Information in social practice
Information-related activities engaged in by engineers

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In this study information-related activities engaged in by engineers during work task performance in the research and development centre at Sandvik Materials Technology AB are investigated. The purpose of the present study was to identify and achieve an understanding of the information-related activities performed by engineers during work task performance in a corporate context. The work task performance in focus is the task of writing a technical report.

The study rests on methodological triangulation through the use of a work task diary, a semi-structured questionnaire and focus groups. In total 16 engineers participated in the study. The theoretical framework is based on theories of information in social practice, the information seeking process and the concept of task.

The study presents results showing that engineers work in a highly complex information environment and their work task performance is to a high degree affected by situational attributes such as previous experience, type of work task, time, target group, and access to information. The results show that the information sources preferred by engineers have not changed over time; rather a change is seen in the type of sources. There is a distinct increase in the use of electronic sources; which in turn seem to affect the way engineers perceive accessibility. The study also shows that there are evident situational and contextual attributes affecting the information-related activities. Information needed to perform a work task is strongly related to data retrieved from experiments. There also seems to be an embedded tolerance for a low scientific level in technical reports, even though the scientific practice is the norm.

This study also shows that the concept of work task forms a relevant basis for studies of information-related activities, particularly in combination with theories on information in social practice. The model of the work task process combined with a faceted classification of work tasks provides a sound methodological tool for the analysis of work tasks in different contexts.

**Keywords:** Engineers, information-related activities, work task, task diary, focus group, information practice, information in social practice
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1. Introduction

It is often said that we live in an information society and that we are experiencing an increasing information use. In 1980, this was highlighted by Mick, Lindsey and Callahan (1980, p. 355) who stated that even though the society over 30 years had seen advances of new technology and an increasing information dependence, information users had not changed the way they accessed and used information. In contrast, the last 30 years, seen from today, have not only brought a continued advance in new technology and the amount of information available, but also a change in how people seek, access and use information (cf. Chowdhury, Gibb, & Landoni, 2011, p. 158), i.e. we are experiencing a change in people’s information-related activities.

People’s changing information-related activities also hold true for people in their professional roles. One example is the corporate library user, who today has a new set of experiences often emanating from the academic context (Harwood, 2002, p. 288). These experiences differ depending on the user’s background and habits, giving rise to different information-related activities. In addition, the corporate library user is more computer-literate than before (Harwood, 2002, p. 288), which changes the kind of services asked for and new ways to communicate information (Levine, Allard, & Tenopir, 2011). The changing information landscape and the development of information technology have created increasing expectations from the employee in the workplace. This study addresses information-related activities engaged in by engineers when performing a work task in a corporate context.

1.1 Information-related activities

Research on information seeking has attracted a widespread interest in fields such as informatics, management, information technology, and especially in library and information science (Bawden, 2006; Case, 2012; T. D. Wilson, 1981, 1994, 1997, 2000). Information seeking has been studied in different contexts such as workplaces, in everyday life situations as well as in educational environments. Such studies have answered questions concerning what kind of information is considered necessary to acquire, how information is sought and used and how individual information seekers are affected by the information seeking process (e.g. Kuhlthau, 1988). Information behaviour has come to be a term widely accepted to represent a wide number of information-related phenomena (Case, 2012, p. 91), but it has also received criticism for being strongly linked to a cognitively oriented research tradition. At the same time, the theoretical development has made the concepts of information need and information seeking too narrow in scope for the study of information behaviour. Therefore, it is relevant to use the term information-related activities, making it possible to include a wide range of variables in order to better understand the context.

Moreover, studies of information-related activities by occupational category has long been a focus in library and information studies and concerned a range of professions such as scientists, engineers, health personnel, and managers (Case, 2012, Chapter 11). When research on information seeking initially increased in importance there was a strong focus on scientists and engineers (Case, 2012, p. 287). However, research on information-related activities performed by professionals have during the last decades seen a shift towards other professions (Case, 2012, p. 287), and throughout time, research on information-related activities performed by engineers in a Swedish context
are rare. This study considers information seeking and use by analysing information-related activities performed when performing a work task.

A study of the information seeking process almost always includes some kind of perceived necessity to acquire information. The concept information need has been defined in many ways by different researchers in different disciplines (Case, 2012, p. 77ff). There is no attempt in this study to demarcate a specific definition of information need. In this study information needed is seen as a generic term. It is recognized that information can be, and perhaps is even likely to be used due to other premises than an intrinsic (cognitive) need. The concept is used as an instrumental understanding of what kind of information is acquired in connection with a specific work task.

Numerous studies have introduced models of the information seeking process (e.g. Kuhlthau, 1988; Marchionini, 1995; T. D. Wilson, 1981, 1997). Although these models seem to have a common basic structure, most of them have adopted different angles in describing the information seeking process. In his model, Wilson (1981, p. 8, 1994, fig. 2) claimed that there are different basic needs that are the driving forces for information seeking. He had a strong focus on different variables and barriers that affected the behaviour. Wilson’s model differs from the model developed by Kuhlthau (1988) who instead of focusing on the factors leading up to the information seeking process stressed the cognitive aspects of the process. The assumption that there is an information need that creates a feeling of uncertainty within the information seeker might not be applicable when studying information seeking in a work context. A professional is accustomed to their area of expertise and may instead be quite sure of what kind of information is needed.

Marchionini (1995, p. 50) also developed a model of the information seeking process in which he placed the information seeking process in an electronic context and focused on the search process and specific queries made by the information seeker. He also suggested that the information search process is dynamic and consists of a number of sub-processes that occur parallel to each other (Marchionini, 1995, p. 59). The distinction between information seeking and information searching might be a limiting factor insomuch as information searching in Marchionini’s model has a focus on finding information in only one source. In this study the concept information seeking is used with the purpose to obtain a broad definition that can include a large variety of information sources. Even though Wilson’s model to some extent incorporated external factors, the models of Kuhlthau and Marchionini do not. This can be seen as reducing their applicability in work environments, since external factors are an important feature when studying information seeking in such contexts. Other researchers, e.g. Byström and Järvelin (1995, p. 197) and Leckie, Pettigrew and Sylvain (1996, p. 180) have developed models of the information seeking process applicable to work environments. Both of these models connect to the context but also to the concept of work task. In this study the model developed by Byström and Järvelin (1995) is used as a theoretical framework for the information seeking process. It is important to bear in mind that the context is understood in different ways in different studies, but is not within the scope of this study to explore the different meanings of context.

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1 The information seeking model is presented in Chapter 3.
There are several studies that have addressed the importance of context in different ways. The importance of understanding the user and their context is stressed by Dervin (1997), Blomgren, Vallo and Byström (2004, p. 65) and Pritchard (2008, p. 220f). Byström (1999, p. 17) even argues that identifying and understanding information-related activities within a given context is a precondition for developing and improving information systems and services. In her recent articles, Lloyd (2010a, 2011) discussed the concept of information literacy in the context of work, advocating the use of information practice and practice theory. Information practice in a work context may be said to represent the agreed upon information-related activities such as where to seek information and the type of information that is seen as relevant and accepted.

With the turn of the millennium there has been an increasing interest in the study of contexts and social interaction. Within this line of research, the possibility to transfer between different contexts has attracted a special interest. Dawson and Chapman (2001) discuss this transfer from the point of view that one person can have several reference groups depending on which context they are present in at a certain point in time. By stating this, they claim that it is possible to transfer between different contexts, but that they represent different norms and values that are not necessarily transferable. Moring (Moring, 2009a, 2009b) presents similar results where people are able to adhere to the existing information practice and at the same time influence and maybe even contribute to changes in an existing practice. However, several studies (e.g. Hedman, Lundh, & Sundin, 2009; Lundh & Sundin, 2006) have shown that information practices are not transferable between contexts and as such there exists no universal skill, but rather a historically and situational bound practice specific to the context itself. Hence, there remains a need for further understanding of how an individual’s background affects the information seeking process and if social mobility is possible without adhering to the information practices present in the new context. In conclusion, there remains a need for further studies addressing work tasks and information-related activities as part of a social practice (cf. Byström & Lloyd, 2012).

1.2 Information-related activities performed by engineers

Technical communication and documentation is an important task in the industrial sector and technical reports are an accepted format for the dissemination of technical information. According to Swarna et al. (2002, p. 3) the technical report can fill the purpose

… to inform the readers/users to initiate actions which form a basis for arriving at a decision, to record for archival or future use, to maintain the history of a job, and to facilitate administrative or legal requirements.

The importance of and use of technical communication has been shown by Barclay, Pinelli and Kennedy (1994) who showed that engineers spent approximately 8-9 hours per week writing technical information and between 6-9 hours communicating technical information orally (Barclay et al., 1994, p. 98f). Similar results have been presented by Allard, Levine and Tenopir (2009) and Levine et al. (2011). The importance of technical communication and documentation underpins the relevance of studies on information-related activities engaged in by engineers.

The information seeking processes of engineers have often been compared to that of scientists (Yitzhaki & Hammershlag, 2004). Scientists and engineers are often contrasted with the claim that the former are interested in developing new knowledge
and the latter more interested in solving (technical) problems (Case, 2012, p. 297; Yitzhaki & Hammershlag, 2004, p. 841). The actual work performed by engineers in the industrial sector and scientists in the academic sector still differs. However, most engineers today have an academic background and are trained in the academic working method and as a profession they have also trained the skill of producing technical documentation and thus contributing to documenting new knowledge (Barclay et al., 1994; Swarna et al., 2002). This convergence between scientist and engineers has also been addressed by Pinelli (2008).

Numerous studies (e.g. Allard et al., 2009; Barclay et al., 1994, p. 101f; Case, 2012, p. 297; Ellis & Haugan, 1997, p. 401; Engstrom, Koparkar, & Morrissey, 2008, p. 16; Kwasitsu, 2003, p. 466; Wild, McMahon, Darlington, Liu, & Culley, 2010, p. 56) have shown that engineers to a very large part depend on information retrieved from their own files, colleagues and internal sources such as other technical documentation. As a consequence, much of the information used is not documented for sharing purposes, but often kept in someone’s mind. This can be contrasted with the importance of documenting information and knowledge in a corporate environment. Information and knowledge produced by engineers within a corporation ought to be documented in order to make it retrievable by others within the same organisation, which is an aim of knowledge management. However, the issue of source use and lack of source documentation in a corporate perspective has been rarely, if ever, addressed based on information-related activities.

It is generally accepted that accessibility and availability play a major part in the engineer’s choice of information sources (cf. Ellis & Haugan, 1997, p. 401; Fidel & Green, 2004, pp. 570, 572; Gerstberger & Allen, 1968, p. 277; Kwasitsu, 2003, p. 468f). Few researchers have addressed the effects of accessibility, and the study by Fidel and Green (2004, p. 573) show that the concept of accessibility have many different meanings and that it is often confused with quality. They proposed that future studies of engineers’ information seeking should address both the way they perceive accessibility as well as how they actually choose sources (Fidel & Green, 2004, p. 579). To summarise, there is still a need to study the information-related activities that different professional groups such as engineers engage in (cf. Hedman et al., 2009).

1.3 Information-related activities connected to work tasks

Information-related activities in a corporate context does not concern information seeking in general, but are rather defined by the field of work and often by the specific work task at hand. The connection between work tasks and information-related activities has generated a growing research interest (see e.g. Byström & Järvelin, 1995). A work task does not differ from a task in general, but has a number of elements that distinguish it from other tasks that makes it a relevant concept in studying information-related activities (cf. Byström & Lloyd, 2012; Byström, 2007; Huvila, 2008, p. 810).

Work tasks have been defined in several ways in different research studies (cf. Li & Belkin, 2008). Byström and Järvelin (1995, p. 194f) defined task depending on how well a task performer could predict the information needed to be acquired, the process of completion as well as the outcome in the beginning of the task performance. In the present study the definition of work task proposed by Byström and Lloyd (2012) is used. A work task is therefore defined as “a piece of labour that is embedded into a context of work within which it forms a meaningful whole… It has a purpose, a
beginning, requirements, goals, an end, and is recognized as legitimate entity by task performer(s) as well as others in the workplace” (Byström & Lloyd, 2012). This definition was first formulated by Byström (1999, 2007, p. 2) and a similar definition was used by Byström and Järvelin (1995) and Hyldegård (2009, p. 145).

Performing a work task is in this study regarded as a process. Within this process the task performer identifies one or several search task/s, perform that or those search task/s by seeking for information in internal or external sources, evaluates and/or validates the retrieved information and applies the information retrieved in order to fulfil the work task (cf. Byström & Järvelin, 1995; Xie, 2006).

1.4 Research need
The major changes in information technology have led to changes in the availability of information as well as changes in the information-related activities themselves during the last decades, which, despite long lasting attention of studies on information seeking, highlight the topicality of studies on information-related activities. These changes call for further studies on information-related activities performed by professionals, especially as part of creating a sound base for information and knowledge management within corporations. In a way, it is two sides of the same coin that highlights the need for further studies. On the one hand, professionals facing a changing information landscape adapt to new practices and come to depend upon the information available and the relevance of this information from different and new sources. On the other hand, corporate libraries are faced with highly information and computer literate engineers and must strive to have a profound understanding of the information practices they are part of in order to provide relevant information in an efficient way.

This study addresses one of these sides – the information-related activities that engineers engage in when performing a work task; what information they value and seek, what sources they use and for what reason out of a collective perspective. As the number of engineers with an academic background increase, it becomes interesting to study how the information-related activities in which they engage are situated and contextualised. It is of interest to further understand what happens with the information-related activities when engineers’ transfer the knowledge and skills they acquired during university training into a new workplace context. Moreover, it is of interest to acquire an understanding of how the changing information landscape has altered the way engineers seek and use information. Thus, in this study it is the engineers’ informational, social interaction that is referred to as information in social practice, which the information-related activities, as the object of study, are seen as embedded within.

Technical documentation needs to be performed in an accurate and effective way to ensure future retrieval and re-use. Engineers’ tradition to depend on in-house sources as well as people as sources highlights the need to understand how that kind of information is documented in order to ensure accurate and effective technical documentation. If source use and documentation of sources are defective, long term use is not ensured, thus leading to ineffective knowledge management. Achieving a better understanding of what is seen as relevant information, how it is sought and used will therefore contribute to sound preconditions for accurate and effective knowledge management as well as pinpoint the discrepancies between efforts of knowledge management and information
in social practice. In order to meet that goal, the information-related activities need to be studied within a given context.

1.5 Purpose of the study
The purpose of the present study is to identify and achieve an understanding of the information-related activities performed by engineers during work task performance in a corporate context. The work task performance in focus is the writing of a technical report. The corporate context is a Research and development (R&D) centre at Sandvik Materials Technology (SMT).

1.5.1 Research questions
In order to achieve an understanding of the information-related activities performed by engineers during work task performance, the following questions were addressed:

- What are the central information-related activities in which engineers engage when writing technical reports, and why are they considered as central?
- How can information used by an engineer writing a technical report be characterised, i.e. how do they value/describe the information they use?
- In what ways do the information-related activities differ between engineers writing technical reports depending on work task?
- In what ways are the information-related activities performed by engineers situated and contextualised?

1.5.2 Significance to the field
The purpose of this study is to present and discuss information-related activities performed by engineers during work task performance. The thesis has a specific focus on the information-related activities in which engineers engage, with the R&D centre at Sandvik Materials Technology in Sweden as a focal point, and it is expected to generate results that can be used as a foundation for information and knowledge management within a corporation as well as a corporate library. However, the empirical results are not considered to be generalisable outside the studied context.

Nevertheless, the study is also expected to produce results relevant outside of the studied context; they will give possibly a new, but at least an up-dated insight on information-related activities in a professional setting in the new emerging information landscape. By addressing information seeking and use from a broader perspective the results are expected to give an up-dated understanding of what are valid information-related activities performed by engineers.

1.6 Limitations of the study
One often discussed issue in research is whether it is possible to make any generalisation based on the results of a qualitative research project. This study is a qualitative case study of a specific group of professionals in a given context which makes it difficult to make generalisations applicable in other contexts. Therefore, there are no claims of making generalisations based on the results of this study.

Despite the difficulties in making generalisations, there is according to Case (2012, p. 280) still a value in trying to some degree to make transferable claims, “otherwise, there would be little point in investigating information seeking at all” (Case, 2012, p. 280).
To be able to do so, he states that it is important to pay close attention to the context; in
the present study this is attempted by describing the context and how it narrates
information-related activities. Furthermore, triangulation is used to assess the results in
different ways in order to draw some general conclusions, which in turn are compared
to previous research results. It is important to remember that even though part of the
result is presented in quantifiable numbers, this is only done in order to facilitate the
identification of trends in the data collected. Since the sample is small, it would be
impossible to analyse and find any statistical viable trends, but it is possible to compare
identified trends with trends in similar studies. Through research diaries a glimpse of
the information-related activities are documented, and then further elaborated in focus
groups in order to be able to draw conclusions that are valid in a larger context.

1.7 Thesis outline

In the first part of the thesis (Chapter 1) I have placed this study in a larger research
field by focusing on information-related activities performed by engineers in an
evolving information society. I also present the main aim and the research question in
the study. The first part also includes a review of previous research relevant for this
study (Chapter 2) in order to further establish the framework and the relevance of the
study. Previous research is addressed through two areas of interest; the process of
seeking information and information-related activities performed by engineers.

In the next part of the thesis (Chapter 3) the theoretical framework for the study is
presented, including the model of analysis. The concept of information-related activities
and information in social practice are used as a theoretical concept apparatus through
which the results of the study are understood and sorted. The information seeking model
developed by Byström and Järvelin (1995) is introduced as a methodological approach
to the understanding of the information seeking in work contexts. In chapter 4 the
methodological framework is presented; including a presentation of the research setting,
the participants, the data collection instruments (a work task diary, focus groups & a
semi-structured questionnaire) as well as the data collection process and the data
analysis performed. Chapter 4 also includes a discussion of ethical considerations,
including an account of the measures taken to adhere to these such as informed consent
from the participants as well as a discussion of trustworthiness.

Chapter 5 presents the empirical results from data collected through the work task
diaries, the questionnaire and the focus group discussions. The results are presented
under four themes; work tasks, the work task process, situational and contextual
attributes and information use. In Chapter 6 the results of the study are discussed and
questions for further research are suggested. In the appendices all data collection
instruments, the consent letters and additional data, such as extensive tables are
presented.
2. Literature review

The overall theme of the literature review is information-related activities and more specifically information-related activities engaged in by engineers in a corporate context. The overall theme is addressed through two different areas related to these activities. In the first section research related to the information seeking process in general and with greater theoretical emphasis is presented. In the second section, there will be a focus on engineers and the information-related activities they perform. At the end of the chapter a concluding remark is made.

The research presented in this literature review covers a wider field than the one that is the focus of this thesis. Much of the theoretical and conceptual growth relevant for research on information seeking and use, in recent decades, is not linked to a specific professional group such as engineers. So, even though research that recognises information-related activities performed by engineers is extensive, it is important to consider research related to other professional groups as well as research on information-related activities in a more general sense. Engineers represent the population studied, but are not the primary theme of this thesis. Rather, it is information-related activities linked to the performance of work tasks that are in focus.

2.1 The process of seeking information

Research on information seeking in its early years\(^2\) focused on explaining and describing information behaviour on an individual level (Case, 2012; Mick et al., 1980). One example of this line of research is the work by Kuhlthau (1988), which is widely used in research on information seeking processes. The study performed by Kuhlthau (1988) was a longitudinal case study of four senior year high school students, in which she expanded an earlier model into a model of six stages describing the actions, thoughts and feelings that the information seekers experienced when they passed through the different stages of the search process. The focus was on the individual seeker and a task of an educational nature in which no external factors or prior experiences were considered. Neither was the context in which the process takes place. The cognitive aspects of the information seeking process have also been addressed in many other studies (cf. Chowdhury et al., 2011; Chowdhury & Gibb, 2009).

Although Kuhlthau’s model, and other models taking a cognitive approach to information seeking, gives a good description of the information seeking process, there are limitations of the applicability of the model. As Byström and Hansen (2005, p. 1053) pointed out, the stage of task construction is not always applicable within a work context since a work task performer normally is confident in what they do. Indeed, it is highly likely that this is in fact the case.

Other researchers have described the information seeking process in work contexts (cf. Byström & Järvelin, 1995; Byström, 2002; Landry, 2006; Leckie et al., 1996; Mick et al., 1980). Most studies have focused on specific groups of professionals, but aimed at providing a representation of the information seeking process that is applicable to other professional groups. One example is a study by Byström and Järvelin (1995), in which

\(^2\) For a more thorough discussion see Du Preez (2008, Chapter 2) who present and analyse information seeking models by numerous researchers.
they presented both a model of the information seeking process and a model for categorising a work task.\(^3\)

Another example of a model of the information seeking process adapted to a work context is the model developed by Leckie et al. (1996). Their model was based on a synthesis and interpretation of research on information seeking performed by professionals. Drawing on an extensive range of sources they aimed to propose a model of the information seeking process applicable to any group of professionals. They stressed the importance of addressing the work roles that people have as professionals. These work roles differed not only between people, but also for each person in their professional lives. The examples they gave show that an individual, e.g. an engineer, can have the roles of service provider, administrator, manager and researcher within the same engagement which in turn give rise to different work tasks that affect the information seeking process (Leckie et al., 1996, p. 180f).

The model developed by Leckie et al. (1996) was the starting point for a study reported by Landry (2006). The study aimed to explore the work worlds of dentists and gain an understanding of how the Internet has affected their information seeking. The results from Landry’s (2006) study confirmed the findings of Leckie et al. (1996), namely that work roles and their specific work tasks influence the task performer’s information seeking. The findings also supported the information seeking model developed by Leckie et al. (1996); stressing the applicability of the model (Landry, 2006).

The issue of work roles has also been addressed by Huvila (2008). In his paper on work, work roles and work tasks (Huvila, 2008, p. 809) he states that work roles are not components of work, but rather lenses through which a task performer perceives and forms the task at hand. The individual takes on one or more work roles which forms the way he/she interpret and perceive the work task. Huvila did not connect his model of the relationship between work, work roles and work tasks to the information seeking process, but the similarities of how work roles can be seen and used in the research process is similar to that of Leckie et al. (1996). As such, these lenses can be used by the researcher to analyse tasks in relation to the context they exist within.

At the end of the 1990s Vakkari (1998) showed that there had been a considerable growth of knowledge within research on information seeking, but also that there had not been any major theoretical growth over a longer period of time. Numerous studies have verified similar hypotheses and therefore contributed to the growth of knowledge (Vakkari, 1998, p. 376). The concept of information had for a long time been seen as a thing without any connection to information understood by people (Vakkari, 1998, p. 379). According to Vakkari (1998, p. 379) these long established research practices took a new turn with the works by Byström and Järvelin (1995) who brought conceptual, theoretical growth by introducing different types of information, and thus widened the concept to include other kinds of information than the one readily available in documents (Vakkari, 1998, p. 379).

### 2.1.1 Information seeking and work tasks

It is generally accepted that information seeking connected to tasks in everyday life differs from information seeking connected to work tasks. In a work context the

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\(^3\) For a presentation of the model of the information seeking process see Chapter 3.2 and Figure 1.
information seekers are more confident regarding their subject area and usually in due time develop a profound understanding of what information is relevant and where it can be found. The degree of uncertainty is much lower than of a person encountering a problem in everyday life or as part of education. This understanding has been acquired both during education, early work training, but even more during a person’s increasing work experience. Information seeking connected to work task has therefore attracted the attention of several researchers (cf. Byström & Järvelin, 1995; Byström, 1999, 2002; Saastamoinen, Kumpulainen, & Järvelin, 2012; Vakkari, 1998, 1999; Xie, 2006).

In a paper from 2007, Byström discussed the role of task in information research and presented different theoretical perspectives on tasks. A task is presented as a multidimensional activity (Byström, 2007, p. 3). This of course has implications for research focusing on work tasks in connection to information seeking. In a more recent paper, Byström and Lloyd (2012) stated that work task performance and information seeking do not exist in isolation, but are rather determined by the corporate or organisational context. In research aiming to understand the information practices in a corporate or organisational context, the concept work task, therefore, constitutes a strong unit of analysis when viewed through the analytical lens of practice theory (cf. Byström & Lloyd, 2012).

Savolainen (2012, p. 583f) suggested that the way an individual seeks information connected to a task is a complex phenomenon that includes several different factors which in turn are seen as a cyclic process, i.e. performance can alter future information seeking. First of all, information seeking connected to a task is affected by the context, both cultural and social, in which the task exists, e.g. the corporate culture of an organisation. Secondly, the information seeking is influenced by the performers’ previous experiences e.g. previously used sources that are seen as trustworthy. Thirdly, the performers’ own agenda, goals and awareness of their competence and capabilities affect the perceived success in the information seeking process. Lastly, the process is cyclic and the actual information seeking performance can alter the way the performer views previous experiences (Savolainen, 2012, p. 503f).

A work task is also possible to divide into different task categories. Byström and Järvelin (1995, p. 194) worked with five categories of work tasks based on how well it is possible to determine the input, process and outcome of the work task, i.e. how structured the task is as well as the complexity of the task⁴. In addition, they also defined different kinds of information that is needed in work task performance: problem information, domain information and problem-solving information (Byström & Järvelin, 1995, p. 195f)⁵. They found that only four of the five task categories were present in their study, no task could be categorised as a genuine decision task (Byström & Järvelin, 1995, p. 199). Most common were normal information processing tasks and normal decision tasks, i.e. there was a high degree of a priori determinability concerning input, process and outcome.

Different categories of work tasks have also been addressed by Xie (2009). In Xie’s study, task categories constituted one of three dimensions of tasks that were found to

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⁴ The different task categories developed by Byström and Järvelin (1995) are used as part of the theoretical framework in the present study and are further presented in Chapter 3.3 and Figure 3.

⁵ The different types of information are used as part of the theoretical framework in the present study and are further presented in Chapter 3.2.1.
affect information seeking and retrieval (Xie, 2009, pp. 348, 351f). The first dimension was the nature of task which in turn was divided into three task categories; routine, typical and unusual tasks. These three categories of task could be connected to the categories used by Byström and Järvelin (1995, p. 195) in that a routine task would correspond to an automatic information processing task, a typical task would correspond to the normal information processing task together with a normal decision task, and an unusual task could be seen as corresponding with known, genuine together with genuine decision tasks. The second dimension of the task in the study by Xie was the stage of the task which related to task performance process and consisted of the pre-focus, formation and post-focus stages (Xie, 2009, p. 349). The third dimension was the time frame for the task, i.e. how urgent the task was perceived to be (Xie, 2009, p. 349).

Xie (2006, 2009) used these categories in a study of the impact of task on the information seeking and retrieval process in both the industrial and the academic sector. Xie (2006, p. 132f, 2009, p. 348) found that most tasks within the corporate group were seen as typical (regularly performed, but not exactly the same) tasks, which correspond to the results of Byström and Järvelin (1995, p. 199). Only a minor per cent of the work tasks were new tasks (done for the first time) or routine (repeated) tasks. Most tasks were perceived as non-urgent or urgent, and a smaller proportion as extremely urgent (Xie, 2006, p. 133). The participants from the academic sector performed mainly typical tasks or new tasks, none were classified as routine or deemed as urgent (Xie, 2009, p. 348). The researcher also classified the tasks from where they originated. In the corporate and the academic sector most of the tasks were self-generated, with a slightly higher proportion of self-generated tasks within the academic community (Xie, 2009, p. 350).

2.1.2 Information seeking and work task complexity

Numerous studies have established that there is a relation between task complexity, information types and information sources (cf. Byström & Järvelin, 1995; Byström, 1999, 2002; Saastamoinen et al., 2012). These studies have shown that an increasing task complexity leads to an increase in the number of sources used, and also promotes an increasing use of people as information sources. The study by Byström and Järvelin (1995) suggested that increased work task complexity leads to an increase in the amount of information needed to solve the task, at the same time as the amount of factual information needed decreases. Success in finding the relevant information also decreased with complexity. A higher task complexity also led to an increase in the number of sources used, especially the use of external sources. As Byström and Järvelin (1995, p. 197) themselves pointed out, the study did not include an analysis of the use of information nor details on specific information search activities, which can be seen as a limitation. Further, this study did not address information seeking performed by engineers which is the focus of this study.

Byström (2002, p. 581, see also Byström, 1999) addressed the effects of task complexity on the relationship between different types of information and sources used by municipal officials. The results showed that no information was sought in the simple tasks where the information needed to perform the task was received along with the documentation initiating the task (Byström, 2002, p. 584). When specific task information was necessary to acquire, in addition to the initiating documentation, the main source used was peers or colleagues. When the information needed also included
domain information, the amount of sources used increased and were spread over a larger variety of sources (Byström, 2002, p. 585).

In a more recent study, task complexity and how it relates to information seeking was revisited by Saastamoinen et al. (2012). The results of the study showed that the higher the complexity of a task the more searches were performed. The perception of task complexity had a high correspondence with a priori knowledge of the performer (Saastamoinen et al., 2012, p. 212). These findings confirmed results from previous studies (Byström & Järvelin, 1995; Byström, 1999).

Huvila (2010, p. 2227) found that there is a relationship between perceived work success, i.e. the perception of how well a work task had been performed, and the choice of information sources. In the study (Huvila, 2010, p. 2222f) the participants indicated the importance of different types of sources as well as how they perceived the importance of different success measures. This relationship between perceived work task success and the sources used are according to Huvila shown to be complex, but Huvila also stated that “Information sources function as measures of success and serve an instrumental purpose” (Huvila, 2010, p. 2227). The perception of success can be both on an individual and organisational level. On an individual level the relationship is connected to how the task performer chooses information sources which he or she deems as important for work task success. This also means that the task performer’s choice of information sources can be steered towards the sources that on the organisational level are perceived as promoting success in order to become successful in the workplace and as a way to learn to become a practitioner.

2.1.3 Information in social practice

In recent years, there has been an increasing amount of literature on information seeking in practice which draws upon theories of practice (cf. Byström & Lloyd, 2012; Cox, 2012a, 2012b; Lloyd, 2010a, 2010b; Schatzki, 2001, 2006). This sub-chapter will review some research studies that have adopted the perspective of practice.

Moring (2009a, 2009b) presented results from a study of newly employee’s information practices in both an educational practice and work practice. The results showed that the newcomers participate in four different communities of practice, which each of them contains a set of criteria that constitutes the context for participation (Moring, 2009b, p. 176f). The study showed that the information practices are created and recreated in the meeting between communities of practice and between individuals and communities of practice. This encounter is often filled with oppositions, because information, knowledge and competence are negotiated locally in communities of practice through participation and the negotiation of meaning (Moring, 2009b, p. 179; Author’s translation).

With this, Moring suggested that communities of practice are in a constant change through continuous negotiations (Moring, 2009b, pp. 217, 219).

Differences between communities of practice have also been studied by Hedman, Lundh and Sundin (e.g. Hedman et al., 2009; Lundh & Sundin, 2006; Lundh, 2005). Lundh and Sundin (2006) studied teachers’ ability to transfer information practices from an

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6 Chapter 3.1 describes the aspects of social practice that are part of the theoretical framework for this study.
educational context to a work context. The results showed that teachers experience their information seeking practices differently depending on context (Lundh & Sundin, 2006, p. 12). Lundh (2005, p. 54) also found that teachers choose to use a reactive strategy when searching for information and therefore adhered to the community of practice at their workplace without any attempt to negotiate and change it, which is contradictory to the findings by Moring (2009a).

In other words, the information practices at a workplace seem to be different from the educational context. Several factors seem to explain this condition such as time restraints, traditions, values and expectations from both colleagues and potential customers (cf. Hedman et al., 2009, p. 151). At the same time as the general skill that is taught in the educational context is not valid in the occupational context, Hedman et al. (2009, p. 156) also raised a warning for a too strong focus on the information practices in different occupational contexts due to the fast changing information landscape.

Sundin (2003) argued that the transfer of practices between different contexts is possible depending on the work role at the workplace. In his study of nurses and their information strategies in relation to their professional identity, Sundin (2003, p. 213) argued that depending on the professional identity (community of professionals) and the work role (community of workplace) some nurses are part of two communities and are able to link the communities of practice to each other, others are only part of the workplace community (Sundin, 2003, pp. 41, 210ff).

