Human information behaviour and design, development and evaluation of information retrieval systems

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Abstract

Purpose – The purpose of this paper is to introduce the concept of human information behaviour and to explore the relationship between information behaviour of users and the existing approaches dominating design and evaluation of information retrieval (IR) systems and also to describe briefly new design and evaluation methods in which extensive attention is dedicated to the users and their behaviours and conditions.

Design/methodology/approach – The paper takes the form of a literature review with particular concentration on the efforts made by information science researchers.

Findings – The paper finds that there are four classic approaches to IR systems design: system-centred, user-centred, interactive and cognitive. Not enough research has been carried out to explore the relationship between information behaviour and information systems design to date. Contextual design and participatory design are among the new methods where users' behaviour, factors and contexts are considered more proactively than previously when designing information systems.

Originality/value – The paper introduces new methods and research frameworks being investigated currently in the area of information systems design and evaluation in which considerable attention is given to the users' information behaviour and situation. The paper is also useful in gaining a broad understanding about issues explored that have not previously been presented in one publication.

Keywords Information retrieval, Information systems, Information science, User studies

Paper type Literature review

1. Introduction

Information systems, including information retrieval (IR) systems, are tools for users to gain the information they require and for establishing social (Saracevic, 1995) or cognitive (Ingwersen, 1992) communication between two humans, e.g. information generator on the one hand and information user on the other hand (Ingwersen, 1992). Although it is possible to include a variety of information sources, even books, in such a broad definition of IR systems, they are generally thought of as new, computer-based systems that emerged as a consequence of ICT in the IR field (Saracevic, 1996). The terms information systems and IR systems have been used interchangeably in this paper.

The extreme importance of IR systems in the current world in which information is produced and distributed is simple to figure out, but there exists, inevitably, a range of opinions related to the issues of design, development and evaluation of these systems.

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As such, considering the necessity of IR systems in storing, organising and representing information, the question about which design and evaluation approach is most appropriate is a moot point.

The "soft view" or human-centred approach to the design and evaluation of IR systems is in contrast with the "hard view" or system-centred one of their designers, and much effort has been made recently to take the human side of IR interaction into consideration. As a result, a new concept human information behaviour (HIB) has been coined in which people are not considered just as users, seekers or consumers but as "human" and surrounded by a special framework of social, psychological, epistemological and physical characteristics (Saracevic, 1995; Gasson, 2003; Martzoukou, 2005). In addition, IR systems encompass a more extensive body incorporating media such as television, satellite and radio. As Wilson (2000) stated HIB is:

> [. . .] the totality of human behaviour in relation to sources and channels of information, including both active and passive information seeking, and information use. Thus, it includes face-to-face communication with others, as well as the passive reception of information as in, for example, watching TV advertisements, without any intention to act on the information given.

Information Science has emerged as a field of research which is strongly associated with other areas, such as Information Systems, Human-Computer Interaction and Computer Sciences, in which information systems and design, development and evaluation processes are considered as core concepts. Consequently, information seeking and retrieval are among the main issues of research and practice in information science (Ingwersen, 1992; Hjorland, 1997; Wilson, 2000; Fidel and Pejterson, 2004; Spink and Cole, 2006). HIB is a subject new to information science because in many studies conducted it is the information seeking behaviour of users, as a subset of HIB, that has been explored (Spink and Cole, 2004; Johnstone *et al.*, 2004; Martzoukou, 2005; Spink and Cole, 2006). However, more recently, many researchers (Wilson, 2000; Spink and Cole, 2004; Spink and Cole, 2006; Spink and Currier, 2006) have looked into HIB as a distinct subject of research.

By adopting such an HIB approach to the design and evaluation process of IR systems a comprehensive perspective can be obtained as well as more integration between information science and information systems (Ellis *et al.*, 1999). By considering such consequences, this paper aims to explore, through a review of the literature and by particular concentration on the efforts made by Information Science researchers, the relationship between information behaviour and the existing approaches dominating design and evaluation of IR systems and to describe briefly the new design and evaluation methods in which considerable attention is dedicated to the information behaviour of users.

2. IR system design: some approaches

The design process is a complex one to the point that information systems researchers themselves find their field lacking a design theory, so that some of them have called for information systems to be seen as a "design science" (Goldkuhl, 2004, p. 60). Newby (2001), however, categorises the approaches as: systemic, user-centred, interactive and cognitive.

