

# An Integrated Model of Information Seeking and Information Retrieval

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**Abstract.** While past studies in Information Retrieval have been largely ‘system-centric’, studies in Information Seeking have revolved around the needs of the user and the process of seeking. Lately, there have been calls for collaboration between the two and a growing realization that information retrieval research needs extension toward more context, while information seeking research needs extension towards task and technology. In this paper, we present an integrated model of information seeking and retrieval. The model is based on several past models of information seeking and information retrieval, and draws on the work of several leading researchers in the field. The model contributes to theory development in the field. It would also be useful to practitioners and designers of information systems for research. A number of propositions based on the model have also been presented. The model can be tested empirically through experiments and surveys. An example is also provided whereby this process of synthesis among models could serve as a methodological move, whereby the work of a particular theorist is taken and other theories and models mapped to it. This should help bring about synthesis and convergence in research.

**Keywords:** Information behavior, Information Seeking, Information Searching and Information Retrieval, Sense-making, Models, Frameworks, Theories, Methodological move

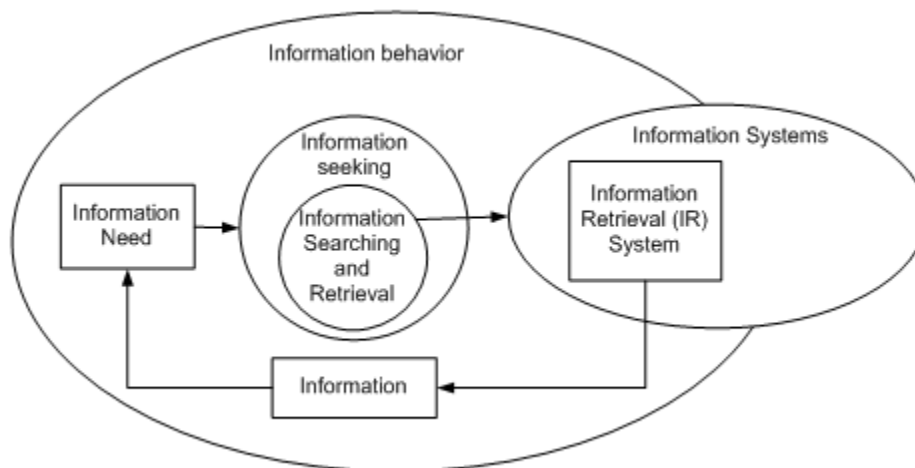
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## 1 Introduction

‘Information, usually seen as the precondition of debate, is better understood as its by-product. When we get into arguments that focus and engage our attention, we become avid seekers of relevant information. Otherwise we take in information passively - if we take it in at all.’ (Lasch 1995, p.162). A commonly held view with sundry minor variants is that data is raw numbers and facts, information is processed data or a construct on a continuum somewhere between data and knowledge (North *et al.* 2004), and knowledge is authenticated information (Machlup 1980; Dretske 1981; Vance 1997). Yet the presumption of hierarchy from data to information to knowledge with each varying along some dimension, such as context, usefulness, or interpretability, rarely survives scrupulous evaluation (Alavi and Leidner 2001). According to North *et al.* (2004), information is determined or defined by its use and has value when it is relevant to the task at hand, is available in the right format at the right place, and is considered fairly accurate and recent. There are always generators and users of information. The generators produce the information whereas the users consume the information. It is important to link the users of information with the appropriate generator. Effective information systems and information transfer requires development of theories and ways to ease transfer from generator to user (Ingwersen 1992). As Ingwersen says, this involves methods and technologies that may improve the quality and performance of information.

Apart from information, a number of related concepts have emerged in the interdisciplinary fields of information seeking and information searching/retrieval.



**Figure 1 Related Research Areas**

Figure 1 extends Wilson's nested model (1999 p.263) of the information seeking and information searching research areas to include information, information need, information systems and an IR system. While *information need* is defined as the recognition that our knowledge is inadequate to satisfy a goal that we have, *information seeking* is defined as a conscious effort to acquire information in response to a need or gap in our knowledge (Case 2002). Allen (1996) defines information seeking as 'the behavior that is the directly observable evidence of information needs and the only basis upon which to judge both the nature of the need and its satisfaction' (p.56). *Information behavior* may be seen as a more general field of investigation subsuming seeking and searching, as well as the totality of other unintentional or passive behaviors that do not involve seeking, such as avoiding information (Wilson 1999; Case 2002). *Information searching*, on the other hand, is 'a subset of information seeking, particularly concerned with the interactions between information user...and computer-based information systems, of which information retrieval systems for textual data may be seen as one type' (Wilson 1999 p.263). An *information retrieval (IR)* system has the goal of 'leading the user to those documents

that will best enable him/her to satisfy his/her need for information' (Robertson 1981, p.10) or for the user to obtain information from the knowledge resource which helps him/her in problem management (Belkin 1984).

In this paper, we present an integrated model of information seeking and retrieval. The model is based on several past models of information seeking and information retrieval, and draws on the work of several leading researchers in the field. In the next section, we briefly review the theoretical development in the fields of information seeking and information retrieval and also highlight why an integrated model is needed. The integrated model is then presented. We also discuss how the model is derived from past models in the field. A number of propositions/hypotheses derived from the model are proposed. We also take Dervin's sense-making as an example and illustrate how the process of mapping among models could serve as a methodological move, whereby the work of a particular theorist is made dominant and other theories and models nested under it. This is followed by conclusions and recommendations for further research.

The model contributes to theory development in the field. It should also be useful to practitioners and designers of information systems for research. The model could be tested empirically through experiments and surveys. This process of mapping different models also serves as a methodological move in synthesizing the works of different theorists. We invite other researchers to join in this endeavour, by following the process illustrated in this paper.

Let us look at a brief review of the two closely related fields of information seeking and information retrieval.

## 2 Information Seeking and Information Retrieval – A brief review

Models typically focus on more limited problems than do theories, and sometimes may precede the development of formal theory (Case 2002). Many models of information seeking and retrieval have emerged. While searching and retrieval have had a system focus, information seeking has been concerned about user needs and the process of seeking, without the IT artifact. Wilson (1999) and Case (2002) have been the major sources for this review.

Systematic research on information seeking (use of sources like books or newspapers) goes back a century. In the first three decades of the 20th century, studies were carried out on information *channels* and *systems* – chiefly libraries and the mass media. The first reviews of the literature were published in the 1940s. By the 1960s, such investigations (e.g. the needs and uses of scientists and engineers) were appearing regularly in a variety of journals and reports. But what was mostly carried out was ‘system oriented’ research (Vakkari 1999) where information sources and how they were used were studied, rather than the individual users, their needs (as they saw them), where they went for information and what kind of results they expected. In the 1970s, the emphasis shifted away from the structured information system and toward the person as a searcher, creator, and user of information – making way for terms such as ‘information seeking’ and ‘sense making’ (Case 2002, Choo and Auster 1993).

The *system-oriented* approach has motivated thousands of studies – typically institutionally sponsored evaluations of library use, selective dissemination of information (SDI) programs, information retrieval systems, interface designs, information campaigns, advertising effectiveness, etc. (Case 2002). The classic

information retrieval research tradition commenced with the Cranfield tests in the 1950s and 1960s (Cleverdon 1967) and continued with the MEDLARS evaluation (Lancaster 1968), the work of Vickery (1961), Cuadra and Katter (1967), Saracevic's (1975) work on relevance judgment and Salton's (1971) research on automated systems. These were fundamental influences for the theoretical work of Van Rijsbergen (1979) and Robertson (1977). They also influenced the empirical work of Robertson and Sparck Jones (1976) on relevance feedback and Willett (1988) on comparisons of Boolean and best match searching. The cognitive approach in information retrieval is represented in the work of Brookes (1977), Belkin (1990), Ingwersen (1992), and Vickery, Brooks and Robinson (1987). Croft (1987) and Smeaton (1992) combine research aspects from both the statistical and cognitive approaches (Ellis, Allen and Wilson 1999). Several models of this approach exist, such as Belkin's Monstrat Model (Belkin 1984), Ingwersen's Mediator Model (Ingwersen 1992) and other subsequent models (e.g. Ingwersen 1996; Saracevic 1996; Spink 1997; Jarvelin and Ingwersen 2004a).