In a study from 2001, Cross, Rice and Parker (2001) addressed the issue of social context in information seeking. The purpose of the study was to investigate whether organisational and social relationships affect the way and from whom people seek information and if these relationships affect the perceived informational benefits. The study took place at a pharmaceutical organisation and data were collected from 34 information scientists through a survey followed by interviews with ten of the informants. The results showed that trust has a high influence on who is consulted for information, which is in compliance with the theory on cognitive authority (P. Wilson, 1983).

Dawson and Chatman (2001) addressed the issue of transferring between different contexts in connection to reference group theory. They discussed different concepts in relation to research in library and information science and stressed that these concepts can contribute to the understanding of people’s information seeking and use, especially when studying specific groups, e.g. professional groups. One concept is social mobility which refers to when an individual transfers from one reference group to another (Dawson & Chatman, 2001, p. 11). A reference group is defined as a social unit which consist of people who share a set of values or norms (Dawson & Chatman, 2001, p. 9). They also discussed the fact that one individual can have multiple reference groups of which each of them is connected to a specific part of that individual’s life world (Dawson & Chatman, 2001, p. 10). Two more concepts are the comparative reference group and the normative reference group. The first is a reference group which the individual uses as a standard or point of reference e.g. an engineer who has formerly worked as a scientist would thus use the academic way of seeking and using information as a standard when writing a technical report in his or her new work context. The second group is a group in which the individual aspires to be part of (Dawson & Chatman, 2001, p. 9).
2.2 Information-related activities performed by engineers

As stated earlier, there are numerous studies (e.g. Barclay et al., 1994; Ellis & Haugan, 1997; Fidel & Green, 2004; Hertzum & Pejtersen, 2000; Hertzum, 2002; Kwasitsu, 2003; Leckie et al., 1996; Swarna et al., 2002; Yitzhaki & Hammershlag, 2004) that have addressed different aspects of information-related activities performed by engineers. Still, there are few studies (cf. Allen & Cohen, 1969) that have provided a model of the information seeking process specifically from the viewpoint of engineers. The closest to this is the works of Leckie et al. (1996) who based their models on previous research focusing on information seeking behaviour engaged in by, among others, engineers. But their model is also based on research on the information behaviour of health care professionals and lawyers, giving the model a wider applicability. In this section the information-related activities performed by engineers are in focus. Studies from a large time span are presented and sometimes references to studies of other professional groups are made. These address the same questions and are mostly set in a corporate and/or industrial environment and are therefore seen as relevant.

Previous studies (e.g. Allard et al., 2009; Leckie et al., 1996; Swarna et al., 2002) have reported that information is an important feature of the work lives of engineers. Leckie et al. (1996, p. 164) even stated that engineers need more information in performing their work tasks than they produce. The work tasks of engineers are often (Kwasitsu, 2003) characterised by problem solving in order to present a new product, production process or service and as such they do not produce a lot of new knowledge which reinforces the statement by Leckie et al. (1996). This is also one of the features that distinguishes engineers working in a corporate environment from that of scientists working in the academic sector (Mick et al., 1980).

Studies like those by Barclay et al. (1994) and Swarna et al. (2002) have highlighted the importance of technical documentation and communication for engineers. The study by Swarna et al. (2002) addressed specific features of technical reports and the issue of collaboration when writing a technical report (Swarna et al., 2002, p. 3). The results showed that there had been a cumulative growth of technical reports emanating from the organisation studied with approximately 6 to 7 reports published per month. The reports had an average number of pages of 49, a mean of 11 figures, 8 tables, 3 illustrations, 3 appendices and 23 photographs. Out of the 554 reports analysed they found that only 75 were single authored which gave a high collaboration coefficient (Swarna et al., 2002, Table 2).

2.2.1 Engineers’ choice of information sources

The use of information is an important part of information-related activities. Information use concerns both the information sources used and the way the retrieved information is actually used. Previous research on engineers’ information seeking behaviour have reported that engineers often prefer to seek information from internal sources and more specifically their own personal files, colleagues and in-house technical reports (cf. Allard et al., 2009; Barclay et al., 1994, p. 101f; Case, 2012, p.

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7 Read Chapter 2.1 for a discussion of information seeking models in general and Chapter 3.2 for a presentation of the information seeking model used in this study.
Barclay et al. (1994, p. 102) has shown that engineers relied a lot on their own personal knowledge as an information source complemented by information in personal files, people internal and external to the organisation, literature and library personnel or a technical information specialist. Since the study was conducted, major changes in the information landscape have occurred. The accessibility of information as well as the amount of information available has increased and opportunities for technical communication equally so. One example is the strong dominance of the fax by the participating engineers in the study by Barclay et al. (1994) which today can be said to have been completely replaced by email. Another example is the relatively low use of electronic publishing and electronic databases as shown in the same study, which is more or less commonplace today.

Even though not addressing engineers’ choice of information sources Choo (1994) presented relevant results in a study of the use of information sources among chief executives in the industrial sector. The results showed that newspapers, periodicals (external), subordinate managers and staff (internal) where the most used sources (Choo, 1994, p. 28). In addition, Choo showed a difference between the use of personal and impersonal sources, but did not detect any significant differences between the use of external and internal sources (Choo, 1994, pp. 28, 30). Choo (1994, p. 31) found that internal and personal sources received a higher value concerning perceived quality than external and impersonal sources. Within the categories external and internal sources the personal sources received a higher score than impersonal, which indicate that there is a high trust in personal sources. These results were further corroborated by Choo through interviews where the personal and internal sources were reported as the most used sources. External sources were expressed to be unreliable (Choo, 1994, p. 32f). The results showed that there is a correlation between the sources used and the perceived quality (Choo, 1994, p. 32), insomuch as the sources they had previous experience of were seen as sources of high quality which correspond with the findings of Savolainen (2012).

A study that considers both engineers and scientists in an industrial environment was presented by Ellis and Haugan (1997). They aimed to analyse the need of different types of information by focusing on information seeking performed by researchers and specific information requirements depending on work in general or projects especially. The study by Ellis and Haugan (1997) established that there are differences between researchers and engineers within the same workplace concerning the choice of information sources. The results showed that researchers had a higher tendency to use literature and people outside of their own organisation as well as using the library more. Engineers used a wider range of information sources, including customers and vendors, which were seldom used by researchers. They also, as other studies have shown, used more internal information and sources such as internal documentation (Ellis & Haugan, 1997, p. 400f).

Swarna et al. (2002, p. 6) analysed the references that were used in technical reports. The results showed that about 85 per cent of the references used were so called conventional references i.e. scientific articles, books, standards/codes, manuals and patents. The remaining, non-conventional, references consisted of technical reports, conference papers, theses, personal communications, drawings and lectures (Swarna et
Of the technical reports used as a reference, 36 per cent were reports produced by the organisation. The authors also pointed out differences in the use of references between scientists and engineers, with the former using more conventional literature and the latter using equally conventional and non-conventional references.

Kwasitsu (2003) reported results showing that the main sources of information for engineers were colleagues, personal files and the Internet which is in agreement with other studies (e.g. Hertzum & Pejtersen, 2000; Leckie et al., 1996). In addition, their study suggested that there is a difference in source selection depending on the level of education, claiming that the higher educational degree the more use of databases and external sources at the expense of colleagues and personal files (Kwasitsu, 2003, p. 466f). These results correspond to the findings by Mick et al. (1980) who found that engineers preferred trade literature and people as sources and the further away from science the less interest in scientific and technical information. Kwasitsu also showed that the sources mostly used where internal technical information, technical specifications, conference proceedings and white papers (Kwasitsu, 2003, p. 468f).

In the study by Mick et al. (1980) the comparison of workers (scientist/engineers) in the academic sector and in the industrial sector showed that there were differences in information seeking behaviour depending on where they worked. Their main conclusion was that information seeking behaviour is a complex phenomenon and in an organisational perspective the context is a main factor affecting the outcome.

Yitzhaki and Hammershlag (2004) presented results from a study aimed to compare the use of information and how accessibility is understood by computer scientists and software engineers employed in the industry sector and the academic sector. The results from the study showed that there are clear differences in information seeking behaviour between engineers and scientists, which was explained by differences in goals between their work roles. The differences mostly concerned the use of professional (scientific) journals and conference papers which were mostly used by the academics while engineers were more prone to use books, preferably electronic, trade literature, handbooks, standards and internal technical reports. There were also similarities, such as the use of textbooks, scientific articles and oral sources which were used by both groups (Yitzhaki & Hammershlag, 2004, p. 841).

The study by Allard et al. (2009, p. 444) addressed the information seeking engaged in by design engineers. Besides showing that information tasks are a large part of an engineer’s work they also showed that they mostly used internal sources such as colleagues, institutional document repositories and drawings (Allard et al., 2009, p. 455). In excess of confirming previous findings, they were able to show a change in the choice of sources among the participants. The Internet had increased its importance as an easy way to access external information, e.g. online communities to find a solution to a specific problem (Allard et al., 2009, p. 451; Levine et al., 2011, p. 1156).

Wild et al. (2010) presented a study of information needs and document usage in a group of engineers. Data were collected by using research diaries asking the participants to document the information need they experienced and the corresponding document/access use (Wild et al., 2010, p. 51ff). The results suggested that the engineers seek information by referring to their personal memory and asking colleagues. They often performed several different actions (Wild et al., 2010, p. 55f). When retrieving a document, engineers often used their own personal archives, the company
archive and external databases, but with a strong preference for their own personal archive in printed form (Wild et al., 2010, p. 56).

2.2.2 Why choose that source?
Time saving and ease of use have often emerged as critical variables in the choice of information sources in studies of information seeking performed by different professional groups including engineers (cf. Gerstberger & Allen, 1968; Hertzum, 2002; Kwasitsu, 2003; Xie, 2009).

One often referenced study is the study by Gerstberger and Allen (1968) which aimed to determine the criteria that engineers used in their selection of technical information sources. The study collected data over a period of 15 weeks, asking participants to report two information searches per week by documenting the information they sought, which channels they used and whether their searches were successful or not (Gerstberger & Allen, 1968, p. 274). In addition, they also asked the participants to rank nine different information channels according to their accessibility, ease of use, technical quality and degree of experience (Gerstberger & Allen, 1968, p. 274).

The main result of the study by Gerstberger and Allen and the main reason that other researchers often cite it concerns the issue of accessibility. The study suggested that engineers had a strong focus on the immediate task at hand and estimated the effort needed to complete that specific task (Gerstberger & Allen, 1968, p. 277). Even though they could conclude that both accessibility and (technical) quality influenced the choice of sources, they found that accessibility in itself had the strongest influence. In addition, the engineers’ perception of availability was highly dependent on how long experience they had (Gerstberger & Allen, 1968, p. 279). Due to the technical development and the increase in information and sources available there are some limitations of this study. One limitation is included in the concept of accessibility in itself. Accessibility in today’s information landscape has a different meaning today, than it had over 40 years ago.

In the study by Xie (2006) the participants used electronic resources primarily due to their convenience, familiarity and simply that they enabled seeking for information. The reliability of sources (credibility and expertise), saving time, the opportunity to a two-way communication and to avoid doing the same thing twice were the primary reasons for using people as sources (Xie, 2006, p. 138).

The fact that engineers seek information first and most from colleagues and internal reports based on their preference for fast access and ease of use has been challenged by Hertzum (2002). Through a participatory study Hertzum investigated whether engineers value the possibility to assess trustworthiness in a source and if this affects their information seeking behaviour (Hertzum, 2002, p. 8f). Hertzum (2002, p. 7) argued that previous “studies of variables that affect engineers’ information-seeking behaviour seem to some extent to discard that to assess the quality of an information source it must be available in a way that allows for quality assessment”. The author gave reference to three studies that all have come to the conclusion that the choice of an information source that is seen as trustworthy “leads to a preference for the same sources as a choice based on the principle of least effort” (Hertzum, 2002, p. 7).

The results from Hertzum’s (2002) study showed that 62 per cent of the information sources were assessed and chosen based on quality-related factors such as technical
quality, appropriateness to the task, up-to-datedness and representativeness (Hertzum, 2002, p. 13). These assessments played a major role when choosing people as sources (64 per cent). For the assessment and choice of document sources the quality-related and cost-related factors (accessibility, ease of use and cost of use) were 54 and 30 per cent respectively (Hertzum, 2002, p. 13). These findings are interesting, especially the fact that engineers place importance on quality-related factors and that the engineer's choice of close by sources, e.g. colleagues at the same department, are not solely based on cost. At the same time, the study defined accessibility and ease of use as cost-related factors when both of them could be seen as a quality factor. Being familiar with and putting trust in a source is not a guarantee for quality.

Fidel and Green (2004) analysed the way engineers perceived different information sources based on the concept of accessibility. They also addressed the notion of quality due to the fact that other studies have reported that accessibility is far more important than the quality of the information (e.g. Gerstberger & Allen, 1968). The results of the study by Fidel and Green indicated that accessibility has many meanings. There are many aspects associated with accessibility and the distinction between accessibility and quality is not always clear (Fidel & Green, 2004, pp. 570f, 573). These results were based on actual information seeking incidents and not the perception of the concept among engineers, which can be seen as a strength of the study. The researchers themselves point out that a limitation of the study was the fact that they did not consider both the perceptions of engineers and the way they actually seek information, and they suggested that future studies should do so (Fidel & Green, 2004, p. 579). They also argued that the concept of accessibility is more versatile than defining it as easiness of access (Fidel & Green, 2004).

Similar results are also presented by Allard et al. (2009, p. 451f). They showed that engineers still hold ease of access as an important variable, and were also able to show that new technologies change the information seeking of the engineers’, insomuch as they prefer, “search engines such as Google…” (Allard et al., 2009, p. 452) in contrast to corporate repositories, even though they deem internal sources as having a higher trustworthiness. Several of the participating engineers even said that the internal search engines needed to be developed and become more like online search engines e.g. Google (Allard et al., 2009, p. 452). At the same time they found that the engineers valued the quality of the information highly, and that the engineers showed a high awareness of the varying trustworthiness of information retrieved from the Internet (Allard et al., 2009, p. 452). The results presented show that engineers are dependent on information produced by other colleagues (Allard et al., 2009, p. 453). Allard et al. (2009, p. 453) also states that a new insight is the fact that engineers do not use scientific publication to the extent that could be expected based on earlier studies. This last statement is somewhat unclear since nothing in their article or previous research suggests that would be the case.

2.4 Concluding remarks

As Vakkari (1998) showed there has been a huge growth of knowledge within the research area of information seeking and searching. The past decades have also seen a theoretical growth in this area, not least concerning information-related activities in work contexts. I am not able to give justice to all the research and growth. Instead, I have tried to choose research from a wide range, without the ambition to be comprehensive. This means that the literature review includes a variety of concepts e.g.
context and information, of which there are no coherent or simple definitions. The way these are defined today is not the same as for 20-30 years ago, and there is quite a difference in how they are understood today. Within the scope of this study it has not been possible to give justice to all nuances that different researcher have addressed. Nor, has it been possible to elucidate all different ways these concepts are used.

The theories and concepts used in this study are chosen to compose a sound theoretical base in order to achieve the purpose of the study and to answer the addressed research questions. Therefore, the concept of information-related activities is used to achieve a broad understanding of information and the way information is needed, sought and used. The models used as analytical tools address information seeking from a work context and includes information seeking connected to work task and complexity. Information in social practices is chosen to achieve a sound base for analysis in order not to focus the study on information behaviour or information literacy.

In the fast changing information landscape, it is unlikely that the information-related activities of engineers are uninfluenced. The same applies for practices surrounding technical documentation. The studies reviewed in this chapter indicate that the information-related activities differ depending on the social context of which they are part. Additionally, studies have shown that technical documentation is a complex process that is affected by many different contextualised and situated attributes. Another aspect that has been studied are the situational attributes that affect the information-related activities of engineers, studies that show that engineers are prone to use information sources that are easy to use, accessible and reliable such as known sources and people as a source.

The studies reviewed here show that research on information seeking in everyday life and in different professional groups, e.g. engineers, have to a large extent focused on the individual, information seeker and the information seeking process as such. Few studies have tried to understand the effect of the context by addressing the information-related activities performed by engineers. The studies reviewed have used both quantitative and qualitative research methods, but few have tried to combine research diaries and focus groups. More research with a greater focus on information-related activities in relation to practice is needed to gain an understanding of information-related activities in a work context. This current study will contribute to the existing research literature by producing results that will give possibly a new, but at least an up-dated understanding of information-related activities performed by engineers in a professional context in the new emerging information landscape.
3. Theoretical framework

In this study, information-related activities are seen as originating from the performance of a work task within a specific work context. This implies that these activities cannot be separated from the work task process or the context in which it is performed. Therefore, this study takes on a practice oriented perspective by viewing the work tasks as part of the context in which they are performed. Based on this, it seems relevant to use the concept of practice as a framework for the analysis. In the following chapter the theoretical framework is presented.

According to Byström and Lloyd (2012) practice theory is a relevant starting-point for the study of information-related activities, work tasks and the context in which they are performed. By using practice theory, an inclusion of all kinds of information and knowledge is allowed, not limited to documented material as text but also any other manifestation of knowledge like oral, tacit, or embodied (corporeal) knowledge (Byström & Lloyd, 2012; Huizing & Cavanagh, 2011, p. 5f; Lloyd, 2007). Additionally, the interactions or communication taking place within a given context are widened to include both human and non-human agencies (i.e. tools and symbols) (Byström & Lloyd, 2012; Huizing & Cavanagh, 2011).

Within practice theories, practice is seen as a process that is not fixed, but shaped and re-shaped through the participating agencies and as such change over time (Byström & Lloyd, 2012; Huizing & Cavanagh, 2011, p. 8; Schatzki, 2001, p. 53). Furthermore, knowledge and knowledge production is not seen as an individual process, rather a process that takes place in a socio-cultural context and that is constructed in negotiation between the participating agencies (Huizing & Cavanagh, 2011, p. 9), and that there can exist more than one practice that can affect the performance of a work task (Byström & Lloyd, 2012).

3.1 Information in social practice

There is no cohesive definition of practice. Practices have been defined in different ways depending on the research performed. Schatzki (2001, p. 53) defined practices as “a set of doings and sayings organized by a pool of understandings, a set of rules, and a teleoaffective structure.” Practice can thus be seen as an organised nexus of activities (Lloyd, 2010a, p. 247; Schatzki, 2001, p. 48) which is governed by the specific social, historical, material and political domains of an organisation (Lloyd, 2010a, p. 248). It is the practice that enables the members to perform their work tasks in an expected and agreed-upon manner.

Practices are made up of three kinds of actions (Cox, 2012a, p. 178; Lloyd, 2010a, p. 249; Schatzki, 2001, p. 48ff, 2006, p. 1868f). The first is practical understanding which concerns the understanding of how to perform an activity e.g. how to construct a query, how to write references or how to perform an experiment. The second action is rules which are explicit representations of how to perform or how to proceed with a doing or saying e.g. a set of formal requirements regarding the writing of a technical report in a given context. The third action concerns what Schatzki (2001, p. 50ff) calls teleoaffective structures which are defined as reasons for doings and sayings e.g. the ends and means of a work task within a practice. It also concerns the values, beliefs and hopes of a task performer that are seen as indirectly or subtly forming the practice and work tasks within it (Lloyd, 2010a, p. 249), e.g. knowing how to adjust the writing of a technical report to a specific work task.
Traditionally, studies of information seeking have had a strong focus on information behaviour. In adopting a practice perspective the concept of information behaviour is replaced with the concept of information-related activities or information practices (Byström & Lloyd, 2012; Lloyd, 2010a, p. 251). Using practices with the concept of information can prove difficult for two reasons. One is that it can be difficult to decide what is to be in focus. Cox (2012a, p. 183) exemplifies this with the problem of differentiating between context and practice. Another difficulty, is that it is problematic to decide where one practice ends and others begin (Cox, 2012a, p. 183).

Cox (2012b, p. 61) argues for an alternative approach, one which, without abandoning the practice perspective, focus on how different social practices define what is considered relevant information, and how actors seek, use, create and share information (Cox, 2012a, p. 185). It is presented as a path away from information practices towards a focus on information in social practice. In the present study a specific social practice, namely a work practice is studied. For a presentation of the relationship between different types of practices see Byström and Lloyd (2012).

Two other concepts often studied and related to information practices are information literacy and information literacy practices. None of these concepts are in focus for this study, but there are some features that are relevant when using a practice perspective as a theoretical framework. Lloyd (2011) identifies a number of key areas from previous studies of information literacy practices in workplaces which also are deemed as relevant. Lloyd presents these aspects from an information literacy practice perspective, but in this study the are introduced through the concept of information-related activities.

Firstly, the context of workplace is quite different from other contexts when it comes to understanding information-related activities insomuch that employees need to “draw information from the verbal, the material, and physical sources that constitute the information landscape, in order to learn about the internal and external performance of work.” (Lloyd, 2011, p. 290) In spite of this, there are few studies that approach the issue of whether the generic skills traditionally associated with information-related activities and learned in the educational setting are the ones that are relevant in a workplace (cf. Lloyd, 2011, p. 280ff). Secondly, the kind of information that is relevant is not always decided by the work task performer, but most likely already identified as relevant within the organisation (Byström, 2002; Lloyd, 2011, p. 282). This notion is close to the relationship between perceived success and the choice of information sources identified by Huvila (2010). Thirdly, the issue of copyright to information and knowledge seems to become blurred. According to copyright laws something that has been created is owned by the creator if nothing else has been agreed upon. In a workplace context information and knowledge are not a property of the work task performer, it is “owned” by the organisation. Plagiarism is not a big deal and over time the rights of the task performer seem to be lost (Lloyd, 2010b, p. 101, 2011, p. 283). A fourth area that Lloyd (2007, 2010b) identifies is that information-related activities has often been seen as a set of transferable skills; something that are challenged by Lloyd and several other studies (cf. Lloyd, 2007, 2010b; Lundh, 2005; Moring, 2009a).

3.2 Information seeking process
The information seeking process is in this study seen as a process that exists in a social practice. The information seeking model (Figure 1) developed by Byström and Järvelin (1995, p. 196f) is used as the conceptual framework for depicting the information
seeking process. The starting point in the model is a task performer that has a work task at hand. During the task performance the engineer may find that information is needed in order to confirm, verify or fill a gap in order to perform the task. In the actual process personal attributes such as motivation, current state of mind and prior experiences of seeking information also affect the process. When the engineer has analysed the task and different paths to perform it, a choice of action is made, it is implemented and evaluated to see if it results in an applicable and sufficient enough outcome.

In addition to individual attributes e.g. experience, motivation or preferences (Byström & Hansen, 2005, p. 1053) and personal seeking style the analysis of the information needed is seen as influenced by situational attributes, which are temporary conditions affecting the process, e.g. urgency or accessibility and indirectly by contextual attributes, i.e. attributes that are stable over time (Byström & Hansen, 2005, p. 1052f). What actions the engineer decides to take are in turn influenced by the information needed to be acquired, the available information sources and the engineers’ previous experience of information seeking. If needed, this process can be repeated more than one time (Byström & Järvelin, 1995, p. 196). The attributes and phases in focus for this study are indicated with shaded ellipses and boxes in Figure 1. In the model (Figure 1) the organisation is displayed as a separate circle which is not in compliance with contemporary practice theories, and should not be seen as a separate area in reality. In this study, the focus is on work tasks as one of many aspects that could be included in the context of an organisation.

3.2.1 Categories of information

Information can be defined in numerous ways (Case, 2012, Chapter 3). In this study there is no attempt to give a specific definition of information; it is merely a basic concept that can take any form for the task performer (cf. Lloyd, 2010b). Instead different kinds of categories will be used to describe the information used.
Different categories of information have been proposed by various researchers, e.g. Dervin (1976 cited by Case, 2012, p. 49ff). She distinguished between objective information (as a way of objectively describing the world), subjective information (the way an individual sees or interprets the world) and sense-making information (allowing us to make sense of and understand the subjective and objective information). These typologies are possible to apply to information in any context and in everyday life. However, even though a typology of this kind is fully applicable, it is more relevant from the perspective of this study, to use categories that are specifically adapted to a professional context. One such typology is developed by Byström and Järvelin (1995, p. 195f) who suggested three information categories.

The first information category is problem information which concerns any kind of information that is connected to the specific task at hand. This kind of information is available in the form of facts in the actual task environment. If a similar task has been performed earlier the information might be available in old documents. The second category is domain information which is information relating to the subject at hand e.g. facts, concepts, theories or rules. That is, information that one can find readily in textual formats. The third category is problem-solving information and concerns information that aids the task performer to decide what kind of problem information or domain information is needed. This kind of information is often retrieved from human sources such as experts. In this study this categorisation of information is used, with the minor modification, as in Byström (2002, p. 584), of replacing problem with the term task: task information (TI), domain information (DI) and task-solving information (TSI).

Of interest for the analysis of information used by the engineers in this study are the three modalities (or necessities) of information developed by Lloyd (2011, p. 290f). The first is the epistemic modality which is the kind of information that is, by the organisation, seen as relevant and useful information. It is strongly associated with objective information that is used in different situations e.g. textbooks, standards and procedures (Lloyd, 2010b, p. 161f). The second information modality is social modality which is close to what is known as tacit knowledge. This modality can be both the collective knowledge of people or an organisation (Lloyd, 2010b, p. 163f). This modality is part of finding one’s professional identity and how to engage in one’s professional practice. The third modality is corporeal modality and encompasses practices observed through actual performance, such as participating during experiments or actually performing a certain practice under the supervision of more experienced colleagues (Lloyd, 2007, 2010b, p. 165ff). It could also include help from experiments from a more experienced colleague.

3.3 Work task/s
Byström and Hansen (2005, p. 1058), Byström (2007, p. 6) and Byström and Lloyd (2012) argue that task is a useful concept in library and information studies. I agree with this statement and also agree with the notion that it is important to define the concept when used in a study in order to achieve comparability between studies. Thus, a task can be defined according to different perspectives. How to define the concept depends on what perspective is adopted for the research. Defining task from a practice oriented perspective means that a task is dependent on the context in which it is performed and as such can be studied from the perspective of information practice as well as information in social practice.
What is regarded as a work task depends to a large degree on the performer’s view of the task. It is through the lenses of the performer’s work role that the task at hand is defined (Huvila, 2008). A work task can often be divided into different subtasks such as several different information search tasks (Byström & Hansen, 2005, p. 1056). The process of work task performance, including the relationship between work tasks and subtasks are illustrated with a model (Figure 2) developed by Byström and Hansen (2005, p. 1056). A work task is constituted of three stages; task construction, task performance and task completion. The stages are affected by situational, individual and contextual attributes (Figure 2: Byström & Hansen, 2005). Within each stage of the work task process subtasks can be identified. In this study the relationship between task, subtasks and even subtasks within subtasks are addressed.

In this study tasks are classified according to the task categories developed by Byström and Järvelin (Byström & Järvelin, 1995, p. 194f) and later used by Byström (1999, p. 43ff, 2002, p. 583f). These categories (Figure 3) are based on the task performer’s evaluation of a priori determinability and are related to the perceived difficulty or complexity of the task. In an automatic information processing task, the performer is able to completely determine the information needed as well as the task process and the outcome. The total opposite is valid for a genuine decision task which means that the task performer cannot a priori describe the input, process or outcome of it. In a normal information processing task, the task performer is still able to describe most of the task ahead, but there is some uncertainty about the amount of information needed. When moving further on to the normal decision task the a priori non-determinable parts increase. The task still has a high degree of structure, but there are some variations from task to task. In a known genuine decision task the a priori determinable part is the type of outcome, but there has not yet established any common and detailed enough way for performing the task, so large parts of the process as well as the information needed to be acquired are not a priori determinable (Byström & Järvelin, 1995, p. 194f).
In addition to these five task categories, the task facets developed by Li and Belkin (2008, p. 1833ff) are used in order to get an understanding of the task performance in context. According to Li and Belkin (2008, p. 1833) task facets are “different aspects, properties or characteristics of tasks.” They do not include topic of task when it is next to impossible to group them into a limited number of categories based on virtually an unlimited number of topics (Li & Belkin, 2008, p. 1833). The facets used (Table 11 in Appendix 10) are chosen as base to discuss the work tasks analysed in this study are chosen as a base to discuss the tasks. All of these are first and foremost based on the task performer’s own perception of the task, even if it can be argued that the perceptions in the present study are certainly not free from their context.

3.4 Concluding remarks

Cox (2012a, p. 185) states that “all social practices involve information use, creation and seeking, but this does not make them information practices, because only a few practices are specifically information-related.” Therefore, the concepts of information in social practice (Cox, 2012a, p. 184f, 2012b) together with information-related activities are used in this study. This does not make concepts and ideas from practice theories or theories on information literacy obsolete. Rather information in social practice more precisely identifies what is the focus of this study. It is not information practices in itself, but information-related activities. The concept of practice and practice theory are used as “an interpretive lens” (Huizing & Cavanagh, 2011, p. 11) when studying information-related activities in connection to performing a work task. The focus is on a work task as part of a social practice. In the present research a work task is part of a work practice which is a social practice (Byström & Lloyd, 2012). Within these practices, sayings and doing e.g. different kinds of information-related activities are
gathered. Information-related activities are performed as part of a work task and are therefore seen as observable instances of information in social practice. The practice acts as a lens through which the workplace, within which tasks are performed, is studied. The practice theory apparatus becomes the methodological approach, stating how the object of study are choosen to be seen.

The model of the information seeking process together with the information and work task categories developed by Byström and Järvelin (1995), Byström and Hansen (2005), Li and Belkin (2008) and Lloyd (2010b) form the theoretical conceptual apparatus which are to sort and understand the empirical material. By sorting and analysing the empirical material with the help of these models, it becomes possible to study what different agents actually do, i.e. sayings and doings, because the practice is here and now. This could possibly give an understanding of the information-related activities considered legitimate in the studied practice. The force of collectively shared habit present in practice theories, which consider traditions and structure, appeals to me.

In this study the work task is seen as part of the corporate context. This makes it possible to connect the individual performance of information-related activities with the practice. In the study by Byström and Järvelin (1995) they did not discuss the reasons behind the individual performance, i.e. whether it is the thought and ideas of the task performer or the organisation that control the information-related activities they engage in. By studying the sayings and doings of the individual performer this is substantialised. A work task is only complex if the work context deems it to be complex (Byström & Lloyd, 2012). Thus, if a task performer perceives a task as complex and therefore spends more time performing it than what is deemed, by the context, as appropriate, he or she might be seen as wasting time.
4. Method

This qualitative study describes the information-related activities in which engineers engage during work task performance. The study used method triangulation (Berg & Lune, 2012, p. 5ff; Boeije, 2010, p. 176) involving task (research) diaries, a semi-structured questionnaire and focus groups (Liamputtong, 2011; Wildemuth & Wilkins Jordan, 2009). Methods triangulation is used to analyse the subject under study from different angles and by doing so achieve a profound description of the subject (Boeije, 2010, p. 176). The work task diaries and the semi-structured questionnaire were used to collect data on an individual level and to form a base for the focus groups. Focus groups were conducted to achieve a deeper understanding of the information-related activities performed when writing a technical report. The focus group data were transcribed and categorised into themes related to the research questions.

In order to identify and understand the information-related activities performed when writing a technical report, the concept of work task was used as a starting-point for documenting the information seeking process. The documentation was conducted using a work task diary. The work tasks in focus, that is writing technical reports, are part of the corporations’ internal information and knowledge management. This strategy makes it possible to study processes that reflect on how the performer perceives the information needed, how the seeking is performed and how the information sought and retrieved is used (Byström & Hansen, 2005, p. 1051). Nine staff members were introduced to and used the work task diary to document their information-related activities during work task performance. In total, 14 task diaries were completed. Additionally, seven staff members were selected to participate in the focus groups. All in all, twelve engineers participated in the focus groups, whereof five had completed a task diary and seven had not. All participants, in total 16 staff members, answered the semi-structured questionnaire.

