Madely du Preez

Junior Lecturer

Department of Information Science

University of South Africa

Box 392

Unisa

0003 South Africa

Tel: +27 012 429 6792

Fax: +27 012 429 3792

Email: preezm@unisa.ac.za

The information behaviour of consulting engineers in South Africa

Madely du Preez is a junior lecturer at the Department of Information Science at the University of South Africa where she teaches information retrieval, information organisation and information literacy modules. The title of her recently completed MINF dissertation is *The information needs and information–seeking behaviour of consulting engineers in South Africa: a qualitative investigation.* This paper is based on that study.

# The information behaviour of consulting engineers in South Africa

**Abstract**

**Introduction:** Consulting engineers have unique information needs. These engineers also do not necessarily have formally organised information services such as libraries available in their companies to provide in their needs.

**Method:** Time-line interviews were conducted to collect the data. The gap- metaphor in Dervin's Sense-Making Approach was used to analyse the data. Leckie, Pettigrew and Sylvain's General Model of the Information-Seeking of Professionals provided the framework for the study.

**Results:** Consulting engineers rely heavily on people, personal files and personal knowledge for information. Other frequently used information sources include the Internet, FTP sites and digital cameras. Consulting engineers need information from varied sources in the initial stages of a project. Information in the final stages of a project comes from the project itself.

**Conclusion:** More studies are required to study the use of FTP sites and digital cameras as sources of information. .

## Introduction

Engineers seem to have unique information needs and most studies investigating their information behaviour seem to have been conducted on engineers working within a research and development environment and on engineers working for the same organisation. No studies have been conducted in South Africa on the information behaviour of consulting engineers.

Consulting engineers are experts in their field of engineering. They are employed by clients for their advice and guidance on specific engineering projects (Du Preez 2008). South African legislation requires all practicing

engineers to be registered as professional engineers with the Engineering Council of South Africa (ECSA) (ECSA 2007:3). Consulting engineering companies can be, but are not necessarily required to be, affiliated with the South African Association of Consulting Engineers (SAACE). Some consulting engineers also subscribe to engineering associations or institutes.

Some of the larger consulting engineering companies have formally organised information services such as libraries available within the companies. However, the smaller companies seldom have the resources available to employ information workers. Engineers working for these companies therefore need to rely on information services that are made available to them by the National Library of South Africa (NLSA), the Council for Scientific and Industrial Research (CSIR), and the engineering associations or institutes to which the individual engineers subscribe (Du Preez 2008).

The purpose of this presentation is to report on the outcomes of a study into the information behaviour of consulting engineers employed by small engineering companies. This was a qualitative study. Attention will be paid to the research design, the method of data collection and the research results.

## Research Design

To deepen an understanding of the information behaviour of engineers, a systematic review of the literature was completed. The subject literature not only reported on the research findings of studies aiming at acquiring an understanding of engineers' information needs, but also revealed how engineers' and other professionals' information behaviour was studied. The literature review also supported the selection of the most suitable research method for the study and the selection of the most appropriate model to serve as a framework for the study.

An examination of different models that were discussed in the subject literature indicated that different models focus on different aspects of information behaviour. The models that have been used to study the information needs and information-seeking behaviour of engineers include Ellis' (1989) Behavioural Model of Information-seeking, Dervin's (1983) Sense-Making Approach, Leckie, Pettigrew and Sylvain's (1996) General Model of the Information-seeking of Professionals, and Cheuk Wai-Yi's (1998) Information-seeking and Using (ISU) Process Model. Leckie *et al's* (1996) General Model was selected from these to provide the framework for the literature review and for systematising the data collected in the empirical research of the study. The gap-metaphor in Dervin's (1983) Sense-Making Approach provided the means to qualitatively analyse the data collected from time-line interviews pertaining to consulting engineers' tasks.

## General Model of the Information-seeking of Professionals

Leckie *et al's* (1996) General Model of the Information-Seeking of Professionals studies the professionals' information behaviour from the individual's information needs and an information-seeking point of view. This facilitates an understanding of how engineers' work roles, work related tasks and user-related characteristics of information needs influence their information needs, which again prompts information-seeking. Other factors that influence information-seeking addressed by Leckie *et al* (1996) are the sources of information, an awareness of the existence of information and the outcomes of the information-seeking process. The outcomes of information-seeking either results in the completion of a task or, in instances where the retrieved information did not satisfy the information need, the outcomes could prompt a renewed search.

