistic shifts. Keeping a history of what a user has done and allow him to go back to his/her original goal/intention is an option for this type of shift.

- As **assisted shifts** happen when users have problems to achieve their current search goals/interactive intentions, “levels of goals,” “system knowledge” and “domain knowledge” are major factors for the shifts, therefore, “learning” is the most frequently applied interactive intention for the shifts. **Suggestion:** when the outcome is unsuccessful, an adaptive IR system needs to detect or inquire about the reason of the failure, and further provide suggestions on task or current search goal related assistance for leading search goal/current search goal shifts or help mechanisms for interactive intention assisted shifts.
- As **alternative shifts** appear when users need another similar goal to achieve the same higher level goal because of the failure of the previous one. According to the data, “finding a known item” to “finding items with common characteristics” is the most frequently applied alternative shift. “Levels of goals,” system knowledge and “domain knowledge” are the determinants for alternative shifts. **Suggestion:** when users decide to abandon the previous goals, adaptive IR systems should guide users to change their goals from narrow to broad, such as from finding a known item to finding items with common characteristics, from a specific item by an author to other items from that author, etc.
- **Supplemented shifts** happen when users can only partially achieve their interactive intentions by applying their information seeking strategies. Supplemented shifts could change either methods or resources, but mostly resources, and they happen in *scanning, searching, comparing, acquiring, etc.* “Information seeking knowledge” and “interaction results” normally lead to

supplemented shifts. **Suggestion:** Supplemented shifts are the products of partially successful outcomes. As shifts of information seeking strategies are highly correlated to outcomes, adaptive IR systems should keep getting feedback from users in terms of their outcomes. Adaptive IR systems should not only allow for the changes of resources of different methods but also recommend other sources available.

- **Improved shifts** occur when users can not fulfill their interactive intentions, so they have to refine their information seeking strategies. The results showed that improved shifts mainly happen in *searching*, and users changed meta-information to improve their information seeking strategies. “System knowledge” and “information knowledge” influence improved shifts. **Suggestion:** Improved shifts are the products of an unsuccessful outcome. Adaptive IR systems need to provide partial searches and browsing mechanisms so that the systems can improve users’ information seeking strategies automatically. In addition, adaptive IR systems can also support improved shifts by listing all the search options with examples so that users can easily reformulate their information seeking strategies or select different search options.
- **Alternative Shifts** occur when users can not accomplish their interactive intentions by applying the previous information seeking strategies, so they have to introduce new information seeking strategies as alternatives. Alternative shifts change both methods and resources. Alternative shifts generally are determined by “system knowledge” and “interaction results.” **Suggestion:** alternative shifts

are also the products of unsuccessful outcomes. As alternative shifts require the change in both methods and resources, it is much more complicated. However, there are still patterns of alternative shifts, for example, most popularly used alternative information seeking strategy for *scanning*, *searching*, and *trial & error* is *consulting an expert*. In addition, *scanning an area/location* is an alternative for *searching a system*. Adaptive IR systems can be programmed for the typical types of alternative shifts and interactive help mechanism so that they can guide or provide users alternative choices when users have to apply new information seeking strategies because of the unsuccessful of the outcomes.

Interactive approach provides detailed recommendations for individual interactive system feature as well as general guidance of an adaptive IR system design. However, to implement these suggestions into system design, we need to do further research.

6.4 Further Research

Further research needs to focus on the following three aspects: 1) understand the different types of interactive intentions people engage in different settings; 2) explore new approaches/theories to investigate interactive information retrieval; 3) support multiple types of interactions without compromising its simplicity.

6.4.1 Understand Different Types of Interactive Intentions People Engage in Different Settings

In addition to library settings, further research needs to cover the in-depth study of users' interactive intentions, patterns between interactive intentions and associated

information seeking strategies, and factors affecting the shifts current search goals, interactive intentions and information seeking strategies in variety of settings, such as office settings, home settings, etc.

Further research also needs to further investigate prototypical sequences of interactive intentions and information seeking strategies as well as shifts of interactive intentions and information seeking strategies within an information seeking episode.

