Task complexity, information types, search strategies and relevance: integrating studies on information seeking and retrieval

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INTRODUCTION

Research in information science aims to comprehend the facilitation of access to information for supporting purposeful action. The major themes to be addressed have been how information is organized for access, how it is retrieved from storage, and how it is sought out and used for various purposes. Two central research areas in the field are information retrieval (IR) and information seeking (IS) (Vakkari & Rochester, 1998). Although intuitively the fields seem to be overlapping, their research communities have been active in their own enclosures. Few researchers have visited the neighboring side. However, there are researchers (Bates, 1989; Belkin & Vickery, 1986; Belkin, 1993; Ellis, 1989; Ingwersen, 1992, 1996; Järvelin 1987; Kuhlthau, 1993; Marchionini, 1995; Saracevic & Kantor, 1988) who have stressed the need to connect results from both research traditions.

IR can be seen as a part of a broader process of information seeking. By IS is understood a process of searching, obtaining and using information for a purpose (e.g., form a solution for a task) when a person does not have sufficient prior knowledge. By IR is understood the use of an information system for obtaining relevant information for a purpose (e.g., a task). This implies that information systems are a specific means among other sources and channels for obtaining information. Thus, from the point of view of a person construing a solution by using information from various sources, IR systems and retrieving information provide one

means of getting in touch with useful information for that purpose. It is obvous that the role of IR systems and the information they provide varies depending on the task and the situation of the actor (Checkland & Holwell, 1998; Ingwersen, 1996; Järvelin, 1987; Kuhlthau, 1993).

Although boundary spanners in information studies have shown a common field of interest in IR and IS studies - understanding information needs reflecting tasks, for information retrieval interaction and systems design - the integration of the research traditions is fragmentary. The field of IR has mostly been interested in representations of documents for their retrieval, search strategies, and assessment of the relevance of retrieved documents, and not so much in representations of information needs and actions to be supported. (Bates 1989; Belkin, 1993; Schamber 1994). On the other hand studies in IS have mainly concentrated on the use of documents and channels for supporting various actions, but not connecting results for developing IR systems (Ingwersen, 1992; Rouse & Rouse, 1984; Vakkari, 1997). Figure 1 shows in greater detail the relations between the various types of IR and IS studies.

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<tr><th colspan="2" rowspan="2"></th><th colspan="2">System-oriented</th><th colspan="2">Non-system-oriented</th></tr>
<tr><th>Documents*</th><th>Channels*</th><th>Documents*</th><th>Channels*</th></tr>
<tr><td rowspan="2">Non-task-oriented</td><td>Non-process-oriented</td><td>Traditional IR study</td><td>L&I service user study</td><td></td><td>Typical user study with multiple channels</td></tr>
<tr><td>Process -oriented</td><td>Interaction with texts within a search session (between sessions)</td><td>Library use study</td><td>Citation study</td><td></td></tr>
<tr><td rowspan="2">Task-oriented</td><td>Non-process-oriented</td><td></td><td></td><td colspan="2">Use of channels and document types for a job</td></tr>
<tr><td>Process -oriented</td><td>Interaction with texts within & between search sessions</td><td></td><td colspan="2">Use of channels and document types for a task
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Use of documents to understand a problem</td></tr>
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* = as objects of study

Figure 1: Typology of IR and IS studies

The point of departure of this paper is that analysing actions to be supported by information and IR systems are vital in understanding the needs of different types of

information, search strategies and relevance assessments, in short, understanding IR. A necessary condition for this understanding is to link results from IS studies to the body of knowledge by IR studies. The actions to be focused on in this paper are tasks and problem solving. I will analyse certain features of work tasks and problem solving and relate these features to types of information people are looking for and using in their tasks, patterning of search strategies for obtaining information and relevance assessments in choosing retrieved documents.