*Person-centered* research offers understanding of information seeking and use within the various contexts of people's lives. In the person-centered approach, many models of information seeking exist as well. These range from Donohew and Tipton (1973)'s model (one of the earliest; depicts sequence of events) to the models of search processes by Ellis (Ellis 1989; Ellis *et al.* 1993) and Kuhlthau (1991). These models show a series of cognitive, and affective (Kuhlthau 1991) stages through which people are thought to move as they are looking for information. General models of information seeking, applicable in multiple contexts, occupations, roles and knowledge solutions are those of Wilson (Wilson 1981; Wilson and Walsh 1996), Krikelas (1983), Leckie *et al.* (1996) and Johnson (1997). New ways of looking at

information seeking have emerged, such as Savolainen's (1995) work on *Everyday Life Information Seeking*.

Models of both Ellis and Kuhlthau relate to *active search* mode of information-seeking behavior (put forth by Wilson and Walsh 1996). Krikelas' model shows its age in the way it privileges document/library usage, but is simple and widely recognized. Wilson (1981) is more general as it refers to systems, sources and people. It introduces concepts of results of seeking (success/failure) and degree of satisfaction of a need, but ignores questions of source characteristics and personal preferences. However, it is more useful than Krikelas' model for designing empirical studies on Information Seeking. Wilson and Walsh's (1996) model introduces factors that Wilson's first model ignored – personal variables, modes of seeking, relevant theories of motivations. Johnson's model is causal, simple and general, while Leckie's model is limited to professionals (Wilson 1999). In addition, there have been important meta-theories, such as Dervin's sense-making (1983). A number of theories from various fields such as sociology (Durkheim's grand theory of the division of labour – Chatman (1990) and Roger's (1983) diffusion of innovation theory), mass communication (Katz and Foulekes' (1962) uses and gratifications theory), psychology or cognitive theories (e.g. Daniels 1986) have also been applied to information seeking. Gattis (2002) seeks to explain how novice technical communicators learn to search for information. Recognizing that no single model can fully represent this complex process, Gattis combines two different cognitive models – information foraging theory and strategic planning theory. Other theories used are Chatman's (1996) 'theory of information poverty', Zipf's principle of least effort (Zipf 1949), the cost-benefit paradigm (Hardy 1982), Katz, Blumler and Gurevitch

(1974)'s uses and gratifications paradigm and the Social Action Model (Renckstorf and McQuail 1996).

These models, frameworks and theories in the system-centric (information searching and retrieval) as well as the user or person-centric (information seeking/user studies) tradition of information seeking and retrieval have made a seminal contribution in advancing the field. However, transfer of concepts across user studies and information retrieval/information systems remains problematic and insufficient (Kuhlthau 2005). In their study using citation analysis, Ellis *et al.* (1999) found that scholars do not cite across the overlapping areas of information systems, information retrieval and user studies/information seeking. The tradition of research into information seeking considers information seeking from a systems perspective and information users as passive, situation independent receivers of objective information (Dervin and Nilan 1986). Yet it has been often accepted that information needs and information seeking processes depend on user's tasks (Belkin *et al.* 1982; Ingwersen 1992; Mick *et al.* 1980; Bystrom and Jarvelin 1995). Kuhlthau (2005) has called for collaboration between the insights of user studies and the innovations of information retrieval and information systems.

'These overlapping areas...conduct different streams of research. One stream concentrates on system design and system use mainly at the point of interface. The other stream concentrates on the context and experience of information seeking and use...Collaborative research of this type offers opportunities to apply the findings to designing systems and services that are tailored to specific needs of users.' (Kuhlthau 2005)



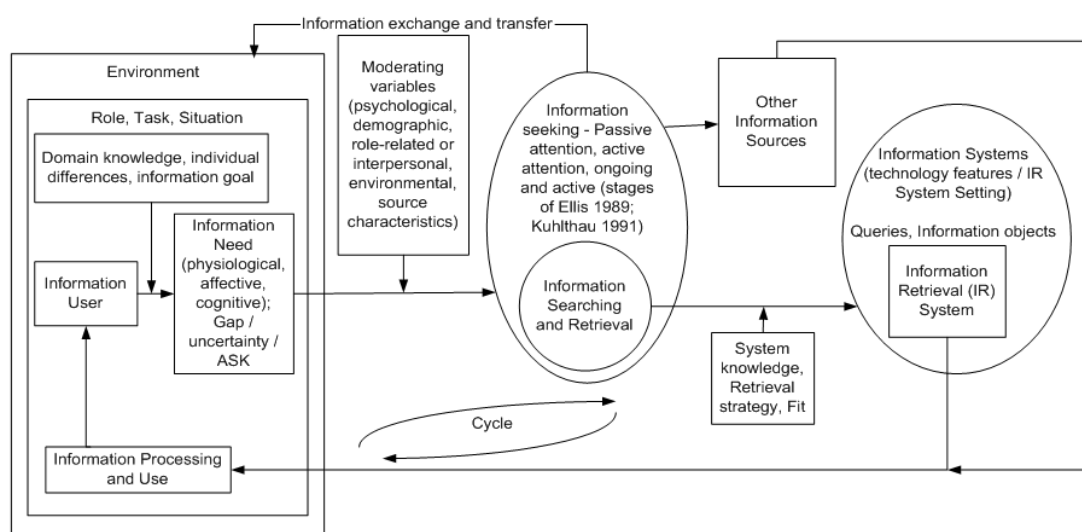
Ingwersen and Jarvelin (2005) and Jarvelin and Ingwersen (2004a) have also concluded that Information Retrieval research needs extension toward more context and Information Seeking research needs extension towards task and technology.

Taking Kuhlthau's, Ingwersen's and Jarvelin's call, this paper endeavours to present a model integrating both the fields. Later, we also illustrate how we could take the work of a particular theorist and map other models and theories to it, thereby contributing to the process of synthesis and convergence in research.

### **3 An integrated model of Information Seeking and Retrieval**

Very few researchers work at the boundaries of information seeking and information retrieval. Notable among these include the work of Cuadra and Katter (1967), Bates (1990) and Saracevic (1975). Jarvelin and Ingwersen (2004) and Ingwersen's (1992) cognitive and Ellis' (1989) behavioral approaches could also be seen as representing contributions to both the areas (Ellis, Allen and Wilson 1999).

We have briefly mentioned a number of models – both in information seeking as well as searching and retrieval. We now attempt to integrate the two closely-related fields into a model that combines the process and person-centred approach of information seeking, and the system-centred approach of information retrieval.



**Figure 2 An integrated model of Information Seeking and Retrieval**

Figure 2 shows the integrated model of Information seeking and retrieval. The model expands the adapted nested model of Figure 1 to combine various models of Information seeking and retrieval.

The model shows that the information user is situated in the context of his work role, task or situation, which are part of the user's environment (work, socio-cultural, politico-economic or physical). Within this context, an information need arises, which may be due to a gap, uncertainty or anomalous state of knowledge (ASK – Belkin *et al.* 1982). The level of uncertainty or gap in knowledge is moderated by the user's prior domain knowledge (Allen 1991; Wildemuth 2003; Miura, Fujihara and Yamashita 2006), individual differences (such as cognitive ability, cognitive style and problem-solving style - Kim and Allen 2002) and his information goal (Limberg 1997; Todd 1997; Kuhlthau 2005). The path from information need to information seeking is moderated by variables (barriers of Wilson 1981) of six types: psychological dispositions (e.g. tending to be curious, or averse to risk), demographic background (e.g. age or education), factors relating to one's social role (e.g. acting as