6.4.2 Explore New Approaches/Theories to Investigate Interactive Information Retrieval

This study integrates a planned model from cognitive science and situated action from social science into one framework to examine interactive information retrieval. The complexity of interactive information retrieval determines that it can not be investigated by applying knowledge from one discipline, therefore, it requires the applications of approaches and theories from multiple disciplines. Human-computer interaction theory and interactive IR models have contributed a lot to the understanding of interactive information retrieval. Further research needs to explore new approaches and new theories to explore interactive information retrieval.

6.4.3 Support Multiple Types of Interactions without Compromising its Simplicity

It is the final destination of interactive IR research to design adaptive IR systems to support users' multiple types of interactions within an information seeking episode. However, identifications of multiple types of interactions, different levels of shifts and factors affecting these shifts only answer part of the design question -- what to support.

The second part of the question is how to support. The interactive approach offers users rich tools to select from rather than a top-down design that anticipates all needed tools. One implication of this design perspective is that it complicates the interface for users. It might put more decision-making burden and authority on users. The basic requirement of IR system design is ease of use, and this raises another issue for further research, that is how to support multiple types of interactions without compromising its simplicity.

Further research will enable us to understand the nature of interactive information retrieval, and moreover, allow us to design an adaptive IR system.

Appendix 1: Data Collection Instruments

Appendix 1.1: Entry and Exit Online Questionnaires

Questions asked in Entry Questionnaire. Academic Library

1. You are:

- a. Student
- b. Faculty
- c. Staff
- d. Post Doc
- e. Other

(for each of the above, further screens for specific status and department, major or occupation are displayed as required)

2. Your age: _____

3. Your use libraries:

never _____ 1-2 times/year _____ monthly _____ weekly _____ daily _____

4. You have used computerized catalogs:

never before _____ 1-2 times/year _____ monthly _____ weekly _____ more _____

5. You use computer outside libraries:

never _____ 1-2 times/year _____ monthly _____ weekly _____ daily _____

6. On a scale of 1 to 5, rate yourself on how familiar you are with computers, where 1 is never used and 5 is very familiar

1 _____ 2 _____ 3 _____ 4 _____ 5 _____

7. I am using the library to obtain material for: (choose all applicable categories)

- 1. Educational assignment (subdivisions on successive screens)
- 2. Recreational use
- 3. Research project
- 4. Dissertation
- 5. Teaching
- 6. Publication
- 7. Professional use
- 8. Keeping up to date
- 9. Personal information use (please specify)
- 10. Other (please specify)

8. The kind of materials I am looking for are: (choose all applicable categories)

- 1. Books
- 2. Magazines/Journals
- 3. Indexes

4. Newspapers
5. Audio/visual (record cassettes, tapes, CDs, videotapes, etc.)
6. Other (please specify)

9. I am using the catalog: (choose all applicable categories)

1. To see if the library has a specific item I know about (e.g. books, journals, newspapers, music, videotapes, films)
2. To see what materials the library has by an author I know about
3. to see what materials the library has on a subject I'm interested in
4. To see if the library has materials like something I know about
5. to browse the collection to see if here is something I want
6. to see if something is available to chick out
7. To get information about an item or items I know about
8. To find the call number/classification number of an item
9. Other (please specify)

Questions asked in Exit Questionnaire, Academic Library

1. In your search today you found:

1. Nothing you were looking for
2. Some of what your were looking for
3. Enough of what you were looking for
4. Just what your were looking for
5. More than you were looking for

2. Searching the computerized catalog was:

1. Very easy
2. Easy
3. In between
4. difficult
5. Impossible

3. What are you going to do next?

1. Consult the card catalog
2. Use an index
3. Consult a librarian
4. Get what you found
5. Go to the shelves to look around/browse
6. Do some other work
7. Look for something else
8. Leave the library
9. Other (please specify)

Appendix 1.2: Non-OPAC Entry Questionnaire, Academic Library

USER QUESTIONNAIRE - USE & TYPE OF MATERIAL

Please complete this form by choosing all of the answers which apply to you.

1. I am using the library to obtain materials or information for:

- a. an educational assignment (class assignment, term paper, etc.)