4.1 Setting

This study was conducted at Sandvik AB, a high-technology engineering group represented in over 100 countries around the world. The engineering group operates within five different business areas, each responsible for all activities connected to their product area, ranging from production, sales and research/development (Sandvik AB, 2013). In this study, one of these business areas is represented, namely Sandvik Materials Technology (SMT) hereafter titled either as the corporation or SMT. The corporation consists of four product areas: Tube, Strip, Primary products, and Wire and Heating Technology (Sandvik Materials Technology, 2013a). All four product areas are represented within the research and development centre (hereafter referred to as the R&D centre) within the corporation located in the town Sandviken, Sweden, which is the setting for this study.

The R&D centre has a long tradition of research and innovation and collaborates with customers, other research centres as well as universities (Sandvik Materials Technology, 2013b). The assumption in this study is that a R&D centre is a workplace with a high degree of information dependence which makes it a relevant setting for a study on information-related activities in a work context. The R&D centre is divided into seven different research areas, whereof six are represented in this study. The selection of research areas was based on the criteria that engineers working within the research areas should have as one of their work tasks to write technical reports. These six areas are:
strategic research, metallurgy, tube, strip, wire and heating, and materials science. The area not included is one that primarily performs tests and measurements that are not reported in the form of a technical report.

The R&D centre also includes the company library. The library was founded in the 1930s (Jacobson, 1986, p. 3) and has since undergone several reorganisations. Jacobson (1986, p. 4) stressed that the main factors affecting the operation of the library were the emerging information landscape, restructuring of the organisation, new technology and downsizing. Some of the services available in the 1980s are still present such as the technical report database, and the service of ordering literature and scientific articles, i.e. inter-library loans. Some services, e.g. routing of documents such as journal or newspapers is still present but highly downsized. New services have emerged, such as provision of electronic reference or full text databases, and also electronic provision of standards. The library which is physically enclosed in the R&D centre holds a minor collection of books in the library itself. The major part of the library collection is depository in the staff members’ workrooms. The library also holds a historical collection of scientific journals which at the time of this study were inaccessible due to lack of space in the archive. Most of the newly-published scientific journals are available through electronic services provided by the library.

4.1.1 Technical documentation
Technical documentation at the R&D centre has a long tradition. The main purpose of the technical documentation is to make information, data and knowledge available for future applications (Sandvik, 2013d, 2013f). The library is responsible for the report database and the central archive, and as such responsible for the archiving of technical reports, travel reports, memoranda, minutes and confidential documents produced within the R&D centre (Sandvik, 2013c). The documentation of technical data, information and knowledge is regulated by a number of steering documents that guide the engineers in how to produce and document technical data or information (Sandvik, 2013a, 2013b, 2013d, e.g. 2013f). These steering documents are in this study seen as reifications of the practices that ought to steer technical documentation within the corporation. A technical report should be used to document

- technical results and conclusions from projects, other investigations of materials and process evaluations that could be of interest in a long time perspective (more than three years);
- development of new methods to control the direction of future applications;
- investigations regarding problems and methods that have not yet been documented;
- technical documentation claimed by a specific customer or to preserve customer relationships;
- a product safety matter;
- results from routine investigations in order to secure the access to typical values and future statistical analysis;
- specific customer processes or a product quality that they value;
- extensive mapping of material properties to avoid repeated investigations;
- development projects – even the not successful ones (Sandvik, 2013a).

See Moring (2009a, p. 165) for a discussion of reifications as institutionalised practice.
The documentation of information, knowledge and data is labelled the Writing process (Skrivprocessen) (Sandvik, 2013d). The Writing process can be illustrated with four steps (Sandvik, 2013d) starting with the actual writing (step one) of e.g. a technical report (Figure 4). Step two is composed by the reviewer within the specific research area who evaluates both content and formalities. Step three is a second review from a responsible assistant, e.g. a staff member from the library who reviews the report based on the document management regulations. Based on the Writing process, these regulations can be considered as reifications. The last step is the user who can search the report database for technical reports and reuse the information, knowledge or data.

Figure 4 The writing process for documents at Sandvik Materials Technology R&D centre
Source: Adapted from Sandvik (2013d, p. 2)

The document management holds instructions for both formalities, e.g. headings, fonts and illustrations (Sandvik, 2013d), as well as for content (Sandvik, 2013f). These guidelines resemble to a large extent what is valid for scientific publications. All kinds of reports that are produced within the R&D centre are to be archived for all times, the only exception is the minutes that are to be kept for at least 10 years (Sandvik, 2013c, p. 3). In this study, it is the information seeking during step one of the writing process that is in focus. The other three steps are relevant in the discussion of the results when it concerns traceability and documentation of the sources used.

4.2 Sample/participants
The participants in the present study were chosen based on their occupational status as engineers and whether writing technical reports were one of their work tasks. A convenience sampling was used in order to ensure a relevant number of participants, but also to ensure that the research questions could be answered with the data that were collected. Participants in this research study included 16 engineers who all are involved in writing technical reports. The ambition was to receive participants equally divided on six of the seven areas within the R&D centre, but this was not possible, because participation in the study was voluntary and those who chose to participate in the study were not equally distributed.9

9 For a discussion of how confidentiality and anonymity has been considered in this study see Chapter 4.7.
At the start of the study the idea was to compare three different professional roles, researchers, engineers and technicians, within the R&D centre. This proved to be difficult to uphold since there is no strict difference between researchers and engineers and the number of technicians was too low and only a few of them actually had writing technical reports as a work task. The decision then fell on selecting only engineers as target group and study whether different work tasks gave rise to different kinds of information-related activities. Since a convenience sample was used there was no ambition to try to uphold an equal number of different educational backgrounds or different kinds of engineers within the R&D centre.

The selection and distribution of participants were discussed with the head of the R&D centre together with the head of the corporate library. An invitation letter (Appendix 1) was composed by the researcher and sent out by the head of the R&D centre to the managers of the six research areas with a call to receive voluntary participants. Unfortunately, only a few people responded and a second try was made through personal contact with the managers in order to receive suggestions on potential participants. A personal email with the introductory letter was sent to the suggested staff members. This resulted in twelve participants in the first phase of the study. Some of the participants had been approached personally by a representative of the library. This proved to be less than ideal, since these participants did not have a technical report to write during the time available for collecting data. The same goes for one other participant who did not have the time to complete a technical report due to other responsibilities. However, these participants were later included in the focus groups and therefore their experiences of writing technical reports could be accounted for in an acceptable way. In total, nine engineers (Table 1) completed one or two work task diaries, resulting in a total of fourteen completed work task diaries. Seven of the nine work task diaries completed, reported information-related activities performed during the writing of a technical report. Two of the work tasks were not strictly technical reports; one was the writing of a user’s manual and one was in the form of a memorandum. Including these two diaries allows for a checkpoint on whether information-related activities performed when writing a technical report differs from other types of work tasks.

<table>
<thead>
<tr>
<th>Task diary</th>
<th>Questionnaire</th>
<th>Focus group</th>
<th>Total no. of participants</th>
</tr>
</thead>
<tbody>
<tr>
<td>9</td>
<td>16</td>
<td>12</td>
<td>16</td>
</tr>
</tbody>
</table>

In the second phase of the study, the participants that had completed a work task diary were asked to suggest two staff members who they thought would be suitable for participating in the focus groups. An invitation letter was sent out to these people, out of eighteen proposed participants only four agreed to participate in the focus groups. This was slightly disappointing, but together with the three participants that had not completed a task diary, the number of participants in the focus groups that had not completed a diary ended up at five participants. They were matched up with the group of seven participants that had completed a task diary giving a total of 12 participants in the focus groups (Table 1). The participants were randomly distributed in three different focus groups based on their ability to participate at different occasions. A larger number of participants had resulted in either a too large number of participants in the focus...
4.2.1 Description of participants

The following description of the participants is based on data collected from the distributed semi-structured questionnaire. All 16 of the participants are employed as engineers, but with a varied number of titles, e.g. senior engineer, professional engineer, principal engineer or specialist. Most of them include senior R&D engineer in their title. All of the participating engineers work within the field of research and development, but have different areas of responsibility. The area of responsibility is determined by the department the engineer is working within and whether the engineer is working with market and production support or product and material development. The participating engineers represented all of these areas. The highest educational qualification among the participants is doctoral degree and the lowest master’s degree. In total eleven of the participants had a doctoral degree, one had a licentiate degree and three had a master’s degree.

On average the participants have been working at Sandvik AB for eight years, with a minimum of two years and at the most 37 years. Eight participants have been working in the corporation between 1-5 years and four of them for 6-10 years. On average they had been working in their present position for two years, most of them, i.e. 11 out of 16, for less than two years. Fifteen of the participants reported that around half or a small part of their job assignment is made up of writing technical reports. Only one of the engineers said that nearly all of the job assignment consisted of writing technical reports.

All of the participant engineers have had an urgent need for information either once a week (or more often) or at least once a month (but not weekly). Their use of the corporate library differs, and half of the participants (8) use the library at least once a month (but not weekly). Only one of the participants has not used the library during the last 12 months, and the rest of the participants (7) have used the library at least once during the same period but not monthly. This implies that the selected participants are performing information-related activities on a regular basis, both on their own and through the corporate library. The sample is therefore seen as relevant and valid for addressing the research aim and questions in this study.

4.3 Research process

The data were collected based on the idea of methodological triangulation (Berg & Lune, 2012; Boeije, 2010) using research diaries, a semi-structured questionnaire and focus groups. In the first phase of the study data were collected through a work task diary. Introduction and instruction to the work task diary took place individually in each of the engineers’ own workrooms or a place of choice by the engineer. During this time the participant also received a presentation of the consent letter as well as to their entire participation in the study. The work task diaries were completed individually by each of the participants who were instructed to do so during the actual performance of the work task of writing a technical report. During the period when the participants completed the diaries I visited them on a regular basis in order to answer any questions or issues regarding their participation and to find out how the task was progressing. Those that I did not meet in person I contacted through email. When the engineers had completed
their work task diary, a follow-up session with each of the participants took place. These sessions lasted between 30 minutes up to an hour depending on the additional information required or given by the participant. In total, 14 work task diaries and follow-up sessions were completed.

During the second phase of the study, data were collected through a semi-structured questionnaire and focus groups. The semi-structured questionnaires were distributed to each of the participants either face-to-face or by internal mail. The participants completed the survey at a time and location of their own choice and handed them in prior to the focus groups. The participants that did not participate in a focus group delivered the completed questionnaire by internal regular mail. In total, 16 questionnaires were completed and 12 engineers participated in the focus groups.

4.4 Work task diaries

The task diaries used in this study were designed as work task diaries for the participant to complete during performing the work task of writing a technical report. The work task diaries were constructed based on previously used task diaries (cf. Byström & Järvelin, 1995; Byström, 1999). Although in many ways similar, some modifications were made, e.g. emphasise the data to be reported a priori, during and after task performance. Other adjustments were also made in order to try to gain a better understanding of the participants’ own perceived success regarding information-related activities.

4.4.1 Pre-testing

The work task diary was pre-tested in a group of staff members at a university library. In total four people volunteered to participate in the pre-test. They chose their own work task as a starting point for the work task diary, which could be a task that they already had completed or one that was fictional but resembled a work task that they normally perform. The results from the pre-test are not included in the results of the primary data collection and had the sole aim to help in the development of the data collection instruments.

At the time of the pre-test the data collection instrument was developed as one task diary with five different parts; the first part concerned assessment of the initial situation, the second was the log, the third an evaluation of the work task process, the fourth concerned background and work-related information and the last part consisted of questions regarding regular information-related activities.

After the pre-test the two parts concerning the participants’ background and questions about regular information-related activities were separated and formed the semi-structured questionnaire. Only a small number of linguistic changes were made in part one of the work task diary. Through the results and comments from the pre-test it was concluded that the most difficult part to comprehend was part two, i.e. the log. The work task diary used in the primary data collection was therefore supplemented with a column for time and date and a number of clarifying notes regarding each of the different columns. In part three concerning evaluation of the information sought, the statements were rephrased after comments from the participants in the pre-test.
4.4.2 Primary data collection instrument

The work task diary (Appendix 4) used in the primary data collection was only available in a paper-based form and consisted of three parts. The first part of the diary was semi-structured and the participant described, a priori to task performance, the task at hand, the a priori perception of information needed, probable information sources, the perceived complexity and their expertise regarding the task. Most questions in the first part were open-ended, giving the participants the chance to freely describe different aspects of their task. Other questions were structured and the participants were asked to indicate their own expertise, their ability to a priori describe the task process and task complexity on a visual scale (cf. Byström, 2002, p. 583).

The second part of the work task diary consisted of the log, in which the participant documented the actual performance of the task, the sources used, the reasons for choosing a source and the success and applicability of the information retrieved in a table-like format (cf. Byström & Järvelin, 1995; Byström, 1999; Sheble & Wildemuth, 2009). They were also asked to document the time spent on different subtasks i.e. information-related activities during task performance. As in the task diary used by Byström (1999, p. 65, 2002), this part was unstructured with the exception of some instructions on how to fill in the log, i.e. what the participant was to document. Future work should, as previously done by Wild et al. (2010, p. 51), include sample entries in order to clarify the use of the log. During data collection a clarification (Appendix 9) was made regarding the estimation of time spent.

The third part of the work task diary was designed to function as an evaluation of the information retrieved and the information used. This part had a structured question regarding how the participants’ value the information they gathered. This question is in line with the evaluative questions formulated by Reid, Thomson and Wallace-Smith (1998, pp. 99, 102) in their study of how information affects decision making in the UK banking sector. The participants in the present study were asked to rate certain statements concerning the value of the information gathered. The rating was made on a Likert scale where one represented strongly disagree and five strongly agree (cf. Frankfort-Nachmias & Nachmias, 2008, Chapter 236f). They also had the choice of answering that a statement was not applicable. There were also two open-ended questions asking the participant to estimate the time spent on the task as a whole and information seeking and gathering especially. They were also asked to describe the situational attributes that actually had affected the performance, which made it possible to evaluate the participants’ ability to describe the work process a priori.

The work task diary was concluded with an opportunity for the participant to reflect on their participation in the study so far, and more specifically filling out the work task diary. Some participants noted that it was time consuming to fill in the work task diaries and that it was difficult to accomplish on top of regular work tasks. Four of the participants commented on the work task at hand and made reflections on the sources necessary to complete the task, other not anticipated duties and the usefulness of gaining an understanding of the work process surrounding technical reports. Six of the participants did not give any comment at all.

4.4.3 Data collection/procedure

The work task diaries were distributed individually to each of the participants and completed during actual work task performance, i.e. writing a technical report. Each
participant was asked to complete one task diary per work task, i.e. for each technical report they wrote. This was not possible to achieve for all participants during the time available for this study.

The data collection began in January 2013 and was completed in June 2013. The study first set out to have all task diaries completed at the latest on 28 March, but due to different individual circumstances, the participants completed the work task diaries at different times. Since the diaries are connected to the entire cycle of producing a technical report it was important that the work task diary captured the entire cycle (cf. Sheble & Wildemuth, 2009). The last task diary was collected in late June 2013. Sheble and Wildemuth (2009) highlight the risk that data collected over a longer time period, when using diaries, can result in lack of commitment from the participants. There is no indication of lack of commitment from the participant with the work task diary that was kept for the longest time period, rather the opposite. In total 14 task diaries (Table 1) were completed and collected and later on analysed. The number of diaries is seen as sufficient for the purpose of the present study.

Out of the 14 completed work task documented through diaries twelve were technical reports, one was a memorandum and one was a user’s manual. All of the technical reports are published in the template for technical reports according to the Writing process at the R&D centre. This means that they all follow the same basic structure with an abstract, introduction, experiment, result, discussion and conclusion. The memorandum is published in the template for memoranda according to the Writing process at the R&D centre. The user’s manual is not published and is in the form of a word-document. All work tasks are hereafter discussed under the collective concept technical reports, unless there are specific differences that are of interest to highlight.

A follow-up session was carried out with all participants. During this follow up session any ambiguities and vagueness were brought up by the researcher. The participants were also asked to describe the relation between the technical report as a subtask and the overall work task. This was done by illustrating the relationship between the connective tasks. The idea was to gain an understanding of what was seen as the overall work task and what was considered a subtask and as such gain an understanding of the work task process (cf. Byström & Hansen, 2005). The participants were also asked to classify their task according to the task categories developed by Byström and Järvelin (1995, p. 195) and also used in a similar way by Byström (1999, p. 65).

4.4.4 Data analysis

The first part of the analysis was to categorise the work tasks into task categories (cf. Byström & Järvelin, 1995, p. 194f). The categorising was based on the task performers’ own classification of the work task during the follow up session. Five categories were available for classification (Figure 3 in Chapter 3.3), but only four of these could be identified in this study.

The types of information used during task performance were classified into three categories (cf. Byström & Järvelin, 1995, p. 195f; Byström, 2002, p. 584). The information sources used were classified into two main categories which in turn were

10 The work task categories are presented in Chapter 3.3.
11 For a closer presentation of the information categories used see Chapter 3.2.1.
divided into subclasses specific to this particular work domain (cf. Byström & Järvelin, 1995; Byström, 2002). One main source category was people. People as sources were categorised into people that were involved in the task at hand or people as experts. Another main source category was documentary sources which in turn were subdivided into literature e.g. books and reports, official documents, e.g. organisational papers and registers e.g. datasets. The faceted classification developed by Li and Belkin (2008, p. 1834) was used to describe the work tasks from the diaries.

The tasks not reported through the work task diaries were analysed using the model of analysis used in Byström and Järvelin (1995, p. 200)12. The work tasks were first abstracted into work charts (Figure 5) based on the information seeking model. These abstractions were summarised in process and thinking tables (Appendix 12) for each task category.

![Figure 5](image.png)

Figure 5 The model used to analyse the data collected through the work task diaries. Adapted from Byström and Järvelin (1995).

4.5 Semi-structured questionnaire

The semi-structured questionnaire (Appendix 8) was to a large part highly structured and aimed to collect data on the participants’ background and regular information-related activities. These questions were answered by all participants and gave a general understanding of information-related activities performed by the participants. The data collected through the questionnaire had the purpose to function as a way of verifying the results from the work task diaries by comparing general patterns with actual information activities during work task performance. This was also a way to gain a broader view of the sources used and at the same time collect data that could be compared with data collected through the diaries and the focus groups.

12 The model of analysis is presented in Chapter 3.3.
The questions concerning the participants’ professional background and their use of the corporate library were more or less identical to questions used in the study by Reid et al. (1998, p. 101). The adjustments made compared to their study concerned a minor change; the questions addressing the length of their employment within the corporation were changed from response categories to an open ended question. The categories used in the previously mentioned study were reused in the presentation of the results.

To obtain a general understanding of information-related activities in which the participants engage they were asked to indicate the sources they usually go to in order to obtain information as well as specify the degree of usage. The categories of information sources are modified from the work of Yitzhaki and Hammershlag (2004, p. 836).

4.5.1 Pre-test
The design of the questionnaire has been commented on during a pre-test in a group of staff members at a university library. In total four people volunteered to participate in the pre-test. Their comments concerned content, language, the format of the questions and the response categories, which led to the following modifications:

- The questionnaire was separated from the work task diary.
- The question regarding whether the participant had contacted the library in the last twelve months was moved to the end of the questionnaire in order to diminish the connection to the corporate library.
- The question concerning what type of information is most/least useful to the participants was formulated as two separate questions.
- The question concerning the sources the participants usually go to in order to obtain information was expanded to include the degree of usage, asking the participants to record if they used a source fairly often, often, sometimes, almost never or never.
- Those questions that could be answered with a priori given response categories were reformulated into questions with response categories for the participant to choose between.

4.5.2 Data collection/procedure
The semi-structured questionnaire was personally distributed to all participants, both those who completed a work task diary and those who only participated in the focus groups; resulting in a total of 16 completed questionnaires. The participants could choose any time and place to complete the questionnaire, but were asked to deliver it before or at the time of the focus group. Only one participant handed in the questionnaire later, which proved to be a bit impractical, but did not affect the analysis.

4.5.3 Data analysis
The data collected through the semi-structured questionnaire was analysed with descriptive statistics using Excel. The answers to the questions regarding the participants’ educational and professional background were also used in the analysis of the work task diaries.

4.6 Focus groups
Focus groups were chosen as a data collection instrument because it is a suitable tool for collecting data concerning information-related activities and to study processes. It is
also a relevant data collection instrument when the researcher is interested in understanding how participants in a group think and reason around a common phenomenon as well as understanding the norms and practices within a given context (cf. Berg & Lune, 2012, p. 349; Boeije, 2010, p. 64; Liamputtong, 2011, p. 5; Wibeck, 2010, p. 52), which is part of the aim of this study.

4.6.1 Data collection/procedure

The focus groups were conducted during May 2013. The focus groups started with a short introduction to the study and the basic ground rules for the discussion. The participants were again informed that their participation was voluntary and that their participation would be treated anonymously and confidentially. The participants were also asked to respect the anonymity and confidentiality of their colleagues. This was followed by a short presentation of preliminary observations from the work task diaries, which gave a common reference point for the groups (cf. Liamputtong, 2011, p. 64).

Smaller groups of four to six people, often termed a mini-focus-group, have received an increased interest in research since they offer an environment that encourages discussion between the participants (cf. Liamputtong, 2011, p. 42; Wibeck, 2011, p. 17f; Wildemuth & Wilkins Jordan, 2009). In this study, a total of three focus groups were conducted with five, four and three participants respectively. The number of focus groups was limited due to available time and resources (cf. Wibeck, 2010, p. 60) and the availability of people willing to participate (cf. Liamputtong, 2011, p. 60). In the group of three participants, there was a no-show participant.

The focus groups in this study are seen as homogenous groups (cf. Boeije, 2010, p. 64; Liamputtong, 2011, pp. 34, 36; Wibeck, 2010, p. 63), since all participants were engineers and all had as part of their area of responsibility to write technical reports within the R&D centre. The groups rested on the assumption that the participants had common experiences. According to Wibeck (2010, p. 63f), homogenous groups based on common experiences, share an interest and are more prone to share ideas and thoughts with each other. It is important to remember that even though the groups were homogenous there was no ambition to strive for consensus in the discussions (cf. Liamputtong, 2011, p. 34), a point that was stressed at the beginning of the focus groups. The fact that the participants have different work roles, work tasks and were employed within different research areas at the R&D centre was seen as a way of achieving heterogeneity within the groups in order to explore different perspectives (cf. Liamputtong, 2011, p. 35). All focus groups were arranged as unstructured groups (cf. Wibeck, 2010, p. 83), in which the moderator introduced the themes for discussion and intervened only if needed. The degree of intervention differed between the three groups.

All focus groups lasted approximately one and a half hours, including the moderator’s introduction, which is regarded as an appropriate time span to allow for a thorough discussion without being too long (cf. Liamputtong, 2011, p. 46). The participants had been informed in advance of the expected time frame. All focus groups were recorded with a small digital recorder and thereafter transcribed by the researcher/moderator who had the experience of the focus groups in memory. It also gave the moderator a chance to achieve a first understanding of ways to analyse the material. All focus groups were conducted in Swedish and the transcriptions were made in Swedish.

The researcher acted as moderator in all three focus groups, which is a way to increase reliability in the research process (cf. Wibeck, 2010, p. 88). In order to ensure that the
focus groups were conducted in a similar way a moderator’s guide (Appendix 11) was prepared in advance (cf. Wildemuth & Wilkins Jordan, 2009) based on the template presented by Berg and Lune (2012, p. 179) and Liamputtong (2011, pp. 76, 83). During the focus group session the moderator also used probe and prompt questions to challenge the participants to discuss further (cf. Liamputtong, 2011, p. 77ff). The researcher arrived in good time before the start of the focus group discussion to ensure that the conference room was in order and to welcome the participants. The recording equipment was tested prior to each of the groups.

The moderator was seated at one end of the table which is not an ideal position, and it is recognised that this may be a condition that can affect the discussion (cf. Wibeck, 2010, p. 87). Some participants did turn to the moderator with questions, but judging by the nature of the questions they mainly concerned issues regarding the form of the discussion and confirmation that they were on the right track. During the entire session the moderator aimed to have an unobtrusive role. The moderator clearly stated at the beginning of each session that it was not the moderator who was the expert but they. The moderator aimed to not intrude in the discussion for as long as possible, but at times the moderator intervened by introducing new themes for discussion, asked for clarifications, and made sure that all participants were able to express their thoughts and ideas.

In the first focus group a minor divergence concerning the recording is noted. The recording did not start until after the researcher’s introduction. Nevertheless, all introductions were done based on the same procedure so it is recognised that the effects were minimal. In the two proceeding focus groups the participants also commented on the preliminary observations. In the third focus group this turned out to be a very long discussion that also covered many of the themes for the focus groups which is recognised as a minor deviation. In order to not interfere in the discussion the moderator allowed for the discussion to continue. This discrepancy also led to a relocation of the presentation of the participants and their work tasks to the end of the discussion.

The three focus groups differed a lot from each other. In the first, the researcher experienced that it was difficult to steer the discussion so that it actually took place between the participants without involvement from the moderator. The participants often turned to the moderator for some kind of confirmation. The second focus group was more self-driven and functioned quite well, according to the idea of focus groups. The third and last focus group was highly self-driven insomuch that the researcher had difficulties to steer the discussion towards a priori decided themes. Another difficulty that was evident in all focus groups, although most obvious in the final, was how the existing relationships between the participants influenced the discussion. This effect was manifested in different types of address between participants, how different people confirmed other people, specific statements that indicated power relations depending on length of service, previous experience, educational background and interdependencies between actors (e.g. manager/subordinate).

4.6.2 Data analysis

Firstly, the focus groups were transcribed. In this study the transcripts were aimed to be as close to a level one transcription as possible, but in reality they became something in between a level one and a level two transcript. This means that the transcripts were written in spoken language and contain as many details as possible, trying to include
volume, hesitation, overlapping speech, rate of speech and accentuated words (cf. Wibeck, 2010, p. 95f).

In this study, the purpose of a detailed transcription has been to enable an analysis of the content in order to say something about the existing information-related activities performed by the participating engineers. It is therefore of interest to be able to analyse if there are any agreements or disagreements and any other nuance indicating what are the predominant attributes regulating participation in that information practice. The quotations presented in Chapter 5 are all written on a level three transcript (Wibeck, 2010, p. 96), i.e. they are in normalised language with the purpose to enhance readability and reproduce the main content. It is commonly known that it can be slightly problematic to distinguish between different voices in a discussion (Liamputtong, 2011, p. 166; Wibeck, 2010, p. 91). In this study this has proven not to be a problem during transcription, only minor pieces of unidentified speech have been noted especially when several participants have spoken simultaneously. The average transcript contained approximately 13,700 words and in total all transcripts contained around 41,000 words.

The analysis of the data from the focus groups have been done on three levels (cf. Boeije, 2010, p. 139f). The first level is the intragroup level, i.e. analysis of the interaction within the group and content analysis. The second analysis is made on an intergroup level i.e. the data from the three different groups have been compared to identify any similarities and differences concerning topics discussed, participants or the procedure in each of the groups. Lastly, an analysis on an individual level has been made to identify any saliences in the participant’s responses or behaviour that can have affected the discussion or indicated different accentuated roles in the group. All participants were familiar faces, which stresses the importance of considering existing relations, roles and hierarchies (cf. Liamputtong, 2011, p. 39; Wildemuth & Wilkins Jordan, 2009).

The analysis of the focus group data has been done as a thematic analysis, i.e. the data have been analysed to identify repeated patterns of meaning (cf. Braun & Clarke, 2006 cited in Liamputtong, 2011, p. 173). The transcribed material was organised according to the themes that developed during the focus groups (cf. Wildemuth & Wilkins Jordan, 2009). A coding method was used to organise the material in themes with a close connection to the research questions (cf. Fidel & Green, 2004, p. 567). These themes were also compared to results from the work task diaries and the survey to see if they were in corroboration. Four areas of information seeking were of interest:

- the process of writing a technical report
- expected and relevant information/content in a technical report
- situational attributes affecting the work of writing a technical report
- types of technical reports.

Within these four areas, categories were developed to gain an understanding of the information-related activities at the R&D centre. The attributes affecting the way engineers performs technical reports are the attributes of most importance in understanding the information-related activities. In addition, a strong focus on themes that emerge within the groups allows for an analysis of group interaction (cf. Liamputtong, 2011, p. 175). In this analysis questions concerning topics/opinions producing agreement or conflict, contradictions and common experiences has been considered. Furthermore, attributes related to representation of certain people's positions
or interest have been analysed as well as how well the participants managed to stick to the issues presented for discussion (cf. Liamputtong, 2011, p. 176).

4.7 Ethical considerations

In order to comply with good research practice, especially in research which involves humans in the humanities and social sciences the Swedish Research Council has formulated ethical requirements. The research council differentiates between research and individual requirements. The individual requirement consists of four claims that aim to protect any individual participating in a research project (Swedish Research Council, 2002).

The first claim concerns information (Swedish Research Council, 2002, p. 7). The researcher is obliged to inform all participants about the aim of the study, about all procedure that will involve the participant, about any risks or benefits as well as where the results of the study will be published. It is also important to inform the participant that participation in the study is voluntary and can be disclosed at any time without any prejudice to the participant. In this study this is achieved by presenting the participants with open invitations (appendices 1 & 5), an introductory letter (appendices 2 & 6) as well as a consent letter where all necessary information is included (appendices 3 & 7). In order to formulate a clear and comprehensive consent letter, templates from Minnesota State University (Institutional Review Board, n.d.-b) and University of Utah (Institutional Review Board, n.d.-a) were used. All participants were also introduced to the study and the consent letter in person by the researcher.

The second claim concerns consent (Swedish Research Council, 2002, p. 11). The potential participant in a research study has the right to decide whether or not to participate. Participation is fully voluntary and if a person decides to participate it is necessary for the research to receive consent from the person involved. In this study this is done in signing, by both the researcher and the participant, a letter of consent (appendices 3 & 7).

The third claim concerns confidentiality (Swedish Research Council, 2002, p. 12). All information regarding individuals that are participating in a research study has to be treated with utmost confidentiality. In the present study all information of this kind was kept in the personal possession of the researcher. When data were no longer needed, they were destroyed. All recordings were destroyed after transcribed and finished analysis. In the presentation of the results of this study all references or citations to individual participants are made anonymously by using codes. These codes are not the same codes used during data collection as a means to further enhance the confidentiality of the participants. The fact that the corporation and the unit within the corporation at which the study were performed are named has been discussed with representatives for the unit and no reason to do this anonymously has been found. It is not seen as a breach of confidentiality. To further strengthen the confidentiality and anonymity of the participants the codes assigned to each engineer during the data collection process have been changed prior to the publication of the thesis. This is what has been done to ensure confidentiality from the part of the study.

The fourth claim concerns use (Swedish Research Council, 2002, p. 14). It is the responsibility of the researcher to inform the participants on how the collected materials will be used. Any data concerning individuals can only be used for research and not for any commercial purpose. The use of the results was presented both through a personal
meeting with the researcher and in the consent letter. All participants have been offered a copy of the transcriptions of the focus groups and a copy of the published thesis. A copy of the consent letter has also been given to each participant. It is also the participants’ right to receive a copy of the result and/or the publication. The thesis will be published by the corporation, making it available to all employees, including those who participated in the study.

4.8 Trustworthiness

The most common way to evaluate the quality of research has been through the criteria of validity, reliability and objectivity (Zhang & Wildemuth, 2009). These criteria are slightly problematic to apply to interpretive qualitative research, and recognising these problems Guba and Lincoln (1982) therefore developed the concept of trustworthiness. Trustworthiness is constituted by the criteria of credibility, transferability, dependability and conformability (Guba & Lincoln, 1982; Zhang & Wildemuth, 2009).

In this study, credibility is mainly established through member checking and method triangulation. Member checking has been done in four ways: (1) comments on the data collection instruments received during the pre-test were taken into consideration (2) during the follow-up sessions with work task diary participants, clarifying questions were asked in order to refine and interpret the data (3) all participants completing a work task diary were asked to comment on their participation in the study (4) during the work task diary process the participants were contacted in order to check on how the work was progressing. Method triangulation by using complementary and overlapping data collection instruments has made it possible to address the purpose of the study from various angles.