The aim is to develop a theoretical framework for explaining variance in the type of information needed, in search strategies adopted and in relevance assessments in IR in work tasks. The major claim is that these information activities are systematically connected to task complexity and the structure of the problem at hand. The argument is based on both theoretical and empirical results from studies on IR and IS.

First, I will discuss briefly the position of actions to be supported by information in explaining information seeking and retrieval. Then I will introduce the basic concepts of construing a theory for explaining the chosen information activities. Finally, I will partly validitate the theory suggested by presenting empirical findings from studies in IR and IS.

IR AND IS STUDYING INFORMATION IN SUPPORT OF PURPOSEFUL ACTION

In IS studies a central methodological rule has been to start the analysis of information needs and seeking by scrutinizing the activity they are a part of. Information seeking is seen as embedded in the activity that generates it (Dervin & Nilan, 1987; Kuntz *et al.*, 1977; Vakkari, 1997; Wilson, 1981). General models describing this connection has been developed e.g., by Dervin (1992), Kuhlthau (1993), Wersig & Windel (1985), and Wilson (1981, 1997). However, there are only a limited number of advanced attempts at analysing empirically how information seeking is related to the various features of activity (work) processes it supports (e.g., Allen, 1978; Byström & Järvelin, 1995; Dervin, 1992; Garvey, 1979; Kuhlthau, 1993; Kutz & Rittel, 1977; Streatfield & Wilson, 1982; Sutton, 1994). In these studies certain features of the activity have been used to explain variation in use of information, source and channel types. These features include the nature and phase of the R & D process (Allen, 1978, Garvey, 1979; Kuntz & Rittel, 1977), the work process of professionals (Streatfield & Wilson, 1982; Sutton, 1994) and the task

uncertainty or complexity (Byström & Järvelin, 1995; Kuhlthau, 1993). The scope of the few IS studies have included analysis of search strategies or relevance assessment (e.g., Ellis, 1989; Ellis & Haugan, 1997; Kuhlthau, 1993; Sutton, 1994). Thus, the traditional domain of IR has mainly been untouched by IS studies.

Several researchers (Bates, 1989; Belkin, 1980, 1996; Ellis, 1989; Ingwersen, 1992, 1996) have contributed to developing a more general model of IR based on the interaction of texts and users. This interactionistic approach supposes that information searching is inherently an interactive process between humans and texts intermediated by an IR system. Bates (1989: 409-410) describes IR as evolving searches. Every new piece of information the searcher encounters gives him new ideas and directions to follow, and consequently, a new conception of the query. She called this process berrypicking. Belkin (1993) also remarks that if an information seeker's knowledge changes by virtue of engagament with the text, it will be reflected in some change in the anomalous state of knowledge that led to that information seeking. Thus, it is evident that this will lead to a change in the search tactics by the seeker as well as his criteria of assessing the relevance of the information carried by the texts.

The interactionist approach emphasizes the changing nature of information needs during the search process. However, it typically studies moves between search strategies without relating these changes to variance in information needs. The research concentrates more on identifying the steps of search strategies than explaining patterns of the strategies by changes in information needs or by features of the activity that generated the search. This is reflected in the research setting of many of these studies: IR has been studied as the interaction between texts and a searcher within a single search session. The session might consist of several search strategies and resemble the berrypicking model presented by Bates (1989). The searcher might modify at least the query, and propably the request if the process changes his problematic situation. It is crucial that the IR interaction is understood here as a process containing a single search session. If we analyse IR as a tool for obtaining information for problem solving, it becomes obvious, that limiting the interaction within a single session does not cover the whole process of problem solving or task performance. Consequently, the single session aproach will not depict accurately the changes in information needs during the problem solving process, and thus, it does not reflect the changes in the conceptual structure of the actor. However, the ultimate goal of IR systems is to match the representations of the conceptual structure of an actor in a problematic situation to the conceptual structure of the texts or their surrogates in the system, and provide relevant texts in each phase

of the problem solving. The single session approach is not capable of answering this challenge.