Is this for:

- Class assignment/term paper
 Thesis dissertation
 Research project
 Other (Please specify)

- b. Research/professional use
 Is this for:

- Research Project
 Dissertation
 Teaching
 Publication
 Other work related (please specify)

- c. Keeping up to date

- d. Personal information use

- e. Recreational use

- f. other (please specify)

2. I am interested in using

- Books
 Magazines/Journals
 Indexes
 Audio/Visual Materials (e.g. records, CD's audio tapes, videotapes)
 Newspapers
 Other (please specify)

Appendix 1.3: Activity Recording Form

Observer's Notes

Time	Activity#	Activity	Location Be as specific as possible & locate on floor plan
------	-----------	----------	---

CONSULTS SERVICES
CONSULTS OTHERS
ORIENTATION
RETRIEVAL
RETRUN MATIRAL

CONSULTS TOOLS
COPIES MATERIAL
PHYSICAL MOVEMENT
PERSONAL ACTIVITIES
USE

Appendix 1.4: Non-OPAC Post Search Questionnaire, Academic Library

USER QUESTIONNAIRE - BACKGROUND AND CONTEXT

Please fill out the following questions by checking the box for each appropriate category and answering questions where necessary.

1. You are:
- () a. Student
- () Freshman
- () Sophomore
- () Junior
- () Senior
- () Graduate
- What is your major?
- () b. Faculty
- () Professor
- () Associate Professor
- () Assistant Professor
- () Instructor/Lecturer
- Which department are you in?
- () Librarian
- () Other
- What is your position?
- () c. Staff
- () Library Staff
- () Administration
- () Research
- () Other
- What is your occupation
- () d. Post Doc
- What department?
- () e. Other
- What is your occupation?
2. Your age is
- () Under 18 years of age
- () 19 - 25 years of age
- () 26 - 35 years of age
- () 36 - 45 years of age
- () 46 - 55 years of age
- () 56 - 65 years of age
- () Over 65 years of age

3. You use libraries

- Never
 1-2 times/year
 Monthly
 Weekly
 Daily

4. You have used computerized library catalogs

- Never
 once/twice
 3-10 times
 11-30 times
 30+ times

5. you have used card catalogs

- Never
 once/twice
 3-10 times
 11-30 times
 30+ times

6. You use computers outside libraries

- Never
 1-2 times/year
 Monthly
 Weekly
 Daily

Please answer the following questions by a check mark at the appropriate point, Several of these questions refer to the reason that brought you to the library, please consider that reason when answering these questions.

7. How familiar are you with computers where 1 is never used and 5 is very familiar.

(1)	(2)	(3)	(4)	(5)
Never				Very
Used				Familiar

8. How much had you already done on the specific purpose of your visit today before You came where 1 is nothing and 5 is a lot.

(1)	(2)	(3)	(4)	(5)
Nothing				A lot

9. How far along were you on the project/reason that brought you to the library where 1 is beginning to think about it and 5 is the end of the project.

(1)	(2)	(3)	(4)	(5)
Beginning To think about It				End: completion (drawing of Conclusion, Writing, etc.)

10. How much do you feel you knew about the project/reason that brought you here before you came to the library where 1 is nothing and 5 is a lot.

(1)	(2)	(3)	(4)	(5)
Nothing				A lot

11. During your visit today, you found

- Nothing you were looking for
- Some of what you were looking for
- Enough of what you were looking for
- Just what you were looking for
- More than you were looking for

12. Indicate the degree to which the materials you found were of value or utility to the purpose of your visit where 1 is no value and 5 is high value.

(1)	(2)	(3)	(4)	(5)
No value				High value

13. How successful did you feel your visit was today where 1 is unsuccessful and 5 is completely successful

(1)	(2)	(3)	(4)	(5)
Unsuccessful				Completely Successful

14. How important is it that you accomplish your overall purpose where 1 is unimportant and 5 is very important

(1)	(2)	(3)	(4)	(5)
Unimportant				Very Important

15. How important is the material you were looking for today in helping you accomplish your purpose where 1 is unimportant and 5 is very important.