The system-centred, or physical, approach to IR system design is the traditional one (Ingwersen, 1992; Saracevic, 1995; Julien *et al.*, 2005). It evolved from the inception of

information systems production, if an information system is defined as a tool simplifying the communication between information and user (Petjersen, 1989), and its history goes back to the emergence of Library and Information Science (LIS; Ingwersen, 1992). In this approach it is the system, with its strengths and weaknesses, not the user that determines how information or data are represented. The designers represent contents mainly based on the system requirements. In fact, the representation is the main goal in this paradigm (Ingwersen, 1992). Through this approach designers try to represent data with inadequate attention paid to how actual users would use the systems. Because humans are complex, designers have not considered them sufficiently in the design process (Ingwersen, 1992; Julien *et al.*, 2005).

The user-centred approach developed in the 1970s when researchers, particularly in the LIS community, queried the system-centred approach as they realised that the classic approach to designing IR systems would not result in systems in which the increasing and complex information needs of ever sophisticated users could be met. Over the years, a variety of researchers (Dervin, 1983; Belkin, 1984; Dervin, 1995; Dervin and Nilan, 1986; Saracevic, 1995, 1997a, b; Savolainen, 1993; Dalrymple, 2001; Kuhlthau, 1991, 2004) have called for a paradigm shift from a systemic to a user-centred approach. Many studies have been conducted to confirm this user-centred revolution (Rouse and Rouse, 1984; Nahl, 1996). The goal of user-centred design is usability (Maguire, 2001; Kujala, 2003), i.e. how the final system would be used by end-users (Gasson, 2003). Overall, in this approach emphasis is allocated to users rather than the system, object or technology (Saracevic, 1997b). But, as Saracevic (1995) well realised, the user-centred approach, like the systemic one has overlooked having a holistic outlook because the user is an important component but not the totality of an effective IR system design process.

Johnstone *et al.* (2004) suggested system thinking and modelling as a research framework to bridge the gap between the system-centred and user-centered approaches. It is possible, they argue, that the two approaches be combined by considering the process as a whole and treating it as a unique system.

Researchers have investigated alternative approaches since the 1980s (Saracevic, 1997a). Much attention was devoted to the interaction between the system and the user to the degree that researchers considered it as "The most important feature of IR" (Saracevic, 1996). Marchionini (2004) proposed that the notion of "information interaction" would better reflect the role of people and the dynamics of information objects rather than "information retrieval". Belkin (1993) asserted that it is easy to find out the centrality of the human component in IR systems and their interaction with these systems as central processes in retrieving information. Therefore, the "interaction design" approach is, and will ever be, dominantly one of the most common approaches to IR system design and evaluation (Rogers, 2004). Although this includes the various components of IR, the interactive approach seemingly has deficiencies to be considered as comprehensive (Rogers, 2004), because the context and organisational variables, for instance, are hardly ever given sufficient attention in this approach.

The "cognitive turn" or "cognitive movement", as described by Ingwersen (1992), arose during the 1990s as a consequence of efforts made from the 1960s onwards to find a scientific, comprehensive theory involving artificial intelligence and expert systems. Its goal is to take "world models" consisting of "knowledge structures or cognitive structures" determined by aspects affecting humans' mental, rational and

physical activities into consideration. In other words, it attempts to "provide *conditions* as to how and when to talk about 'information processing' and 'information' vs data processing, potential information and data" (Ingwersen, 1992, p. 22). Based on this viewpoint, information science itself can be redefined as a field whose goal is to "facilitate the effective communication of desired information between human generator and human user" (Ingwersen, 1992, pp. 11, 15). The theory proved to be useful and efficient (Kim and Allen, 2002; Chen and Macredie, 2002) and many studies from different fields have been conducted, including some in the IR field (Ingwersen, 1992, 1996; Belkin, 1984, 1990; Ingwersen and Järvelin, 2005). Nonetheless, despite considerable efforts, the cognitive approach has failed to be treated as a pervasive and exhaustive one (Newby, 2001), mainly because of its dependency on findings from research studies of fields other than Computer Science or Information Science and also on "controlled laboratory setting" instead of "messy real world" (Rogers, 2004).