The research put forward by the interactionist approach has deepened our understanding of the IR process. Many studies (Bates, 1989, Belkin *et al.*, 1993, Ellis & Haugan, 1997) have contributed to our understanding of the nature and elements of the information search process. However, they have left open the question about the relations between task performance that have led to an anomalous state of knowledge, and the choice of information search tactics found in the studies. Thus, the studies have been classificatory.

To conclude, it seems that studies on IS have not succeeded in contributing to how changes in the problematic situation and consequent information needs are reflected in patterning of search strategies and relevance assessments. The interactionist perspective in IR has been able to demonstrate theoretical ideas for relating tasks and problematic situations to IR activities, but its empirical studies have been classificatory finding elements for building theories to link IR interaction with actions that it supports.

BASIC CONCEPTS

Informational support is sought in situations when an actor does not have sufficient prior knowledge to accomplish his purposeful action. This situation is conceptualized as an anomalous state of knowledge (Belkin1980), problematic situation (Wersig 1979), sense making (Weick1995; Dervin 1992) or uncertainty reduction (Daft & Lengel 1986, Kuhlthau 1993). The lack of undertanding generates information actions for solving the problematic situation in order to proceed in the task. The major elements in the situation are actions to be supported by information, insufficient prior knowledge of the actor and informational support mechanisms. In this paper the scope of actions will be restricted into work tasks which will be analyzed from the point of view of problem solving. Thus, the evolving frame work is applicable only for information actions in work environments. In this phase the framework fails to take into account features of the communities, e.g., their structure and information provision where the actions are taking place.

Task complexity

A worker's job consists of tasks which in turn consist of levels of progressively smaller subtasks. Tasks are given or identified by the actor. Each task has a recognizable beginning and end, the former containing recognizable stimuli and guidelines concerning goals or measures to be taken (Hackman, 1969; Byström & Järvelin, 1995). Seen in this way, both large tasks as such or any of its subtasks may be considered as a task. In this study tasks are analyzed as perceived by the actors, because the understanding of the task by the actors is the basis for his interpretation of information needs and promising actions for satisfying them (Byström & Järvelin, 1995: 193).

The complexity of a task is a central feature in determing its performance and consequent information needs. Task complexity can be understood in many ways (Campbell, 1988; Järvelin, 1987; March & Simon, 1967; MacMullin & Taylor, 1984; Van de Ven & Ferry, 1980). Its central dimensions can be reduced to a priori determinability of tasks and the extent of tasks. (Byström & Järvelin, 1995: 193) In IS research *a priori* determinability is the feature of task complexity which has been mostly used in studies (Vakkari, 1998). It will be the point of departure in defining task for the target framework.

By task complexity is meant the degree of predeterminability of task performance. The predeterminability of a task can be divided into the predeterminability of its information requirements, process, and outcome. The determinability of the task is often associated with its structuredness. (Byström & Järvelin, 1995: 194; Van den Ven & Ferry, 1980) By structure is meant the elements of the task and their interrelations (cf. Partridge & Hussain, 1995: 82). The more structured the task, the more determined in advance is its performance. Both definitions imply that the determinability of the task increases when knowledge about its information requirements, process and outputs increases. The more the actor knows about the dimensions of the task, the less complex it becomes, and the easier it is to accomplish. Thus, we can connect the degree of predeterminability of a task to the structuredness of the knowlege or conceptual space of the performer about the task. The structure of the conceptual space depends on a person's prior knowledge of the dimensions of the task. If there is a severe lack of knowledge about the task, we can say that the person is in a problematic situation and has an anomalous state of knowledge.