Figure 1 illustrates the General Model of Information-seeking of Professionals and shows the relationship between the different components in the model. Feedback indicates satisfaction or non-satisfaction of the information need (Leckie *et al* 1996; Leckie 2005).
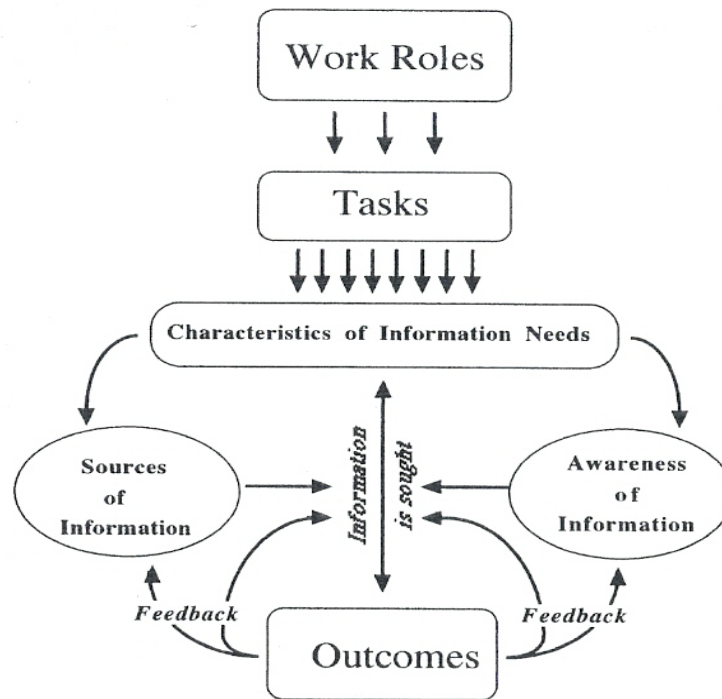
Figure 1: Leckie et al's Model of the Information-Seeking of Professionals
*(Leckie et al 1996)*

However, more than a framework is needed to study engineers' information behaviour. A research method is required to analyse the data. This was provided by the gap-metaphor in Dervin's (1983) Sense-Making Approach.

## The gap-metaphor in Dervin's Sense-Making Approach

The Sense-Making Approach is an important process model which provides a theoretic approach to information behaviour studies and a set of research methods (Dervin and Nilan 1986; Dervin 1999). The central metaphor, also known as the gap-metaphor, of Sense-Making is based on concepts relating to time, space, movement, and gaps. It "pictures the person as moving through time-space, bridging gaps and moving on" (Dervin and Nilan 1986:21; Nilan, Peek and Snyder 1988; Dervin 1999; Pettigrew, Fidel and Bruce 2001; Dervin 2005:27). Figure 2 depicts the central metaphor in Dervin's Sense-Making's Approach.
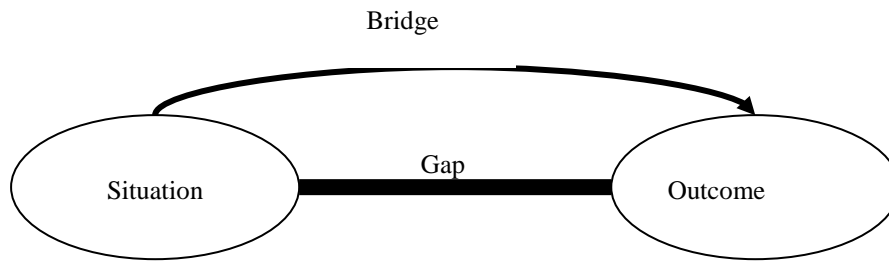
Bridge

Gap

Situation

Outcome

*Figure 2: The Sense-Making Approach (Ingwersen and Järvelin 2005)*

The Sense-Making gaps are cognitive gaps as perceived by individuals which can be explained as "a situation in which people are unable to make sense of their experiences" (Choo, Detlor and Turnbull 2000; Kraaijenbrink 2007). The cognitive gaps or situations which will prompt consulting engineers to seek information to bridge their knowledge gaps and make sense of their experiences are related to the engineers' work roles and tasks. Time-line interviews, the data collection method most used in Sense-Making studies provided the means to determine specific cognitive gaps arising from the engineers' tasks. This method therefore assists in revealing the nature of a problematic situation, the extent to which information can bridge cognitive gaps and the nature of the outcomes from the use of information (Wilson 1999).