3. IR system design and the problem of information behaviour

Pettigrew *et al.* (2001) reviewed works related to the models and theories used in information behaviour research since 1978. They highlighted the distinct gap that exists between research on that topic and its application into information system design. Not enough research, in fact, has been conducted to explore the relationship to date (Zhang and Fine, 1996; Saracevic, 1999; Johnstone *et al.*, 2004; Kuhlthau, 2005; Julien *et al.*, 2005; Case, 2006). Traditionally designers have taken human factors, but not necessarily human behaviours, into account while designing information systems (Zhang and Fine, 1996). The topic is important and interesting as designers themselves look for information to be used in the design process (Christiaans and Restrepo, 2004). There has been some research bringing these two issues closer together (Belkin, 1993; Ingwersen, 1992; Ingwersen and Järvelin, 2005). Belkin (1993), for example, suggested that "the goal of IR system is to support the range of information-seeking behaviours" and Spink and Wilson (1999) believe that in the reality of HIB, the IR system is in secondary or mediatory level, in that information seekers with information needs implement IR systems to solve their problems.

Rouse and Rouse (1984) described the direct relationship that might exist between human information seeking and information systems design. They stated that design methods had limited usefulness for the systems, resulting from neglecting the human side of the design process for which such systems are produced. They emphasised information seeking as a basis for designing IR systems, including issues such as context in design, complexity and the multidimensional nature of information seeking, individual differences and variability of information seeking, cognitive styles and design. They suggested that the nature of environment specifies important attributes of the system and they identified flexibility as the most central practical issue to reflect the lack of theoretical basis. Some years later Ellis (1989) distinguished, from a behavioural perspective, some features or stages researchers go through, respectively, in their information seeking: starting; chaining; browsing; monitoring; differentiating; and extracting. He added guidelines, one for each of the six features, with some from actual systems.

There are some examples of information systems in which information behaviour has been included in the system design. For instance, DALTEX was a prototype user-centred information system allowing query and browse access based on hyper-graph representations of data instances (Watters and Shepherd, 1994).

Soft system methodology (SSM) was proposed by Checkland (Pejtersen, 1989; Checkland and Scholes, 1990) as a human-considered methodology. In the information science community, THOMAS (Oddy, 1977) and I^3R (Croft and Thompson, 1987) are behaviour-centred systems developed with the aim of user engagement in the retrieval process. Belkin *et al.* (1993) designed BRAQUE as an interface supporting information seeking strategies and movement from one to another. Marchionini (2004, 2006) also designed two systems based on what he calls human-centred IR (HCIR): a relation browser and an open video digital library.

4. Contextual design and participatory design: new approaches to IR system design

Though the importance of information behaviour was identified in the early days of IR systems research (Rouse and Rouse, 1984), there are some recent approaches in which the topic is highly regarded as an influential element – especially "contextual design" and "participatory design".

It is impossible to design an information system completely close to actual human behaviour just based on the observable behaviours. In addition, context-based aspects such as task, environment and organisational setting are of substantial importance (Smart and Whiting, 2001; Olsson, 2004; Case, 2006). As a distinct approach, "contextual design" could be viewed as a method utilising the "field methods" (Kujala, 2003) in which communicating with users and understanding their implicit needs can be provided. Through methods like round-table discussions and qualitative interviews, users are seen as information providers without having to take active roles in contextual design activities. Users are watched and talked to about their searching while in their own environment (Smart and Whiting, 2001). Two methods using this approach are briefly described.

Cognitive works analysis (CWA), developed from an information systems perspective, is a framework dealing with constraints or invariants (Vicente, 2002; Fidel and Pejterson, 2004) that shape human-information interaction. This framework is based on work situations in which individual users' behaviours, from different perspectives, are considered as a basis for research and study. By considering issues as to what, where and how work is carried out in a particular context, thereby predicting possible user's behaviour, this framework tries to analyse simultaneously environment and cognitive, perceptual and even ergonomic attributes of people undertaking specific tasks and then including them in the system design. In other words, in this framework, instead of considering complicated information behaviours of actual users, the designer first tries to predict them by analysing the environment where work will be done in order to predict possible behaviours. Naikar *et al.* (2005) describe the application of CWA in interface design. Although it has proved to be a successful approach in information system design, CWA presents some challenges when being implemented in different contexts. For example, it lacks knowledge and expertise related to HIB or it is domain-specific and highly resource demanding. COLLATE is a project being developed based on CWA (Fidel and Pejtersen, 2004).