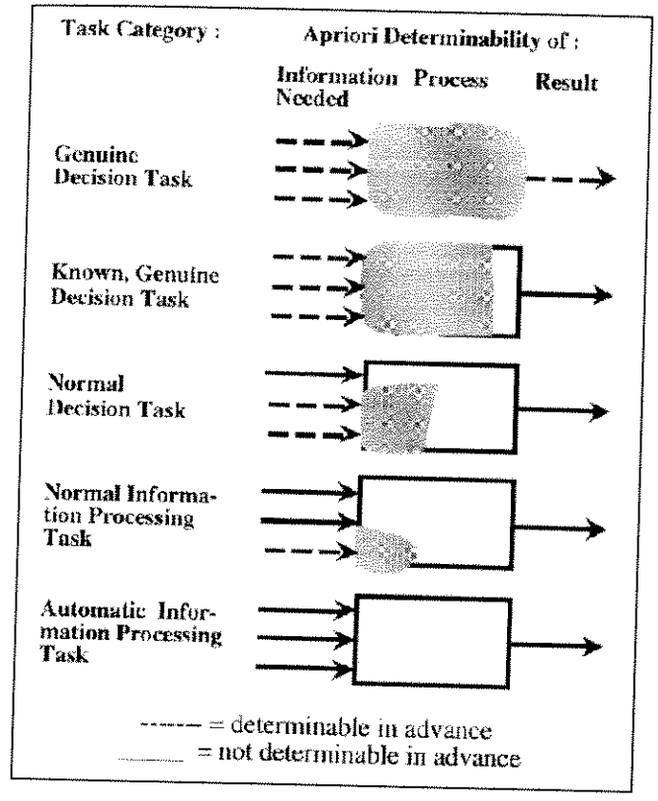

Figure 2: Task categories

Byström and Järvelin (1995: 194-195) have divided task complexity into five categories according to the predeterminability of information reguirements, process and output of the task (Figure 2). Simple tasks are routine information processing tasks where the elements of the task are predetermined, i.e., the actor knows them. Complex tasks are new and genuine decision tasks where the information required for the accomplishement cannot be determined in advance.

Problem structure

Problem formulation and problem solving are distinct phases in task performance. The structure of a problem is a central feature in problem solving. A problem is structured if the variables involved and their relationships are well known, and unstructured, if they are unknown or vague. (Partridge & Hussain 1995: 82) In problem treatment formulation creates a solution space and determines the information requirements of the task (Byström & Järvelin 1995: 194). After the formulation step, the actor has a problem that might be solved, and he knows more clearly what information is relevant. The problem formulation includes the choice of the central elements (concepts and their relations) of the task, and guides the actor to focus on them.

There is a direct relation between task complexity and its problem structure. The more structured the problem of a task, i.e., the more is known about its central variables and their interrelations, the more determinated are its information requirements, process and outcome. The more clearly an actor knows the major elements of a task, the better he is capable of assessing what kind of information is needed and what processes are required for its accomplishment. We can also infer that simple tasks are typically tasks with structured problems.

Kuhlthau (1993) has shown that task performance can be differentiated into various phases depending on how clearly the actors understand its information requirements, and structure the process. Once the focus of the task has been identified, actors tend to employ different information seeking strategies. Prior to the focus identification their understanding of the problem was vague and they used general information sources. After focus finding their conception of the task became clearer and they used more specific sources.

As Byström & Järvelin (1995: 194) have pointed out, in terms of Kuhlthau's (1993) model, the phases of initiation, selection, exploration and formulation belong to the problem formulation step, and collecting and presentation to the problem solving step. If a problem is formulated, it is structured, and thus, it has a focus. The stages can be called the pre-focus and post-focus stages.

Focus formulation of the problem is a crucial step in task performance. Once this is done, the actor has more insight about what information might be useful. Thus, the process of a task performance is characterizised by the increasing awareness of its information requirements. The structure of the task also becomes clearer. The progress in task completion and problem solution is correlated with the growth of

knowledge on the issue at hand as well as with the decrease in perceived task complexity.