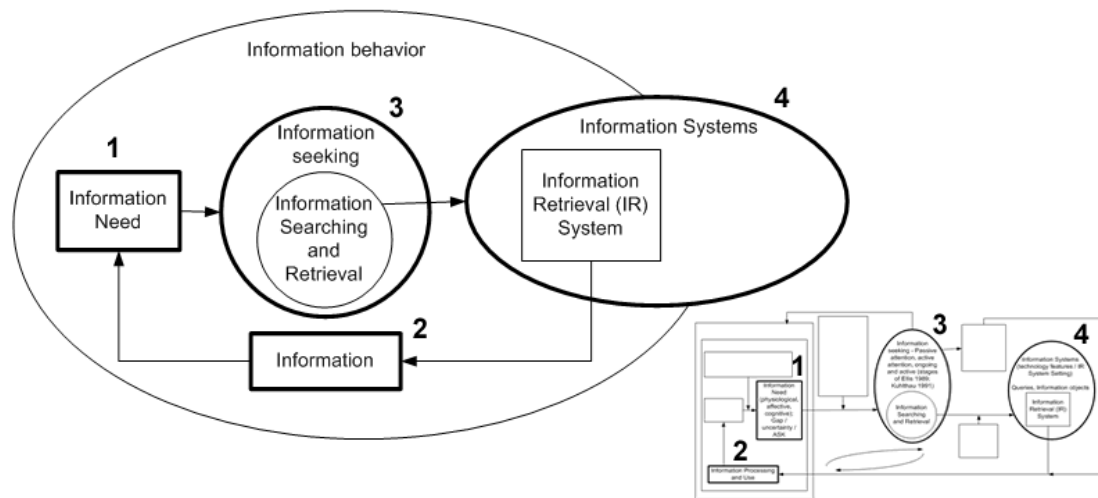
a manager or as a mother), environmental variables (e.g. the resources available) and characteristics of the sources (e.g. accessibility and credibility) (Case 2002). The information seeking process might be passive (taking in information involuntarily or active and ongoing. During active information seeking, the user goes through Ellis' (1989) behavioral stages of starting, chaining, browsing, differentiating, monitoring, extracting, verifying and ending as well as the feelings and thoughts associated with each stage (Kuhlthau 1991). Information may either be sought from people and other information sources (information seeking) or through an information system/IR system (information searching and retrieval). The knowledge of the search system (Dimitroff 1992; Hoelscher and Strube 1999), retrieval strategy and the degree of fit between the search task and the technology features will moderate the path between information searching and the relevance of the search output. The IS characteristics consist of IR system setting such as search language/IR techniques, database structure and indexing rules/computational logic. Queries are sent via the search interface and information objects (text/knowledge representations, full text, pictures and semantic entities) retrieved. The information retrieved from the information system, as well as through other channels such as people is processed and used by the information user, who evaluates whether his need is satisfied or not based on the new information (a new situation in time/space as per Dervin's sense-making approach). This cycle of interactive feedback loops, search tactic or moves and user judgement (as per Spink 1997) repeats until either the need is satisfied or the user loses motivation. Case (2002) interestingly points out that the searcher always 'gives up' eventually, because there is always more that could be known regarding a topic. The question of 'when' is determined by available resources and the searcher's level of motivation. The arrow

from information seeking to the user’s environment highlights information exchange and transfer to people/entities in the user’s environment (Wilson 1981).

#### 4 Existing Models and their mappings to the Integrated Model

In each of the figures below, the model on the left represents the model from which the different portions of the integrated model (at the right) are derived. The number correspond to areas of the models which map to one another.

The two nested ellipses depicting information seeking and information searching/retrieval are derived from Wilson’s nested model (1999 p.263). The model extends Figure 1. See Figure 3 below.

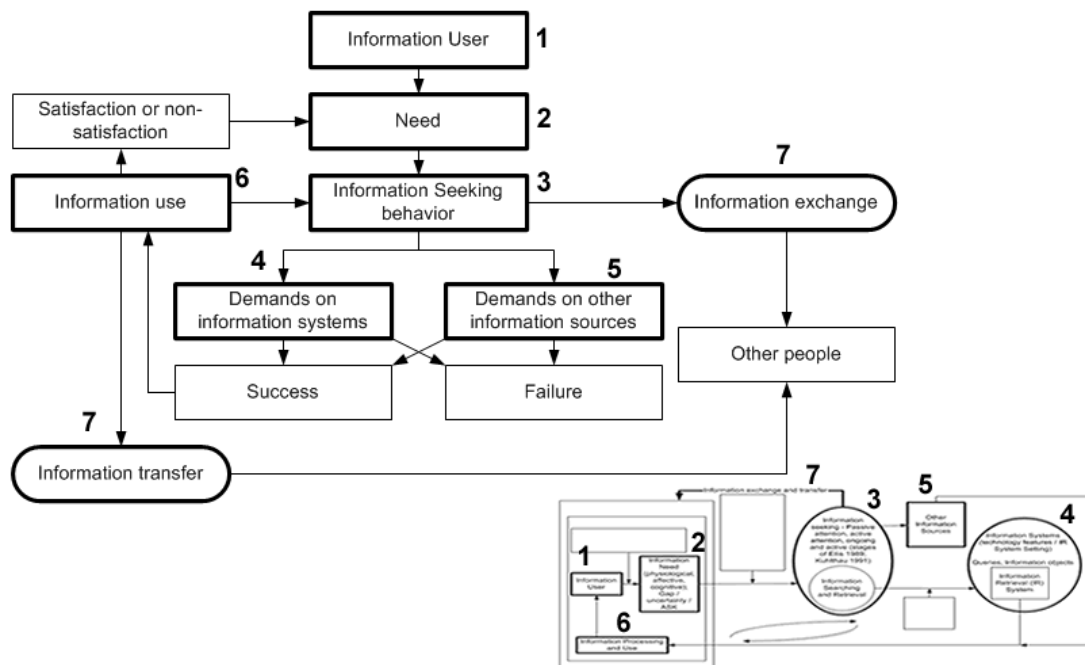


**Figure 3 Extending Figure 2 (derived from Wilson (1999)'s nested model)**

Wilson’s (1981) model of Information behavior (Figure 4 below) elaborates research areas of Figure 1 and Figure 3, with the information searching and retrieval field relating to ‘information seeking behavior’ with ‘demands on information systems’. It includes the concepts of information user, information use (which had received little attention till then), information exchange and the phenomenon of

informal transfer of information between individuals. However, there is no arrow from failure to need (the seeking process typically repeats when a particular search fails to satisfy the need). Also, there is no suggestion of causative factors and it does not directly suggest hypotheses to be tested (Wilson 1999).

In our integrated model, we have drawn the information user and need from Wilson’s (1981) model of Information behavior. See mappings of the numbers 1 and 2 in Figure 4 below.



**Figure 4 Mapping to Wilson’s (1981) model of Information Behavior**

Another well-known approach to information seeking is Brenda Dervin’s (1992) sense-making paradigm<sup>1</sup>. The paradigm has theoretical groundings in the constructivist learning theories of John Dewey (1933, 1960) and Jerome Bruner

<sup>1</sup> ‘Some people call sense making a theory, others a set of methods, others a methodology, others a body of findings’ (Dervin 1992, p.61) designed to cope with information perceived as, ‘...a human tool designed to making sense of a reality assumed to be both chaotic and orderly’ (Dervin 1983).

(1973, 1990) and proposes that information is not ‘something that exists apart from human behavioral activity.’ Rather, it is ‘created at a specific moment in time-space by one or more humans’ (Dervin 1992, p.63). Unlike other approaches to information seeking that see information as something ‘out there’ that is transmitted to people (as Dervin says, an information ‘brick’ that is put into a human ‘bucket’), sense-making sees information as construed internally in order to address gaps or discontinuities (Case 2002; Wilson 1999).

Sense-making is implemented in terms of four constituent elements (Figure 5): a *situation* in time and space, which defines the context in which information problems arise; a *gap*, which identifies the difference between the contextual situation and the desired situation (e.g. uncertainty); an *outcome*, that is, the consequences of the sense-making approach, and a *bridge*, i.e. some means of closing the gap between situation and outcome (Wilson 1999)

In the integrated model, need reflected as ‘gap’ is drawn from Dervin (1992) (see the number 2 in Figure 5) and as ‘Anomalous State of Knowledge (ASK)’ from Belkin *et al.* (1982).