Ecological interface design (EID) is another method highly regarded by information system designers and it begins with work domain analysis (Vicente, 2002). It is assumed in this approach that, like any ecology where there are several components impacting upon each other, in information seeking environments different components including

humans, computers, information resources and the like are interrelated, constituting an information ecology. BOOKHOUSE, an IR system, has been designed based on EID (Pejtersen, 1989; Vicente, 2002).

Kujala (2003) believes that participatory design is a "bottom rung for user involvement philosophy and users' rights", and that successful systems are those designed for and with users. It is believed in this method that it is not sufficient to take users only as information sources or objects for design, but it is also important for users to participate in the design process at informative, consultative or participative levels (Kujala, 2003), as democratic participation and skill enhancement are important concerns and the following benefits may result:

- increased sales;
- increased user productivity;
- decreased training costs; and
- decreased user support.

The concept of participation is unclear and Olsson (2004) introduced the concept of "active user participation" in which users take active roles in the design and development of information systems. There are challenges in using users in the design process given the undefined concept of user participation, ambiguous user population, the analysis of raw data collected, designer-user interaction, the allocation of high time and cost resources and the extent to which users can practically be involved (Kujala, 2003; Marchionini, 2006). However, this approach is an important and positive step forward in the design process (Maguire, 2001).

5. Evaluation issues of IR systems and information behaviour

It may be thought that evaluation of IR systems is a process fundamentally different from the design process, however, the design and evaluation processes are directly related to each other and from inception have become inseparable (Saracevic, 1995). The approach that is used to design an information system will consequently determine how such a system would be evaluated and vice versa. Saracevic (1995) evaluated the evaluation measures utilised to assess whether an IR system works well. He divided these measures into six categories:

(1) engineering;
(2) input;
(3) processing;
(4) output;
(5) use and users; and
(6) social levels.

Each of these has its objectives which, in turn, impact on evaluation outputs. He believes that the majority of evaluations have been conducted regarding processing level, i.e. from system-related point of reference (Wang and Forgionne, 2006). Even if there are some cases based on user-related measures, they are not considerable and comprehensive owing to the fact that they could not involve numerous aspects closely related to users' information behaviour (Beaulieu, 2000). Traditional measures

like relevance, precision and recall are largely criticised because of their weakness in assessing user attributes. Relevance, as an underlying measure, has been poorly characterised or addressed in evaluation performances (Beaulieu, 2000; Hjorland, 1997) due to the difficulty of its definition, to the degree that it has been labelled as the "dark matter" of IR (Ingwersen, 1992). Precision and recall both have constraints in showing the interactive nature of IR and the user side of this interaction (Spink and Wilson, 1999).

In the information science community, there have been examples of including information behaviour in the evaluation process (Harman, 1992; Wang and Forgionne, 2006). Spink and Wilson (1999) developed, from the problem-solving approach, a theory named "problem shift" in which evaluation is conducted based on shifts the user personally experiences before and after the process of IR. From a different perspective, Wang and Forgionne (2006) applied a model, or process approach, to establish a research framework in which IR systems could be evaluated. They choose Kuhlthau's (2004) information search process model, consisting of six stages of initiation; selection; exploration; formulation; collection; and presentation, as a basis to explain that the information-seeking process is similar to the decision-making process in terms of stages any user goes through to make a decision. It is possible, they suggest, to evaluate an IR system according to its role during the process of making a decision. This decision-theoretic approach evaluates the performance of IR systems in terms of improving the process and outcomes of the decision making of the users.

Evaluation measures, as Spink and Wilson (1999) stated, should be of value and interest to researchers, designers and especially information seekers, not to a specific group of them, in a way that they can gain required knowledge to contribute to improving IR systems' performance and to enhance outputs whereby their tasks could be accomplished. As Harman (1992) has stated, "complete evaluation [. . .] requires not only evaluation of user interaction with retrieval system, but also evaluation of the entire information-seeking experience of the user".

6. Conclusion

Typically, the findings from studies on information behaviour of users are rarely incorporated into real IR systems and services. There should be work undertaken to consider and include information behaviour implications in the design and evaluation of these systems as it is a critical factor.

The studies being conducted recently show a promising future in the area of system design and evaluation in which humans and systems are well adapted together and the systems serve as extensions to human memory. People involved in the design and evaluation of such systems, for example, information scientists, must actively approach the phenomenon from their professional perspectives so that a unit of research and practice can be fulfilled, acceptable to designers and users.

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