## Data collection

Time-line interviews was used to collect the data for the study from the interview sample.

### The interview sample

Eleven consulting engineers were selected from amongst the consulting engineers located in Central and North Gauteng. These engineers represented different age groups, different engineering disciplines and gender (the sample included two women). A combination of snowball sampling and convenience sampling was used to select the interview sample for this study.

Although most of the participating consulting engineers were members of the professional team appointed to construct a large library building in Pretoria, not all the engineers described their involvement in the library building.  Some of the engineers described projects located far from their offices which had to be managed over a distance.

Most of the engineers work for different companies. Some are business partners but no more than two engineers employed by the same company were interviewed. None of the engineers have a formally organised library available within their companies. References made to a 'library' by some of the engineers were references to a central place in the engineers' offices where they kept specific sources of information such as their trade literature collections, codes of conduct, regulations and textbooks.

**Time-line interviews**

Micro-moment or time-line interviews are the interviewing approach most aligned with Sense-Making theory (Dervin 1999a; Tidline 2005). This interview method allows for in-depth discussions with users and provides informative and in-depth data that often reveal thoughts and reasons underlying behaviour (Wang 1999). Using time-line interviews assisted in detecting hidden information not possible through other methods of data collection.

Furthermore, did the use of time-line interviews make it possible to determine the different tasks requiring information, the resulting information needs as well as the information sources used by the engineers to satisfy these needs. The different stages that were identified by the Engineering Council of South Africa (ECSA) (2007) to describe engineering projects and measure progress in projects were used to establish a situation-oriented frame of reference that would encourage the engineers to express themselves as freely and naturally as possible. These stages are the report stage, preliminary design stage, design stage, tender stage, working drawing stage, construction stage, and targeted

procurement stage. Four stages, the design and tender stages, and the working drawing and construction stages were combined into two stages in this study. This was done because the design stage is embedded in the tender stage and the structural engineers are the only engineers who use the working drawing stage.

The consulting engineers were asked to describe their individual projects and the tasks that they had to complete during each stage. They then had to indicate which information was required to complete each task. The reasons why specific sources of information were used to complete the task could be derived from the engineers' responses. Unfortunately this method only allows for the description of information needs encountered in the specific project described by the consulting engineers and did not provide for their information needs in different projects at similar stages of the projects.

Since the consulting engineers can simultaneously be involved in more than one project, a second set of questions was prepared. The assumption was that tasks from different projects might require different sources of information and time-line interviews would only reveal the sources that were used in the project described by the consulting engineers. The intention was to use the second set of questions to learn more about the engineers' use of specific information sources in other projects, should these sources not have been used during the described project described. In this way it was possible to get a fairly comprehensive view of all the sources of information used by the consulting engineers and acquire an understanding for the reasons for their use.

## Describing the study

Data analysis could start once the interviews had been transcribed.

**The work roles of consulting engineers**

The first task was to determine the consulting engineers' work roles since work roles and work situations can facilitate an understanding of their information-seeking behaviour, and help predict their information needs (Leckie *et al* 1996; Wheeler 2004). In order to determine the work roles of consulting engineers, the respondents were asked to briefly describe their roles as consulting engineers. An analysis of their responses indicated their roles as professionals who advise their clients and provide a service (Du Preez 2008).

**Engineering tasks requiring information**

Work tasks are embedded in work roles (Leckie *et al* 1996).
These can be defined as 'abstract, objective sequences of actions' (Ingwersen and Järvelin 2005). Each task can further be divided into subtasks. The degree to which these tasks have been structured by rules and routine may have an effect on the use of information (Choo *et al* 2000).

Engineers will utilise various technological devices or systems to complete each task or subtask. Each of these devices is an entity made up of several interdependent parts or subsystems (Wolek 1969). There now may be a gap between the engineer's knowledge about the task or the devices that will be utilised and the perceived requirements of the task (Belkin, Oddy and Brooks 1982). This knowledge gap constitutes an information need, which then relates to information-seeking and retrieval (Byström and Järvelin 1995; Ingwersen and Järvelin 2005).