(1)	(2)	(3)	(4)	(5)
Unimportant				Very Important

16. How important was it that you get this material today where 1 is unimportant and 5 is very important.

(1)	(2)	(3)	(4)	(5)
Unimportant				Very Important

Appendix 1.5: Non-OPAC Interview Forms

OBSERVER DATA COLLECTION FORM - ACTIVITY REVIEW

Problem Definition

Interviewer--Please note the response given to the questions on Form 4.0. Please be sure you have a full and complete definition of the user problem. If the questions "Purpose of Visit" and "Specifically, what is it that brought you to the library today?" do not address the issue of the purpose to which the information/material is going to be put, please explore the problem by asking "What did you want to do with whatever you wanted to find in the library?"

Observation Log Review

Review Observation Log with User in the following form:

"I would now like to go over with you what you did during your time in the library. For each activity that you were involved in, I would like you to tell me what you intended, how successful you were and why you feel that way."

"The first thing that you did was (read activity from observation form). What did you intend to accomplish? (Response) How successful were you? (Response) Why do you feel this way about it?" (Response)

Review each action the user took and ask specifically what they intended to accomplish, if they were successful and what problems they encountered at that stage.

Notes from Observation Log Review: (Remember to address intent, success and feeling about it)

ACTIVITY NO.	COMMENTS
1.	Did you consider using the computerized library catalog today? If you did consider it, why didn't you use it? If you did not consider it, why didn't you consider it?
2.	What will be your next step in relation to the purpose that brought you to the library today?
3.	Do you have any overall comments relative to your experience in the library today?

Appendix 2: Data Analysis Sample
Appendix 2.1: Transcript of Interview (Alex0117)

- 1 I: Could you tell me specifically what you said that brought you
2 to the library today?
- 3 U I'm trying to find a book that has a picture of a man that
4 I'm writing a report about so I can make a picture of him on
5 the MqacPaint, on the computer, so that's what I came here for.
- 6 I: Okay, the picture is for?
- 7 U: For a report, a term paper.
- 8 I: Before I caught you have you done anything?
- 9 U: Yeah, I'm finished I just wanted to do this as like a cover
10 page. I have a 5 hour Mac and I'm just going to MacPaint
11 today if I could finish it.
- 12 I: Okay, but I mean in the library, if the terminal the first
13 place you came into.
- 14 U: Yeah, as soon as I came in.
- 15 I: Alright, I would like to go with you what I observed. The
16 first thing when you went to the terminal, could you tell me
17 a little bit about how you went about your research?
- 18 U: I used author.
- 19 I: The first thing you did was choose author? And then could
20 you tell me, because I didn't get a chance to read them ,what
21 I would like you to do is tell me screen by screen, okay, what
22 you did, and what you intended and how successful were you,
23 okay?
- 24 U: Okay.
- 25 I: So the first thing hat you did was choose author?

26 U: Um-huh.

27 I: And then the screen would give you a list of entries right?

28 U: Right.

29 I: And what did you

30 U: I typed in the author's name,

31 I: Um-huh.

32 U: and then I sent it,

33 I: Yes.

34 U: and then it brought up the authors name with a couple of

35 selections

36 I: That's right.

37 U: and I wrote down the call number.

38 I: Okay, you saw that book right there. I see. Did you go any

39 further?

40 U: No that was it.

41 I: you got the call number from there and then you stopped there.

42 U: Right.

43 I: And how successful were you.

44 U: I found my book.

45 I: Okay, so you came up to the second floor, right?

46 U: Um-huh.

47 I: And then you kind of browsed the shelf, what did you intend

48 at that time?

49 U: Well at first, I see that they are trying to rearrange the

50 library and I'm not sure if they finished it yet but when I

51 look on the card it says "E" but there are no "E" books there.