In the present study transferability has been achieved by trying to give a as thorough and accurate a description of the research process as possible. The sampling of participants has been done in order to collect as much relevant data as possible. Dependability and conformability is established through the use of overlapping methods which produce complementary results. An audit trail has been established through a thorough description of the research process and the material and data used.
5. Results

The information seeking process in a work context as well as the type of information sought to perform specific work tasks has been described by a number of researchers (e.g. Byström & Järvelin, 1995; Byström, 1999, 2002; Saastamoinen et al., 2012; Vakkari, 1998, 1999; Xie, 2006, 2009). Several studies (e.g. Barclay et al., 1994; Ellis & Haugan, 1997; Fidel & Green, 2004; Hertzum & Pejtersen, 2000; Kwasitsu, 2003; Leckie et al., 1996; Yitzhaki & Hammershlag, 2004) have also shown that engineers work in a very complex environment and their information-related activities are strongly influenced by situational and contextual attributes.\(^{13}\) In this study, the information-related activities in which engineers engage when performing a work task have been studied with the use of a work task diary, a semi-structured questionnaire and focus groups.\(^{14}\)

Results are presented in four themes derived from the study’s purpose and research questions:\(^ {15}\) work tasks, the work task process, situational and contextual attributes, and information use. Within these three themes results from the work task diary, the semi-structured questionnaire and the focus groups are used to illustrate the work process and its place in the organisational context to obtain an understanding of the information-related activities engaged in by engineers.

Quotes taken from the collected material are used interchangeably to illustrate the various themes. To be able to discern from which material a quote is taken and what participant it refers to, the following references are used. Each engineer is referred to by a letter (A-P) e.g. Engineer A or Engineer D. If a quote is taken from the work task diaries each reference is specified with 1 or 2 depending on whether an engineer has completed one or two diaries, e.g. Engineer D:1 and Engineer D:2. If the quote is taken from the follow-up interviews they are specified with an F, e.g. Engineer A:F. If an answer from the questionnaire is used as a quote it is specified with a Q, e.g. Engineer A:Q. Quotes taken from the focus groups have no subsequent specification, e.g. Engineer D. In the running text, work tasks are sometimes referred to by e.g. work task no. A:1 or task no. B:2; these references refers to a task reported by e.g. Engineer A:1 or B:2. All quotes in this chapter are written in a normalised language in order to improve readability and are thus close to a level three transcription\(^ {16}\) (cf. Wibeck, 2010, p. 96).

5.1 Work tasks

The work tasks that generate technical reports have been analysed through the work task descriptions given in the work task diaries, follow-up sessions, and statements made during the focus groups regarding the participants’ work task performance and the discussions in the focus groups. An analysis of work tasks is necessary to be able to discuss and illustrate how information-related activities are situated and contextualised (research question 4). Furthermore, the analysis is the starting point for further analysis of whether and, if so, how information-related activities differ between work tasks (research question 3).

\(^{13}\) For a more detailed discussion of previous research see Chapter 2.
\(^{14}\) The research process and the methods used are described in Chapter 4.
\(^{15}\) The aim of the study and the research questions are presented in Chapter 1.5.
\(^{16}\) See Chapter 4.6.2 for a discussion of the transcription and analysis of the focus groups.
The work tasks reported in the diaries exemplify a wide range of work tasks that result in a technical report: description for handling an instrument for material analysis, material screening, material characterisation, product safety matter, material development, routine tests, product development and reclamations. These results are consistent with the categories mentioned earlier (Chapter 4.1.1) as technical information that should be reported in a technical report. These results are in turn corroborated by the descriptions of work tasks that generate technical reports given by the participants during focus groups. During the focus groups, additional work tasks that were not included in the work task diaries were described, such as market support and process observations.

5.1.1 Types of work tasks
The starting point for this study was information-related activities connected to the work task of writing a technical report. To understand whether the actual writing of a technical report is seen as a work task or not the participants who completed work task diaries were asked to describe the work task at hand as detailed as possible. In the question there was a clarification stating that it concerned the technical report they were about to write.

Instead of describing the specific task of writing a technical report, the participants often describe the broader work task that has given rise to the technical report. This indicates that the task performer's view of a technical report is not as a work task in itself. To further elaborate this, the participants were asked, during a follow-up session, to describe the relationship between the work task that gave rise to the technical report and the task of writing the report. All participants illustrated their work task as an image, which will be presented and discussed below.

Some of the participants described a quite simple relationship between the main work task and the task of writing a technical report (Figure 6 & 7). The four examples in Figure 6 & 7 illustrate a simple relationship between work task and subtask, and also that the engineers know what to do when handling such a work task. The task of writing a technical report can additionally be more or less connected to the main work task, and as such be seen as a specific work task in themselves (Figure 6 &7).

In Figure 6 two types of work tasks are described, showing the technical report as a minor task within the larger work task (Figure 6a). Figure 6b illustrates that a work task also can give rise to a technical report that is separate from the main task. However, the technical report is still seen as dependent on another work task because that work task is the task giving rise to the technical report.

![Figure 6](image.png)

Figure 6 The task of writing a technical report (TR) can be seen as a result of a specific work task, e.g. a customer reclamation (a), but can also become a larger task when a customer reclamation gives rise to further investigations which are reported in technical report not distributed to a customer (b). The proportion between the work task and the technical report displayed in (a) can vary.
Work tasks no. N:1 and no. A:1 are two examples of this kind of work tasks (Figure 6a), which was described by the engineers as follows.

Through the reclamation database I have been assigned the task of handling a customer claim regarding a large forged product which has cracked during processing. The answer is requested in the form of a technical report. (Engineer N:1)

I was appointed the task of handling a customer claim and report the results in a technical report; as a decision base concerning actions to be taken, e.g. whether to compensate the customer or not. The answer, i.e. the technical report, was sent to the [internal customer]. (Engineer N:F)

I have been assigned the task of handling a complaint. It is an internal reclamation. The material is a wire. The investigation [performed by] the customer showed the presence of an internal error in the material; which is the reason for the complaint from the customer. (Engineer A:1)

When a customer claim like this is made the respondent [the corporation] has to conduct [this particular test] and this is done by placing an order [by the internal customer] for this test and then they receive the results in the same database. (Engineer A:F)

An engineer has the opportunity to interpret their work task, and transform a work task into another work task. In such cases the work role of the engineer changes, which indicates that people can have different work roles in their professional lives (cf. Leckie et al., 1996). Two examples of work tasks displayed in Figure 6b are work task no. D:1 and D:2. The engineer explained the relationship between tasks as follows:

Trial melts within a R&D project have been developed with the aim to improve an existing steel grade. In order to realise the exact properties of these trial steels, their chemical composition as well as the distribution of elements in the two different phases has to be measured with certain accuracy. This report gives the results of such measurement using the electron probe Microanalysis technique (EPMA). (Engineer D:1)

The order did not include reporting the results in a technical report. The decision to write the technical report was made as a result of the number of trials and errors made during experiments (Engineer D:F).

The composition of elements in an interface between hard metal and PM steel has been measured. The report will describe the results of the measurements. (Engineer D:2)

Another example of a work task as it is presented in 6b is work task no. M:2, which is described by the engineer as a follow-up task:

Based on the recent R&D report investigation of failed [steel sort] and possible effects, a meeting was held to decide what R&D could do in order to help the product development of [steel sort]. Activities have been suggested by […]. It was decided that [I should] write a memorandum and call for a meeting with [the customer corporation] to finalise the activities. (Engineer M:2)

After the first technical report was finalised, a meeting was held in order to decide on how to proceed. I was given the task to write a memorandum from that meeting in order to summarise the findings, document the decisions and actions to be taken. (Engineer M:F)

Engineer K described the task of writing the user’s manual in a similar way (Figure 6a, but described the relationship between the work task and the technical report as 60 and 40 per cent respectively. This task is quite a typical task.
Our production unit has recently purchased an advanced instrument for materials analysis. Since I was partly responsible for this acquisition, I have been assigned the task of writing a user’s manual in Swedish, which the operating staff may consult. (Engineer K:1)

A reverse variant of the task described in figure 6a is when the technical report becomes superior to the work task that gave rise to the report. An example of such technical report is the one written by engineer P:1 in which experiments as part of a response to a customer claim where performed (Figure 7). The engineer described the relationship between the main work task and the task of writing a technical report in two ways. Firstly, the results from the experiments proved to be of a broader interest and relevant to report other than to the customer. The technical report could be viewed as taking precedence over the main work task (Figure 7a). Secondly, the relationship between the work task and the technical report could be describes as equal in importance (Figure 7b).

The relationship between the two tasks can be seen in two ways. The first way is to view the reclamation as a subtask to the technical report due to the fact that the reclamation gave rise to new and larger questions, not directly connected to the customer claim. The other way to view the two work tasks is that they partly overlap each other in importance and are performed after one another. (Engineer P:F)

The background to this work task is that the customer has a problem with their product becomes too hard after heat treatment. The technical report summarises results from hardness tests of a number of [the product] in order to investigate if their measurement method are equivalent to ours. The purpose is to prove to the customer that there is a problem with their measurement method. (Engineer P:1)

![Figure 7](image)

Figure 7 The work task of writing a technical report (TR) can also be connected to a customer claim but be more of an internal investigation than as part of the claim (a) & (b). However, the size of the technical report can vary.

The work tasks displayed in Figure 6 and 7 are all examples of what could be called typical tasks that generate technical reports. Engineer E:1 described a similar task that may be seen as an untypical task, but still with the simple relationship between tasks as those involving a customer claim.

During a visit to a customer, I received samples of the customer’s products to investigate. They were received on my request. Investigations were performed during November and December but not reported. I will now prepare a short report for the customer which I will visit in two weeks’ time. (Engineer E:1)

When the engineers, during the focus groups, were asked to describe the kind of work task they perform that includes writing a technical report, the simple relationship between a work task and a technical report also occurred as a recurrent theme.

Technical reports that describe processes, observations, and results from tests made on different products that we work with. (Engineer K)
[This could be e.g.] reclaims from customers and process changes; trials, both in production and in laboratories which we evaluate and describe in technical reports. (Engineer B)

[I] work with different characterisation methods in order to analyse materials and the results are summarised in the form of technical reports. (Engineer D)

We [at the department] perform experiments and these are summarised in technical reports. Sometimes we perform an investigation on a small detail. Often we receive an assignment in which we are asked to investigate something connected to welding. (Engineer E)

I am responsible for the [equipment] and write two kinds of reports. One of these is very simple test reports stating that today the results showed ... mega Pascal and that’s it; the report is finished and there is no searching for literature. (Engineer F)

I write technical reports mostly for customers. (Engineer G)

[This could be e.g.] reports to support the market side. (Engineer H)

Another group of the participants consists of the ones describing a much more complex relationship between different parts of the work task process and the technical report (Figure 8 & 9). The work task process described in Figure 8 illustrates the whole work task performance from task construction (case) to task performance (technical investigation) to task completion (TR), similar to the work task model developed by Byström and Hansen (2005).

The description even includes the actions performed by the customer before a claim is filed and the work task which follows after the engineers’ task performance (negotiation). At the end the customer is either compensated or has received a higher knowledge regarding the issue that gave rise to the claim. This type of work task is still very much connected with the types of work task described in Figure 6 and 7, even though the similarities with the model developed by Byström and Järvelin (1995, p. 1056) is more evident in Figure 8. This process is described by Engineer N during the follow-up session as a process in which

The customer most often makes a claim to the person from whom they purchased the product, i.e. the contact person within the corporation. This person turns to [a person working with quality aspects], who in turn reports the claim in the reclamation database and appoints the task to investigate the claim to a person. (Engineer N:F)
Two even more complex processes are illustrated in Figure 9. The most important difference is that work tasks of either of these types are not generated out of a customer claim, and are more often in the form of a research project or concerns a product and/or materials development project.

Figure 9 The white area represents the main work task which involves several subtasks (grey areas), each one of these subtasks result in a technical report (TR). The technical report can therefore be seen as a sub-subtask.

However, Figure 9 clearly illustrates that there is an overall work task (the research process or a development process) and that there are subtasks which give rise to several technical reports, which can be seen as sub-subtasks (Figure 9a). Work task O:1 and O:2 are examples of the type of work task described in Figure 9a.

To summarise the results of an external study conducted within the project. In total 2 days of instrument time was spent at [a laboratory] to perform materials characterisation of steel samples. The purpose was to understand why our product is working so well in order to be able to improve it even further. The report will be presented to the project members and be used as a basis for further discussions in future spin-off projects. (Engineer O:1)

[This report was written] to summarise the results of an external study within the project. In total 3 days was spent at the [laboratory]. The purpose was to perform further characterisation of steel samples using a technique that soon will be available within [the corporation]. The results will be presented to the project members and used as an example to show what kind of studies will be possible [to perform] after the installation of the instruments. (Engineer O:2)

Engineer C described the work task process as an even more complex process, showing that there are several processes that are parallel to each other (Figure 9b). First, there is the process of developing a product or material. During that process, a research project may be initiated (work task) which in turn includes several subtasks performed which could be a technical report or experiments reported in the form of a technical report (grey areas in Figure 9). The process is fluctuating depending on the size of the subtasks. During the process a result or something in the process opens the door to a new work task, e.g. the development of the material for a specific purpose or application. Work tasks C:1 and C:2 are examples of such tasks insomuch as they represent two subtasks within a research project.

A material under development was aged (heat treated for a prolonged time). Then mechanical properties were tested, and I will study the microstructure in the microscope. I will document
the aging, the mechanical properties and the microstructure in a report. The purpose of the
test was to see if the material can be used at this temperature without deteriorating. (Engineer
C:1)

I will report the result of an oxidation study of a material that is under development. The aim
of the study was to see if the material can form a good protective oxide also at relatively low
temperatures. The study is not finished yet, but I will start writing the report and then add
more and more results as I get them. (Engineer C:2)

Both engineer M and engineer E describe work tasks that can fit within one of the types
in Figure 9, either as a work task or as a subtask.

Failure of [steel sort] at [the customer corporation] was observed during delivery testing
corrosion and flattening. An earlier R&D report and meeting minutes summarised that [the
compound] could be responsible for the failure. [The chemical element] could have an effect
on the compound formation and stability. Corrective actions suggested were trials, [chemical
element] content in hollows, and production route of extrusion bars. After additional analysis
and trials at R&D centre, the effect of [the chemical element] could be confirmed. All results
shall be sorted in order to draw conclusions and give suggestions to [the customer
corporation] for product development of [steel sort]. (Engineer M:1)

This task concerns a new product of [a specific material] that had been approved. A customer
bought a product made of this [material] sort, but during testing of the delivered product a
failure occurred. In order for the customer to receive their product a change of material was
made. The current work task was then initiated in order to investigate what happened as part
of the product development process and to compose a decision basis in order to decide
whether to proceed or not with this new [material]. (Engineer M:F)

We are developing a new, stronger overlay welding concept. It has been patented. But we
were in such a hurry that it was not decided who was to and how to document the test. The
report is to be published in a few days. (Engineer E:2)

During the focus groups, some of the engineers described more complex work task
processes similar to those described previously, i.e. writing several technical reports and
thus classifying the task of writing the reports as subtasks.

It is often a balance. Many projects last for several years and at some point in time the results
need to be presented. Often you write a partial report under the duration of a larger project
and then summarise the whole project in a final report. (Engineer K)

[I write] both technical reports that describe the results of my projects, including reports on
experiments [subtasks] and reports that summarise a whole project as well as technical
reports for minor research projects. I have also written some state of the art reports, but not as
often. (Engineer L)

I have to write partial reports and final reports. (Engineer M)

[I] perform the experiments asked for [within projects] and report the results both within the
R&D and to other external departments. (Engineer O)

To summarise, the work task descriptions given by the task performers in the task
diaries and during focus groups, clearly show that the definition of a work task differs
depending on the work role of the engineer and when he or she joins the process. These
findings are in line with Leckie et al. (1996, p. 180f) and Landry (2006) as well as in
line with Huvila’s (2008, p. 809) discussion about work, work roles and work tasks,
insomuch that an engineer describes a work task differently depending on the work role
he or she have in performing the work task. The work tasks that are illustrated in the
Figures 6-8 all have a similar origin, but depending on the work role of the engineer and

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the specific task they perform, they describe the tasks differently. If the engineer is given the role of investigating the customer claim the descriptions are more like the tasks in Figures 6 or 8. If the engineer has the work role of performing one or more tests ordered by the person in charge of answering the customer claim, they describe the work task at hand more like the work tasks in Figure 7. The work task descriptions given also show that a work task, such as writing a technical report exists and is affected by the context of which it is part.

5.1.2 Faceted classification of work task

In this section the faceted classification of work and search tasks suggested by Li and Belkin (2008) are used to describe the work tasks that were included in the study. The classification scheme is presented in Appendix 10. In this chapter the applicable value of the facets or sub-facets defined by Li and Belkin are marked with italics.

Most of the 14 work tasks were externally assigned by other departments in the corporation. Only three of the work tasks were generated through collaboration, and only one was internally generated. This is quite different from the study by Xie (2009, p. 350) which showed that most tasks were self-generated. Most of the work tasks were performed by an individual task doer (i.e. writing the technical report) but most were performed by an individual in a group (engineers being dependent on other people to perform tasks e.g. technicians to perform experiments or tests). Some of the tasks comprised experiments done by a group of task doers. Most of the tasks were seen as intermittent (the engineers saw them as typical tasks conducted more than one time but not frequently). Some of the tasks were seen as unique (performed for the first time).

The work task of writing a technical report was seen, by all engineers, as a short-term task. At the same time several of the technical reports were classified as subtasks and the larger work task, e.g. a product development project, were classified as long-term tasks (taking over a month to complete). All work tasks, i.e. writing the technical report, documented in work task diaries where final (completed). Again the overall work task was sometimes in the middle or even in the beginning of a project. In all cases the task resulted in an intellectual product (i.e. the technical report). Some of the engineers also produced other intellectual products (e.g. a user’s manual, a patent) and even contributed to a physical product (e.g. a new material or a new product). Very few, if any, of the work tasks can be seen as a one-time task. The technical reports performed are part of the Writing process and as such they are objects of an iterative process, including feedback, which makes them multi-time tasks. This study did not include an analysis of the degree of iterative elements. In work task C:1 there are examples of another type of iterative elements, when a work task gives rise to additional sub-tasks, i.e. additional information-related activities, turning the task into a multi-time task.

I found some unexpected results that made me have to do some more analysis, thinking and discussing with colleagues. (Engineer C:1)

Most of the work tasks have a single and specific goal (a technical report seems to have a narrow scope) when incorporating the overall work task they become part of a multi-goal task. The degree of objective task complexity varies quite a lot between different work tasks, ranging from low to high complexity. The subjective task complexity (as defined by the task performer) varied less and only varied between low and moderate

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17 The Writing process is presented in Chapter 4.1.1.
The degree of interdependence in task performance was mostly moderate to high, a consequence of the division of labour between engineers and technicians as well as between different departments within the R&D centre. Most task performers view their task as having high salience; only three tasks are seen as having moderate salience. How urgent a task is estimated to be, depends to a large degree on the source of the task. If, e.g. the source of a task is a customer claim it is deemed immediate (urgent) (6) since a customer is waiting for an answer. Even though it might be urgent to receive the results from experiments the technical report might be of moderate urgency (6) or even delayed (not urgent) (5). Compared to the study by Xie (2006, p. 133) the tasks in this study seem to be classified as more urgent. In 12 out of 14 work task diaries the engineers a priori judged their expertise (knowledge of task topic) to perform their work task as high (6) or moderate (6). When faced with a new work task two of the engineers judged their expertise as low. The knowledge of task process is seen as high by eight of the engineers and five estimated it to be moderate (one dropout).

5.1.3 Faceted classification of search task

In this chapter the faceted classification (Appendix 10) according to Li and Belkin (2008) is applied to the search tasks engaged in by the engineers during task performance. Here the search task is seen as an information-related activity and as such the analysis helps to understand the types of activities they engage in (research question 1). This makes it possible to discuss whether the information-related activities engaged in are differing between work tasks, are situated or contextualised (research question 3-4).

All search tasks performed by the engineers were internally generated (for the different facets see Appendix 10) as a mean of accomplishing the work task. Some of the engineers have reported that they have received feedback on their work task which in turn resulted in further searching for information which suggests that there were elements of external and collaboration assigned search tasks. Whether they were or not cannot be elucidated in this study. Feedback leading to a supplement could equally be an internally generated search. The search for information has been done by an individual task doer, except in those tasks where the engineer has participated in the performance of an experiment. Even though the different search tasks have been performed on different occasions all of them were short-term search tasks. The information search tasks performed can be seen as routine (only using internal databases), intermittent (seeking scientific articles from time to time) or unique (searching results from experiments done within the work task).

The search tasks performed resulted both in intellectual information (e.g. scientific articles, technical reports) and factual information (e.g. lab reports, results from experiments) and images. Some of the searches also resulted in mixed products, especially those that involved information from experiments which could be images, figures, tables, data sheets or lab reports. Some search tasks have been multi-time tasks, e.g. within work task E:2, due to the fact that the search for information was only partly successful. Another example is work task C:1; unexpected results led the Engineer to search for additional information through additional experiments and consulting with colleagues. Most of the search tasks were, however, seen as one-time tasks. All search tasks have had a specific and single goal, e.g. finding a formula, a definition, test results or corroborative information.
Depending on the engineer’s objective view of the complexity of the work task the search tasks are deemed as either moderate or high objective complexity. Some of the engineers have consulted only a few information sources while others have used several sources; in work task C:2 a large amount of search tasks were conducted and 37 sources were consulted. In general, the search tasks have been performed with low interdependence; other people have been involved in the performance of experiments, but it is only the single task doer that has been the driving force in information searching. The level of urgency in the work task has evidently had an effect on the urgency of the search tasks. If a work task is immediate then the search task has to be done with urgency too. None of the engineers have expressed any problems with the information seeking process which indicates a high knowledge of task procedure. What has been expressed is a moderate degree of difficulty to access some types of information sources. In some of the work tasks the knowledge of task topic has been shown to be high, resulting in very few search tasks. Information seeking in this study has a broad definition, which allows it to also include gathering of information through experiments. A task that could be seen as collecting data instead of engaging in information seeking in some contexts becomes an information-related activity in this context since it is a way for the engineer to find information to be able to answer a specific question. Other work tasks have included several information sources which could be seen as the engineer possessing a low knowledge of the task topic (having some knowledge, but further exploration is needed), but could equally be that the engineers are seeking for corroborative information.

5.1.4 Typical and untypical tasks

At the beginning of the work task diaries the participants were asked to, if possible, choose one typical and one untypical work task to document in the diaries. They were asked to decide whether the tasks were typical or untypical based on the types of work tasks performed within the boundaries of their corporate responsibility. In ten of the fourteen work tasks the participants used the category typical explicitly, sometimes with qualifiers like rather or very. Several of the engineers refer to their area of responsibility as a reason for classifying a task as typical.

Since I work a lot with production/materials analysis hardware, this is a very typical job assignment. (Engineer K:F)

It’s a typical example, because these products lie within my area of responsibility [at the corporate department]. (Engineer M:1)

It’s typical, because I like to prepare a document before a meeting in order to easily go through it by clear points. (Engineer M:2)

The work task is common, but seldom anticipated and it often differs from case to case. (Engineer N:F)

Typical. My responsibility is to perform technical investigations using instruments in-house or externally when needed. (Engineer O:1)

Rather typical, but I usually know at the time if I am to make the report. (Engineer E:2)

When discussing about typical and untypical tasks in the focus groups, one engineer said:

A typical report is when you have a number of observations. (Engineer K)
Others refer to the responsibilities within the corporation, such as liabilities and obligations.

Investigating a complicated customer claim is a typical work task at our department. (Engineer N:F)

Typical. Frequently the market side request a technical report that describes what they principally already know, as a way to make clarifications in the discussion with the customer. (Engineer P:F)

If [the corporation] receives a reclamation concerning a material from a customer, [the corporation] are liable to respond to the reclamation as soon as possible. (Engineer A:F)

Engineer C refers directly to a specific method that is used in an experiment, and states that it is a quite common way of testing a material, and therefore the task can be seen as typical. This is a reference not to the engineer’s area of responsibility, rather a reference to the role as an engineer. This could indicate that there are certain kinds of domain information (cf. Byström & Järvelin, 1995) that would make an engineer categorise a work task as typical.

It is rather typical to age a material at certain temperature and then investigate the effects of aging. (Engineer C:1)

Only four work tasks have been reported as untypical. In one case the work task has been described to be not typical. The reasons for categorising these tasks as untypical are mostly that the method used in the overall work task is new or that the task itself is new to the engineer.

This is the first time we are using this technique and it will therefore have to be regarded as untypical. However, it is within the bounds of my responsibility and I hope it will become a typical example. (Engineer O:2)

The work task was a unique work task, but will be more intermittent in the future. (Engineer O:F)

It was the first time this test was done for the corporation. The equipment will be available at the corporation in the future and therefore the test will be performed again. (Engineer O:F)

Rather untypical. The test method (we scratched some of the samples before testing) is unusual. Oxidation mechanisms are quite new to me even though it is within my area of responsibility now. (Engineer C:2)

The work task was totally new to me and therefore unique. (Engineer D:F)

Yes and no. It is not typical since I have never done such measurements before, but since I will be working with this method, it will be [typical] in a short while. (Engineer D:1)

Interesting to note is that all three engineers (Engineer O, C & D) see these tasks as future typical tasks. Statements like “I hope it will become a typical example” (Engineer O:2) and that “it will be in a short while” (Engineer D:1) indicate that it is only because the task or the method is new to them, that they are seen as untypical. In the second work task diary engineer D concludes that

This is “starting to” become a typical work task (Engineer D:2).

During a follow-up session with one of the engineers who had started to fill out a work task diary, but was unable to complete it, the engineer made a comment that
It [the technical report] turned out to be more complex than expected and thus turned out to be an unusual report. (Engineer B:F)

During the focus group discussion engineer B were asked to elaborate on what actually constitutes a typical and an untypical technical report. The engineer explained that one of the things that made it an untypical report was that “the amount of information needed to be retrieved increased” (Engineer B). The engineer explained that

An ideal situation is when you only have to retrieve the formulas you need, do the calculations and report the result. (Engineer B:F)

When the situation changes and become more complex the technical report becomes untypical.

A typical technical report is one which describes the trials conducted, i.e. results have been analysed and are reported in a technical report. You report what you see. If the things you detect do not add up you start looking for additional information to find an explanation for the unexpected result. (Engineer B:F)

The case when unexpected or unusual results give rise to further information seeking is corroborated during the focus group discussions.

When you find some kind of effect, you try to make some kind of literature review to see if someone else has seen it. (Engineer L)

What you find can be off the mark and it might be doubtful. (Engineer H)

Despite the fact that the results from the work task diary study suggests that most work tasks are typical, the discussions during the focus groups indicate another stand. In the first focus group the moderator raised the issue of typical and untypical work tasks and in the other two the issue was raised as a result of the participants’ comment on the preliminary results. One participant expressed during the focus group discussion that it is hard to define what a typical or untypical task is.

I don’t know if I have a definition of a typical or untypical technical report. What is an untypical and what is a typical report is hard to say. I don’t have a stereotype, a recurrent type of report. (Engineer L)

The same engineer also expressed that

My technical reports differ quite a lot from each other. (Engineer L)

This statement is almost the same as the comments

It was difficult to decide whether a report was typical or untypical. Almost all reports are unique. Sometimes, I have several reports in a series within the same project and then I can actually use some parts, such as the introduction, in all of them. (Engineer O)

When the damage cases are the same time after time, then you copy, you take a new picture and paste it. (Engineer F)

During focus groups, some participants expressed surprise concerning the preliminary results showing that most technical reports were seen as typical and said that:

When you work at the R&D centre, one day is not the same as the other, they differ a lot. If you are writing a report, I rarely manage to copy a previous report, to start with. I do not think it is possible to work like that, as much as you should do if you perform routine work tasks. (Engineer J)
It depends on where you work, but at certain [departments within the corporation] one performs different tasks all the time. So the same kind of routine reports cannot be generated all the time. (Engineer D)

Work tasks connected to market support are considered more of routine and to have less content than a work task that concerns research and development. A work task that is part of a research project is seen as an exploration and it is “much nicer to be able to investigate a problem thoroughly” (Engineer L). A more typical or routine task is something that the engineers want to get rid of. These work task descriptions are in line with the descriptions given by the respondents filling out the work task diaries and displayed in Figure 6-9.

An interesting aspect of these results is whether the engineers are discussing the content of the reports or the format. During the focus groups it was apparent that the discussion concerned the content of the technical reports. Another aspect that shows that the discussion concerned the content and not the form is that all technical reports within the corporation are published in the same template and undergo review in two stages of which one specially reviews the format. One indication of what constitutes a typical or routine report can be found in the description, given by the engineer, of the work task process for such tasks. They are described as a rather common investigation that generates a set of results which in turn are presented in a technical report. But even then the results indicate that the reports in themselves are difficult to produce in a similar manner.

### 5.2 The work task process

The work task process presented in the work task diaries is analysed by using the model developed by Byström and Järvelin (1995). In total 14 work tasks were analysed. The tasks were classified by the participants themselves according to the task categories in the model. The number of tasks in each category is summarised in Table 2 along with the number of engineers that supplied a task in each of the categories. Each task performer contributed with 1-2 task diaries.

<table>
<thead>
<tr>
<th>Task category</th>
<th>No. of engineers</th>
<th>No. of work tasks</th>
</tr>
</thead>
<tbody>
<tr>
<td>Normal information processing task</td>
<td>5</td>
<td>6</td>
</tr>
<tr>
<td>Normal decision task</td>
<td>6</td>
<td>6</td>
</tr>
<tr>
<td>Known genuine decision task</td>
<td>2</td>
<td>2</td>
</tr>
</tbody>
</table>

The original model (Byström & Järvelin, 1995) contained five categories of work tasks. In this study only three of these are present: normal information processing task, normal decision task and known genuine decision task (Table 2), no task are categorised as automatic information processing task or genuine decision task (cf. Byström & Järvelin, 1995, p. 199). The most common task categories are normal information processing task and normal decision task, as in the study by Byström and Järvelin (1995, p. 199). These tasks are characterised by a high degree of a priori determinability concerning the information needed and the work task process. The low number of routine tasks also confirms the findings of Xie (2006, p. 133).

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18 The model is presented in Chapter 3.2 and Figure 1.
The result of the analysis of each category is presented in this chapter and addresses the different information-related activities the engineers engage in during work task performance (research question 1). This is followed by a comprehensive analysis of the information seeking process in order to discuss whether the information-related activities differ depending on work task (research question 3).

5.2.1 Normal information processing tasks

All engineers performing normal information processing tasks have, with one exception, a PhD-degree, have been working with the corporation for less than five years and half of their job assignments consist of writing technical reports. Only task performer 2 and 12 write technical reports to a small degree as part of their job assignment. The normal information processing tasks in this study include the two work tasks that are not technical reports, i.e. the user manual and the memorandum.

All work tasks reported, except the memorandum and the manual, are of a quite simple type involving experiments of some kind. The work task includes delivering the results to another department or an internal customer at the R&D centre. One exception is work task C:1, which is a minor study of a specific phenomenon. All tasks can be compared to the typical tasks described in Figures 6 & 7 in Chapters 5.1.1 and 5.1.4.

We carry out some form of observation by using a method, no more than that. We cannot say why, since we do not have the full history behind the claim, the customer does not leave so much information concerning that. What we do? We make observations and then we give the answer to the customer, who can do what they want, [draw] the conclusions they want. I can perform the measurements as accurately as I can, then he or she [the customer] can draw the conclusion presumably in their report. We work with the characterization of materials, we observe it; just like a patient that goes to the hospital and have a blood test at the lab, which measures some stuff in the blood and give the answer [to the doctor]. Why this patient has received these values [it] is not our job, it is another doctor that has to find that out. (Engineer D)

The information needed to perform normal information processing tasks is to a large degree task information (TI), i.e. information that is specific to the individual work task (Table 12 in Appendix 12), with a small amount of domain information (DI), i.e. information applicable to other work tasks as well. These findings are in accordance with the findings by Byström and Järvelin (1995, p. 204). Based on the number of information sources used, it is possible to divide the normal information processing tasks into two subgroups. The first subgroup consists of tasks with between 4-9 sources and the second subgroup consist of work tasks with a medium of 24 sources.