As previously indicated, the data pertaining to the consulting engineers' tasks that was collected from the time-line interviews was analysed according to the gap-metaphor in Dervin's (1983) Sense-Making Approach.  The Sense-Making situations were translated into tasks

needing information, knowledge gaps were translated into information needs and the uses into information sources and the outcomes. This method of data analysis is similar to the general model used by Kraaijenbrink (2007) in his study of the information usage and processes of engineers. Table 1 is an excerpt from the table analysing the collected data in Stages 3 and 4, the design and tender stages of an engineering project.

| ENGINEER & PROJECT | TASK | INFORMATION NEEDED | INFORMATION SOURCES AND OUTCOMES |
|---|---|---|---|
| *Engineer E: (Electrical engineering):* | *Task(a):* Budget. | *Task (a), needs (i):* Clients' budget and standards. | *Task (a), needs (i)&(ii):* I needed information from the architect, the client [in this project the client was the library and the Department of Public Works], SABS standards, regulations, and suppliers. |
| | *Task (a):* Compiling tender documents. | *Task (a), needs (ii):* Detailed design. Bill of quantities. Price schedules. | |
| *Engineer G: (Acoustical engineering)* | *Task (a):* Advises the mechanical engineers on acoustical issues concerning air conditioning systems. | *Task (a), needs (i):* Which type of air conditioning system is being used? | *Task (a), needs (i):* The mechanical engineers provide this information. The manufacturers of the equipment also provide specific information on the noise ratios emitted by the equipment. |

**Table 1: Design and tender stage**

The engineers' description of their tasks, information needs and the sources of information in the Table 1 were freely translated since the interviews with these engineers were conducted in Afrikaans.

Table 1 shows that one task can have more than one information need and might require the consulting engineers to access more than one source of information to successfully complete the task.

The empirical research findings showed how specific engineering tasks influence the consulting engineers' information needs and the selection of sources of information to complete their tasks. The use of time-line interviews further indicated that the consulting engineers often used the same sources of information to complete different tasks in various stages of the project. Specific patterns of information needs and use throughout a specific engineering project could therefore be identified.

In instances where the consulting engineers could not find the required information to solve a specific problem, they relied on their engineering judgement or returned to basic engineering principles. A lack of information therefore did not prohibit the engineers to complete their tasks.

The analyses of consulting engineers' information needs during various stages of a project further indicated that the consulting engineers' information-seeking is most extensive during the preliminary design and design stages (the initial phases) of a project. They utilised a variety of formal and informal sources of information sources during these stages. Most of the information during the construction phase came from the construction site and very little additional information was required. These findings correspond with the findings of Byström and Järvelin (1995), Ellis and Haugan (1997), Vakkari (1998), Vakkari (2001:452).

The consulting engineers' information-seeking activities during the different stages of the projects also assisted in identifying components from other information-seeking models. These include the different situations in Cheuk Wai-Yi's (1998) Information-seeking and Using Model; the surveying mode in Ellis's Information-Seeking Behaviour Model (Ellis and Haugan 1997); information patches in Sandstrom's (1994) Optimal Foraging Theory; initiation stage in Kuhlthau's (1993) Information Process Model; information search in Aguillar's (1967), Modes of Environmental Scanning.

**Characteristics of information needs**

Apart from the information needs that arise from work roles and engineering tasks, there are certain consulting engineer related characteristics of information needs that also influence or shape their information-seeking. These are the consulting engineers' individual attributes and circumstances (including particular demographic factors) and various project- or task-related factors, namely context, frequency predictability, complexity and importance.

**Attributes and circumstances of consulting engineers**

The attributes and circumstances that could influence the consulting engineers' information needs are:

- *age.* The responding consulting engineers' ages were indicative of their experience as consultants. The older engineers tended to act as mentors and relied more on their personal knowledge and personal files than the younger engineers. The two oldest participating engineers (they are 72 and 73 years old) do not use design software but are confident in using the Internet to find information.
- *engineering discipline.* All the engineers needed similar information sources at the same stages of the project. The engineering discipline influenced the selection of specific sources, for example the codes of conduct selected by the consulting engineers was determined by their engineering disciplines.
- *geographic location of the project.* The geographic location of the project influenced the engineers' preference for specific sources of information and the way information was communicated. Consulting engineers managing projects over a distance relied more on photographs, faxes and emails to solve site specific problems than the engineers managing projects located geographically closer to their offices.

- *Personal factors*. Personal preferences seemed an important personal factor that influenced the consulting engineers' selection of sources.