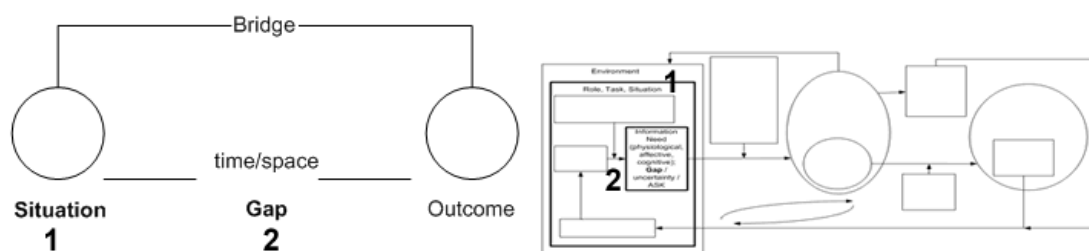
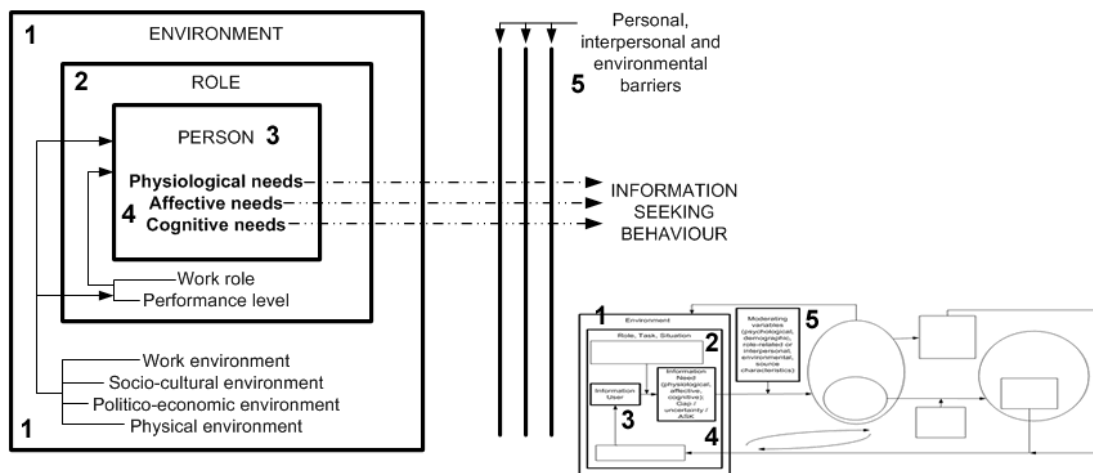


Figure 5 Mapping to Dervin's (1983, 1992) Sense-making theory

Wilson's (1981) model of Information-Seeking behavior (Figure 6) expands the first two boxes of Figure 4 (numbers 1 and 2) – information user and need and leads

to the third box (number 3), information-seeking behavior. The information user is depicted as a person in the context of his work role and surrounding environment. The needs are elaborated as physiological, affective and cognitive. Wilson also introduces the concepts of different types of barriers to information seeking. The strength of the model is that it suggests how information needs arise and what may prevent or aid the actual search of information (barriers). The model implicitly embodies testable hypotheses concerning information needs in different work roles or environments, different types of needs and barriers. The weakness lies in the fact that there is no indication of processes whereby context has effect upon the person, or of the factors that result in the perception of barriers. It is also not clear whether the various assumed barriers have similar or different effects upon the motivation of individuals to seek information (Wilson 1999).

In the integrated model, the contexts of role and environment surrounding the user are from Wilson's (1981) model of information seeking behavior (see numbers 1 and 2 in Figure 6 below), as well as the need-creating event/environment of Krikelas' (1983) model (see number 1 in Figure 7) and the situation in time/space of Dervin's (1992) sense-making theory (number 1 in Figure 5).



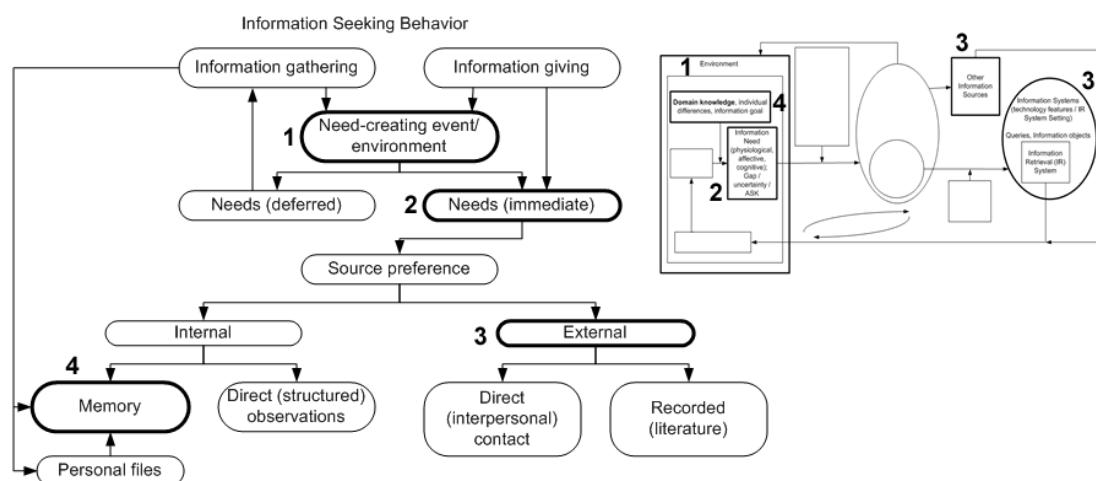
**Figure 6 Mapping to Wilson’s (1981) model of Information Seeking Behavior**

Krikelas’ (1983) model of information seeking behavior (Figure 7) is a simple, one dimensional flowchart. It expands the ‘need’ of Figure 4 into two kinds – immediate and deferred. It also identifies the role of memory as an internal information source. In addition, the model identifies *uncertainty* as a key concept – a situation in which a person becomes aware of a state of uncertainty about a problem and attempts to reduce it to an acceptable level. The weakness of the model lies in its lack of clarity around a number of issues – shouldn’t need-creating environment be depicted as surrounding other factors, are ‘information giving’ and ‘sources’ different, can ‘personal files’ include ‘recorded literature’ or personal notes, etc (Wilson 1999). A number of empirical studies have utilized Krikelas’ model. McKnight *et al.* (2002) conducted a study to understand the differing perceptions of information needs and communication patterns of healthcare professionals as they relate to medical errors. The survey questions were based on Krikelas’ model. The study suggests that information needs and communication difficulties are common and can lead to medical errors or near misses, but the problems may be amenable to IT solutions. Other studies include the comparison of youngsters’ use of CD-ROM and the Internet



as information resources (Shenton and Dixon 2003) and a study on the information environment of veterinary researchers (Chikonzo and Aina 2001).

In the integrated model, the information user's domain knowledge reflects the 'memory' of Krikelas' model (see 4 in Figure 7).



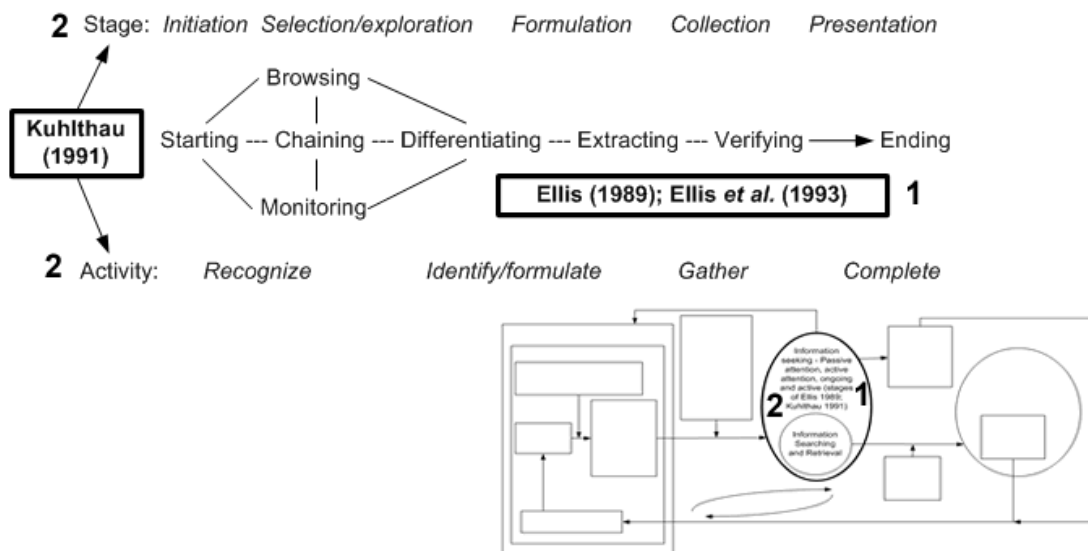
**Figure 7 Mapping to Krikelas (1983)**

Ellis' (1989) and Ellis, Cox and Hall's (1993) model of information search process outlines different behaviors in information seeking – starting, chaining, browsing, differentiating, monitoring, extracting, verifying and ending, which are intended to function at different levels of the overall process of information seeking. These stages are based on empirical work and tested in subsequent studies e.g. Ellis and Haugan (1997) tested the 'features' in the context of an engineering company. Wilson (1999) has shown how Ellis's stages can be incorporated within Wilson's (1981) model of Information Seeking Behavior (Figure 6).