Prior knowledge

Prior knowledge about a task by an actor is a major factor in determining what information is needed for its accomplishment. Current research both in cognitive psychology and in organization research has shown that human perception and learning of new categories is dependent on our knowledge and theories about the world. Theory refers to a body of knowledge that may include scientific principles, stereotypes and informal observations of past experiences. (Checkland & Howell 1998: 98-104; Choo, 1998; Hahn & Chater, 1997: 49-50; Heit, 1997: 10-15; Weick 1995) In learning about new categories people act as if these categories will be consistent with previous knowledge. People seem to act economically, so that previous knowledge structures are reused when possible. According to Heit (1997: 10-15), learning of new categories is affected by our prior knowledge about the world so that it steers us to integrate our previous knowledge to new categories, and to selectively weigh up objects and their features. This selective perception is a result of the interest, previous experience and history of the actor (Checkland & Howell, 1988; Choo, 1998; Weick, 1995).

The significance of prior knowledge to human action and information processing is also expressed in the root definition of the cognitive paradigm in IR. It implies that each act of information processing - whether perceptual or symbolic - is mediated by a system of categories and concepts which, for the information processing device, constitute a world model (De Mey, 1980).

Althought the cognitive point of view has expressed an interest in prior knowledge and its relations to the changes of cognitive sructures of actors in information searching, we can find few studies that try to capture this theoretically or empirically. In IS this problem is tackled e.g., by Dervin (1983, 1992), Kuhlthau (1993), Sutton 1994, Todd (1997), Wersig (1979) and Yang (1997). IR studies by Belkin (1980, 1996), Brookes (1975), Harter (1992), Ingwersen (1992, 1996) and Wang (1997) are indicative. One of the main difficulties in research has been how to describe changes in understanding, i.e., in cognitive structures.

We can conclude that prior knowledge is vital in determining what information is needed to accomplish a task. This implies that the degree knowledge about the task is the principle which determines what type of information is sought, how the search strategy is formulated and how the information discovered is evaluated and utilized.

Cognitive structures

IR research is interested in cognitive structures both in the mind and in literature and especially their interaction in IR . They both can be described as consisting of concepts and their relations. In cognitive psychology these structures are called mental models or semantic networks (Gavin 1998: 85-107). In theory of science a familiar noun for concepts and their relations is theory.

If an actor has insufficient knowledge and thus, insufficient conceptual structure about a task, it implies that he does not have the necessary concepts and links for the phenomena he intendends to understand. We can say that insufficient knowledge refers to the degree a person is capable of connecting a task with his prior knowledge. By combining this with our definition of task complexity, we can infer that insufficient knowledge refers to the degree a person is incapable of relating his prior knowledge about information requirements, process and outcome of the task to his knowledge structures. The person might be lacking sufficient concepts, relations or if-then relations.

The process of problem solving is moving from a vague conception of the problem with a state of uncertainty towards a more clear understanding of the problem with a coherent conceptual structure. Once the task has accomplished a person has a more developed conceptual structure concerning the task. We can borrow ideas of describing growth of theories from the theory of science for modelling this growth of knowledge and understanding (Kuokkanen & Savolainen 1994; Wagner & Berger, 1985; Vakkari & Kuokkanen, 1997).

The scope of a person's conceptual structure refers to the domain covered by those concepts. Differentiation refers to the degree of differentiation of the conceptual structure in the domain. Integration refers to the amount of interrelations between the concepts in the domain. Thus, we have three elements for describing a conceptual structure: scope, differentiation and integration. The broader, the more differentiated and integrated the conceptual structure of a task, the richer it is. A rich conceptual structure is equivalent to abundant knowledge about a domain, e.g., task. It is also evident that the more concepts and links an actor has in a problem domain, the more options, i.e., positions, he has for creating and linking new concepts in his knowledge structure.

An expert can be described as a person who has a rich conceptual structure in his field. His comprehensive and differentiated knowledge model of the problem domain provides him with more options (positions) to infer from his knowledge resources hypotheses for problem solving than does the more limited knowledge of a novice.

This explains why experts are able to infer more hypotheses for a problem solution based on a single cue than can novices (cf. Marcionini, 1995:34; Wildemuth *et al.*, 1995: 593). We can thus infer that an increase in expertice and learning leads to an increase in predeterminability of the task.