52 So then I went around the corner and I saw "D" all the way up

- 53 to "DZ" and then I got on to the "E." But to try to move the
54 library around they are doing it really slow. So the book are
55 kind of, some places, some places have two sections for the
56 same thing, they are not all there yet.
- 57 I: I see. So when you browsed the shelf, what did you look at?
- 58 U: I just, I looked for the numbers that I wrote down, for the
59 call number and you know just to see what else is there while
60 I'm there, in case I need something else.
- 61 I: And how successful were you?
- 62 U: Very, I finished.
- 63 I: When you browsed did you find anything else?
- 64 U: Yeah, I saw most of the books I already had, I've been
65 researching this paper for over a month so,
- 66 I: I see.
- 67 U: Most of the books are already familiar to me.
- 68 I: So, then when you pulled out his book, you kind of browsed
69 it, scanned the text, what did you intend at the time?
- 70 U: To see if they had the kind of picture that I'm looking for.
71 That's basically it, because like I said the text is already
72 written the paper, I'm just trying to make the cover page.
- 73 I: Okay, so you found that right. So then you went back to check
74 out the book, okay, great. What will be your next step in
75 relation to the purpose that brought you the library today?
- 76 U: Like I said, I'm going to go back and use the Mac and try to
77 see if I can make a half decent representation of the picture
78 in this book. And then I'm finished I'm really finished.

(Questions not related to this analysis are omitted.)

Appendix 2.2: Data Analysis Sample (Alex0117)

ID #	Leading Search Goal	Current Search Goal	Interactive Intention	Information Seeking Strategy	Outcome	Factor
al17a1	term paper 7	find a book that has a picture of a man 3-5	find/locate items with common characteristics 25-26	search a system 30	successful 34-35, 44	
al17a2	term paper 7	find a book that has a picture of a man 3-5	keep record specific items 37	acquire meta-information 37	successful 37, 44	
al17a3	term paper 7	find a book that has a picture of a man 3-5	access items specific items 58	track meta-information 45, 47-48	unsuccessful 51	environment 49-56
al17a4				trial and error 52-53	successful 62	
al17a5	term paper 7	find a book that has a picture of a man 3-5	find items with common characteristics 58-60	scan one location 57	unsuccessful 64	domain knowledge 64-65
al17a6	term paper 7	find a book that has a picture of a man 3-5	evaluate the usefulness of an item 70-72	scan the whole item 68-69	successful 62	
al17a7	term paper 7	find a book that has a picture of a man 3-5	obtain the item 73-74	acquire a whole item 73-74	successful 73-74, 77-78	