While Ellis' suggests that the sequences of behavioral characteristics may vary, Kuhlthau's framework posits 6 successive stages in the information search process on the basis of behavior analysis. These stages are initiation, selection, exploration, formulation, collection and presentation. In each of these stages, Kuhlthau identifies

the feelings (affective) and thoughts (cognitive) common to each stage, as well as the appropriate actions (physical) and tasks. The framework is sequential, with no iteration suggested. Kuhlthau's model is based on a series of studies investigating common experiences of users in information seeking situations. What Kuhlthau's model reveals is a process of the gradual refinement of the problem area, with information searching of one kind or another going on while that refinement takes place. Thus, a successive search process is implicit in Kuhlthau's analysis of the search activity (Wilson 1999). Kuhlthau's model also forms the basis of Vakkari's theory of task-based Information Retrieval Process (Vakkari 2001). Wilson (1999) combines Ellis' and Kuhlthau's stages of the Information Search Process (see Figure 8).

The information seeking behavior of the integrated model combines Ellis' (1989) and Kuhlthau's (1991) cognitive and affective stages (see Figure 8).



**Figure 8 Mapping to Kuhlthau's and Ellis' stages of Information Search Process (combined by Wilson 1999)**

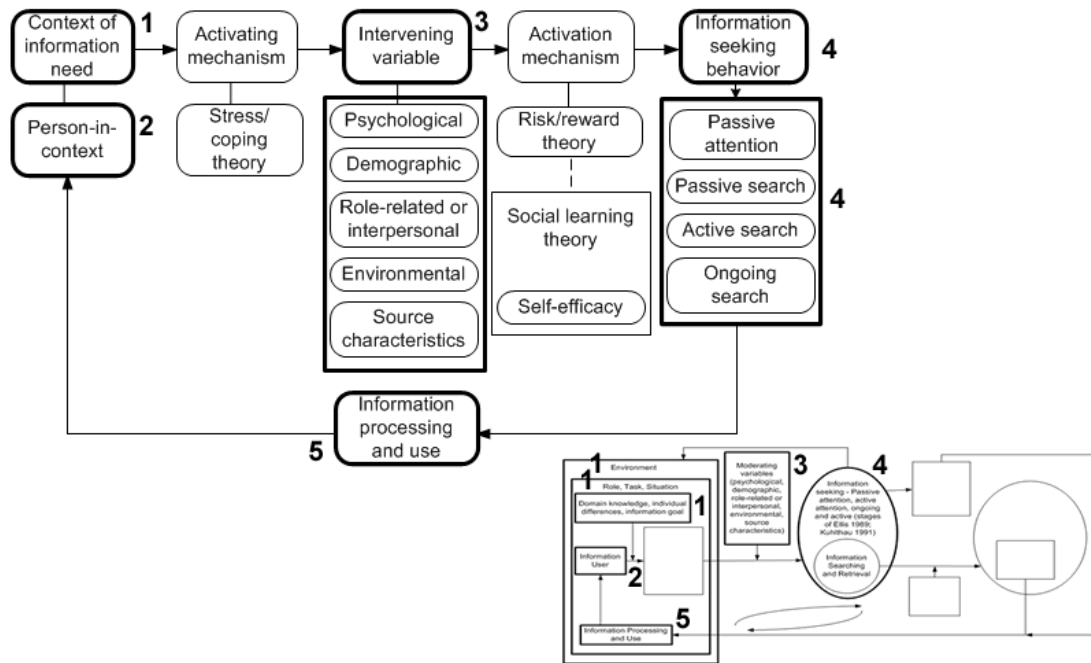
Wilson and Walsh's model of information seeking (1996) emphasizes the complex context of information seeking (Figure 9) and invokes explicit theories to explain the following aspects of information seeking:

- Why some needs prompt information seeking more so than others (stress/coping theory, from psychology)
- Why some sources of information are used more than others (risk/reward theory, from consumer research)
- Why people may, or may not, pursue a goal successfully, based on their perceptions of their own efficacy (social learning theory, from psychology)

Wilson and Walsh's activating mechanisms are motivators (what motivates a person to search for information, and how and to what extent?), affected by 6 intervening variables. The model also recognizes that there are different types of search behaviors – passive attention, passive search, active search and ongoing search. 'Information processing and use' implies that information is evaluated as to its effect on need, and forms part of a feedback loop that may start the process of seeking all over again if the need is not satisfied. Wilson's expansion and inclusion of other theoretical behavioral models make it a richer source of hypotheses and further research compared to his 1981 model (see Figure 6) (Wilson 1999; Case 2002).

In the integrated model, the link between information need and information seeking in the integrated model is moderated by the barriers of Wilson (1981) (number 5 in Figure 6), which Wilson and Walsh (1996) expanded to form the intervening variables in their model (see number 3 in Figure 9 below). The concepts of passive attention, passive search, active search and ongoing search (number 4 in

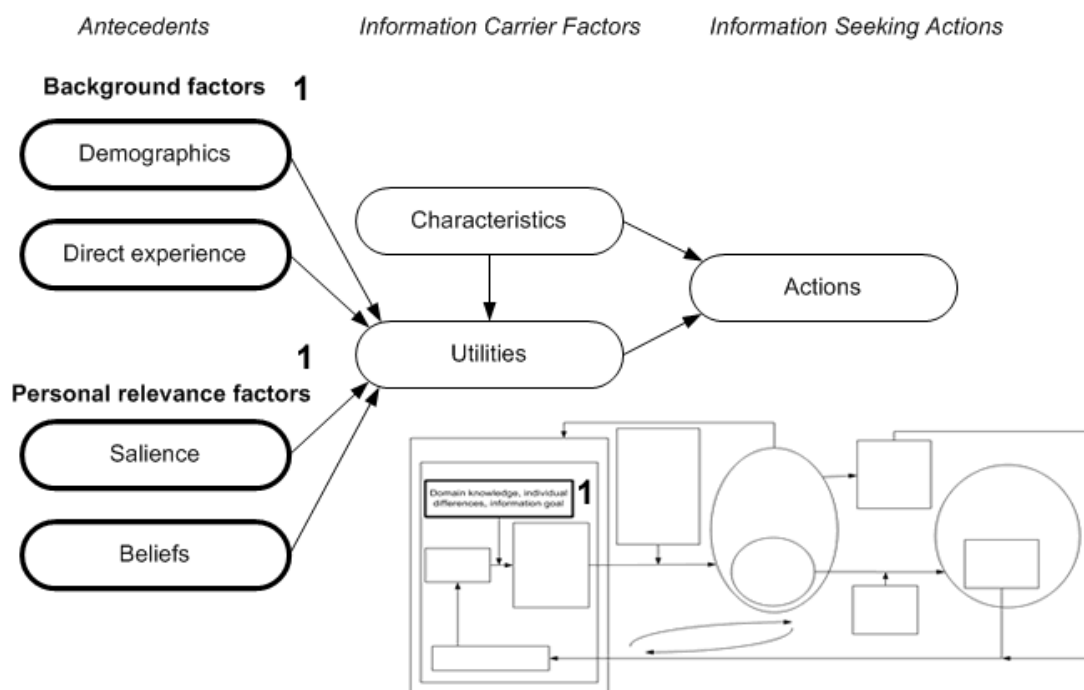
Figure 9), as well as information processing and use (number 5 in Figure 9) have been incorporated from Wilson and Walsh (1996).



**Figure 9 Mapping to Wilson and Walsh (1996)**

Johnson’s (1997) model (see Figure 10) depicts a causal process that flows from left to right. Antecedent background and personal relevance factors motivate a person to seek information. Information carrier factors are characteristics and utility of the information channels selected and used. What information seekers are concerned about is the content of the information, not the channel through which it arrives (a preoccupation criticized by Dervin (1989)). The model adopts a ‘sense-making’ perspective like Dervin, when saying that all information seeking takes place within a context, and begins only when a person perceives a gap in existing knowledge. The strength of Johnson’s model is that it is empirically tested in health and decision making and is being used in a series of health care studies funded by the U.S. National Institutes of Health through the University of Kentucky.

In our integrated model, Johnson’s (1997) background and personal relevance factors are reflected in the characteristics and the context surrounding the information user (see number 1 in Figure 10 below).