Work task D:2 is an exception due to the use of task-solving information (TSI), which is explained by the lack of experience of the engineer with this specific kind of work task. A similar case was also found in the study by Byström and Järvelin (1995, p. 204). They also showed that the task performers’ confidence increased as the work task progressed (Byström & Järvelin, 1995, p. 206ff), which is also shown in this study. When performing work task D:1 the engineer expressed that “This is “starting to” become a

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19 The number of sources was calculated in accordance with Byström and Järvelin (1995). When a source type was indicated in plural they were counted as three sources of that type.

20 The number of sources was calculated in accordance with Byström and Järvelin (1995). When a source type was indicated in plural they were counted as three sources of that type.
typical task”. The engineer used a previous report as a template. Engineer C and D also used older reports to get an idea on how to write his or her own report as well as a way to get an idea on how to interpret data or present results.

[I consulted] an older report on a microstructure investigation of this material. Someone more skilled than me did a similar investigation. [It gave me] tips on how to interpret my results.

(Engineer C:1)

This report was basically the same structure as the previous one so it has served as a template. (Engineer D:2)

The work process shows that the engineers performing this type of tasks have a high degree of knowledge of where to get hold of information. The engineers know what sources to use.

You receive a task from an internal or external customer; it can also be a complaint. Then you start to perform experiments, collect information in different ways. You may have some ideas or not. If the same task appears over and over, you know what to do. If it is a new task you have to think or ask a colleague for information. (Engineer M)

Almost all of the sources (91 per cent) consulted in each task are internal, which is much higher than the corresponding number in the study by Byström and Järvelin (1995, p. 204). Work task K:1 is an exception in that external sources are used due to a need to retrieve information from an external vendor. One possible explanation for this deviation is the fact that work task K:1 (the user manual) is one of the tasks that were not a regular technical report.

Out of all sources used, only 28 per cent are people as sources, which is a lower usage than was recorded for normal information processing tasks in the study by Byström and Järvelin (1995, p. 204). The reasons for using people as sources are a question of proximity as well as that they need to be knowledgeable, are more skilled and experienced. As in the study by Byström and Järvelin (1995), whether the people used as sources consulted their own personal documents was not recorded. This is definitely possible since they were consulted due to their expertise and previous experience of similar analysis or work tasks.21

More than half of the sources used (63 per cent) are personal documents, results from experiments, internal databases and in-house technical reports. The information seeking is mostly successful, and the information retrieved is applicable to the work task at hand. Almost all of the sources identified a priori to task performance are actually used (Table 13 in Appendix 12). During the work task performance a considerable amount of not initially anticipated sources were also used. Not initially anticipated sources mostly consisted of internal sources, e.g. personal collections, test results and colleagues. Some sources not a priori mentioned were external experts and documents (Table 13 in Appendix 12). Sources like scientific articles and literature (domain information) are not used (cf. Byström & Järvelin, 1995, p. 204).

5.2.2 Normal decision tasks
The engineers performing normal decision tasks are quite similar to the engineers in the previous category (Table 14 in Appendix 12). All but two have a PhD-degree and all

21 For further discussion on people as sources, see Chapter 5.3.4.
but one have worked at the corporation for less than 5 years and a small part or half of their job assignment consist of writing technical reports.

Four of the six work tasks reported in the work task diaries included in this category concern some kind of customer. These work tasks consist of investigating customer claim and drawing a conclusion (making a decision) that could be delivered to the customer. Work task O:1 and C:2 are more of a research character, but are still seen as typical tasks. All tasks can be compared to the typical tasks presented in Figures 6, 7 or 8 in Chapters 5.1.1 and 5.1.4, and have a higher degree of a priori uncertainty than the previous category.

One example is the customer claim report. You investigate the reclamation, try to find the cause and if the report is intended for a customer, you give an account of the experiments that you have performed; you do not report the extras. If you find something obvious you include it, if not you do not include it. (Engineer L)

The type of information needed is most typically both task information (TI) and domain information (DI). The type of information needed to perform these tasks, correspond to the findings in Byström and Järvelin (1995, p. 205). Work task no. 8 is the only exception as it only involved task information. As in normal information processing tasks the engineers seem to have a high knowledge on where to seek information. During the follow-up session engineer A gives the following statement showing that engineers often have a good understanding of the information needed, of the work process but less knowledge on what the result might be.

When a customer claim like this are made, the respondent [the corporation] has to conduct [this particular test] and this is done by placing an order [by an internal customer] for this test and then receive the results in the database. The engineer knows how to handle the reclamation, but not what the result of the testing will be, which give rise to a certain degree of a priori indeterminability. (Engineer A:F)

Engineer C even suggests a slightly modified task category, in which both the information needed and the process are a priori determinable, but the expected result are not a priori determinable (Figure 10).

![Figure 10 An alternative way of describing a work task in which information needed and the work process are a priori determinable, but the results are not.](image)

It is possible to divide the normal decision tasks into two subgroups based on the number of sources used. The first subgroup is composed of tasks that concern customers’ claims and uses 6-822 different sources, and have some similarities with normal information processing tasks and are similar to those found in the study by Byström and Järvelin (1995, p. 206) and those tasks presented in Figure 6a. The second subgroup is composed of tasks that have a stronger emphasis on research and

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22 The number of sources was calculated in accordance with Byström and Järvelin (1995). When a source type was indicated in plural they were counted as three sources of that type.
development, but still less complex than the category known genuine decision tasks. The number of sources used, 19-32\(^{23}\), is higher than for subgroup one as well as for normal information processing tasks. Almost all sources (89 per cent) used in both subgroups are internal, corresponding to the findings in Byström and Järvelin (1995, p. 207). Work task no. O:1 is an exception, which is explained by the fact that the experiments within the project are performed at an external facility.

The number of people used as sources is slightly higher (31 per cent) than for normal information processing tasks. The reasons for using people as sources are again mostly that they are skilled, experts, specialists, but also their proximity or that they have information concerning the background of the project or the experiments performed. People as sources are also chosen in order to confirm or explain certain results or facts. The utilisation of personal documents, internal databases, results from experiments and technical reports are still rather high (51 per cent), but are used less than within the normal information processing tasks. Among the sources used in sub-group one these types of sources are the dominating ones, which strengthens the similarities with normal information processing tasks. As in the study by Saastamoinen et al. (2012) the categorisation of tasks that the participating engineers made has been the starting point for the analysis. It would not have been possible to perform such categorisation as part of this project.

The information seeking success (Table 14 in Appendix 12) is quite the same as for normal information processing tasks. As a contrast the level of applicability is lower; this can be seen as a consequence of increasing complexity.

I found older technical reports that concerned the specific steel sort in the reclamation at hand, but the applicability was very low. They concerned other problems or aspects. (Engineer A:F)

With a few exceptions the sources considered a priori to task performance are used (Table 15 in Appendix 12). There are initially not anticipated sources identified and used, in some tasks more than in others (Table 15 in Appendix 12), e.g. internal databases, colleagues, literature and a few external such as search engines and standards. This is an indication that the engineers underestimate the need for information when performing a normal decision task, and overestimate the simplicity of the task. In the study by Byström and Järvelin (1995, p. 207) the use of additional sources are also evident. The types of sources used, when the use of domain information increases, are found in a broader group of available sources (cf. Byström, 2002, p. 585) than for normal information processing tasks.

As in the study by Byström and Järveling (1995), there is a marked difference in the types of sources used in this task category compared to the normal information task. The use of general-purpose (DI) sources is more common in normal decision tasks. The general-purpose sources used in this task category are mainly experts and literature (17 per cent), which is a difference to normal information processing tasks, even though not as dominant as in Byström and Järvelin (1995, p. 207). This can be seen as an indication of the impact of context, insomuch that the uses of internal sources, e.g. test results, pictures and previous technical reports are dominant.

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\(^{23}\) The number of sources was calculated in accordance with Byström and Järvelin (1995). When a source type was indicated in plural they were counted as three sources of that type.
5.2.3 Known genuine decision tasks

In this study, the category known genuine decision task (Figure 3) includes only two work tasks (Table 16 in Appendix 12). The engineers performing these tasks have the same educational background, i.e. a doctoral degree, and have worked for less than 5 years within the corporation. The part of their job assignment that consist of writing technical reports differs between them. For engineer C, writing technical reports constitutes about half of her or his job assignment and for engineer E it is only a small part of it.

The two work tasks, categorised as known genuine decision tasks, differ quite a lot and could also exemplify different subgroups. Both can be seen as untypical tasks.\(^{24}\) Work task no. O:2 is a work task performed within a larger project. It is a collaborative project involving external facilities and experts. The techniques used are new to the task performer and within the corporation, which explains the use of task solving information (TSI). The information seeking is less successful if we only consider work task no. O:2, but the applicability is quite high. In total 37\(^{25}\) sources are used in this task, of which 63 per cent are internal sources. The amount of people used as sources are lower than in the two previous task categories, only 20 per cent. Work task no. E:2 is an externally generated\(^ {26}\) project, from outside of the R&D centre but within the corporation. The aim of the project is to develop a new use of a product. The technical report is purely a report of results from experiments. The number of sources used in task no. E:2 was 12\(^ {27}\).

The two work tasks are examples of how different situational attributes (cf. Byström & Hansen, 2005, p. 1053) can give rise to complexity. In work task no. O:2 it is the novelty of the technique both for the engineer and for the corporation.

\begin{quote}
This report was quite a challenge as the technique used was completely new to Sandvik. The result was that large parts of the report describe the settings used and presents both successful and less successful procedures. (Engineer O:2)
\end{quote}

\begin{quote}
Evaluation of large datasets takes time, in particular when the analysis technique is new and exact settings are unknown. [I] have to try many different settings and discuss the accuracy with my contact at the University. (Engineer O:2)
\end{quote}

In work task no. E:2 other situational attributes are present. Here the main work task was performed quite some time prior to the writing of the technical report, which complicated the task performance. Several different tests were performed and the results were distributed to different people involved. When the task of writing the report was given to the engineer, the task became more complicated. The information seeking that had to be done in order to complete the report was complex, since data were present in different databases and important information needed to identify the data was omitted.

\(^{24}\) For a discussion of typical and untypical tasks see Chapter 5.1.4.
\(^{25}\) The number of sources was calculated in accordance with Byström and Järvelin (1995). When a source type was indicated in plural they were counted as three sources of that type.
\(^{26}\) Externally generated is here used in the meaning as assigned by someone else in accordance to the faceted classification of work tasks by Li and Belkin (2008, p. 1833ff). For a closer presentation of the categories suggested by Li and Belkin (2008) see Chapter 5.1.2 & Appendix 10.
\(^{27}\) The number of sources was calculated in accordance with Byström and Järvelin (1995). When a source type was indicated in plural they were counted as three sources of that type.
The experiments were performed in a great hurry so the results are spread on several people. (Engineer E:2)

I wrote 5 different detailed procedures for [these] tasks last autumn. They were done in a hurry and many things were left out, like batch numbers. (Engineer E:2)

There are different portals depending on where you have ordered tests. And these [have] different [structures] and that affects the retrieval of information. If I send something to metal physics, it looks one way. If I need information from a text, for example, chemical analysis or a tensile testing and so on, someone else can have made the order and this means that I cannot in an easy way go back and check [the results], I cannot access them. There is no cohesive way to retrieve results from tests, which is insufficient or complicated. (Engineer E)

The complexity of the task performance in work task no. E:2 indicate that some sources of information used while searching have been omitted in the work task diary. There are no people concerned used as sources reported in the task diary, which these quotations indicate would be the case.

All initially anticipated information sources are used (Table 17 in Appendix 12). For task no. O:2 there are additional, initially not anticipated, information sources used, e.g. literature, external databases, and test results. Work task no. E:2 is exclusively based on results from experiments, composed of pictures of the investigated material. In this task, the internal databases were a priori not anticipated. The use of general-purpose sources such as literature and experts are quite high (40 per cent). More than half (58 per cent) of the sources used in task no. O:2 are external sources, which is explained by the collaborative art of the work task involving external facilities and researchers. In task no. O:2 situational attributes are present and affecting the task performance, e.g. the communication with external experts and people concerned are slow.

Situational attributes are also evident in task no. E:2, insomuch that the circumstances at the time of the performance of experiments affect the work task of writing the technical report. As has been shown in previous studies (cf. Byström & Järvelin, 1995; Byström, 1999; Saastamoinen et al., 2012) the result of the present study show that the amount of information used increases with higher task complexity, even though the sources used are not mainly external and general purpose sources. These tasks, especially work task no. E:2, show the importance of using internally generated information in the form of data retrieved from experiments. This strengthens the fact that information seeking is situational bound and contextualised (cf. Leckie et al., 1996; Savolainen, 2012).

5.2.4 Analysis of the information seeking process
Even though the analysed sample in this study is small, a number of summary indicators have been calculated with the purpose to support a summarising analysis of the work task and information seeking process. The summary indicators used are the same as used in Byström and Järvelin (1995, p. 202f), with the exception of indicators related to channels, which were not within the scope of this study. The result of this analysis are presented in Table 3.

The information needed changes with a perceived increasing complexity and the information complexity increases from task categories II/III to IV, which is in compliance with earlier findings (Byström & Järvelin, 1995; Byström, 1999, 2002; Saastamoinen et al., 2012). An interesting finding is that the initially anticipated sources resulted in a higher complexity in task category II than in category III indicating that task performers are overestimating the information requirements, or simply stating the
sources expected to be used. Despite this, the results show a high correspondence between sources considered and sources used, indicating that the participating engineers are aware of what information is required and where to find it. This supports the fact that work task performers are confident in what they do (cf. Byström & Hansen, 2005, p. 1053). As a contrast, the number of not initially anticipated sources indicate that the participants underestimate the amount of information needed.

The orientation of the sources considered and used also show a specific pattern which is consistent with the pattern found by Byström and Järvelin (1995, p. 209). The share of general purpose sources increases markedly between classes II and III / IV, while the opposite holds for task oriented sources (Table 3). The pattern is almost the same comparing sources considered and sources used. The use of fact oriented sources are slightly a priori overestimated for task category III and slightly a priori underestimated for task category IV. The substantial use of task information in almost all work tasks indicate the importance of experiments/tests as a source of information for work task completion. This indicate that what is seen as relevant information is affected by contextual attributes. The information used is dependent on the work task at hand, which in turn has a specific goal to accomplish.

Table 3 Summary of main findings in the analysis of the information seeking process

<table>
<thead>
<tr>
<th>Summary indicator</th>
<th>Task category</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>II</td>
</tr>
<tr>
<td>Typical information needed</td>
<td>TI(+DI)</td>
</tr>
<tr>
<td>Information complexity index (used)*</td>
<td>1.83</td>
</tr>
<tr>
<td>Information complexity index (cons.)*</td>
<td>2.50</td>
</tr>
<tr>
<td>Orientations of sources consideredd</td>
<td></td>
</tr>
<tr>
<td>General-purpose %</td>
<td>12</td>
</tr>
<tr>
<td>Task-oriented %</td>
<td>52</td>
</tr>
<tr>
<td>Fact-oriented %</td>
<td>36</td>
</tr>
<tr>
<td>Orientations of sources usedd</td>
<td></td>
</tr>
<tr>
<td>General-purpose %</td>
<td>16</td>
</tr>
<tr>
<td>Task-oriented %</td>
<td>42</td>
</tr>
<tr>
<td>Fact-oriented %</td>
<td>42</td>
</tr>
<tr>
<td>Seeking success</td>
<td></td>
</tr>
<tr>
<td>Seeking success ratec</td>
<td>1.74</td>
</tr>
<tr>
<td>Information applicability ratec</td>
<td>1.77</td>
</tr>
<tr>
<td>Source related</td>
<td></td>
</tr>
<tr>
<td>Source count per taskd</td>
<td>1.70</td>
</tr>
<tr>
<td>Source internalityc</td>
<td>91</td>
</tr>
<tr>
<td>People as sourcesd</td>
<td>1.8</td>
</tr>
</tbody>
</table>

Note: Summary indicators were calculated in accordance with Byström and Järvelin (1995, p. 201). II = normal information processing task; III = normal decision task; IV = known genuine decision task; task Ti = task information; DI = domain information; TSI = task solving information.

* Each task was quantified as follows: T I= 1, D I= 1, TSI = 2, PI+DI = 2, TI+TSI = 3, DI+TSI = 4; the mean of these quantifications was then calculated for each work task category. The share (%) of the different subclasses of the total number of sources used. The information source's ability to provide relevant information was weighted as: ns/na = 0, ps/pa = 1, and s/a = 2; where after the mean of the overall sources used in each task category was calculated. The average number of sources used for a task in each task category. When a source type was indicated in plural they were counted as three sources of that type. The per cent of internal sources among the total number of sources used. The average number of people as sources used for a task in each task category.

The information seeking success rate shows a slightly decreasing rate towards category IV (Table 3). The information applicability rate does not indicate the same decreasing
rate from category II to IV. Instead, there is an increase between category III and IV. This could be a result of the combination of the two subgroups in category III (Table 4 & Chapter 5.2.3). The work task and the information needed are considerably situated. The number of sources used decreases toward the higher task categories, which is not consistent with previous findings (Byström & Järvelin, 1995, p. 209). However, the results do show that the need for facts, the use of internal sources and the seeking success rate decrease with increased complexity, i.e. towards category IV (cf. Byström & Järvelin, 1995, p. 209) and are without exception rated high. Additionally, the use of people as sources increases with complexity (cf. Byström & Järvelin, 1995; Byström, 1999, 2002). This is probably caused by the differences between the subgroups of work tasks that have been identified within the task categories (Table 4 & Chapter 5.2.3).

Analysing the different subgroups (Table 4) indicates that the subgroup with a higher complexity on average uses more sources than the subgroups with a lower complexity. This appears regardless of how the subgroups are composed, i.e. regardless of whether the subgroups are based on the number of sources used or the complexity index. The fact that the correspondence differs depending on how the division is performed (subgroup 1 & subgroup 2 in Table 4) indicates that situational attributes can affect the work task process, but not increase the number of sources used. Due to the small sample these findings need further corroboration.

Table 4 Divisions of work task categories into subgroups. Subgroup 1 is based on the complexity index. Subgroup 2 is based on the number of sources used.

<table>
<thead>
<tr>
<th>Task no.</th>
<th>Task category</th>
<th>Information type used</th>
<th>Complexity index a</th>
<th>Sources used (n) b</th>
<th>People as sources (n) b</th>
<th>Subgroup 1</th>
<th>Subgroup 2</th>
</tr>
</thead>
<tbody>
<tr>
<td>M:2</td>
<td>I</td>
<td>TI</td>
<td>1</td>
<td>4</td>
<td>2</td>
<td>a</td>
<td>a</td>
</tr>
<tr>
<td>D:1</td>
<td>I</td>
<td>TI</td>
<td>1</td>
<td>7</td>
<td>0</td>
<td>a</td>
<td>a</td>
</tr>
<tr>
<td>K:1</td>
<td>I</td>
<td>TI&amp;DI</td>
<td>2</td>
<td>9</td>
<td>2</td>
<td></td>
<td>b</td>
</tr>
<tr>
<td>D:2</td>
<td>I</td>
<td>TI&amp;TSI</td>
<td>3</td>
<td>5</td>
<td>3</td>
<td>b</td>
<td>a</td>
</tr>
<tr>
<td>E:2</td>
<td>I</td>
<td>TI&amp;DI</td>
<td>2</td>
<td>24</td>
<td>1</td>
<td>b</td>
<td>b</td>
</tr>
<tr>
<td>C:1</td>
<td>I</td>
<td>TI&amp;DI</td>
<td>2</td>
<td>24</td>
<td>3</td>
<td>b</td>
<td>b</td>
</tr>
<tr>
<td>A:1</td>
<td>II</td>
<td>TI</td>
<td>1</td>
<td>6</td>
<td>0</td>
<td>a</td>
<td>a</td>
</tr>
<tr>
<td>N:1</td>
<td>II</td>
<td>TI&amp;DI</td>
<td>2</td>
<td>7</td>
<td>2</td>
<td>b</td>
<td>a</td>
</tr>
<tr>
<td>P:1</td>
<td>II</td>
<td>TI&amp;DI</td>
<td>2</td>
<td>8</td>
<td>2</td>
<td>b</td>
<td>a</td>
</tr>
<tr>
<td>M:1</td>
<td>II</td>
<td>TI&amp;DI</td>
<td>2</td>
<td>32</td>
<td>9</td>
<td>b</td>
<td>b</td>
</tr>
<tr>
<td>O:1</td>
<td>II</td>
<td>TI&amp;DI</td>
<td>2</td>
<td>19</td>
<td>0</td>
<td>b</td>
<td>b</td>
</tr>
<tr>
<td>C:2</td>
<td>II</td>
<td>TI&amp;DI</td>
<td>2</td>
<td>20</td>
<td>4</td>
<td>b</td>
<td>b</td>
</tr>
<tr>
<td>E:1</td>
<td>III</td>
<td>TI</td>
<td>1</td>
<td>12</td>
<td>0</td>
<td>a</td>
<td>a</td>
</tr>
<tr>
<td>O:2</td>
<td>III</td>
<td>TI&amp;DI&amp;TSI</td>
<td>4</td>
<td>37</td>
<td>6</td>
<td></td>
<td>b</td>
</tr>
</tbody>
</table>

Note. Summary indicators were calculated in accordance with Byström and Järvelin (1995, p. 202f). II = normal information processing task; III = normal decision task; IV = known genuine decision task; task TI = task information; DI = domain information; TSI = task solving information.

a Each task was quantified as follows: TI = 1, DI = 1, TSI = 2, PI+DI = 2, TI+TSI = 3, DI+TSI = 3, and TI+DI+TSI = 4; the mean of these quantifications was then calculated for each work task category. b The number of sources used are calculated depending on whether the engineer referred to a source or sources. When a source type was indicated in plural it was counted as three sources of that type.

The engineers also a priori estimated tasks to be more complex than they are. This is shown when comparing the complexity assigned to the work task a priori to task performance and the task category assigned to the task after completion (Table 5).
Complexity varied from under 20 to 70 per cent. The categories in Table 5 correspond to the categories used by Saastamoinen et al. (2012, p. 208). In the present study, the participating engineers were asked a priori how they estimated the complexity of the work task. After the completion of the task they were asked to categorise the work task according to the task categories by Byström and Järvelin (1995, p. 195 & Figure 3). If the a priori complexity is compared to the a priori knowledge concerning the work task process it shows that they deem themselves knowledgeable of the process, but at the same time estimate the task to be complex. This is not in correspondence with the statement that “it is probable that the sparser the task performer’s a priori knowledge, the more complex the task is perceived” (Saastamoinen et al., 2012, p. 208). This could indicate that the process of writing a technical report is a well-known process, but at the same time the subject of the work task is seen as complex. Another possible explanation and one that corresponds with the findings of Saastamoinen et al. (2012) is that even though the task of writing a technical report is familiar, the work task that is to be reported is novel to the engineer and therefore seen as having high complexity.

Table 5 A comparison of the complexity and knowledge of work task process assigned to work task a priori to task performance and the task category assigned to the task after completion. The table shows the number of tasks assigned to the three categories of complexity.

<table>
<thead>
<tr>
<th>A priori complexity</th>
<th>Simple</th>
<th>Semi-complex</th>
<th>Complex</th>
<th>No. of diaries</th>
</tr>
</thead>
<tbody>
<tr>
<td>After completion</td>
<td>5</td>
<td>7</td>
<td>2</td>
<td>14</td>
</tr>
</tbody>
</table>

Note: Simple task = complexity less than 20 per cent (normal information processing task); Semi-complex task = 20-39.9 per cent (normal decision task); Complex = 40 per cent or more (known genuine decision task).

From the summary analysis, it is evident that the relationship between information seeking and work task complexity shown by Byström and Järvelin (1995) holds true in this context as well. These relationships have also been shown by Byström (1999, 2002) and Saastamoinen et al. (2012).

5.3 Situational and contextual attributes

To gain an understanding of the information-related activities in which engineers engage during work task performance, the work tasks and activities identified in Chapter 5.1 and 5.2 have been analysed on the basis of contextual and situational attributes (research question 4).

The work task diary had a strong focus on the individual task performer in order to get an understanding of what kind of information-related activities an engineer actually performs during task performance. In the work task diaries the engineers were asked to a priori describe the situational attributes that they thought might affect their upcoming task performance. Additionally, they were asked to describe the situational attributes that they consider to actually have affected their work task performance.

The attributes that were described a priori as possible to affect the task performance concerned access to information (availability), types of information, previous experience, and time. These attributes were to a large degree in correspondence with the attributes actually considered to have affected task performance. The only marked difference was the fact that several of the engineers mentioned colleagues or other people as sources as a variable that actually affected their performance, which was not a variable mentioned a priori.
To gain a better understanding of the situational and contextual attributes that enable or constrain the work task performance and thus information seeking, the work task process of writing a technical report was the starting point for discussion in the focus groups. During focus groups a number of situational attributes affecting the process of writing a technical report emerged. Together with the attributes described in the diaries, these attributes can be summarised in five categories:

- education and previous experience
- access to information
- type of work task
- target group
- aspects of time.

In this chapter all of these situational and contextual attributes are analysed and discussed separately based on results from the different datasets, but first and most the focus groups and work task diaries.

5.3.1 Education and previous experience

During focus groups, educational background and previous experience were brought up on several occasions. Both of these aspects are closely connected since previous experiences most often were discussed with reference to the academic sector and the level of education giving rise to different levels of previous experiences. The importance of these aspects can be illustrated by the following quotes from the focus groups below.

If you have done research after [your undergraduate studies] then you have been schooled even more in this, [how to] write articles. (Engineer K)

I see a difference [concerning] where one has studied. Different schools [i.e. Universities] have different policies on that sometimes. (Engineer L)

You might see a difference between those who come directly from undergraduate studies [and] those that have [completed] research studies, concerning how you [present] the results and in the discussion set the results against references. You don’t have to train those who have a doctoral degree. (Engineer L)

I worked for a long time within the area of research, writing papers and presenting results, so I have some experience I can use [when writing technical] reports. I try to present it [the content of the report] in a simple and clear way and not to include everything. (Engineer M)

I have noticed that newly employed engineers need to learn how to write and present results in a simple and clear way. (Engineer M)

The prerequisites you yourself have. (Engineer F)

There seems to be a mutual understanding that academic studies in engineering differ from other educational contexts.

It [the template] is based on what a technical report [should look like]. If you have studied engineering, you have learned what a technical report should include; summary, background, experiments, results and discussion. The issue of conclusions depends on what you have learned. There is a framework concerning what a technical report should look like. Those that have studied engineering have learned this. It can be short or long, but has the same kind of content. (Engineer L)
The same engineer also states that

A degree project [in engineering] is not as a university degree project [in general], which can be a little bit howsoever. A requirement in an engineering degree project is that [the student] show that [he or she] can write a technical report according to that template. Engineers are more disciplined in this. (Engineer L)

In the work task diaries the lack of experience of specific methods or types of information was described as attributes that affected the work task performance.

Previous experience: initially my level of expertise was more a novice than an expert. (Engineer K:1)

Having written a similar report recently had a massive impact on the speed of the work. (Engineer D:2)

I was not used to work with this kind of information, i.e. Micrographs from SEM. (Engineer E:1)

Another aspect brought up during the focus group discussions is the way newcomers are introduced to the process of writing a technical report at the R&D centre. The discussion indicates that there is a deficit in the training of newcomers, which in turn is not consistent with the discussion on the training students receive during engineering studies.

It is important to consider what the newly employed receives in the package at their arrival, cause the way you search varies a lot depending on what you have done before. (Engineer O)

It takes time to learn how one seeks information within the corporation, [and] what resources one use within the corporation. (Engineer G)

That could mean that the introduction for newly employed is not okay when it comes to how to write a technical report, how to search for information and what kind of resources that are available for information seeking. (Engineer I)

The transfer between the educational context and the industrial context could be less troublesome than expected. One of the participants has recently done the transfer and thinks that work task performance is very much the same and the information seeking is still performed in a similar manner. This is also one of the engineers that in the work task diary is using scientific articles.

I recently transferred from the academic to the industrial sector. I very much do the same things and perform searches in the same way. The difference is that the waiting time is longer. Otherwise, I don’t think that I have changed my way to perform my work. (Engineer O)

But there are differences that are brought up which indicate that the transfer is not as smooth as described by engineer O. One such difference concerns the access to information.28

It is different. When you work in the academic sector your target group is people with front edge competence, it is some kind of elite. Here you write to document and your target group is colleagues who do not have the front edge competence in your area of expertise. It is sort of a different level of work. (Engineer F)

28 Results concerning access to information are presented in Chapter 5.3.2.
It depends, when you received your doctoral degree you performed more basic research than what you do here. You had more time and money to perform that kind of work; here it is a stronger focus on production or something. You dig as deep as you have to. (Engineer H)

These quotes indicate that there might be an adaptation to the context into which the engineers have transferred. Engineer O might be choosing sources based on the perception of success on an individual level (cf. Huvila, 2010, p. 2227), which in turn is based on the way information and sources are perceived as relevant and appropriate in the academic sector. The quotes from engineers 13 and 15 could be seen as a way to adapt to the practice of the workplace, but also a reactive strategy, i.e. a way to adapt to the practice without negotiating and changing the practice (cf. Lundh & Sundin, 2006; Lundh, 2005; Moring, 2009a). The time being employed within a context may affect the information sources an engineer choose, in order to achieve success in the workplace, i.e. success on an organisational level (cf. Huvila, 2010, p. 2227).

The results show that the academic sector is seen as a reference group (cf. Dawson & Chatman, 2001, p. 9), with regard to the ability to write a technical report and what is relevant information to include. This is in stark contrast to the fact that the engineers, at the same time, express that there seems to be a need to adapt to the industrial context. Dawson and Chatman state that it is possible to have multiple reference groups connected to specific social practices, but the results from the present study indicate that there is a need for different reference groups to exist in the same social practice. It could also be that there is an ongoing negotiation between the sayings and doings of the academic sector and of the industrial sector; it is a question of which of these saying and doings that are to become the practice in the industrial sector.

5.3.2 Access to information

Access to information is extensively discussed in the focus groups. The discussion concerned general aspects, changes over time, the physical library, access to electronic information, e.g. through (commercial) bibliographic databases and in-house databases.

One aspect of access to information is the decrease in access to bibliographic databases and full text articles experienced by several of the participants when transferring from the academic context to the industrial context.

The problem is that, well, there are simply too few journals. Sometimes you can find the information you seek, but not [the journals in] related fields; journals that concern slightly different things, but still have some common points of touch. Unfortunately, it is not as good as it was at the university where you could access principally everything from Gutenberg [and onwards]. (Engineer K)

A large problem that we have at the moment is that our search tools are limited. We have Scopus and Science direct, which is only Elsevier. These have more of academic texts, while the more engineering [and] material science relevant sources are [not available, e.g.] we cannot access Metadex now, [or] ProQuest as it is called today. (Engineer L)

It is also a question of limited access to information and databases. [It is quite a difference] compared with the university where one has unlimited access and you can download anything without any thought on whether you will use it or not. With a limited access you have to take into consideration whether you will use it or not in advance and [also] do I want to wait [to access it]. You read the abstract and [choose to] use another. (Engineer D)

You wish you could access, for example Inspec, which includes everything. (Engineer H)
The limited access to bibliographic databases and full text articles means that the engineers often have to order copies of articles from other instances, most often through the library. This is expressed as a time consuming process which sometimes leads to late arrival of information needed. Sometimes the engineers even decide not to order a specific document due to the time constraints. Another striking result is the fact that several of the engineers state that they actually opt out of information that is not available electronically and in full text; engineer J even compares the situation with indulgence.