We can now briefly summarise the relation of our basic concepts as follows: the more complex the task, the more ill-structured it is, and the less prior knowledge the actor has. The richer the conceptual structure of an actor about a task, the more clearly can be expressed 1) what type of information is useful, 2) concepts and relations in a request and a query, 3) and criteria for relevant documents; and the easier it is to select relevant documents on the bases of metadata and retrieved documents. Thus a greater number relevant documents can be found. Figure 3 depicts elements of the theory on task complexity and information actions.

	Structure of the problem	
	Ill-structured	**Structured**
Search strategy	• *Browsing* • Scanning1 • Browsing2 • Learning1 • Recognition1 • Surveying-Chaining2 • Journal run3	• *Querying* • Selecting1 • Specification1 • Ending2

Figure 3: Problem structure and search strategies
1) Belkin & all 1993; 2) Ellis & Haugan 1997; 3) Bates 1989

EMPIRICAL FINDINGS

The following studies on the relations between task performance, information types, search strategies and relevance assessment will be analyzed especially from the point of view of stages in the task accomplishment. The process will be divided into pre and post focus construction stages. The aim is to find elements which support the theoretical ideas presented from empirical studies.

Tasks, information types and searching

A handful of empirical studies have linked task performance, information types and search patterns. The results show that there is a systematic connection between these elements. Kuhlthau (1993) has differentiated the task completion process into six phases, and has shown, that the information sought and search types vary accordingly. To summarise, the finding of a focus is crucial in the search process. In pre focus phases thoughts are general, fragmented and vague, and actions involve seeking background information. The searcher is unable to construct the task and unable to express specifically what kind of information is needed for it. Browsing and discussions with other people are the most fregvently used modes of information searching. General background sources such as encyclopedias are mostly used at this stage. After a focus has been construed, the search for information becomes more directed. Thoughts about the task become clearer and more structured. A clearer understanding guides the person to seek relevant, focused information using the whole spectrum of information resources. At the end of the process rechecking searches are made for possible additional information.

The findings by Yang (1997: 81-82) corroborate Kuhlthau's results. He identified three major search strategies during the information seeking process in hypertext by students. Each state of searching reflected the subjects current mental state. They typically engaged in exploratory searching before coming up with a specific direction. At this stage they aim to establish a framework for their task. Databases were searched without specific criteria or a coordinated plan. Purposeful searching occurred once they could maintain a more constant points of reference. At this stage they could search for specific information which they had identified as directly relevant to the current goals. Finally, they demonstrated associative searching when they proactively looked for related and interconnected information to support arguments they had already established. Yang (1997: 81) showed also, that as the task becomes more clear, the share of exploratory and purposeful searches decrease and associative increase.

In a study of the work of higher civil servants, Byström and Järvelin (1995) showed that task complexity is systematically connected to the use of certain information types. They differentiate between problem information (PI), domain information (DI) and problem solving information (PSI). PI describes the structure, properties and requirements of the problem. DI consists of known facts, concepts, laws and theories in the domain of the problem. PSI covers the methods of problem treatment. It describes how problems should be formulated, and what PI and DI should be used in order to solve the problem. According to Byström & Järvelin

(1995) as task complexity increases, 1) the number of different information types increases, 2) the need for DI and PSI increases, 3) the share of general purpose sources increase, 4) the share of problem and fact oriented sources decreases, and 5) the number of sources used increases.

Tasks and search strategies

The studies by Kuhlthau (1993) and Yang (1997) already showed connections between search strategies and the stage of task performance. Next we will present results by Ellis & Haugan (1997) on the relation between the R & D process and search patterns. Then we will introduce categorization of search strategies by Belkin, Marchetti and Cool (1993). Finally, we will summarize the findings on search strategies and connect them to the problem structure.