## Context

Leckie *et al* (1996) regard context as the situation specific need, which can be, prompted both internally and externally. The engineering project, the geographical location thereof and the stage provided the context in this study. People (e.g. clients) are often the consulting engineers' only sources of information, especially in the design stage. Since the engineers are involved in a number of projects simultaneously and each project has a different client, professional team and contractor the project will determine who will be approached for information, despite the fact that the different projects are similar. These networks are examples of the intensional networks described by Nardi, Whittaker and Schwarz (2000).

## Frequency predictability

In cases where tasks become routine, as in repetitive projects, the consulting engineers relied more on their personal knowledge and experience to complete the task. This behaviour corresponded with the findings reported by Gerstberger and Allen (1968), and Hertzum and Pejterson (2000). The explanation given by the consulting engineers for their reliance on their personal knowledge is that engineering principles have remained constant and they therefore do not require new information for repetitive projects.

## Factors influencing information-seeking

Leckie *et al* (1996) identified two factors that can motivate information-seeking. These are sources of information and an awareness of information. The data collected from the time-line interviews as well as the data from a second set of questions aimed at determining the role of potential sources of information not used by the consulting engineers in the projects they described, was used to examine these factors.

**Sources of information**

The following is a summary of the sources of information that were used by the consulting engineers during the different stages of the engineering projects they had described.

- Stage 1 – Reporting stage: personal contacts such as the client, the architect, geotechnical engineers.
- Stage 2 – Preliminary design stage: personal contacts, architectural design and drawings, suppliers, visits, task-based sources of information (literature) (e.g. textbooks, codes of practice, standards, brochures or catalogues, and engineering trade journals such as *Security World* and *Vektor*), Internet, email, design software, personal knowledge and personal files).
- Stage 3 and 4 – Design and tender stages: architectural designs and drawings, suppliers, catalogues, brochures, pamphlets, standards, regulations design software, personal contacts, and journal articles.
- Stage 5 and 6 – Working drawing stage and construction stage: System test results or an analysis of the system's behaviour, construction site reports, digital cameras and cellular phones, brochures and pamphlets, factory test results.
- Stage 7 – Target procurement stage: The only tasks remaining during this stage are the commissioning of systems, completion of the final report and updating as-built drawings. All the required information during this stage comes from the project itself.

The sources of information that are used by the consulting engineers was subdivided into internal and external sources of information, interpersonal communication and social networking.

**Internal sources of information**.

The following are examples of internal sources of engineering information used most by the consulting engineers.

- *Personal knowledge and personal files* are important sources of consulting engineering information. These findings correspond with the findings reported on by Aguillar (1967), Gralewska-Vickery (1976), Taylor (1991), Case (2002), Kwasitsu (2003), and Tenopir and King (2004).

- *Books*, *codes of practice, acts* and *regulations* are used frequently by consulting engineers, especially the codes of practice, building regulations and acts. Most of the consulting engineers also indicated that they buy these sources for their own collections since the chances are that they would need them for more than one project. All South African codes of practice and some international codes of practice are available from the South African Bureau of Standards (SABS). Regulations and Acts are retrieved from the Internet.

- *Trade literature* provides important engineering information and the consulting engineers frequently use trade literature during the design and tender stages of their projects.

- *Digital cameras.* This study seems to be the first to report on the use of digital cameras to record project progress and assist in reporting. Photographs are also very useful sources of information in retrofit projects – this is when an old project is upgraded or extended. It seems as if the use of digital cameras has become a standard practice amongst most of the consulting engineers. To me this practice is evident that practical solutions become a determinant of consulting engineers' information behaviour.

- *Engineering software.* The younger engineers seem to rely more on software packages than the older engineers who prefer to use the "classical" method of design. However, some projects do not warrant the use of software packages. The project or task will therefore determine whether a software package is used or not.

- *Technical journals* seem to be the least frequently used source of project related information. The engineers mainly use technical journals for personal development. The engineers will browse old numbers of their journals for relevant articles when they need specific information.

**External sources of information**

The consulting engineers also discussed the role played by external sources.

- *Internet.* Most of the consulting engineers reported they frequently accessed the Internet for information. All the engineers preferred Google as a search engine. Other frequently used search engines are AskJeeves, Dogpile and AltaVista. Some of the engineers also use Wikipedia, subject portals and specific websites like www.acts.co.za.
- *FTP sites* are secure sites to which only the engineers involved in the project for which the site was created have access. FTP sites have proved to be useful in bridging the communication gap between project team members who are employed by different companies. The engineers will upload their drawings on an FTP site and inform their team members via email that new information is available on the site. Fidel and Green (2004) have reported that engineers posted information on the Internet, but one can assume it was on an intranet since the engineers seemed to be employed by the same company. The behaviour described by Fidel and Green (2004) might therefore be different from the use of FTP sites described by the consulting engineers.
- *Email* is used frequently to exchange information with fellow team members but also to issue instructions to contractors, place orders and manage a project.
- *Visits* to factories and other installations are important sources of information. The engineers also reported that they would visit factories to test equipment before the equipment is shipped to the construction site for installation.
- *Libraries* and *online databases* could provide engineers with information. These resources are used the least by consulting engineers, if ever.