You become spoiled when information is available in electronic form. It’s a quite high barrier between the electronic [information], you know that you can get hold of it directly [and the] one who is not [electronic]. You have to search somewhere or order and wait, and that time, until you receive the information, is not certain that you have [or] the endurance to [wait] and so you pass on it [and] you only look at the electronic [information]. (Engineer J)

A couple of years ago, you could only read the abstracts so you checked if the article were available in-house. If it were, I retrieved it, if not I ignored it - even if it seemed interesting. It is very important how quickly you can retrieve it. Everything is relative and today if you can retrieve it electronically, it’s a bit more essential than if you have to go down to the basement and find a copy of an old journal. (Engineer J)

I seldom have any alternative. The journals that I use the most are not part of our subscription. Hence, it becomes important to choose those that I know will contribute and try to weed out and keep the number chosen to a minimum. (Engineer O)

No direct access to several scientific journals. Ordering through the library normally adds approx. one day before the articles are available. This slows down the information gathering. (Engineer O:1)

A positive development concerning access to information accentuated by some of the engineers is the improved access to electronic standards through E-nav.

There is an improvement when searching for standards. (Engineer E)

I think that’s a huge improvement is how we can search for standards today. E-nav for Swedish standards is really good. What I do not know is what books, and information in books, that are available at the library. (Engineer I)

The focus group discussions indicate that access to information is closely connected to the access to in-house databases, e.g. the report database (rapportdatabasen), the image database (bilddatabasen) and the different portals used by different departments for the order of experiments and dissemination of results. A project at the R&D centre has its own project database, which is available only to the members of that project group. For the project members this has become a way to more easily access relevant information. But the easy access to this information for project members is contrasted with the inaccessibility for other engineers outside the projects.

There is a big difference between the project database and the library report database. The project database only includes materials that are generated within or concerns the project. Technical reports produced within the project are filed into different subject folders. This way, it is easier to find what you need when working with something within the project. (Engineer C:F)

The lotus notes databases is almost like hiding information, which is a waste. There is no structure at all in them, at least what I have seen. There is no common structure which makes it very difficult to search for documents. Even the ones you know exist, but can’t remember where they were located, and you are only allowed to access those which belong to projects you are involved in. (Engineer E)
The project databases are only for project members. A lot of information is archived in those, information that could have been used by others. It’s limiting. The search engine at the library is under all critique. The key words are not correct, e.g. let’s say that there are four types of a steel sort. If you want to find the reports that concern those types you have to search for each one of them. It [the database] is not intelligent as if you search for a two letter combination, but you only have the first letter. That’s an insufficiency, which makes searching for information in old technical reports a heavy task. Some kind of Wikipedia, or search engine a la Internet, i.e. when searching you receive a number of suggestions. (Engineer I)

At the R&D centre there are several portals available, in which the engineers can order experiments and tests from other departments within the organisation. This is also the source where the engineers can retrieve information they need to complete a technical report, i.e. the results from experiments and tests. In addition to this there is a database where all pictures taken during experiments are to be stored.

The latter database is a database where employees can order, e.g. different tests, and it is also the source where you retrieve the results of those tests, e.g. graphs and tables with data. The first database is where pictures are stored, pictures taken during e.g. tests. I collect results/information from the two databases and then I interpret them and report them in a technical report. (Engineer E:F)

Sometimes I order a test from a welding technician, who in turn order tests from other people, which leads to a complicated mess of information seeking. (Engineers 12)

The results, from the focus group discussion, indicate that there seems to be deficits in the in-house databases, especially concerning accessibility (traceability). Information seeking in the in-house report database is compared to the lottery; it is not often you win. According to the participants the situation is even more alarming when seeking in the image database. The discussion also reveals that it is easier to consult a colleague to find a previously published report than to search for them in the database. Thus, colleagues are considered as access points to information.

The in-house reports are based on specific search terms and during the last couple of years these terms have been neglected. (Engineer J)

I also lack traceability in the [internal] databases; I think that searching in our in-house report databases is very capricious. It is difficult to find anything in it. I also recognise a problem with finding older property or production data. (Engineer L)

Traceability, searchability and access to information, as in how fast you can access, [is important]. You shouldn’t opt out of information just because the time to receive the information is too long. The traceability mostly concerns in-house information. Access to information concerns both in-house and external [sources]. (Engineer O)

It is like a lottery, at least for me. On occasions when I know who is the author of a specific report, I have asked that person for it. In that way, I either receive the information I need or a copy of the report. (Engineer O)

One should be much more careful when writing for example the summary and keywords. And if it could be decided that all reports should be searched for based on these two criteria, focus should be on choosing relevant keywords and writing a consistent and well formulated summary. This is not what has been done. Instead the keywords have been chosen roughly, with the consequence that finding the information becomes difficult. One does not comply with the Writing process. (Engineer D)

The situation for information in the form of data, graphs or images is even worse. There are no joint rules for how you should name or save the images that are taken. You just deposit it in the image database. I have my system and you have another. So, for the standardised
methods we use there should be some systematic way for how to save, name and archive too. The vulnerability is high when it comes to this kind of information. (Engineer D)

Both engineer D and O reports that sometimes there is a gap in time between the performance of a test and recording the data or images in the database or the technical report. This gap can sometimes be quite long. This in turn means that the engineers do not always remember exactly what was done and even sometimes have difficulties in interpreting their own notes. It is not a prioritised work task to archive graphs, images or data.

The access to in-house databases, e.g. the report database, is limited to those employed at the R&D centre with few exceptions. Access can be granted to e.g. former staff members that have produced technical reports. It also concerns the issue of confidential and non-confidential reports. One participant states that

This is the most secretive place I have worked at. (Engineer F)

From the focus group discussions it is clear that the issue of confidentiality presents a problem concerning accessibility. Within the corporation, there is a distinction made between non-confidential and confidential documents (Sandvik, 2013e). A non-confidential report may be imparted to a person that is not in the distribution list with permission from the author. A confidential report may be distributed to a person not included in the distribution list with the permission from the manager of the R&D research area. When results are regarded as confidential they are not available to other researchers at the R&D centre, which could mean that the same test or experiments are performed again. It could also mean that important information is left out of the technical report, e.g. in a standard reclamation report. Whether a technical report is confidential or not, also affects the way information is sought and used.

You want to keep [the reports] secret for most of those working at the R&D centre. You chose this because you don’t want everyone at the centre to know about it. (Engineer E)

The consequence is negative for the organisation since information is lost, which could have been useful in [other] projects and technical assignments (Engineer I).

Engineer G gives an example of when finding a previously published in-house report saves time and resources.

I wrote a report for a customer last month. I checked in the in-house database if there were any previous reports written concerning this customer. I found a report concerning the same problem from a couple of years ago. In that [report] we explained what experiments we had performed, which was thoroughly done, and I could conclude that there was no use in spending more research time and resources on writing the same report and do the same experiments again just to show the same results. I wrote a very short report and referred back to the previous one. (Engineer G)

Even though the confidential technical reports are not accessible to all, there has been an improvement in that they are searchable in the report database.

Previously, we couldn’t even search the reports, now we can. (Engineer E)

Today you can find an in-house report and if it is [non-confidential you can access it if you work within the R&D centre and if it is] confidential you can at least see the title and then contact the authoring engineer and explain your problem and ask whether the report can help you solve it, and if it is possible to access the report. (Engineer I)
As results from the questionnaire indicate the use of the corporate library is limited. Two issues are raised when the corporate library is brought up for discussion by the participating engineers. The first issue concerns the access to the physical collection. Most of the library’s printed books are deposited in the employees’ offices. This means that in order to get hold of a book you have to go through the library personnel, who will contact the depositor and ask if they are willing to lend the book to another borrower. The second issue raised concerns the library’s collection of scientific journals which at the time of the study was stored and unavailable.

I think it is a bit odd that almost all books are located in the offices; very few [books] are available in the library. It is not possible to browse the library collection on, e.g., physical metallurgy and find something. Instead, you start to consider who might have a book on the bookshelf in their office. Then you have to walk over to that colleague and look at the book. (Engineer F)

The location of the books are not stated in the library catalogue. It is only the library personnel who know where it is. (Engineer J)

A few years ago, when someone had been to a conference and brought the proceedings, they were not automatically registered in the library catalogue, which was a problem. It ended up in the bookshelf and no one knew it existed. (Engineer J)

The library’s physical collection isn’t large, and [the library] aren’t the information source they could be. [Two explanations is that information] becomes more electronically as in e-books and [the use of] long distance loans. (Engineer O)

When it comes to access of information, people as sources such as colleagues or experts play an important role. One important situational attribute, which affected the work task performance of several engineers, described in the diaries, where access to people as sources. Comparing the situational attributes that actually affected performance with the situational attributes that the engineers a priori thought might affect performance, show that they strongly underestimate the relevance of people as sources.  

5.3.3 Type of work task
The analysis of work tasks (Chapter 5.1) and the work task process (Chapter 5.2) showed that the type of work task performed, affected the information-related activities engaged in by engineers as well as the type of and amount of information used. These results are corroborated by the discussions in the focus group, which also revealed that the type of work task affects the writing of a technical report and as such the type of information and information sources used. The information-related activities engaged in by engineers are in this chapter discussed from the perspective of situational and contextual attributes (research question 3 & 4). During the focus groups, it became evident that there is a difference between technical reports written as market support and technical reports with a focus on research and development.

It also depends on what kind of report you are writing. If it is an interim report as part of a project and dealing with a specific area you might give references to generally accepted journals, but in a final report, you only give reference to the interim reports. (Engineer K)

In Chapter 4.2.1 the characteristics of the participating engineers based on the semi-structured questionnaire are presented.

For a closer discussion of people as sources see Chapter 5.4.4.
If it is not an important fact, you do not include anything that could be misinterpreted [by the customer]. (Engineer L)

If you are involved in development and research [projects], then I agree that the reports are not similar. But if you support the market side and different customers have similar problems with the same product, you perform fraction tests or something. You perform the same measurements most of the time, resulting in routine. (Engineer G)

When a technical report is intended as market support and might be distributed to a customer it is described as a very simple work task process (cf. Figure 6, 7 & 8) and some participants indicate that sometimes the result is already “known” beforehand. This would be a work task that can be categorised as a normal information processing task or normal decision task.\(^{31}\) One example of such a work task is work task no. P:1. The focus group discussions confirm this relationship.

This type of a technical report (or investigation), in which conclusions, in principal, are already drawn, is not very interesting to write and this probably affects the quality of the results. (Engineer P:1)

If it is to support the market side you might already know the answer. (Engineer H)

Technical reports concerning reclamations are quite simple. The requirements are stated in a standard and the guarantees we [the corporation] give for the product are stated in the product sheet. The investigation you perform is really to control that the material complies with these. That’s mainly what needs to be done, since we do not give any other guarantees. You could possibly give some recommendations. (Engineer L)

A technical report produced in a research and development project is a much more unknown territory and the engineers do not have a preconception of the result. As such, this kind of technical report gives rise to an increased number of information-related activities and also includes more types of information. This is also a kind of work task that the engineers would like to perform more often, and the kind of work task that would be categorised as a known genuine decision task.\(^{32}\)

The most awarding is to write a research report regarding issues that you don’t really know where you will end up. In a research report you want to include as much as possible. In a research project you do not, when you start, have the answer. You receive the results as you go, and if something is not clear you would want to dig deeper. (Engineer H)

A research project is more a journey of exploration. (Engineer K)

Several engineers mention that literature reviews are common during the performance of a research or development project, but they differ depending on when in the process they are performed or the reason to why they are initiated. This, in turn, affects the information-related activities engaged in.

Literature reviews are often performed before the project starts. During the project life cycle literature reviews may also be initiated as a result of unexpected results. (Engineer K)

There is always a stage at which you perform a literature review, which has to be reported in some kind of report. (Engineer L)

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\(^{31}\) Normal information processing tasks are discussed in Chapter 5.2.1 and normal decisions tasks in Chapter 5.2.2.

\(^{32}\) Known genuine decision tasks are discussed in Chapter 5.2.3.
There are different kinds of literature reviews. It is the explicit literature review, when you spend a week scanning a specific subject which you have to report. Then you have the literature review that you perform if you find an effect and you start to search for information to see if someone else have reported the same results or something different. (Engineer H)

These results indicate that the type of work task performed has a strong effect on the information-related activities that engineers engage in, and can therefore be seen as a situational attribute. A variety of work tasks have been presented, but a recurrent theme was that the target group is an important attribute that affects the work task at hand.

5.3.4 Target group
When addressing the issue of which attributes affect the work task process of writing a technical report and information-related activities, the major attribute discussed is target group. It concerns whether the report is intended for internal or external use. If a report is intended for external use, or might be distributed externally, especially if it concerns a customer, the engineer has to

be careful with what one says to them [the customer], you have to remind yourself [when working with] reclamations. (Engineer B)

You never include relevant measurement dimensions. You have to uphold that integrity. (Engineer L)

During one of the focus groups, one engineer argued that a technical report as understood by them, as engineers, is not the same as a technical report understood by a customer.

The question is whether, when a customer asks for a technical report, it's necessarily the same thing as our understanding of an internal technical report. (Engineer H)

They also discuss the fact that customers do not benefit from a very detailed technical report and that it has to be adjusted to the practical circumstances in which the customers are present. Several of the engineers conclude that they only need to produce a simple report for a customer compared to a report intended for internal use. During this discussion the participants make a clear distinction between “our” definition and “our” system and those of others’, i.e. the customers’ definitions.

The customer might be content with something that is thinner. They [the technical report] do not have to look like a technical report as we define them. (Engineer H)

Time available is almost the same as the quality of the report, sometimes you do not have to write a detailed technical report for a customer, who is not benefited by such details. These [kind of reports] turns out to be simpler. The methods you chose to describe from the investigation of the material or they become simpler so the customer can understand what we mean. (Engineer G)

There is no use in writing a report that the end-user doesn’t understand. (Engineer F)

You cannot give references to previous internal technical reports, since they [customers] do not have access to them. (Engineer B)

Other participants express a certain duality in the work process;

One requirement that we have on our reports is that they should have scientific standard. This is not something that a customer often has. At the R&D centre, we should always write a report. A customer may not need a written report and doesn’t need the report to have a certain
objectivity and structure as we try to uphold here at the R&D centre. We are to satisfy the customer and our own in-house needs, in order to be able to use it in the future. (Engineer E)

This can be difficult, you often write for the target group which is here and now, but the information is often used later, when searching for older reports, and if you get hold of a report in which you have written for someone with a thorough background knowledge you may lose the applicability (Engineer O)

This duality seems to be a complex situational attribute which affects the amount of and the kind of information used in a technical report.

It is important to write the technical report for a broader group, not just for the customer who already has the background information. The background needs to be broad, relevant and written in a way so that it is possible to read and understand in ten years time. (Engineer O)

It’s the customer’s needs [that determine the content of the report], what they have ordered, the problem investigated and how it will be used. (Engineer M)

What the customer asks for. Sometimes, they have quite low demands; they have a problem and they want you to investigate, that’s it. They want you to analyse what is wrong and present the root cause. (Engineer M)

A customer has a problem and you investigate, but cannot find any problem. Then they want a technical report to present as it looks better than an email. (Engineer E)

Sometimes the customer is internal and in such cases we do not know whether the report will be delivered to an external customer. This could indicate an ambiguity in the order concerning what type and level of technical report is asked for. (Engineer I)

Another aspect brought up in one of the focus groups is whether it is always necessary to produce a technical report. Some of the responses to customers or results from measurements would be possible to report in a less strict manner, e.g. a letter or a memorandum.

There are those technical reports where you only summarise the information requested by the customer. Simply, what they want. (Engineer L)

These results indicate that the attribute target group has a strong impact on the information-related activities engaged in by engineers. This attribute particularly affects the information used in a technical report and create a duality in the work situation. The strong impact of target groups indicates that the information-related activities are situated and contextualised. Target groups also have an impact on the next situational attribute, namely time, which is discussed in the next section.

5.3.5 Aspects of time

The last of the situational attributes brought up during focus group discussions and in the task diaries is time. The task performers receive a task that often has to be completed within a certain time frame. Most often these concerns work tasks like market support and reclamations. Two aspects of this situation are discussed during focus groups. One is that time is limited, and it is not possible to perform a detailed work process and produce a detailed technical report. The other is that you should not perform more than is expected of you in the assigned work task, which can be seen as a way to increase efficiency. This is strongly connected to different types of work tasks

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33 Different types of work tasks are discussed in Chapter 5.1. Work task as a situational attribute is discussed in Chapter 5.3.3.
and the context of the workplace. In the industrial sector the aspect of time is always present.

It is an aspect of time. The work you do is much more slimmed. The relevant information has to be presented, no fussing around. (Engineer O)

The time factor; when you write a technical report it is to be approved, it is an approval process at the end that can be quite long or short depending on who the approver is. In the worst case, it gets delayed by the approver. Sometimes, to avoid this you choose a different kind of documentation where an approval is not needed, e.g. a memorandum. This might also affect the quality. (Engineer O)

The aspect of time was also brought up in the work task diaries as a situational attribute that actually affects the engineers’ work task performance and information-related activities. Several of the engineers stated that other work tasks affected and intruded during the time they wrote the technical report.

Other higher prioritised tasks made me postpone the work with over a month. (Engineer C:2)

[When] other projects having a higher priority, [it can be] difficult to find dedicated time. (Engineer O:2)

[I am] working on several projects in parallel. The report will have to wait if other projects are prioritised. Although the total time used is reasonable (45h+2h) and it is within the estimated time of 1-2 weeks, the total time from start to finish is 42 days!! (Engineer O:1)

The time to perform other sub-tasks or to wait for others to perform tasks was also reported in the work task diaries as situational attributes affecting the work task performance.

The largest attribute affecting the work were waiting for test results. (Engineer N:1)

Sampling: sorting and polishing [the samples] were difficult, time consuming and [the] surface quality was not always good enough for analysis. (Engineer M:1)

A lot of time was also spent searching for information in the databases; however, this did not affect feedback to the customer. (Engineer N)

Contacts outside [the corporation] being slow to respond → little feedback on accuracy of routines. (Engineer O:2)

Together, these results provide important insights into the differences between the academic and industrial sector. When working as an engineer in the industrial sector you are not able to choose how to perform your work tasks to the degree that you might be able to do in the academic sector. Even though the participating engineers are working at a R&D centre they are affected by time due to involvement in other work tasks and the fact that it is important to respond to a customer claim in due time. It is important to consider that this study only includes a sample of work tasks. The fact that time affects the engineers’ work task performance and the information-related activities they engage in does not mean that all tasks are performed in a hurry and only require a small amount of information. Several work tasks are performed over longer time periods and the use of information is quite extensive. The next chapter, therefore, moves on to discuss the information-related activities engaged in by the engineers as well as the actual information used.
5.4 Information use

This chapter focuses on the information-related activities engaged in by engineers when performing a work task, i.e., writing a technical report. Firstly, the technical reports documented in the work task diaries are presented as part of understanding the information-related activities (research question 1). Secondly, the characteristics of the information used (research question 2) and the choice of information sources used (research question 1-4) are analysed. People have previously been shown to be an important source of information for engineers. Therefore, people as sources are discussed in a separate chapter. Lastly, the value of the information gathered during work task performance is discussed.

5.4.1 Physical bibliographic characteristics

Technical reports produced at the R&D centre can have a variety of content as well as a variety of purposes. As mentioned earlier (chapter 4.1.1) a technical report can contain results from research projects, product and process development, material screening and description, quality controls, but can also be literature reviews, state of the art or freedom to operate studies.

When you seek information in order to decide whether you can proceed within a [subject] area there is a different kind of technical report [that you write], a literature review. You can also use a different kind of information, but it is difficult to write in a technical report, it concerns [writing] a state of the art or freedom to operate report. In such [a report] you have to be very summative due to legal reasons. (Engineer L)

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It is not that easy to perform all reports in a cohesive way. A report doesn’t look the same depending on whether it is a literature review or if it presents results from e.g. welding trials. (Engineer E)

In line with Swarna et al. (2002, p. 4), the physical bibliographic characteristics of the technical reports in this study are used to describe their structure. Illustrations and tables are counted throughout the whole technical report, including the appearance in appendices. The analysed technical reports comprised between 4 and 42 pages with an average of 14 pages. The number of technical reports of less than ten pages is almost equal to the number with more than ten pages. Only one out of the fourteen reports was co-authored.

The number of illustrations in each technical report ranged from 1 to 38 with an average of 11 illustrations. The illustrations used are graphs and images. The number of graphs used range from 0 to 52 with an average of 6 graphs per technical report. The images that are used in the reports are mostly images taken during experiments and tests. They are therefore seen as part of the information retrieved. On average the reports contained 19 images, ranging from 0 to 72. Tables are used to present results from experiments and tests, but also to declare properties of the material that has been tested. The number of tables used ranged from 0 to 32 with an average of 6 tables. When appendices are used they most often present additional results in the form of images, graphs and tables. The number of appendices ranged from 0 to 17 with an average of 3, but was only present in half of the total number of reports that were analysed.

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34 State of the art refer to an investigation concerning prior research or findings that could be seen as a hindrance to the novelty or the invention.

35 Freedom to operate refer to the process of determining “whether the product risks infringing existing patents.” (Swedish Patent and Registration Office, 2011)
The use of references ranged between 0 to 13 with an average of 3 references per technical report. The sources referenced in the reports were internal technical reports, scientific articles, personal communication, standards, literature and memoranda. Of the internal technical reports cited 33.9 per cent were self-citations (cf. Swarna et al., 2002, p. 6), i.e. previous reports authored by the same engineer. In comparison, 58.5 per cent of the references given in the technical reports were produced by other engineers within the R&D centre. This indicates a strong preference for internal sources.

Internal reports are always accepted as reference material. (Engineer B)

Looking at a previous [technical report] that someone else or you yourself have written [is] a very common way to address a problem. (Engineer J)

[I] start with reviewing some similar work that has been done previously and the information regarding the specific case, information about why it happened and the circumstances. That’s the starting point for writing the report; if additional knowledge is needed regarding [e.g.] a certain method that I am not familiar with, more and more information seeking [is performed]. (Engineer G)

The result of the present study also show that there is a higher use of non-conventional references than conventional, quite the opposite to the findings of Swarna et al. (2002, p. 6).

When analysing the layout of the technical reports it is apparent that they follow the template available through the Writing process. During focus group discussions the engineers also show a high awareness of this template.

[We have] our template for technical reports. (Engineer K)

We have a template for technical reports. We apparently also have a template for memoranda and PM as well, but first and most it is the template for technical reports that we have in mind, sitting here. (Engineer H)

It is very individual, but we certainly have the template. (Engineer O)

When we open the template the disposition is automatically there. The disposition is self-evident and without it, it will not be approved by our manager. (Engineer M)

The chapter division in our technical reports is given when opening the template and that means that we all find our way there. If for any reason another order would be more effective, is not the most important thing, rather that all of us quickly and easily can find our way. (Engineer E)

I think it is important to adhere to the rules that are formulated in the Writing process, and to follow them as precisely as possible. That gives a standardised format for all reports. That would make it possible to work with the problem concerning searchability/traceability. It would make it possible to structure the database for all internal reports much better, taken that all adhere to the rules. That is not done today. (Engineer D)

These results suggest that there is a high awareness of the Writing process and an common approach that you should adhere to it. The results presented in chapter 5.3.1 in turn show that a common view among the participants is that previous experience and training has an important impact on the engineers’ ability to write a technical report. Comparing these results indicates a discrepancy between what one expect to be and what actually takes place. The fact that the Writing process is resembles a peer review

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36 The Writing process is presented in Chapter 4.1.1.
process, but fails with that ambition due to several different situational attribute proves that it is highly contextualised. As a peer review process it becomes empty and futile, in that it comes to focus more on structure than on securing the quality of the content.

The low number of references included in the technical reports indicate that the work and knowledge of others is not fully observed or credited. On the one side, the knowledge and information created are regarded as the property of the corporation. On the other hand, the fact that one participant stated that the knowledge or practice is secured just by the fact that the person is still working at the corporation can also be seen as taking a risk. Giving reference to an information source is not only a question of quality, but also a way to ensure that the information will be available in the future as part of a sound knowledge management. In the two next chapters the characteristics of and the actual information sources used will be discussed, which will highlight differences between sources stated in the technical report and those actually used.

5.4.2 Relevant information and its characteristics

In this study the concept of type of information (cf. Byström & Järvelin, 1995) has been used in order to gain an increased understanding of the information-related activities engaged in by engineers. All participating engineers were asked to describe the characteristics that information need to have in order to be used in their work task performance (research question 2) as well as in what form information should be.

There seems to be some consensus regarding what should be included in a technical report at the R&D centre. First of all, this is shown in the discussion of educational and vocational qualifications. Second, this is present in the reifications at the centre, e.g. the Writing process. During the focus groups the participants described relevant information in a technical report.

The conclusion presented on the first page [of the technical report] is quite important. Despite what the technical report is about, you should present the main results, regardless of whether it is a tube that has broken or if there is a five year project. (Engineer K)

Material, trials and tests, how we have performed our experiments and results from those tests, and of course, you have to discuss the results and draw conclusions. (Engineer E)

Background, why we do this, the material involved, the tests we make, how the tests are performed and the results we receive. Appendices are also something that corroborates the facts [in the technical report]. (Engineer I)

When asked about what characteristics information should have in order to be used in their work task performance the engineers mostly mention characteristics that concern the relevance and reliability of the information, e.g. concise, error-free, quality control, reliable, known source, tested & verified, accuracy, applicability, precise, fresh (up-to-date), relevant, and trustworthy. Such aspects of relevance and reliability have also been presented in a study by Fidel and Green (2004), who grouped them as variables associated with quality when engineers choose information sources. Hertzum (2002) also corroborates these findings when he reported that engineers chose information sources based on quality-related variables.

37 The educational and vocational attributes and how they affect information-related activities are discussed in Chapter 5.3.1.
Additionally, the engineers preferred information in electronic format (Table 6) over printed or oral information. Engineer C ranked the format of information according to how often they were used; again the electronic information was mostly used. Another commented

My field [of work] is much specialised and requires access to scientific journals normally not included in R&D. (Engineer O:Q)

Table 6 A ranking of the importance of different formats of information for work task performance. Rank 1 is the most important and 3 the least important, i.e. the lower the mean, the more important is the format of information.

<table>
<thead>
<tr>
<th></th>
<th>Rank 1</th>
<th>Rank 2</th>
<th>Rank 3</th>
<th>Mean</th>
<th>Median</th>
</tr>
</thead>
<tbody>
<tr>
<td>Printed</td>
<td>3</td>
<td>6</td>
<td>7</td>
<td>2.3</td>
<td>2</td>
</tr>
<tr>
<td>Oral</td>
<td>3</td>
<td>6</td>
<td>7</td>
<td>2.3</td>
<td>2</td>
</tr>
<tr>
<td>Electronic</td>
<td>11</td>
<td>3</td>
<td>1</td>
<td>1.4</td>
<td>1</td>
</tr>
</tbody>
</table>

Characteristics such as accessibility or availability were only mentioned by a few of the participating engineers, and when mentioned it is in the form of traceability and the ability to actually get hold of the source and read the information. This is again in line with the findings by Fidel and Green (2004, p. 570f, Table 1) who showed that accessibility could be seen as other aspects than in the meaning available. They presented results showing that engineers, when mentioning accessibility, used attributes such as, sources I know, saves time, has the right format and right level of detail.

Several of the engineers in the present study also describe the genre of the information, e.g. internal publications, papers, technical reports and datasheets, basic technical information, i.e. theories and definitions, technical data as well as quantitative and qualitative data as important characteristics. This shows a strong preference for task information (TI) and domain information (DI).

In the questionnaire the participants were asked to reflect upon what kind of information is more difficult to get hold of, and which is most and least useful (Table 7). If an example has been given more than once or is quite similar to other examples, they have only been presented once. The examples have also been grouped as either internal or external sources. Additionally, in the category most useful there are some examples that could be both internal and external and as such constitute a separate group.

It is evident that different types of external information are perceived as more difficult to get hold of than internal information. It is striking that the external sources are of the same type of information as the information that from the corporate perspective is seen as in-house properties and also difficult to get hold of internally, e.g. specific technical information and in-house reports from suppliers/competitors. During the focus groups, some of the engineers also addressed the difficulties of getting hold of certain factual information.

There are some things that I lack on the intranet. Phase diagrams are available in books at the library but not available through the intranet, which I think it should be. To be able to use the printed versions you have to go to the library and it has to be open. At least there should be [phase diagrams available] for the kind of alloys we [at the R&D centre] work with, and the kinds we might work with in the future. [Then they would] become searchable as well. (Engineer E)
Another thing I lack is the possibility to search for, both in-house and externally, is material properties. If I have a certain material and want to know its properties, I would like to be able to search in a material database for that information. I do not know if we have access to any material databases. How can I access information regarding properties for our own materials? There are technical specifications available, but I think a database in which you could search different properties of the same material should be available. This is something I lack when writing a report. (Engineer G)

The examples of least useful information differ from the other two, in that they are more a description of the information than types of information. Only one participant stresses that in-house technical reports are less useful as information.

Table 7 Information that is difficult to get hold of, and which is most and least useful. Each category is divided into internal and external information. Each division is in turn classified according to the information categories defined by Byström and Järvelin (1995), depending on whether the information is factual, task, general purpose or domain (within parentheses).

<table>
<thead>
<tr>
<th>Difficult to get hold of</th>
<th>Most useful</th>
<th>Least useful</th>
</tr>
</thead>
<tbody>
<tr>
<td><strong>Internal information (factual/task)</strong></td>
<td><strong>Internal information (factual/task)</strong></td>
<td><strong>Internal information (factual/task)</strong></td>
</tr>
<tr>
<td>confidential in-house technical reports</td>
<td>in-house technical reports</td>
<td>in-house technical reports</td>
</tr>
<tr>
<td>(older) in-house technical reports</td>
<td>results from experiments/ports/tests</td>
<td>meeting minutes</td>
</tr>
<tr>
<td>technical information on materials produced within the corporation</td>
<td>material properties from earlier testing and applications</td>
<td>issues related to administration</td>
</tr>
<tr>
<td>information from other product areas within the corporation</td>
<td>technical information/data about materials, materials processing and procedures for performing analysis</td>
<td></td>
</tr>
</tbody>
</table>

**External information (factual/general purpose/domain)**
- detailed product specifications from suppliers/competitors
- internal reports from other companies
- conference articles/proceedings
- journal articles outside corporate library subscription
- books
- illustrations e.g. graphs
- novel subject areas
- terminology/vocabulary in a novel subject area
- information on applied materials research
- accurate technical data for a specific material

**Internal/external information (factual/general purpose/task/domain)**
- previous studies of similar experiments
- description of analysis techniques, materials tested, chemical content, observations on behaviour and previous results in relevant studies (both external and internal)

**External information (factual/general purpose)**
- observations/data from scientific articles
- books (in a specific area)
- (scientific) articles
- formulas and graphs
- conference reports

In Chapter 5.3.2 the problem with accessing information was addressed. One of the most important problems discussed in the focus groups concerned the access to internal reports (Table 7). With this as a background a it is possible draw the conclusion that the requirements regarding what information is seen as relevant to include in a technical report is not part of the reifications (cf. Moring, 2009b), i.e. the Writing process. It seems as if what is relevant information is being negotiated on an individual level,
which in turn seems to be affected by several situational attributes such as type of work task, target group and time.\footnote{Work task, target group and time as situational attributes are discussed in Chapter 5.3.}

The Writing process or the rules that you should follow when writing a technical document, they are either not in place or people ignore them. They are not fully complied with. If you compare with the ideal technical documentation, people shuffle off with important information like charge number or composition or other information. (Engineer D)

In-house [technical] reports need to be searchable and traceable, and you need to adhere to the written rules. It would be possible to improve the background description if you in the template have certain points that have to be included, e.g. a table that summarises chemical analysis performed, charge number, and lot number. Without thinking [you should] understand that this information is to be included before you continue writing the report. (Engineer G)

There is no standard concerning what we can give out to a customer regarding chemical composition versus what we can include in an in-house scientific report. (Engineer I)

One thing that is often overseen is the description of the material that has been investigated. Information regarding the charge might not be of high relevance today, but in 10 years when someone retrieves the report, that information is highly relevant in order to make use of the information. … That a report should be useful in ten years is something that not everyone reflects upon. Sometimes an order is urgent, and generally you are not interested in a technical report. As the performer of the test, you are expected to deliver a graph or an image, and the customer is satisfied. In such cases, very little are documented at all, and it becomes impossible to return and remember what you delivered. (Engineer J)

Another important thing is the background in the reports. It often lacks information, and maybe we could emphasise that more. But there is always the issue of lack of time. The engineer performing a test receives a certain amount of information and includes that in the background, the customer knows why the test was performed. … The background information is worst off. If you would search the same technical report after 10 years, you would lack information about what was ordered. (Engineer O)

In the process of producing information, it seems as if the quality of the documentation has been renegotiated. Situational attributes such as time and target group have gained precedence over quality.