Ellis and Haugan (1997: 388) have modelled the information searching patterns of engineers and research scientists. They found eight generic search strategies, of which five that relate to this study are introduced. Surveying is characterized by the initial search for information to obtain an overview of the literature. Chaining means following chains of different forms of referential connections. Monitoring is characterized by activities involved in maintaining awareness of developments in a field by regularly following particular sources. Browsing refers to the scanning of primary sources or metadata from searches. Ending means rechecking of sources in the final stage of accomplishing a task.

Ellis and Haugen (1997: 388) leave open the interrelations of these activities. However, in some cases they relate the stage of the research process to certain information seeking patterns. Ellis and Haugen (1997: 400) claim that when researchers progress through preliminary to advanced phases of the project, and become more knowledgeable and specific about the problem, they are increasingly selective. The use of formal channels decreases as they progress in the project, and person to person communication becomes more dominant. Thus, the more familiar the topic, the more the use of formal channels decreases and informal, person to person, increases.

Studies by Allen (1978) and Garvey (1979) also show that the type and source of information used by scientists and engineers vary depending on the statge of the R&D project. These studies also showed that problem formulation was a crucial differentiator in source selection and information use.

Belkin *et al.*, (1993) have categorized information seeking strategies by combining three dimensions. Method of interaction differentiates between searching,

which refers to looking for a specific item, and scanning, which means looking around for something interesting. The goal of interaction is either to learn about relevant issues by inspecting items and their contents, or to select useful items by identification. Mode of retrieval differentiates between recognition, which refers to looking around in a group of items, and specification, which refers to searching for items on some identified topic.

As argued earlier, the structure of the problem influences the patterning of search strategies. We suppose that the structure of the problem differentiates search strategies as depicted in Figure 4.

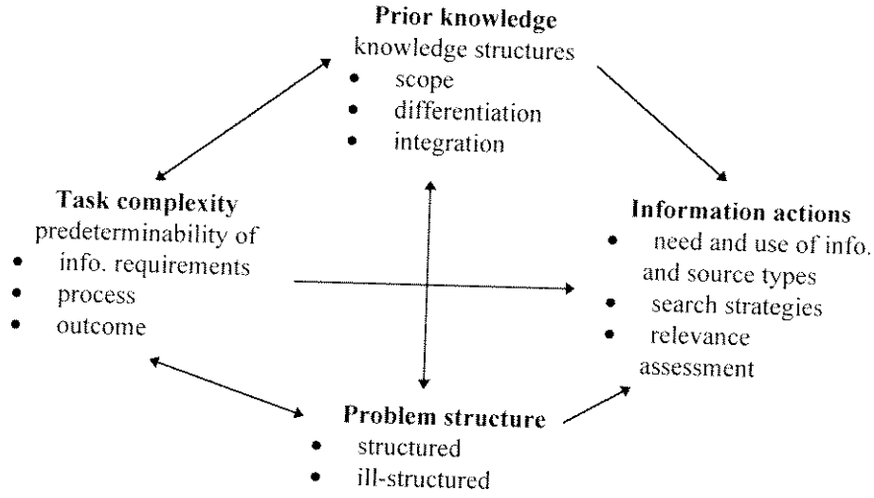

Figure 4: A model of task complexity and information actions

Ill-structured problems lead to ill-structured searches. If concepts and their links in a problem domain are vague, it will not be possible to formulate an exact request and consequently a structured query (Marchionini, 1995; Taylor, 1986). Browsing is the generic search strategy in these cases. By browsing is understood information searching where the initial search criteria or goals are only partly defined or known in advance (Chang & Rice 1993: 235). In several studies (O'Connor 1993: 213; Chang & Rise 1993: 238; Marchionini 1995: 100) it is argued that browsing is a major mode of looking for ideas, approaches and general information when shaping the structure of a task. Surveying and chaining (Ellis & Haugan, 1997), and journal

run (Bates, 1989) are typical strategies as well as browsing of referencies and abstracts from retrospective searches. In the latter case I would differentiate between browsing where the object is metadata and scanning where the object is text.