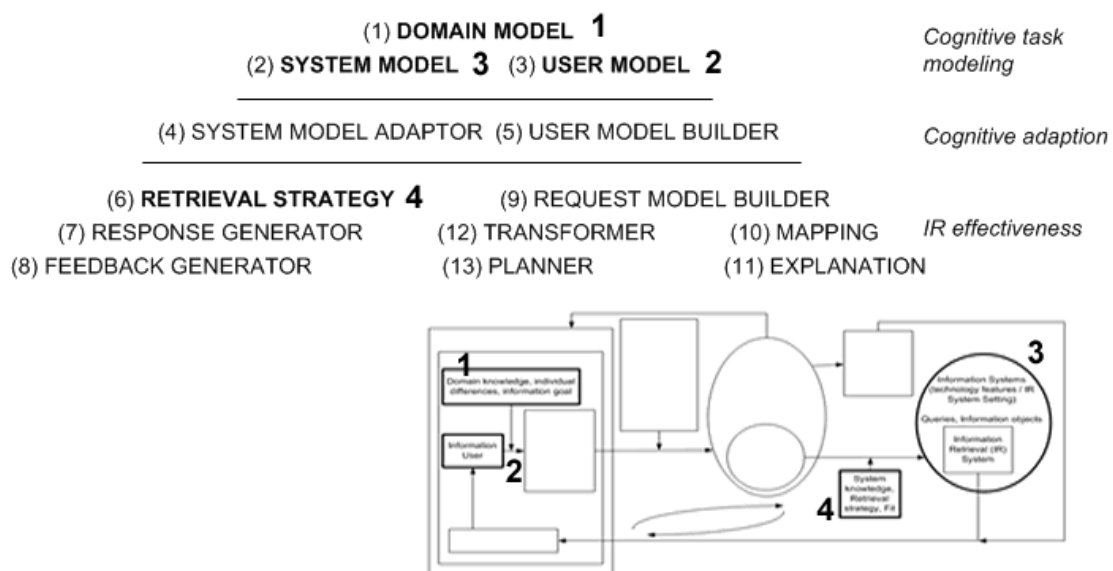
**Figure 10 Mapping to Johnson (1997)**

So far, we’ve seen how the model maps to, and has been incorporated from several well-known models in Information Seeking. The figures below reflect the portions of the model relating to models from Information Searching or Retrieval.

Belkin’s (1984) MONSTRAT model is based on the cognitive model of IR interaction. It models system characteristics, user characteristics and problem characteristics and has ten functions (dialogue mode, problem state, problem mode, user model, problem description, retrieval strategy, response generator, input catalyst, output generator and explanation) which correspond to system modules. The model assumes that it is possible to construe an intelligent mechanism, which is able to understand the information needs of users and perform like an intermediary.

Both Belkin (1984) and Ingwersen’s (1992) Mediator Model (Figure 11) are constructed within a research tradition in which it is assumed that the study of individual users’ psychological, mental or cognitive structure may uncover the principles of information retrieval. Ingwersen’s (1992) mediator model is a consolidated framework of functional requirements for intermediary analysis and design. It considers all participating knowledge structures in the entire IR interaction process and isolates the fundamental knowledge elements internal to an intermediary. The model evolves around 13 integrated functions on 3 levels, and 54 sub-functions (building on Monstrat Model’s 10 functions). It integrates the Monstrat Model’s user orientation with generalized domain and task knowledge as well as IR system adaptation.

The system and user characteristics of our integrated model are drawn from Belkin’s (1984) MONSTRAT model (1984), Ingwersen’s (1992) Mediator Model (Figure 11) and Saracevic’s (1996) stratified interaction model (Figure 12). Figure 11 shows the mapping to Ingwersen (1992).



**Figure 11 Mapping to Ingwersen’s (1992) Mediator Model**

Saracevic's (1996) 'stratified interaction model' (Figure 12) was developed within an overall framework of an 'acquisition-cognition-application' model of information use. The levels of strata are simplified to three: 1) *surface* level of interaction between the user and the system interface (query, text/images); 2) *cognition* level of interaction with the texts or their representation (output, utility assessment) and 3) *situation* context that provides the initial problem at hand (search results applied to situation). The model has a strong resemblance to Ingwersen (1996) (see Figure 13) (Wilson 1999).

Figure 12 shows the mapping of the integrated model to Saracevic (1996).

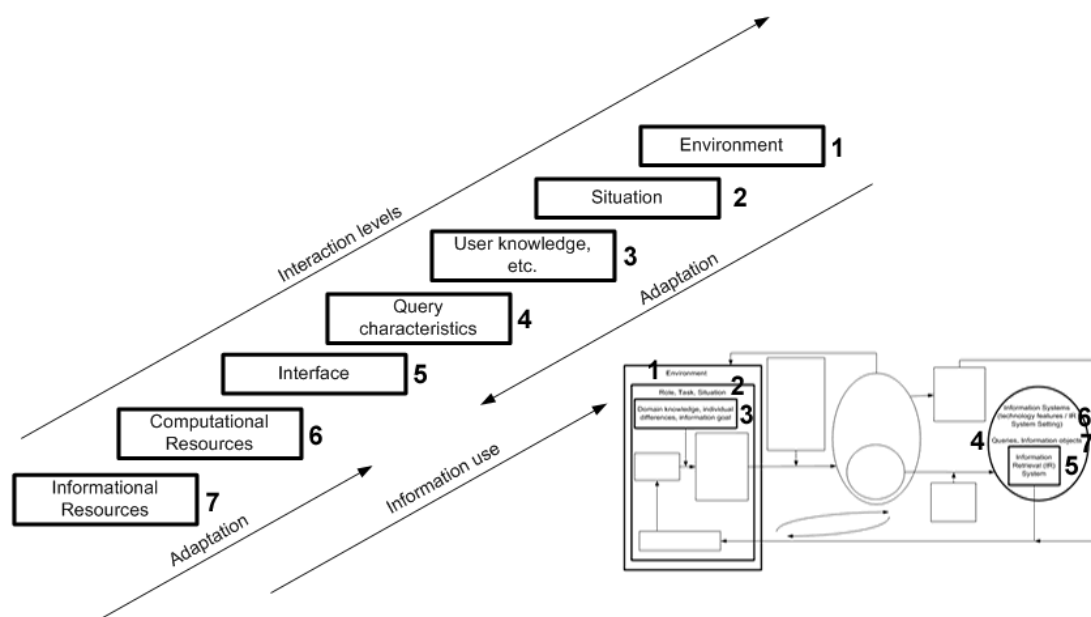


Figure 12 Mapping to Saracevic (1996)

In his later model (Figure 13), Ingwersen (1996) concentrates on identifying processes of cognition which may occur in all the information processing elements involved. The elements *user's cognitive space* and *social/organizational environment* resemble the 'person in context' and 'environmental factors' of Wilson's models. The *queries posed* can be related to Wilson and Walsh's (1996) 'active search' (see Figure

9). The strength of the model is that it integrates ideas relating to information behavior and needs with issues of IR system design. The weakness is that it does not provide for testability or for evaluation of IR systems (although Borlund and Ingwersen (1997) have developed an evaluative strategy based on this model) (Wilson 1999).

In the integrated model, the concepts of information objects and the IR system setting are from Ingwersen (1996). See Figure 13.