- *Conferences* are only attended for personal development purposes and to comply with continuing professional development requirements.

## Interpersonal contacts

The empirical findings of this study show a preference for personal contacts as sources of engineering information. The main reason for this trend seems to be that people often are the engineers' only sources of information (considering the client's needs and the information needed from the architect and the mechanical engineers reported in Table 1). The studies reported on by Ellis and Haugan (1997), Hirsh (2000), Hertzum and Pejtersen (2000), Fidel and Green (2004), and Wheeler (2004) reported similar preferences for interpersonal contacts.

## Awareness of information

Awareness of information includes engineers' perceptions of trust, cost or time, accessibility or availability of information sources. This study did not investigate trust as a selection criterion, which is a shortcoming of the study. One engineer however did comment on her preference to use products that she trusted and knew would work, but this is not the same as trusting an information source.

Cost and time do seem to be important factors impacting on the selection of information sources. Most engineers indicated that they don't have much time available to seek information. Since the time that is required to find information (whether it is the time seeking the information or the time spent waiting for the information to be delivered) is time lost to complete a task. Time and cost considerations can also be the reason why mentorship is such an important source of engineering information and why consulting engineers' are reluctant to attend conferences.

None of the responding engineers reported that they had problems in accessing the required information or that they experienced problems in

finding the relevant information to solve a problem. Accessibility therefore does not seem to be a factor influencing consulting engineers' selection of information sources.

The quality of information does not seem to be a factor when engineers select information. What seems to be more important is that the level of sophistication of the information and the amount of information available in the source is more important. Engineers do not want to buy a source that consists of a number of pages if they only need one page of calculations or drawings from the source. Information summarised in graphics and statistics is easy for them to interpret and saves time.

**Outcomes of information-seeking**

The outcomes of information-seeking is the final component in Leckie, Pettigrew and Sylvain's (1996) General Model of Professionals' Information-seeking. The findings for this component could be derived from the time-line interviews since the outcomes involves the completion of tasks during each stage of the project and eventually the completion and delivering of the project.

Another possible outcomes is to write an article on the completed project. This is however not the main objective of the engineers' mandate and seem to feature low in their information behaviour. Only few engineers reported that they would at times publish articles or a brochure on a completed project.

## Conclusion

This presentation aimed at reporting on the information behaviour of consulting engineers in South Africa. Leckie, Pettigrew and Sylvain's (1996) General Model of Professionals' Information-Seeking provided the framework for this report in the same way it was used to structure the data collected for the empirical study. The presentation also briefly showed how gap-bridging

metaphor in Dervin's (1983) Sense-Making Approach was used to analyse the data collected from time-line interviews. This method assisted in determining the consulting engineers' information needs during the various stages of individual projects.

The empirical findings indicated that the engineers collect most of the data they need for their projects during the preliminary design, design and tender stages. Thereafter most of the information comes from the construction site itself. People, personal knowledge and files seem to be the most used sources of information.

This study seem to be the first to report on how engineers use FTP sites to communicate project related information with professional team members and digital cameras to record progress in projects.

Leckie *et al's* (1996) model proved to be a useful model to study the information behaviour of consulting engineers, despite the models' focus being on the individual and not a community of practice. The gap-metaphor in Dervin's (1983) Sense-Making Approach also proved invaluable in analysing the data collected from the time-line interviews that pertain to the engineering tasks requiring information at various stages of an engineering project. Great care however needed to be taken not to duplicate data. This especially is a challenge when discussing the information needed to complete specific engineering tasks and when discussing information sources as factors influencing consulting engineers information-seeking.

Future research projects can focus on consulting engineers' use of FTP sites to communicate project related engineering information. More studies are also needed on the role digital cameras have in collecting engineering information.

The reported empirical findings could guide the development of a unique Internet based information service that could provide in the information needs of consulting engineers who do not have an information service available within their own companies.

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