Sometimes you know that there might be more information available, which was not displayed in the report, due to the fact that the report is used to support the market side. In a report from research trials, there is more information incorporated in the report, and as such they are more reliable. (Engineer L)

In general, I think that the focus in the organisation hasn’t been on information seeking and high quality documentation. The focus has been on generating data, lots of data, instead of focusing on qualitative documentation, and no thought on the applicability of the reports in the future, e.g. in 20 years time. (Engineer D)

During focus group discussions the participants addressed additional information regarding relevant information to include in a technical report, which is not part of the reifications. These concern lessons learnt and future implications.

Pure failure is not reported because they are not considered important. But they can be just as important since you learn from your mistakes. (Engineer O)

We have started to include lessons learnt. When we perform tasks and there are no actual results you should include it anyway in order to report on what you have done, that it didn’t
generate any results and why there were no results. [Today] this is not included in technical reports at all today. Lessons learnt are of special importance when e.g. a change in test method and maybe even a change of the aim of the work task are made during task performance. (Engineer I)

The results presented in this section indicate that the information used by engineers when writing a report to a large degree characterised as easy to access, electronic and internal. These results suggest that there has been a transition toward a higher preference for electronic sources than has been shown in previous studies. The next section, moves on to discuss the information sources used by engineers.

5.4.3 Information sources used by engineers

One important aspect of information-related activities is the choice of information sources. A better understanding of the most important sources is of great value for the provision of information sources within an organisation. The participating engineers’ choice of information sources has been addressed in the work task diary, the questionnaire and in the focus groups.

In the questionnaire the participants were asked about how often they generally use a number of pre-selected sources (electronic and/or printed) to obtain information. The frequency categories were originally five, but due to the low number of participants (16) it was decided to merge the categories often/fairly often and never/almost never. The results show that engineers use a wide variety of information sources (Table 8), even though they prefer some above others.

External publications as well, patents, standards, I use such information a lot. It depends on in which area your work. [I] even [use] information from the Internet, but then I need to give a reference to [the source] I retrieved it. (Engineer L)

As can be seen in the histogram in Table 8 (cf. Choo, 1994) the information sources most often consulted are discussions with colleagues/experts within their own organisation (electronic/orally), electronic in-house technical reports and electronic bibliographic databases. A lower usage is discerned for printed bibliographic databases, governmental reports (electronic/printed), librarians (electronic/oral), professional journals (electronic/printed), electronic textbooks and trade promotional literature (electronic/printed).

I use some books as well. The ones that are on my bookshelf are always a good source. It is when you can’t remember [a specific thing], you turn to the book, you look through [the book] since you know it [the information] is there. (Engineer B)

These results are corroborated by the actual use of information sources registered in the work task diaries (Table 9). In comparison with the results from a study by Choo (1994, p. 29, Table 2) there is a marked increase in the use of electronic information sources. In the study by Choo, which did not address engineers, the results showed that electronic information was used either a few times a year or never. In the present study this is the opposite, the printed information is used less. These results are also confirmed by the question concerning the format of information mostly preferred by the participating engineers (Table 6) posed in the semi-structured questionnaire.
Table 8 Histogram of the frequency of usage of different sources the engineers usually go to, to obtain information.

<table>
<thead>
<tr>
<th>Source</th>
<th>(Fairly) Often</th>
<th>Sometimes</th>
<th>(Almost) Never</th>
</tr>
</thead>
<tbody>
<tr>
<td>Discussions with colleagues/experts in the organization (oral)</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>In-house technical reports (electronic)</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Bibliographic databases (electronic)</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Discussions with colleagues/experts in the organization (electronic)</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Textbooks (printed)</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Professional journals (electronic)</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Handbooks and standards (electronic)</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Conference/meeting papers (electronic)</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>In-house technical reports (printed)</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Trade/promotional literature (electronic)</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Discussions with experts outside your organisation (oral)</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Discussions with experts outside your organisation (electronic)</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Handbook and standards (printed)</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Conference/meeting papers (printed)</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Textbooks (electronic)</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Government technical reports (electronic)</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Librarians and information specialists (electronic)</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Librarians and information specialists (oral)</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Professional journals (printed)</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Bibliographic databases (printed)</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Trade/promotional literature (printed)</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Government technical reports (printed)</td>
<td></td>
<td></td>
<td></td>
</tr>
</tbody>
</table>
The results displayed in Table 8 also show that engineers extensively prefer electronic and oral information sources. When an information source is available both in printed and electronic/oral form it is the latter that they usually use to obtain information. This indicates a marked increase in the use of electronic information sources when compared to the results presented by Choo (1994), who showed that electronic information was used mostly up to a few times a year or never. In the study by Yitzhaki and Hammershlag (2004, p. 835ff) printed information such as textbooks, professional journals, and in-house technical reports ranked higher than corresponding electronic information. Only electronic bibliographic databases, handbooks, standards and electronic communication ranked higher than corresponding printed or oral information.

The reason for choosing electronic resources is mostly connected to their accessibility. If a source is not available electronically, then it is not used. Similar reasons, convenience, familiarity and accessibility, were also found in the study by Xie (2006) and Allard et al. (2009). Comments from some of the participants even suggest that bibliographic databases as a source have gained precedence over scientific articles as a source.

The databases in which you can view illustrations without accessing the article are very useful. The information is summarised in the illustrations, which sometimes are the only information I need, and then I don’t have to order that specific article. It could be information regarding a specific method that I need to perform, which I later on never give reference to. (Engineer O)

When you seek an article, you can read the abstract and if you find it interesting and would like to see the content, but it is not available in full text you, skip it. I just want to quickly check the graphs. (Engineer G)

Concerning information seeking, e.g. externally, for me it is important to have access to full text or at least the figures in combination with abstract. (Engineer G)

A comparison of the ten most preferred sources (Table 8) which the engineers use to obtain information indicate that there are differences in choice depending on their highest educational qualification. The engineers with a higher degree (PhD) more often obtain information electronically from bibliographic databases, professional journals, trade/promotional literature and conference/meeting papers than the engineers with a lower education (MSc). The latter group more often chooses to obtain information from printed in-house technical reports and textbooks, as well as electronic communication with in-house colleagues/experts.

I use none [database] at all, basically. Much of what you do is based on the trials you have done, what comes out of them. [I give] very few references to other technical investigations, except previous investigations within the same area, performed at Sandvik, but very seldom references to scientific reports. Not at all, I would say. (Engineer B)

Such similar differences, i.e. education and training, affect the choice of information sources, which also has been shown in previous studies (e.g. Ellis & Haugan, 1997; Kwasitsu, 2003; Yitzhaki & Hammershlag, 2004). The results from this study also show additional similarities with these previous studies, e.g. oral communication with in-

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For further discussion on access to information see Chapter 5.3.2.
house colleagues/experts, the use of electronic in-house technical reports and the use of electronic handbooks/standards.\textsuperscript{40}

In the questionnaire the engineers were also asked to list three written sources that they use most regularly as well as three persons who they most regularly contact to obtain information (Table 9).\textsuperscript{41} The participants were not asked to discern whether the written sources are in printed or electronic format and therefore the results are given without such a distinction. Despite this not being an ideal presentation of results, it offers a reasonable way to compare the results with the ones given in the histogram (Table 8).

Table 9 The most important information sources and the information sources actually used. The column Questionnaire lists the sources ranked as most important, according to the questionnaire. The column labelled Diary lists the number of times the information sources are used according to the work task diary.

<table>
<thead>
<tr>
<th>Source</th>
<th>Questionnaire (n = 16)</th>
<th>Diary (n = 14)</th>
</tr>
</thead>
<tbody>
<tr>
<td>Discussions with colleagues/experts in the organization*</td>
<td>33</td>
<td>58</td>
</tr>
<tr>
<td>Internal databases</td>
<td>2</td>
<td>56</td>
</tr>
<tr>
<td>In-house technical reports</td>
<td>14</td>
<td>30</td>
</tr>
<tr>
<td>Personal documents</td>
<td>2</td>
<td>30</td>
</tr>
<tr>
<td>Other electronic resources</td>
<td>6</td>
<td>14</td>
</tr>
<tr>
<td>Professional journals**</td>
<td>9</td>
<td>6</td>
</tr>
<tr>
<td>Bibliographic databases</td>
<td>4</td>
<td>5</td>
</tr>
<tr>
<td>Discussions with experts outside the organisation</td>
<td>3</td>
<td>4</td>
</tr>
<tr>
<td>Handbook and standards</td>
<td>5</td>
<td>3</td>
</tr>
<tr>
<td>Textbooks</td>
<td>5</td>
<td>2</td>
</tr>
<tr>
<td>Conference/meeting papers</td>
<td>1</td>
<td>-</td>
</tr>
<tr>
<td>Librarians and information specialists</td>
<td>1</td>
<td>-</td>
</tr>
<tr>
<td>Government technical reports</td>
<td>-</td>
<td>-</td>
</tr>
<tr>
<td>Trade/promotional literature</td>
<td>-</td>
<td>-</td>
</tr>
</tbody>
</table>

* Colleagues/experts presented in the column Questionnaire are the number of people listed in the questionnaire as a person that the engineers most regularly contact. Not all engineers listed three persons and persons external to the organisation are not included. The number of colleagues/experts based on the diaries is the actual number of people mentioned.

** Professional journals are here defined as scientific journals and articles

The results from the questions asking the participant to list regularly used information sources are in good agreement with the results presented in the histogram (Table 8 & 9). Consulting with colleagues and experts in the organisation dominate over consulting corresponding categories outside the organisation. Of the written sources consulted, in-house technical reports are dominating. The categories personal documents and in-house databases do not constitute a large part of what is mentioned in the questionnaire, which is likely to be an effect of the question itself, asking the participants to list

\textsuperscript{40} For further discussion on the impact of previous experience and education see Chapter 5.3.1.

\textsuperscript{41} People as sources are discussed in Chapter 5.4.4.
frequently used written sources. These categories are most probably not seen as written sources.

The results from the questionnaire are also compared to the sources actually used as reported in the work task diary (Table 9). As is evident from Table 9 (Diary) the consulting of in-house colleagues/experts is dominating over the use of experts outside the organisation (cf. Kwasitsu, 2003). There is a marked difference between engineers based on educational qualifications in the use of external experts. The higher degree the more use of external experts (cf. Kwasitsu, 2003), both through oral and electronic communication. One possible explanation is that these engineers have a larger network outside of the organisation due to their previous experiences from PhD-studies and research. The written sources used are primarily in-house technical reports. Additionally, personal documents and in-house databases emerge as frequently used sources. These categories include notes taken during experiments, in-house databases that are used to retrieve results from experiments done by colleagues and for retrieving pictures. The dependence on personal files is corroborated by the results reported by Wild et al. (2010) and Barclay et al. (1994).

My own notes are data from the test database and notes taken by the technician. (Engineer P:F)

I keep newly published technical reports that I received by email in the mailbox until I have read them and then sort them into a folder. (Engineer C:F)

It is not always I know what I am looking for, but when looking through the folders and reading titles I can locate what I need. Doing the same in the library report database would require that all project names had been added as a keyword. (Engineer C:F)

It would be possible to categorise these into in-house colleagues and in-house reports, but such an operation would only strengthen the use of the mentioned categories. These findings correspond to previous studies that also show that engineers often use their own personal archives, the company archive, and people as sources (cf. Hertzum & Pejtersen, 2000; Kwasitsu, 2003; Leckie et al., 1996; Wild et al., 2010).

The results presented in Tables 6 and 7 seem to indicate that the sources most regularly used by the engineers are in-house colleagues/experts, data acquired through experiments and in-house technical reports. It is evident that internal sources are used to a higher degree than external sources. This has been shown in other studies of engineers, but studies of other professionals have not shown this difference in use between internal and external sources (cf. Choo, 1994). However, Choo (1994, p. 31) showed that internal and personal sources were rated as more trustworthy than external and impersonal sources.

If the physical location of or the location from where the engineer access the sources is used as a definition of whether a source is internal or external then the number of internal sources could increase tremendously as a result of an inclusion of commercial databases, printed professional journals and handbooks and standards available through the corporate library. Despite the dominance of in-house colleagues/experts as a source some of the participants expressed surprise over this, stating e.g.

[That] colleagues would be the largest information source, they are not for me. (Engineer O)

The results from the work task diaries show that several other forms of electronic sources are used, e.g. Google, Wikipedia and formula repositories (cf. Allard et al.,
2009 &; Levine et al., 2011 concerning online communities). These kinds of sources seem to be used mostly when the engineers need specific information on e.g. a certain formula or information that does not need to be of high quality.

[I] searched directly via Wikipedia (Engineer K:F)

These things [i.e. information regarding an instrument or method] are best found via Google. In such cases, Google is my best friend. (Engineer K:F)

I often use this kind of volatile information as background information. You can find fact sheets […] on the Internet and then you can give reference to what they are. (Engineer L)

The use of search engines and sources such as Google and Wikipedia is also discussed during the focus groups. Google as your “best friend” is present in this discussion as well, but several other aspects are also brought up such as differences between the in-house search engine, Google patents and Google translate. These findings are consistent with those of Allard (2009, p. 452), who showed that engineers prefer search engines like Google ahead of corporate repositories.

We haven’t mentioned the word Google during the discussion. Yet, it is a very important way to search, which we use to retrieve information. (Engineer J)

Google is an important aspect; when nothing else works or to start your search, just to find out what turns up. Often, if you enter a title of a scientific [article], the first question you get is whether you want to search for [scientific] journals, and then poof, there they are. (Engineer O)

If there is something special you are looking for; firstly you try to find it in literature, i.e. if you can get hold of it at the corporation. Secondly, you Google, and then there is Wikipedia [but] you don’t know how correct it is, everyone can add. (Engineer H)

The in-house search engine is so-so. Much depends on the technical development. Google has the best search algorithm. Often, it turns out to be better to search in an available public database, can’t think of one now, but it is often more flexible to search in Google since the accuracy is higher. (Engineer K)

You become quite inventive after a while. You become skilled in searching in Google. Often you can find things at some obscure American university where they might have their own articles published in a journal that is not blocked. You ask colleagues at Sandvik if they have a CD or DVD from a conference with abstracts. And for some conferences, which update their DVD:s every year they might have [proceedings] from 1960 to 2013 on the same DVD. (Engineer K)

Google patents are really good. (Engineer F)

The Google aspect is interesting when it concerns searchability too. If you consider newly employees, they are more or less the Google-generation, at least a generation who has learned to use Google. As such, when you start using a database, you spend time looking and thinking, which search bar should I start with and what are they used for. After [completing] the search [they might end up] with no result, and may think, this is strange - you usually get hundreds of hits, and then just conclude that there is nothing of relevance in [that database]. (Engineer O)

There seems to be a higher awareness among the engineers of the risks of using information sources on the Internet, but also on how to verify the information they find.

You could claim that this has changed the past years, about 10 or 15 years ago you might have been considered disreputable if you used an Internet link [as a reference]. Wikipedia
receives better and better status, since they, just as scientific journals are, reviewed by a lot of other people. (Engineer K)

[Information from the Internet] can be a bit volatile sometimes. (Engineer B)

[Information from the Internet] is volatile sometimes, but it can be a good source, to put things in perspective. It depends on what you work with. (Engineer L)

The problem is when we try to translate our in-house reports and there are digital traces of them. However, we haven’t received any clear directive not to use Google translate. (Engineer O)

If you find it [the information you want to use] in wikis, quite often there are references that in some way are printed, which you in turn can give reference to. (Engineer B)

The really good articles in Wikipedia are marked with a yellow star, I think. (Engineer K)

Taken together, these results suggest that even though engineers prefer information in an electronic format they still prefer the same information sources as have been shown in previous studies. Even though the amount of information sources used has proven to be quite high it is not reflected in the references given in the technical reports analysed. This is especially true when people are used as sources, even though they most preferred sources are colleagues. The next section, therefore, addresses people as sources.

5.4.4 People as sources

The results of this study indicate that people are an important source of information for engineers, which has been shown in several earlier research projects (e.g. Hertzum & Pejtersen, 2000; Kwasitsu, 2003; Leckie et al., 1996; Wild et al., 2010). Colleagues are mentioned on several occasions during the focus groups. Two different themes emerge during the discussions. The first concern what kind of information is sought from colleagues. The second concern if and how the engineers refer to their colleagues in the technical reports. Colleagues are often consulted for discussions of different kinds. According to the work task diaries, colleagues such as technicians are often consulted to gain a better understanding of what has been done during an experiment and a better understanding of the results, through two-way communication (cf. Xie, 2006). Colleagues are sometimes seen as experts and are consulted to gain information on how to interpret or explain the results from experiments or to use their expert knowledge of a specific method, indicating high reliability in people as sources. This has also been shown by Xie (2006).

The work task diaries showed that people as sources are actually used during work task performance. In the work task diaries several of the engineers refer to colleagues that they contacted for various reasons. The reasons for choosing to contact a colleague are often that they are more skilled in the subject or have more experience of writing technical reports.

[I] had a lot of help from my manager during the testing and during the writing of the technical report. (Engineer D:F)

42 For a discussion of the number of sources stated in the technical reports see Chapter 5.4.1.
43 People as source are discussed in Chapter 5.4.3.
I got good results and good help from colleagues which made the work rather simple. (Engineer C:1)

They were contacted in order to ask for help to interpret the results since they are experienced in the method of analysis, but not necessarily in the material under investigation. (Engineer C:F)

I have written the technical report by myself, but have had discussions with my colleagues concerning how to formulate the report, since I was unsecure regarding the subject. (Engineer C:F)

My colleagues are more skilled since they have previously made studies on the same material. (Engineer C:F)

[The] colleagues that I work with, give me comments and help [me] when I have questions. (Engineer M)

Requesting information from other people, concerns results from different tests, what has been measured and the notes taken by the technician. (Engineer E:F)

The second theme that emerged from the focus group discussions concerned whether the engineers refer to colleagues in their technical reports. Interestingly, it seems as if colleagues are seldom referred to in the reports.

We are not writing references in a proper way. It is not often you see someone referring to a discussion with colleagues. (Engineer I)

One holds several discussions with them [colleagues] but never in such a way that I use them as a reference (Engineer B)

Other participants mention that they normally refer to personal communication or give a reference to an email in a technical report.

I write communication and sometimes email and include the date and with whom. I also state what kind of report, e.g. corrosion or metal physic test report and its number. (Engineer M)

Most include [references] but mostly refers to a technical report. First and most this is to compare results and not to look at the structure. Some people have started to give reference to colleagues and webpages, i.e. the www-address from where they have retrieved information. It is becoming more common. (Engineer I)

It is evident that in-house colleagues constitute an important information source, but it seems as if they are not viewed as a legitimate source and therefore are not referred to in the report. Another participant puts it in a different perspective by saying:

In the reports that we write, it is seldom one refers to a private discussion. Maybe one should do that to a greater extent [than today]. But as long as it is internal reports, it feels like they [the colleagues] are here anyway, [which mean] that the information [is available], somehow. (Engineer H)

Referring to colleagues could concern trivial things. A detail of a practical matter which can be extremely hard to find, something that everyone knows about, but no one writes about. (Engineer K)

This statement is closely connected to the issue of information access in a long-term perspective. The low use of references used in the technical reports is verified by the

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44 Access to information is further discussed in Chapter 5.3.2.
analysis of the disseminated technical reports from the work task diaries. The fact that people as sources seldom are stated in the references also poses a problem for the future.

When people leave [the corporation] you might partly lose some information. (Engineer M)

According to Cross et al. (2001) friendship, aside from other social aspects of relationships, is an important factor in the experience of information benefits, but not co-location. In this study, the participating engineers were asked in the questionnaire to report three persons who they most regularly contact to acquire information. With the intention to see if certain persons were more important than others as an information source the engineers were asked to rank them from one to three. Several of the engineers found it difficult to rank people as sources and there were only two persons that were mentioned more than one time. It was therefore decided to omit the ranking in the analysis. Instead, a stronger focus in the analysis was put on the organisational location of the people used as sources in relation to the engineer seeking information. Four participants did not specify any people as sources and therefore their answers have been omitted from the analysis. Out of all specified people used as sources (36), as many as 21 came from the same research area within the R&D centre as the participating engineer (Table 10).

Table 10 The number of people most regularly contacted to obtain information, distributed on their place of work internal or external to the organisation. The grey areas indicate that the engineers most often used a person as source from the same research area as their own.

<table>
<thead>
<tr>
<th>R&amp;D area</th>
<th>Materials science</th>
<th>Metallurgy</th>
<th>Strategic research</th>
<th>Strip</th>
<th>Tube</th>
<th>Wire &amp; Heating</th>
<th>R&amp;D</th>
<th>SMT</th>
<th>External</th>
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<tbody>
<tr>
<td>Materials science</td>
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<td>3</td>
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<tr>
<td>Metallurgy</td>
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<tr>
<td>Strategic research</td>
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<tr>
<td>Strip</td>
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<td></td>
<td>1</td>
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<tr>
<td>Tube</td>
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<td>2</td>
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<td>1</td>
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<td></td>
<td></td>
<td>1</td>
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<tr>
<td>Wire &amp; Heating</td>
<td>2</td>
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<td>4</td>
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</tbody>
</table>

This could be an indication that co-location has an influence on benefits from information seeking, which contradicts the findings of Cross et al. (2001). At the same time the benefits could arise from the fact that a group of people are co-located based on their field of expertise, and that this is more important than the co-location in itself, confirming that trust is an important variable for success (cf. Cross et al., 2001, p. 443). In total 29 people used as sources came from the R&D centre, and only 4 came from other product areas within the corporation (SMT). The participants also mentioned 6 key persons who were located at a different research area than themselves. One engineer had only specified people external to both the corporation and the engineering group.

5.4.5 Value of information gathered

As part of the evaluation of the information seeking process the work task diary participants were asked to characterise the value of the information gathered. The task performers were presented with ten statements of which they were asked to indicate whether they (strongly) agreed or (strongly) disagreed. All of the statements concerned

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45 See Chapter 5.4.1.
the information gathered connected to the process of completing the work task. Only one participant did not give an answer to all of the statements.

In general, the task performers are highly satisfied with the information gathered (Figure 11). The task performers strongly agreed (4.6) that the information they gathered helped them complete the task and that the information gathered was relevant (4.1). This is also an indication that the engineers are knowledgeable of where to get hold of the information they need. The statements that received the lowest agreement indicate that the task performer posteriori acknowledge that their a priori understanding of the work task and the information needed was lower than anticipated, e.g. I was aware of all information needed (3.5) and it substantiated what I already knew or suspected (3.2).

In one of the focus groups the participants had a discussion of the work task process based on a priori judgements. When a work task is constructed, e.g. when a customer claim is filed, the customer may include a lot of information concerning the material at hand and also the process of events that has led up to the problem. This information is of great value since it gives the information necessary to analyse the material and also enables the engineer to draw a conclusion of what has caused the problem. At the same time the participants highlighted the risk of letting the a priori given information affect the choice they make when ordering different experiments based on their a priori judgement of the facts at hand. One of the participants even said that they are biased (prejudicial). This could also affect the way that engineers seek information in that they are looking for information that can confirm the causes they believe explain the problem.
It [the assumption] is a leading question, which can steer how the investigation is planned. (Engineer J)

Often you get some sort of idea that it is like this, but in nearly 80 per cent of the cases I say: no it’s like this. You can write a background description and [describe] any symptoms, and in the results section state that this was suspected, but it turned out to be due to [another cause]. (Engineer O)

[There is a risk] that you find the causes that you suspected from the beginning, even though it’s not the primary cause [of the problem]. (Engineer O)

The results show that the engineers completing a work task diary are satisfied with the information sources used. This taken together with the results from chapter 5.2 showing a high rate of information seeking success and applicability rate, indicates that engineers have high knowledge of the type of information needed to perform a work task and that they know where to get hold of it.

5.5 Concluding remarks

The results from the work task diaries, the questionnaire and the focus groups show that what is considered relevant information for the engineers at the R&D centre depends on the work task at hand. First and most, they depend on task information (TI) which is information produced in-house in the form of data and results from experiments. In addition to this they use domain information (DI) to verify and support their findings. Task solving information (TSI) is used to verify that the engineers have chosen relevant task and domain information in order to solve the work task at hand.

The work task diaries show that it is important for the engineers to receive information in the form of samples or results from experiments in order to perform the task of writing a technical report. Hence, the information-related activities engaged in by engineers when writing a technical report are situated and contextualised.
6. Discussion

Prior research has illustrated the importance of technical documentation (cf. Barclay et al., 1994; Swarna et al., 2002) for engineers and the complex work context in which they perform information-related activities (cf. Leckie et al., 1996). Several studies (cf. Barclay et al., 1994; Choo, 1994; Ellis & Haugan, 1997; Kwasitsu, 2003; Yitzhaki & Hammershlag, 2004) have also shown that internal information sources and especially people as sources play an important role as sources during the performance of a work task. In several studies, information-related activities and work tasks have been addressed (cf. Byström & Järvelin, 1995; Byström, 1999, 2002). However, these studies have mostly focused on either the individual work task performance or specific aspects of information-related activities, and have not focused on connecting individual performance with the information-related activities in social practice.

In this study a work task diary, a semi-structured questionnaire and focus groups have been used to achieve an understanding of the information-related activities performed by engineers during work task performance as well as for an understanding of the situational and contextual attributes affecting these activities. This study has a qualitative approach to investigating information-related activities engaged in by engineers at the R&D centre, Sandvik AB. Therefore, there are no claims of making generalisations applicable in other contexts. The use of methodological triangulation strengthens the validity of the results in the given context. Trends identified in this study are compared to other studies. The fact that the results presented in this study corroborate and are corroborated by previous findings means that this study contributes to an enhanced understanding of the studied phenomenon, and as such it could be seen as contributing to the understanding of information-related activities in other contexts, social practices or for other professional groups.

In this study, the concept of task is used as the object of analysis connected to information in social practice. The results show that these two theoretical concepts provide an adequate basis for the study of information-related activities. This is particularly true when working with qualitative methods such as task diaries and focus groups. By studying the individual engineer’s actual task performance through task diaries and then linking these processes to broader thematic discussions in focus groups, a greater understanding of engineers’ information-related activities has been achieved. By identifying the staff members’ information-related activities, it was possible to produce an understanding of these processes from the participants’ perspective.

6.1 Information-related activities engaged in by engineers

As previous studies have shown, the results presented here show that engineers work in a complex environment and face a wide range of information-related activities. It is not possible to give a cohesive answer to the question concerning the central information-related activities engaged in by engineers due to the influence of situational and contextual attributes. The results of this study show that the central information-related activities engaged in by engineers differ depending on the type of work task as well as the work role they have in that specific work task.

The work tasks described in this study are all possible to discuss with the help of the model of the work task process developed by Byström and Hansen (2005). The way the engineers describe and discuss their work tasks show a clear resemblance to the model with a main work task that is constructed of subtasks which in turn include different
information-related activities. A work task has a beginning, i.e. the task construction which in this study is represented by such tasks as a customer claim or a new application of a specific material. Task performance is constructed by performing experiments, trials and collecting relevant information in order to answer the customer claim or perform experiments to decide whether the new application is to be developed into a new product. Task completion can be several things, for some work tasks the publishing of the technical report is the completion of the task, whereas for others it can be the construction of a new task.

All work tasks documented in this study show that engineers largely rely on information in the form of results from experiments, in the form of data or images. The amount of information needed can be quite high at the same time as the number of information sources used is low. If information is seen as a wider concept including information often used by engineers, the amount of information used increases. The number of sources used would also increase since often several images are used.

In the present study the task performers were asked to a priori estimate the complexity of the work task at hand and a posteriori categorise their work task according to the work task schema developed by Byström and Järvelin (1995). When analysing the complexity of the work tasks the results from this study could not corroborate the results from Byström and Järvelin (1995). The work tasks in this study indicate a relationship between task complexity and amount of information sources used. Within each of the task categories it was possible to identify subgroups of tasks which indicate that engineers relate differently to the concept of complexity when evaluating work task complexity. This study show that when a work task deviates from the normal work routine, it becomes more complex and give rise to an increased number of information-related activities. This is a clear indication that situational attributes affect the work task and the information-related activities. Hence, information-related activities performed by engineers are highly situated.46

Another possible explanation is that the concept of complexity might be interpreted in different ways. For an engineer that is not aware of the operational concept as e.g. within the faceted classification by Li and Belkin (2008) complexity may be closely linked to how they view the task based on their own previous experiences from similar tasks. In time, with increasing experience a task becomes less complex to perform. The concept of complexity is more intricate than it might seem at first glance. People understand complexity differently, but studies (e.g. Saastamoinen et al., 2012) have shown that that people react just about the same in the presence of increasing complexity.

To a priori estimate the complexity of a work task is difficult. As a task performer, you need to have profound knowledge of the work task process in order to make a relevant estimation. In a complex work environment, in which situational attributes affect the process, this has proven to be difficult. There is an overestimation of the complexity of the work task. Several of the work tasks performed by the engineers are of a lower complexity due to a quite simple work process. A categorisation of the work task performed by a researcher (cf. Byström & Järvelin, 1995) would have given a slightly

46 For further discussion of how information-related activities are situated see Chapter 6.3.
different picture. It has not been within the scope of this study to perform such an analysis. But in future studies this should be considered.

In this study the faceted classification of work task and search task developed by Li and Belkin (2008) has been used to describe all work tasks documented in the work task diaries. The description shows that the classification gives a relevant and comprehensive picture of the work tasks at hand. The faceted classification is a relevant complement to the model of the work task process since it gives a researcher or a manager an overview of how the work tasks are initiated, constructed, and performed but also an understanding of the outcome. It also offers an analytical framework allowing a researcher to compare work tasks in different contexts as well as between different studies.

These results and the fact that the present study has shown that the model of the work task process (cf. Byström & Hansen, 2005) is applicable to the descriptions of the work task show that the concept of work task still remains a useful concept in studies of information-related activities in a work context. Work task provide a good analysis tool for studying information-related activities in a work-related context. By focusing on work tasks, it is possible to document both what constitutes a task, document the work performance and the information needed to perform the task.

6.2 Engineers choice of information sources

Previous research has shown that engineers have a strong preference for information sources such as people and in-house technical reports (e.g. Barclay et al., 1994; Bartlett, Ishimura, & Kloda, 2010; Bronstein, 2010; Yitzhaki & Hammershlag, 2004). The result of this study is in good agreement with these findings, showing that colleagues and in-house technical reports are important sources for engineers. In addition, this study is able to show, through a widened information concept, that notes taken in connection to experiments and data from experiments are of particular importance in the completion of a work task. The information the engineers value are to a large degree task information (TI) and domain information (DI). People as sources are mostly used to decide what task and domain information is to be used. In-house colleagues/experts become an important source due to shortcomings in the in-house database systems.

Information used in a technical report varies depending on the work task at hand. If performing a normal information processing task, the engineers describe the information used as task-oriented; sometimes fact-oriented information is added. The higher the complexity in a work task, the more fact-oriented and general-purpose oriented information is used. There is also a strong preference for internal task information in the process of completing the work task of writing a technical report, regardless of the type of work task. This does not necessary mean that there is no preference or use of external or general purpose information.