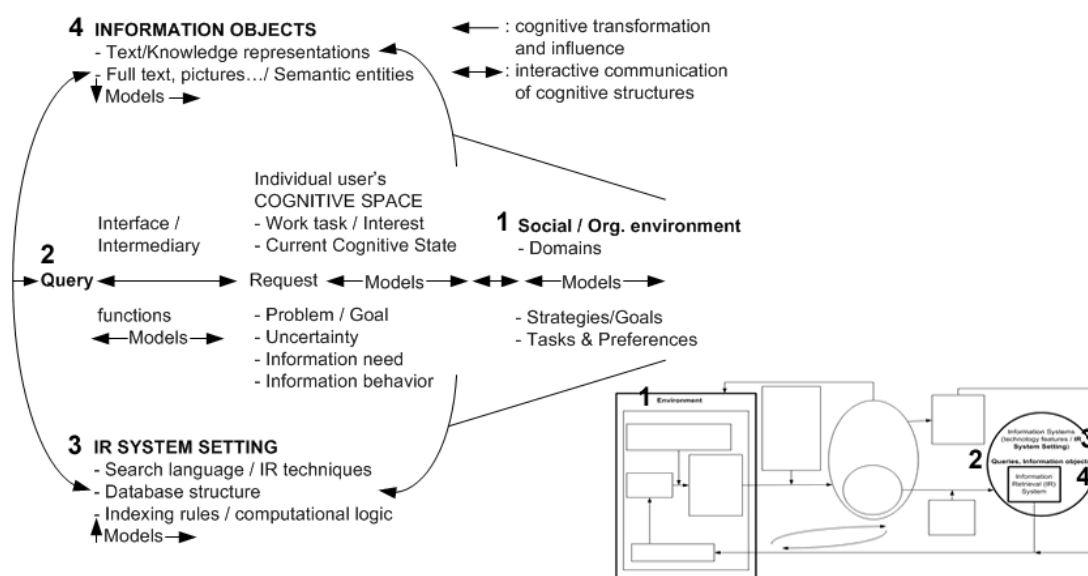


Figure 13 Mapping to Ingwersen (1996)

Spink's (1997) model of the search process (Figure 14), derived from empirical research, can be related to Dervin's (1992) sense-making approach of continuously making sense of a situation in time/space. As Spink describes, 'each search strategy may consist of one or more cycles [one or more search commands ending in the display of retrieved items]. Each cycle may consist of one or more interactive feedback occurrences (user input, IR system output, user interpretation and judgment, user input). An input may also represent a move within the search strategy...and may be regarded as a search tactic to further the search. Each move consists of a user input or query requesting a system's output' (Spink 1997 p.392; Wilson 1999).



In the integrated model, the search cycles of Spink’s (1997) model have also been incorporated (see Figure 14).

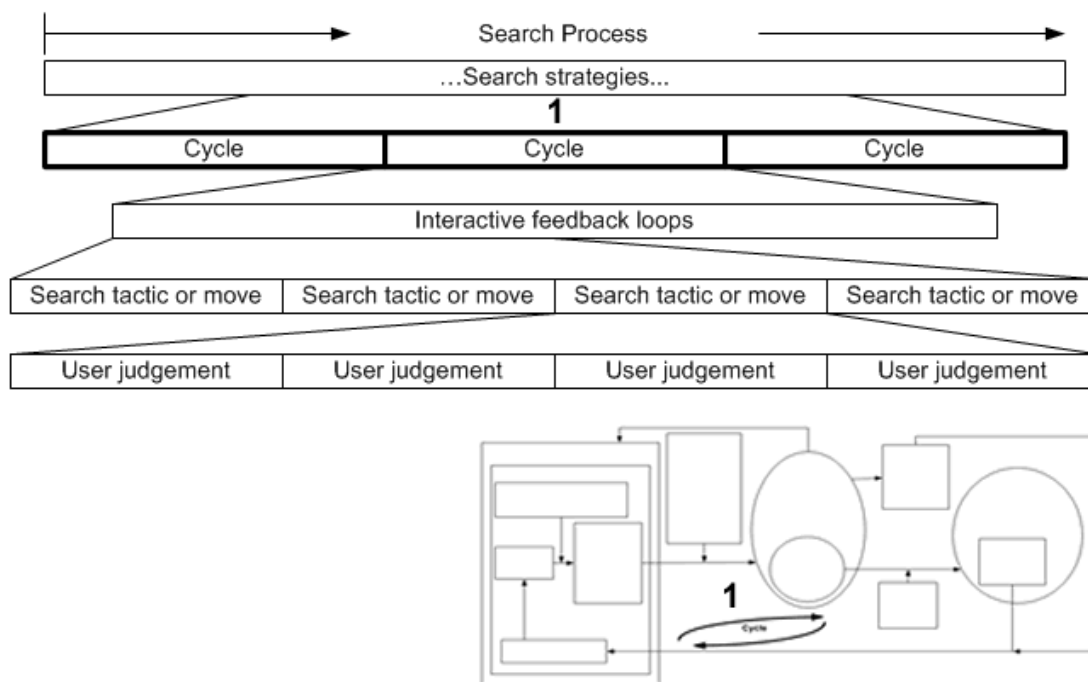


Figure 14 Mapping to Spink (1997)

## 5 Simplified Model

In the words of Wilson (1981), “Our concern is with uncovering the facts of the everyday life of the people being investigated; by uncovering those facts we aim to understand the needs that exist which press the individual towards information-seeking behavior; by better understanding of those needs we are able better to understand what meaning information has in the everyday life of people; and by all of the foregoing we should have a better understanding of the use and be able to design more effective information systems.”

The strength of the proposed integrated model lies in the fact that it combines several important contributions made in the fields of information seeking and retrieval

in a single model. The model can be viewed as a ‘beginning integration’, paving the way for subsequent studies and refinements in the years to come. It shows one possible way of moving forward to the researchers from information systems, information retrieval and information seeking, so that they can carry forth research relating to their common goal of effectively meeting the information needs of information users and knowledge workers. Other researchers are invited to follow the lead in this paper – by viewing this integration as the kind of writing and thinking we desperately need, one that brings about genuine synthesis and engagement.

A number of propositions can be derived from the model. Table 1 lists a few examples.

<b>Context and Need</b>
<ul style="list-style-type: none"> <li>▪ The information need of a user depends on the user’s task and environment.</li> <li>▪ A user in a simple task situation will have higher ability to specify his information need compared to a user faced with a complex or fuzzy task.</li> <li>▪ The user’s prior domain knowledge moderates the level of uncertainty faced by a user in an information seeking task</li> <li>▪ User’s cognitive style, problem-solving ability and information goal determine the extent of his information need</li> <li>▪ Information need positively affects the user’s information seeking behaviour</li> </ul>
<b>Motivation for information Seeking</b>
<ul style="list-style-type: none"> <li>▪ Searcher’s psychological predisposition (e.g. curiosity level) moderates the relationship between information need and seeking</li> <li>▪ Searcher’s demographic background (age or education) moderates the relationship between information need and seeking</li> <li>▪ Characteristics of sources (e.g. accessibility and credibility) positively influences information seeking</li> </ul>
<b>Information Seeking and Searching/retrieval</b>
<ul style="list-style-type: none"> <li>▪ During active search, an information seeker exhibits different behavioral and affective stages</li> <li>▪ Searcher’s prior system knowledge moderates the relationship between information searching and relevance of search results</li> <li>▪ The degree of task-technology fit moderates the relationship between information searching and relevance of search results.</li> <li>▪ Information searching takes place in successive stages until the need is satisfied or the user gives up.</li> </ul>

**Table 1 Propositions derived from the model**

A limitation of the model is the lack of parsimony. To improve parsimony, a simplified integrated model is shown in Figure 15.