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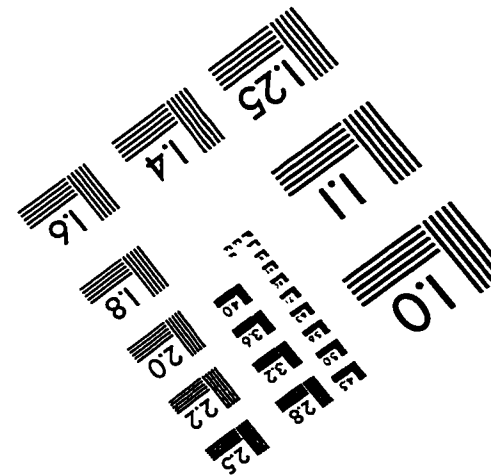
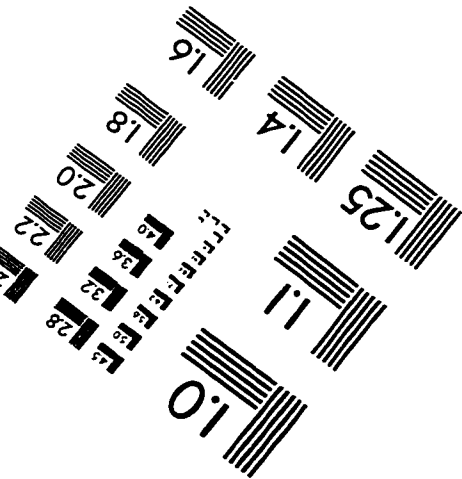
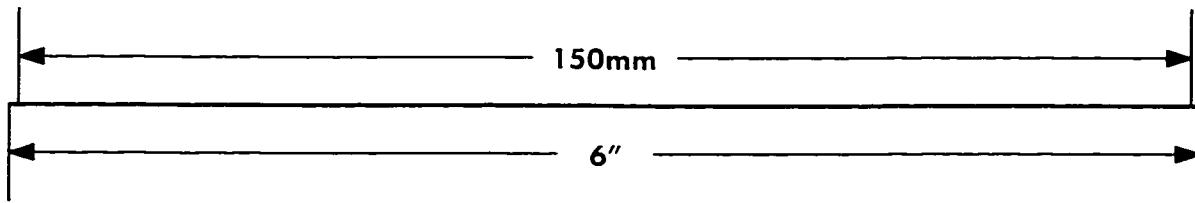
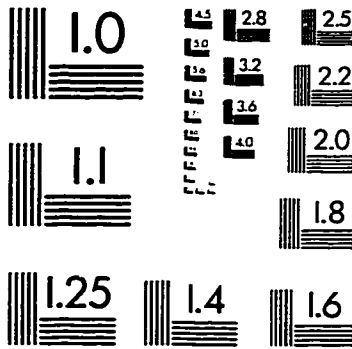
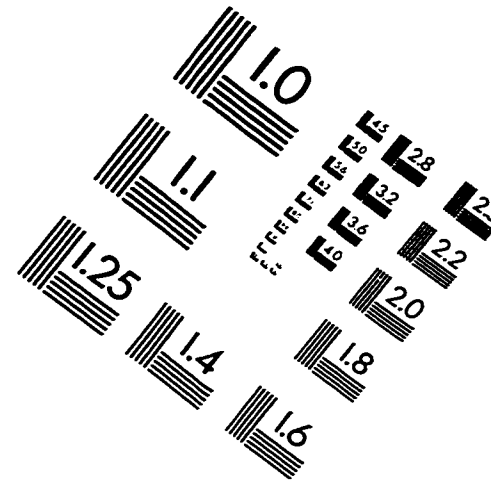
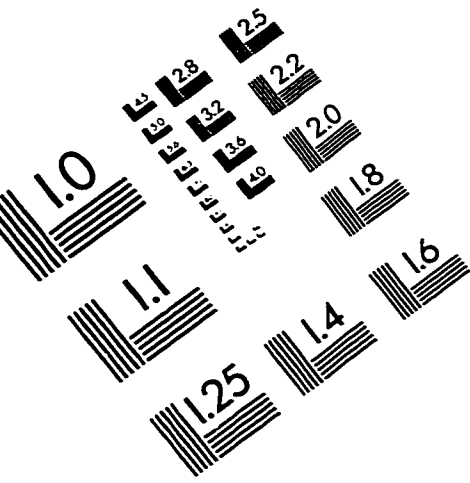
VITA

Hong Xie

- 1986 B.A. in School of Library and Information Studies
East China Normal University
Shanghai, China
- 1987 Yang, Z.R. & Xie, H. The Pattern of the Growth of Author Teams.
Journal of Information Science 8(6): 15-17.
- 1988 Yang, Z.R. & Xie, H. Defining Information Science by Using Inductive
method. Journal of Information Science, 9(1): 45-48.
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Shanghai Academy of Social Sciences, Shanghai, China.
- 1989 Xie, H. Situational Elements in Relation to Users' Information Utilizing.
Journal of Post Graduates, Academy of Social Sciences, 3:60-62.
- 1989-1990 Research Associate, Information Institute,
Shanghai Academy of Social Sciences, Shanghai, China.
- 1990-1991 Manager, AT&T Shanghai Office, Shanghai, China.
- 1991-1992 Research Assistant, School of Library and Information Studies
Alabama University, Tuscaloosa, Alabama.
- 1992 M.L.I.S. in School of Library and Information Studies,
Alabama University, Tuscaloosa, Alabama.
- 1992-1995 Teaching Assistant, School of Communication, Information and Library
Studies, Rutgers University, New Brunswick, New Jersey.
- 1993, 1994 & Project Manager, Intellectual Property Division
1995 Summer AT&T, Liberty Corner, New Jersey
- 1996-1997 Research Assistant, School of Communication, Information and Library
Studies, Rutgers University, New Brunswick, New Jersey.
- 1997-1998 Adjunct Instructor, School of Communication, Information and Library
Studies, Rutgers University, New Brunswick, New Jersey.

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- 1998 Ph.D. in Communication, Information and Library Studies, Rutgers University, New Brunswick, New Jersey.

IMAGE EVALUATION TEST TARGET (QA-3)



APPLIED IMAGE, Inc
1653 East Main Street
Rochester, NY 14609 USA
Phone: 716/482-0300
Fax: 716/288-5989

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