The mode of interaction in the current case is learning (cf. Belkin *et al.*, 1993). In the pre-focus phase when a persons' cognitive structure is vague it is more likely that he is browsing in the database in order to learn something about the problem domain than directly selecting texts, although this would be expected to be his ultimate goal. It is also likely that persons with ill-structured problems choose recognition as their mode of interaction in state of specification. Because their topic is unfocused they don't have an identified topic to search for. It is more typical in these situation to look around in a group of items.

In the opposite case, when the problem, and thus also request and query are structured, the term for this generic search strategy would be querying. In the post focus stage the typical search strategy is the formulation of exact queries. The goal of interaction occurs more in selecting useful items, and the mode of retrieval specification when one is looking for items on some identified topic.

Tasks and relevance

There are a handful of empirical studies analysing relevance assessments in relation to dealing with problems. Saracevic and Kantor (1988) found that if a user has a well-defined problem, then the probability to judge the retrieved items as relevant increases. If a problem is well defined, the user has been able to form a focus for his problem. In a post focus situation the actor has a structured mental model of the phenomena he is intrested in, and thus, he is able to assess clearly the contribution of the sources to his task. Saracevic and Kantor (1988) also showed, that if a request is low in clarity and specifity, then the possibility of judging the retrieved items as relevant increases; and if a question is high in complexity or presuppositions, it increases the odds that retrieved items would be assessed as relevant. Both of these cases refer to the pre-focus stage of task performance when the requester is unable to formulate his problem. In the pre-focus phase the conceptual structure of the problem is vague and the discrimination power of its concepts is low. The criteria for relevance are loosely defined, partial and fuzzy. All references that indicate that the source could contribute in some way to the problem solution are accepted. An ill-structured problem implies an ill-structured set of relevance criteria, which in turn have a low filtering capacity.

Wang (1997) has studied how users' information needs change at different stages of a research process by analysing their document selection from retrieved documents. She analyzed the vocabulary of users in request, document selection and post-project stages. She showed that the persons introduced narrower and related terms as the research process proceeded (Wang 1997: 312-313). Introduction of narrower terms refers to the specification of the research problem and construing a focus for the work. It is typical in the research process that a general topic transforms to a more focused research problem. Conceptual relations within the problem field also become more differentiated. This implies the possibility of using narrower and related terms.

Wang (1997: 315) also showed that the actual vocabulary in each later search stage is substantially larger in size than in the previous one, broader and deeper in hierarchy, and wider in breadth. This also refers to the growth of understanding of the research problem and its solution. When the researcher is proceeding towards the end of the research process with a structured problem he has a more detailed and structured image of the research theme. Central concepts and their relations can be experessed in greater detail. Thus, the vocabulary is broader and the terms more specific and precise.

We can consclude: the more structured the problem, the more precisely the relevance of a document can be assessed both in terms of content and meta-information..

CONCLUSIONS

Task complexity and the related structure of the problem are crucial factors that determine task performance. They are connected systematically to the types of information people are looking for and using, to patterning of search strategies, and choice of relevance criteria in tasks. In this paper an outline of a theory between task complexity and information actions has been sketched. Task complexity and its systematic relations to central dimensions of these information actions are elements from which we can build a more comprehensive and precise theory of information searching. It presupposes two kinds of theoretical activities. First we have to specify the working strategy (Wagner *et al.*, 1992) of information searching, and incorporate task complexity into it. Ingwersen's (1996) attempt at this kind of working strategy is a sound point of departure. On the other hand we should sketch a research program for analyzing the various relations between task complexity and the major dimensions of information activities. A research program consists of a set of interrelated unit theories and the empirical research for testing them (Wagner &

Berger, 1985). Thus, conserted efforts for theoretically sound empirical research would lead to a growing understanding of the phenomena of information seeking and use. This is turn could be utilized in the building of systems or other means of obtaining information.

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