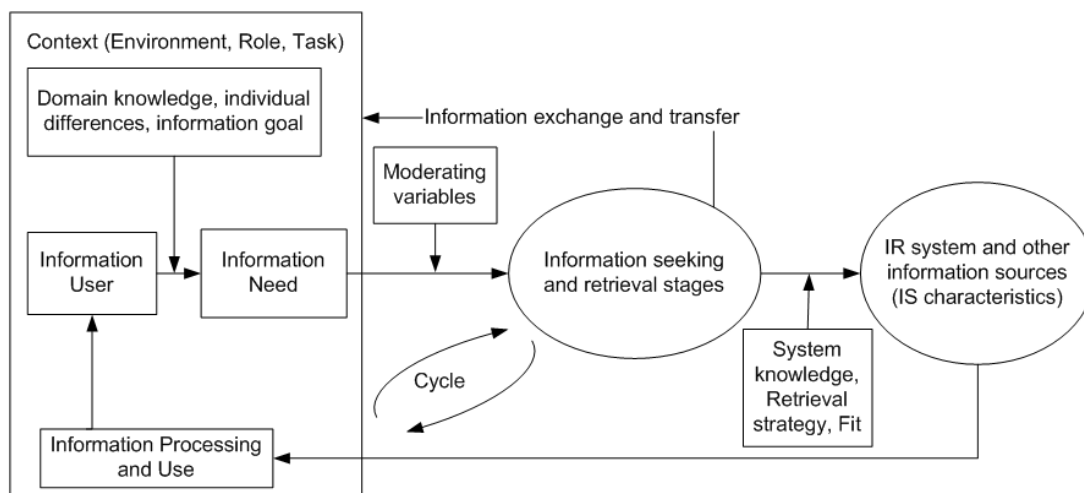


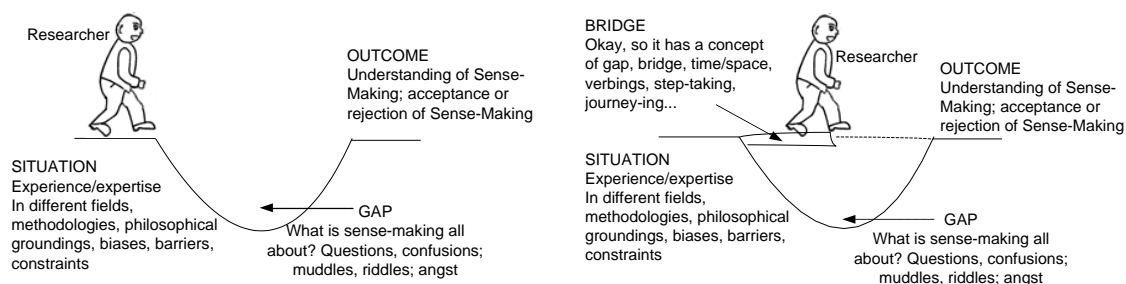
Figure 15 Simplified integrated model

## 6 Model or Methodology?

What has been presented so far is an integrated model of information seeking and information retrieval – one that integrates features from the different extant models of the fields. Let us now look at a slightly different scenario. What if we were to take the work of any of the theorists who have contributed to the different models presented here and those not presented, and look at all other models from the work of this particular theorist? That is, what would happen if we made a particular theorist such as Dervin or Wilson or Belkin dominant and nested everything else inside the chosen theorist's work.

To illustrate, let us look briefly at Dervin's work. Many people are using sense-making in many different ways – as metatheory, as practice and as method (Dervin 1999). It appeared in its emergent form since 1972 (Dervin 2005) and got its name in

the 1980s. Since then, it has continued to advance and emerge, bringing with it work on concepts such as time and step-taking, journey-ing, and verbing and what Dervin points to as the struggle to stay in line (conforming) and struggle to fall out of line (charting a new path). Dervin bases her work on three central assumptions (Dervin 2005) regarding communications practice – 1) that it is possible to design and implement communications systems and practices that are responsive to human needs; 2) that it is possible for humans to enlarge their communication repertoires to pursue this vision; 3) that achieving these outcomes requires the development of communication-based methodological approaches.



**Figure 16 Making sense of ‘Sense-Making’: Encountering and bridging the gap (Adapted from Dervin and Frenette 2003; Savolainen 2006)**

Dervin and Frenette (2003) articulate sense-making through the illustration of a user in a particular situation encountering a gap or a problem which keeps him/her from achieving his/her desired outcome. Once the user makes sense of the gap/problem, s/he is able to construct a bridge to help cross the gap. Figure 16 above takes the analogy further and sees it in the light of a methodological perspective – in particular, it portrays how researchers in the fields of information seeking, information retrieval and information systems come with their own experiences and expertise in different

fields and methodologies. These researchers might encounter a gap when trying to understand Sense-Making. The process of bridging the gap then commences inside the researcher's head, and continues until he reaches a certain set of outcomes – which might be an increased understanding of sense-making, and its acceptance or rejection by the researcher. The figure is termed 'making sense of Sense-Making' as it attempts to illustrate the synthesizing of different methodologies and theoretical leanings in the fields of Information Seeking and Information Retrieval.

Let us briefly see how the central tenets of Dervin's work on sense-making (see Dervin, Foreman-Wernet and Lauterbach 2003 for an overview of Dervin's work) can be mapped to some of the other models that we have seen.

Sense-making's core assumption is that of discontinuity of 'gappiness'. There are gaps between entities, time and spaces. Each individual in an entity moves through time and space, dealing with other entities that include other people, artifacts, systems, etc. and uses sense-making to bridge the gaps encountered (Spurgin 2006).

This gap conforms to Belkin *et al.* (1982)'s anomalous state of knowledge, Wilson (1981)'s need, Krikelas (1983)'s deferred and immediate needs and Ingwersen (1996)'s 'problem/goal, uncertainty, information need'. In our Integrated model, it maps to the box 'Information Need (physiological, affective, cognitive); Gap / uncertainty / ASK'.

Sense-making looks at information as a process (not as an object) and conceptualizes information as "that sense created at a specific moment in time-space by one or more humans". This is similar to the concept of 'knowledge' espoused by Knowledge Management researchers where they seek to differentiate information from knowledge. Here, knowledge is conceptualized as being formed when it is *processed* inside an individual's head. In other words, when the individual makes sense of the information, it becomes knowledge. In sense-making, Dervin does not differentiate

between information and knowledge and sees both terms as that processed inside a person's head. Johnson (1997) also adopts a 'sense-making' perspective like Dervin, when saying that all information seeking takes place within a context, and begins only when a person perceives a gap in existing knowledge. In fact, the entire gamut of recent research on 'information seeking in context' (see Ingwersen, Ruthven and Belkin 2007; Ingwersen 2005; Ingwersen and Jarvelin 2005) can be mapped to Dervin's perspective in-so-far-as the seeing information seeking as taking place within a particular context or situation is concerned.

Sense-Making sees an individual at a certain moment in time and space when s/he encounters a gap or need for information. This situation can be likened to the environment, role and person in Wilson's (1981) model of information Seeking behavior; the need-creating event/environment, memory and direct (structured) observations of Krikelas (1983); context of information need of Wilson and Walsh (1996); background factors and personal relevance factors of Johnson (1997); environment, situation, user knowledge, etc. of Saracevic (1996); and the social/organizational environment and individual user's cognitive space of Ingwersen (1996). Sense-Making studies have found that patterns of gap-bridging behavior are better predicted by the way individuals define the gaps in which they find themselves, than by attributes such as demographic categories or personality indicators (Spurgin 2006).

Similarly, mappings can be found to other aspects of Sense-Making, such as the focus on 'verbings' rather than on nouns. Sense-Making requires a focus on what people do, how they do it, and why they do it that way, rather than on the objects that people do things with (Spurgin 2006).

The discussion above is an illustration of how we could take the work of any one theorist and ask ourselves what would happen if we were to make this work dominant and map the work of other theorists to this particular work. While it may not be possible to map all aspects of all extant models and theories to a particular work, there are certain aspects where it *is* possible. This is what makes it important.

This process of mapping and synthesizing helps bring about convergence of research and a true understanding of where a common direction unfolds, and areas where it doesn't. It allows researchers to engage more proactively in charting the forward movement of a field.

## **7 Conclusion and Future Work**

An integrated model of information seeking and retrieval has been presented, based on past models by leading researchers of the field. While studies in Information Retrieval have been largely 'system-centric', studies in Information Seeking have revolved around the needs of the user and the process of information seeking. Lately, there have been calls for collaboration between the two and a growing realization that Information Retrieval research needs extension towards more context, while Information Seeking research needs extension towards task and technology. This call is also implicit in our experience with the currently prevalent 'one-size-fits-all' search engines, which do not adequately cater to the different contexts surrounding the information need of the searcher at different times. An integrated model is served as a 'beginning integration' that tries to answer Kuhlthau's (2005) call for collaboration between the person and system-centered aspects of information seeking/retrieval. It also takes on the calls of Ingwersen and Jarvelin (2005) and Jarvelin and Ingwersen

(2004) by including context, task/environment and technology in the purview of information seeking and retrieval. The model will contribute to theory development in the fast merging area of information seeking and retrieval. Hypotheses can be derived from the model and empirically tested. The importance of this effort is highlighted by the fact that ACM SIGIR (Special Interest Group on Information Retrieval) has incorporated a workshop on Information Retrieval in Context (IRiX) since 2004. From the practitioner's perspective, the model will serve as a useful guide for developers of information systems for search – knowledge providers, content providers as well as designers of next-generation web search engines. Future work on the study will include empirical validation of different parts of the model through experiments and surveys.

Along with the integrated model, we also illustrated (using Dervin's Sense-Making as an example) how this process of synthesizing could be extended to take the work of a particular theorist and mapping the work of other theorists to it. We invite other researchers to join in this process of synthesizing – this methodological move (in the Weberian sense) that this paper in its best interpretation can be thought to be – not just another model, but a methodological move for better analysis.

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