The result of this study show that it is complicated to classify an information source as internal or external to an organisation, due to the changes in the availability of information through, among other things, improved technology. If a source is defined as internal due to where the information seeker retrieves the information (location) it means that commercial databases have to be defined as internal together with in-house technical reports or internal databases. When looking at people as sources this is even more evident. If a colleague is employed within the same corporation but working in another country, what makes that person an internal source more than a person...
employed at another corporation? With the increasing accessibility of information the ideal situation of what is an internal and external source becomes unattainable. The implication of this is that, as in this study, classifying sources depending on whether they are internal and external might become more or less arbitrary.

6.2.2 Characteristics of information

When asked what characteristics are important for information to be usable, the engineers in this study mostly discuss reliability and relevance which clearly are variables that concerns the quality of the information. When discussing what information is relevant when writing technical reports there is a strong focus on accessibility and especially on the source being in electronic form. The results show that the preference for information in electronic format has increased compared to earlier studies (e.g. Choo, 1994). Accessibility seems to be of such importance (cf. Gerstberger & Allen, 1968) that the engineers even decide to ignore certain information sources if they cannot be easily accessed. The fact that accessibility plays a crucial role for engineers when performing a work task does not mean that quality is something that is not valued in the choice of information sources. But when faced with a choice, accessibility may take precedence over quality.

One could easily conclude that what Gerstberger and Allen (1968) once presented is valid even today. Gerstberger and Allen (1968) suggested that engineers’ strong focus on the task at hand meant that accessibility was an important variable in the choice of information sources. I would like to argue that this is even more accentuated today. If accessibility, seen as the chance for the engineer to get hold of information (or a document) here and now, cannot be achieved, the information (or document) will not be used. However, the accessibility discussed by Gerstberger and Allen has a slightly different meaning today. Access to information is currently not dependent on physical distance, but more dependent on whether the organisation has subscriptions to various electronic resources. This implies that not only is accessibility a versatile concept as demonstrated by Fidel and Green (2004) but also a concept that over time changes meaning.

It is therefore important to reflect upon the meaning of accessibility (cf. Barclay et al., 1994; Hertzum, 2002). As both Barclay et al. (1994) and Hertzum (2002) have shown the concept of accessibility has different meanings, which is corroborated in this study. As has been argued by Bronstein (2010) the relationship between accessibility and quality is complex, and what is sometimes seen as accessible is often a question of quality. The results from the questionnaire indicate that accessibility not only stands for being available; it also means accessible in a qualitative way e.g. reliable, known source, accuracy, applicability, relevant, and trustworthy. In addition, the findings in this study shed new light on the relationship between these attributes. Accessibility could also be a question of what the engineers are normally using. This study shows that there is a high knowledge of both task topic and search topic, which indicate that the engineers know where to go to obtain the information they need.

The impact of accessibility and availability can also be seen in the sources most regularly used by the engineers. The information sources most regularly used are often in electronic format even if the source is available in a printed format. The only sources still preferred in a printed version are textbooks. These results indicate a relatively strong trend towards an increased use of electronic sources in comparison with the
results presented by e.g. Yitzhaki and Hammerslag (2004). In their study, the same kinds of information sources are preferred but unlike the results from the present study there is a higher use of printed sources.

6.2.2 Traceability – another side of accessibility
Another aspect of accessibility that the results of this study show is traceability. Traceability is when information concerning e.g. the background of a customer claim or information regarding a specific sample of a material is central to the performance. In such cases, traceability becomes a critical variable that affects efficiency, time and the use of resources. On several occasions, both during follow-up sessions and in focus group discussions, the participants describe the complicated structure of the internal databases and the lack of traceability when it comes to previous technical reports, prior experiments and the tracing of a specific sample in the different systems.

The result show that the issue of traceability is an important variable for the engineers, which in turn is a question of access to information. Several of the information sources that are perceived as more difficult to get hold of are internal information sources, sources which at the same time are seen by most of the engineers as most useful in their line of work. Several of the engineers also express dissatisfaction with the information resources available within the organisation, which are seen as far fewer than at various universities. The awareness of available information sources is of course an important variable as well, which is in line with the findings of Leckie et al. (1996). One example of awareness concerns the database Compendex which is a commercial database dedicated specifically to sources of high relevance to engineers. The database itself is not available within the R&D centre, which is seen as a problem by some of the participants. However, there seems to be a low awareness of the fact that the resources in this database also are covered by the database Scopus, which is available through the library. The difference is that the latter also includes other resources which are not specifically targeted towards engineers.

All this poses a challenge for the corporation to create improved access to various information sources that are relevant to the engineers’ work, particularly with regard to internal information. This should be seen as part of improved and more effective information and knowledge management.

6.3 Situated and contextualised information-related activities
Even though engineers have acquired skills to master the art of writing a technical report, the performance of information-related activities prove to be both situated and contextualised. The present study is in good agreement with previous findings on the impact of situational and contextual attributes on the information seeking process (cf. Mick et al., 1980). Situational attributes such as aspects of time, target group, type of work task, education, previous experiences and access to information affect the information-related activities performed by the engineers. The result from this study show that the appreciation of what constitutes a work task varies largely between individuals. Depending on the work role of the engineer, they seem to describe the task of writing a technical report differently. This is in compliance with the way Huvila (2008) discusses how work role could serve as an analytical tool when studying information-related activities connected to work tasks.
However, not everything is exclusively linked to the individual’s perception of what constitutes a work task. What constitutes a task is determined largely by the agreements and negotiations between the engineers and the organisation. These agreements are often expressed in different types of reifications (cf. Moring, 2009a) such as the Writing process within the R&D centre (Chapter 4.1.1). The available scope of action for an employee to self-define their work tasks is also limited by who has assigned the work task to the task performer. In the present study this is especially evident since most of the tasks are externally assigned. This is not to say that the practice is set in the reifications, though they aim at setting the ground rules for the practice. The reifications are, as the results of this study show, constantly being negotiated, created, and recreated in the work task process. (cf. Moring, 2009a, 2009b). The art of writing a technical report has its roots in the academic environment, which is a context with many “reifications” regarding what is seen as relevant and accepted information as well as how to compose an acceptable text.

If practices in the educational context are the norm when writing a technical report in the work context, it is surprising to see that there seems to be a built-in tolerance for a low scientific level in these reports. On the one hand, there is a template which allows for a unanimous structure of technical reports at the R&D centre. On the other hand, there seems to be a lack of agreement on what is seen as relevant information and acceptable information sources, i.e. the central information-related activities are not agreed upon. A challenge for the organisation is how to signal which information-related activities are valued (cf. Cox, 2012a, 2012b). These results indicate that the prevailing practice is weak. Hence, the reifications that are present at the R&D centre seem not to take prevalence over the social practices from the educational context. The similarities between the academic and the industrial practice, in regard to structure of a technical report, are striking and this makes it as Cox (2012a, p. 183) puts it, difficult to decide where one practice ends and another starts.

The engineers participating in this study put a strong emphasis on the comprehension of technical documentation that is part of the educational (academic) context and express a belief that it is possible to transfer the practical knowledge of how to write a technical report between these contexts. Such an assumption seems quite reasonable, since it can be assumed that the R&D centre could resemble the academic workplace; both are textual information environments. The result indicate that there is a gap between the idealistic image of information-related activities in the educational context and the work context and the idea that they are and can be performed in the same way. The argument that people being trained as engineers are part of the practice of technical documentation stands in contrast to the fact that engineers express the idea that newcomers need training and a certain period of time to learn the work practice. The results of this study show that knowledge of how to structure a technical report is indeed possible to transfer from one practice to another. On the other hand, the results indicate that the information-related activities connected to the task of writing a technical report are not transferable. The reason seems to be found in the teleoaffective structures (cf. Cox, 2012a; Lloyd, 2010b; Schatzki, 2001) of the two practices. The ends and means are different, which is also expressed by several of the engineers. Even the ambitions of the engineers are different in the different practices.

Therefore, what is relevant information and how to use it becomes blurred and the conceivable similarities between the academic and the industrial practice cease. There is also a question of whether it is possible to or even desirable to uphold this image of a
practice of technical documentation applicable in both the educational and the work context. Different work roles and situational attributes seem to affect the way it is possible to write a technical report that has the scientific standard that seems to be the norm. Whether the report is intended for a customer or for internal use only affects the content and information used. The work role of the engineer as a scientist or as an executor of an experiment affects what is seen as relevant information and how that information is processed and reported.

The way a newcomer learns is not formalised; instead he or she learns the practice of the workplace by using his or her current information skills and with time adopting to new ways of performing information-related activities and becoming information literate in the workplace. Time plays a crucial role in this. The longer an engineer has been working within the organisation the more he or she has learned about the practice of writing a technical report. This corresponds to the cyclic process of information seeking that Savolainen (2012) discussed. What you have done or what you learnt affects the way you perform the task the next time. When such processes lead to perceived success, it has a positive impact; when the information seeking task is perceived as not successful this could mean that an information source is neglected the next time. This reasoning is consistent with the findings in this study, in that the deficiencies in the internal databases, experienced by the engineers, leads to lower use. This means that valuable information and knowledge is not used effectively, which may lead to tasks already performed being repeated.

When using information, e.g. interpretations of results from experiments in the form of data or images, there seems to be some kind of embodied (corporeal) knowledge (cf. Lloyd, 2007) that certain people possess and which makes them cognitive authorities to others (cf. P. Wilson, 1983); as such these people become important information sources or even gatekeepers of information. This embodied knowledge is achieved through experience of interpreting images and results from experiments of the materials the corporation is working with. This kind of knowledge is acquired by the engineer over time and is highly valued in this particular context. Understanding and being able to interpret such information is vital in order to determine the causes of e.g. a complaint. There seem to be some sort of taking for granted when it comes to people with this type of knowledge and proficiencies. The engineers consider them as an existing source without considering the fact that this knowledge, if not transferred, can be lost. It is by observing the sayings and doings of the practice that other engineers can acquire this knowledge and become part of the practice themselves. It seems to be an important task for the corporation to explore what information is relevant, how it should be sought, used, created and shared, and through that define the boundaries for a social practice that contributes to a sound knowledge management for the future.

### 6.4 Future studies

The present study has collected a comprehensive material which is only partially given justice in this thesis. It would be interesting to further analyse the material to see if more far-reaching conclusions could be drawn about engineers’ information-related activities. One line of inquiry could be to analyse the differences between the sources that the engineers a priori described, the sources consulted during the work task performance and the actual sources used in the technical report.
Another interesting line of inquiry would be to address the role of social mobility between different work environments. By doing this it would be possible to compare people with similar work roles but different educational backgrounds and whether this affects the information-related activities performed. Some aspects of differences between different educational backgrounds could possibly be analysed in the material from this study.

A third line of inquiry would be to analyse how different engineers change their use of information and choice of sources over time. This could be addressed by analysing the technical reports written by engineers over a longer period of time. This would be possible to perform within a corporation such as Sandvik which has a long history of technical documentation in their archive. By performing such an analysis, it could be possible to depict something concerning if and how the information-related activities change over time. One way would be to follow a newly employed engineer to see if, and if so how, his or her information-related activities and technical reports change over time. Another way could be to track the technical reports written by an engineer that has been employed for several years back in time to see what has changed concerning the way technical reports are written and the information-related activities. Such an approach could also allow for an analysis of the impact or work role, according to Huvila (2008).
Summary

Studies on information seeking have rendered a long lasting interest within library and information science. The last decades brought major changes in information technology, the amount of information available to the user as well as in the information seeking process which stresses the topicality of studies on information seeking in general but especially for further studies in information-related activities performed by professionals. This should be seen as part of creating a sound base for information and knowledge management. This study addresses one of these sides, namely the information-related activities in which engineers engage when performing a work task: what information they value and seek and what sources they use and for what reasons, from a collective perspective. The study is performed at the research and development centre within Sandvik Materials Technology AB.

The aim of this study is to identify and achieve an understanding of the information-related activities performed by engineers during work task performance in a work context. In order to achieve the aim of the study the following questions were addressed: (1) What is the central information-related activities in which engineers engage when writing technical reports, and why are they considered central? (2) How can information used by an engineer writing a technical report be characterised i.e. how do they value/describe the information they use? (3) In what ways do the information-related activities differ between engineers writing technical reports depending on work task? (4) In what ways are the information-related activities performed by engineers situated and contextualised?

The thesis begins with a background and problem statement, where the aim of the present study is situated within a larger context. It provides a background to the changing information landscape and how this affects the information availability as well as how we seek and use information. Further, an introduction to the information seeking process and work task performance are included, leading to a discussion around a broadened information concept, i.e. information-related activities. The background show that studies of information seeking and use are still relevant and that the changing information landscape requires new approaches to old questions as well as that new questions need to be addressed.

In the literature review previous research related to information seeking and especially information-related activities in which engineers engage are presented. The studies are presented in two focus areas: research studies related to the process of seeking information and research studies with a focus on information-related activities performed by engineers.

The theory chapter presents the theoretical perspectives that are used to interpret and discuss the results. The theoretical framework is based on theories on information practices and information in social practice. The concept of information practice used by Lloyd (2007, 2010b) and the concept of information in social practice introduced by Cox (2012a, 2012b) act as a methodological approach insomuch that it provides a framework for how the object of study are considered. The model of the work task process used by Bystrom and Hansen (2005) and the model of the information seeking process connected to work tasks used by Bystrom and Järvelin (1995) are introduced. These models function as the theoretical concepts which are used in the interpretation and organization of the empirical data.
The method chapter presents the methods used to collect and analyse data: a work task diary, a semi-structured questionnaire and focus groups. The chapter also holds an introduction to the setting and the participants. All data collection instruments are presented: the construction of the instruments, the data collection procedure and how the data have been analysed. The work task diaries were analysed using the information seeking model, the results are presented in thinking and process tables. All focus groups were transcribed and then analysed based on the following themes: (1) the process of writing a technical report, (2) expected and relevant information/content in a technical report, (3) situational attributes affecting the work of writing a technical report, and (4) types of technical reports. This chapter also contains a discussion of the credibility and quality of the study.

This study has used method triangulation in order to allow for analysis of the investigated subject from different angles. This has implications for how the result is presented. The result chapter is thus organised around four themes derived from the study’s purpose and research questions: work tasks, the work task process, situational and contextual attributes and lastly information use. Within these four themes, results from the work task diary, the semi-structured questionnaire and the focus groups are used interchangeably to illustrate the work task process and its place in the organisational context to obtain an understanding of the information-related activities engaged in by engineers.

The study provides an up-dated understanding of information-related activities performed by engineers in a work context in the new emerging information landscape. Previous results regarding engineers’ information-related activities are corroborated; the results show that engineers rely on in-house information sources. The result also indicate that the changing information landscape affects engineers’ information seeking; the increasing information and information sources available have e.g. changed the way engineers interpret accessibility. The information practice of writing a technical report is governed by existing reifications; at the same time these are constantly negotiated through social practices. The study also presents methodological and theoretical implications by confirming the applicability of the models and concepts used as a theoretical framework. The concept of work task, combined with theories on information practice and information in social practice, is shown to be a sound base for the analysis of information-related activities in a professional environment.
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Appendix 1 Invitation letter

We are interested in information seeking and use connected to technical reports

I am a student in Borås at the Swedish School of Library and Information Science and pursuing research towards my Master’s degree under the supervision of senior lecturer Katriina Byström.

My research is concerned with information-related activities connected to work tasks in a corporate setting. Understanding information-related activities such as information needed, seeking and use are of importance for a corporation in order to facilitate the accessibility to relevant information at the right time and place.

The study focuses on the practices of finding out what information is used and how it is acquired in order to contribute to the information and knowledge management within the company. Your knowledge of your work tasks will help in answering my research questions and the possibility to develop an understanding of the information-related processes connected to the work task of writing a technical report.

The study is conducted at the R&D centre within Sandvik materials technology.

Your participation will consist of completing one work task diary that focuses on information acquisition and usage during the writing of a technical report. The expected time commitment for the first phase depends on the nature of the technical report. This part of the study will be arranged in agreement with you and the investigator so that it does not amount to an unreasonable time. After the completion of the diary/diaries I might return to ask you some follow-up questions which in time would amount to no more than one hour. You will also be asked to participate in a focus group where information-related activities relevant for technical reports will be discussed. The expected time commitment for participation in the focus group is 2 hours. You will be able to participate within your normal working hours.

I, therefore, request you to help me in my academic endeavor by participating in the study.

It is my belief that the results of this study will be interesting for many and enhance the development of information and knowledge management within the company. I therefore hope that you will be willing to participate. If you are interested in participating please send an email at the latest on 19 December to s110633@student.hb.se.

Looking forward for your cooperation,

Malin Almstedt Jansson  
Master student  
Katriina Byström  
Senior lecturer  
Pasi Kangas  
Head of R&D-center  
Inga-Lill Bremer  
Head of SandLib
Appendix 2 Introduction letter to work task diary

Dear Participant,

You are participating in a research study that aims to identify and understand information-related activities by studying the information behaviour of engineers during task performance in a work context. You were selected as a participant in this study because you are engaged in work tasks that are seen as part of information and knowledge management, namely writing technical reports.

Your participation consists of you filling out two work task diaries, i.e. you are asked to record you information-related activities during two specific work task performances chosen by you. If possible choose one typical and one untypical work task (technical reports) within the bounds of your corporate responsibility. The expected time commitment during the first phase depends on the nature of the work tasks i.e. the technical reports, but the factual time to fill out the task diary is not likely to extend 45 minutes. I would like you to plan to complete the diaries at the latest on 28 March 2013.

All questions are formulated in English. Your answer can be formulated in Swedish or English depending on what you find most convenient. Please fill in the different parts in correct order. Contact me as soon as you have finished filling out each work task diary, and I will personally collect them from you.

After you have completed your work task diaries I might contact you for some follow-up questions. This follow-up session is expected to take up to no more than one hour.

Your participation is voluntary and you may withdraw at any time without prejudice if you choose to continue participation in this study. Any information that is obtained in connection with this study and that can be identified with you will remain confidential and will not be enclosed in the results. Your answers will be anonymous and may only be accessed by the researcher, the supervisor or the university examiner.

When I have received all work task diaries I will process the collected data and you will be invited to the focus group.

You are welcome to contact me if you have any questions regarding the study or the work task diary at 070-526 24 96 or s110633@student.hb.se.

Thank you for your participation!

Malin Almstedt Jansson
Master’s student
Appendix 3 Informed consent letter – work task diary participants

Background

You are invited to participate in a research study. Before you decide to participate in this study it is important that you understand why the research is being done and what it will involve. Please take the time to read the following information carefully. Please ask the researcher if there is anything that is not clear or if you need more information.

Study procedure

The purpose of this study is to analyse the information-related activities (needs, seeking & use) connected to different work tasks in a corporate setting. You were selected as a possible participant in this study because you are engaged in writing technical reports as part of information and knowledge management within the engineering group.

If you decide to participate, the first phase consists of you filling out a two work task diaries, i.e. you are asked to record you information-related activities during a specific task performance, in this case writing a technical report. The expected time commitment for the first phase depends on the nature of the technical report, but the factual time to fill out the work task diary is not likely to extend 30 minutes. I might contact you to ask of you to answer some follow-up questions. This follow-up session is expected to take up to no more than one hour.

During the second phase of the study I will ask you, together with other participants, to take part in a focus group. During this session I will present some overriding results from the first phase and present the group with a theme to discuss. The focus group aims to give a deeper understanding of information seeking processes connected to writing technical reports. During the focus group your expected time commitment is 2 hours. Prior to the focus group you will be asked to fill in a questionnaire concerning background information and information behaviour in general. The expected factual time for filling in the questionnaire is not likely to extend 30 minutes.

Part of the data collection (focus group) will be audio-recorded in order to facilitate the analysis. These recordings will be transcribed and thereafter be erased.

If you decide to participate, you have the consent to do so during your regular working hours.

Risks

The risks of this study are minimal. These risks are similar to those you experience when disclosing work-related information to others. You may decline to answer any or all questions and you may terminate your involvement at any time if you choose.

Your decision whether to participate will not prejudice your future relationships with the corporate or the corporate library. If you decide to participate, you are free to discontinue participation at any time without prejudice.

There may be risks that are not anticipated. However every effort will be made to minimize any risks.

Voluntary participation

You are making a decision whether or not to participate. If you decide to participate you will be asked to sign a consent form. You may withdraw at any time without prejudice after signing the form should you choose to discontinue participation in this study. You are free to not answer any question or questions if you choose. This will not affect the relationship with the researcher.
Benefits & Costs

There will be no direct benefit to you for your participation in this study. However, we hope that the information obtained from this study may contribute to improving information and knowledge management within the engineering group.

There are no costs to you for your participation in this study.

Confidentiality

Any information that is obtained in connection with this study and that can be identified with you will remain confidential and will not be enclosed. Your answers will be anonymous. Every effort will be made by the researcher to preserve your confidentiality including the following:

- Assigning code names/numbers for participants that will be used on all researchers’ notes and documents.
- Notes, focus group discussion transcriptions, and transcribed notes and any other identifying participant information will be kept in a locked filed cabinet in the personal possession of the researcher. When no longer necessary for research, all materials will be destroyed.
- The researcher and the examination committee will review the researcher’s collected data.
- Information from this research will be used solely for the purpose of this study and any publications that may result from this study. Any final publication will maintain the anonymity of all participants involved in this study.
- Each participant has the opportunity to obtain a transcribed copy of the focus group discussions. Participants should tell the researcher if a copy of the interview is desired.

Contact

Please feel free to ask questions regarding this study or your rights. You may contact me later if you have any additional questions at 070-526 24 96 or s110633@student.hb.se.

You will be offered a copy of this form to keep.

Consent

By signing this consent form, I confirm that I have read and understood the information and have had the opportunity to ask questions. I understand that my participation is voluntary and that I am free to withdraw at any time, without giving a reason and without cost. I understand that I will be given a copy of this consent form. I voluntarily agree to take part in this study.

Signature of participant   Date

Signature of researcher   Date
Appendix 4 Work task diary
Part 1 Assessment of initial situation

1. Describe in detail your work task (background, purpose, estimated task progression i.e. the technical report that you are about to write.

2. How often do you prepare work tasks like this?

3. Is this particular work task a typical and an untypical example within the bounds of your corporate responsibility? Explain.

4. Estimate your level of expertise in this case. Would you say that everything in the work task is totally new (1) to you or that everything is completely familiar (9) to you or anything in between?

5. Describe the situational factors that you think might affect your upcoming work task performance.

6. Describe in detail what kind of information and what sources you think you need in order to perform the task (mention all you consider to use even the ones you may not use)?

7. Estimate how well you can describe the progress of your task at the beginning; Would you say that you (a) don’t even know how to begin or (b) can describe the whole progress in detail. Please shade in – from left to right – the further the better you believe you are able to describe the task progress in detail.

8. In your opinion, how complex seems the work task to be (ranging from simple to impossible)? Please shade up to an appropriate level!
Part 2 Work task diary

Record **Date/time** by giving the dates you were working on the diary and the estimated time spent e.g. 30 minutes.

Record **Source** by describing the sources which you consulted; what type of source it is i.e. documents, databases, literature, electronic or printed, and even your colleagues or your own, previously made notes, as well as others.

Record **Why chosen** by describing in detail the reasons for choosing that specific source.

Record **What information** by describing in detail what kind of information you are searching for.

Record **Success** by grading if you got the information you needed to fulfil the work task with (1) wholly, (2) partly, (3) not at all.

Record **Applicability** by grading the information gathered as (1) well-applicable, (2) partially applicable, or (3) not applicable at all, to the work task at hand.

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<thead>
<tr>
<th>Date/time</th>
<th>Source</th>
<th>Why chosen</th>
<th>What information</th>
<th>Success</th>
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Part 3 Evaluation

1. If you think back of the entire information seeking process during work task performance how would you characterise the value of the information that you gathered?

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<tr>
<th>Strongly disagree</th>
<th>1</th>
<th>2</th>
<th>3</th>
<th>4</th>
<th>5</th>
<th>Strongly agree</th>
<th>Not applicable</th>
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<tr>
<td>The information I gathered refreshed my memory of details and facts</td>
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<td>The information I gathered helped me complete the work task</td>
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<td>The information I gathered helped structure the work task at hand</td>
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<td>It made me confident about the issue at hand or recommendation</td>
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<td>I was aware of all information needed to complete this work task</td>
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<td>All information gathered was relevant</td>
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<td>It substantiated what I already knew or suspected</td>
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<td>I got hold of all information timely</td>
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<td>I had several sources to use</td>
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<td>Every piece of information gathered were used in the report</td>
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</table>

2. How much time did you spend on completing the work task as a whole?

3. How much of the total amount of time spent on the work task was designated to information seeking and gathering?

4. Describe in detail the situational factors that you consider to actually have affected task performance.

5. Any other reflections that you would like to share about the work task at hand? You are also welcome to reflect upon your participation in the study, and more specifically filling out the work task diary.
Appendix 5 Invitation to focus group

Dear Xxxx,

I am a student in Borås at the Swedish School of Library and Information Science and pursuing research towards my Master’s degree under the supervision of senior lecturer Katriina Byström. I am interested in information seeking and use connected to technical reports.

The study focuses on the practices of finding out what information is used and how it is acquired in order to contribute to the information and knowledge management within the company. Your knowledge of your work tasks will help in answering my research questions and the possibility to develop an understanding of the information-related practices connected to the work task of writing a technical report. Your name has been suggested to me by a colleague whom is already participating in the study.

Your participation will consist of completing a survey that focuses on your normal pattern of getting hold of information when performing a work task. The expected time commitment for the filling out the survey is expected to be no more than 15 minutes. After the completion of the survey you will participate in a focus group where information-related activities relevant for work tasks and especially writing technical reports will be discussed among you and some of your colleagues. The expected time commitment for participation in the focus group is one hour. You will be able to participate within your normal working hours. The focus group is expected to take place in the beginning of May.

I, therefore, request you to help me in my academic endeavour by participating in the study.

It is my belief that the results of this study will be interesting for many and enhance the development of information and knowledge management within the company. I therefore hope that you will be willing to participate. If you are interested in participating please send an email at the latest on 23 April to s110633@student.hb.se.

Looking forward for your cooperation,

Malin Almstedt Jansson

Master student
Appendix 6 Introduction letter to focus group participants

Dear Participant,

You are participating in a research study that aims to identify and understand information-related activities by studying the information behaviour of engineers during task performance in a work context. You were selected as a participant in this study because you are engaged in work tasks that are seen as part of information and knowledge management, namely writing technical reports.

Your participation will consist of completing a survey that focuses on your normal pattern of getting hold of information when performing a work task. The expected time commitment for the filling out the survey is expected to be no more than 15 minutes. After the completion of the survey you will participate in a focus group where information-related activities relevant for work tasks and especially writing technical reports will be discussed among you and some of your colleagues. The expected time commitment for participation in the focus group is one hour. You will be able to participate within your normal working hours. The focus group is expected to take place in the beginning of May. I would like you to complete the survey before participating in the focus group.

All survey questions are formulated in English. Your answer can be formulated in Swedish or English depending on what you find most convenient. You can deliver the survey on the day of your participation in the focus group.

Your participation is voluntary and you may withdraw at any time without prejudice if you choose to continue participation in this study. Any information that is obtained in connection with this study and that can be identified with you will remain confidential and will not be enclosed in the results. Your answers will be anonymous and may only be accessed by the researcher, the supervisor or the university examiner.

You are welcome to contact me if you have any questions regarding the study or the work task diary at 070-526 24 96 or s110633@student.hb.se.

Thank you for your participation!

Malin Almstedt Jansson
Master’s student
Appendix 7 Informed consent letter – focus group participants

Background

You are invited to participate in a research study. Before you decide to participate in this study it is important that you understand why the research is being done and what it will involve. Please take the time to read the following information carefully. Please ask the researcher if there is anything that is not clear or if you need more information.

Study procedure

The purpose of this study is to analyse the information-related activities (needs, seeking & use) connected to different work tasks in a corporate setting. You were selected as a possible participant in this study because you are engaged in writing technical reports as part of information and knowledge management within the engineering group.

If you decide to participate your participation will consist of taking part in a focus group, which is the second phase in this study. During the focus group I will present some overriding results from the first phase and present the group with a theme to discuss. The focus group aims to give a deeper understanding of information seeking processes connected to writing technical reports. Your expected time commitment during the focus group is one hour. Prior to the focus group you will be asked to fill in a survey concerning background information and information behaviour in general. The expected factual time for filling in the questionnaire is not likely to extend 15 minutes.

Part of the data collection (focus group) will be audio-recorded in order to facilitate the analysis. These recordings will be transcribed and thereafter be erased.

If you decide to participate, you have the consent to do so during your regular working hours.

Risks

The risks of this study are minimal. These risks are similar to those you experience when disclosing work-related information to others. You may decline to answer any or all questions and you may terminate your involvement at any time if you choose.

Your decision whether to participate will not prejudice your future relationships with the corporate or the corporate library. If you decide to participate, you are free to discontinue participation at any time without prejudice.

There may be risks that are not anticipated. However every effort will be made to minimize any risks.

Voluntary participation

You are making a decision whether or not to participate. If you decide to participate you will be asked to sign a consent form. You may withdraw at any time without prejudice after signing the form should you choose to discontinue participation in this study. You are free to not answer any question or questions if you choose. This will not affect the relationship with the researcher.

Benefits & Costs

There will be no direct benefit to you for your participation in this study. However, we hope that the information obtained from this study may contribute to improving information and knowledge management within the engineering group.
There are no costs to you for your participation in this study.

Confidentiality

Any information that is obtained in connection with this study and that can be identified with you will remain confidential and will not be enclosed. Your answers will be anonymous. Every effort will be made by the researcher to preserve your confidentiality including the following:

- Assigning code names/numbers for participants that will be used on all researchers’ notes and documents.
- Notes, focus group discussion transcriptions, and transcribed notes and any other identifying participant information will be kept in a locked file cabinet in the personal possession of the researcher. When no longer necessary for research, all materials will be destroyed.
- The researcher and the examination committee will review the researcher’s collected data.
- Information from this research will be used solely for the purpose of this study and any publications that may result from this study. Any final publication will maintain the anonymity of all participants involved in this study.
- Each participant has the opportunity to obtain a transcribed copy of the focus group discussions. Participants should tell the researcher if a copy of the interview is desired.

Contact

Please feel free to ask questions regarding this study or your rights. You may contact me later if you have any additional questions at 070-526 24 96 or s110633@student.hb.se.

You will be offered a copy of this form to keep.

Consent

By signing this consent form, I confirm that I have read and understood the information and have had the opportunity to ask questions. I understand that my participation is voluntary and that I am free to withdraw at any time, without giving a reason and without cost. I understand that I will be given a copy of this consent form. I voluntarily agree to take part in this study.

_________________________  _________________________
Signature of participant     Date

_________________________  _________________________
Signature of researcher      Date
Appendix 8 Questionnaire
Part 1 Background & work-related information

1. What is your official title?

2. What is your highest vocational or educational qualification?

3. How long have you worked for the organisation (Sandvik AB)?

4. What is your area of responsibility?

5. How long have you been working in your present position?

6. How large part of your job assignment constitutes of writing technical reports?
   ( ) all of it
   ( ) nearly all of it
   ( ) about one half of it
   ( ) a small part of it
   ( ) gets in my way only very seldom

7. How frequently in the last 12 months have you had an urgent need for information?
   ( ) once a week or more often
   ( ) at least once a month, but not weekly
   ( ) at least once during the last 12 months, but not monthly
   ( ) not at all during the last 12 months

Part 2 General questions regarding regular information behaviour

8. In what form are information most important for you when performing your work tasks – printed, oral (conversational) or electronic format? Rank them in order of importance – where 1 is the most important and 3 the least important.
   ______ Printed
   ______ Oral
   ______ Electronic
   ______ Other ____________________________

Comments:
9. What characteristics does information need to have in order to be used in your work task performance?

10. Record three persons whom you most regularly contact to acquire information. Write down their official titles and the department where they work. If you cannot decide the rank on a scale where 1 is most regularly used, write the names down on the same row. Please spell out possible acronyms.

1. 
2. 
3. 

Comments:

11. Record three sources of written information that you use most regularly. Write down whether they are in electronic or in paper form. If you cannot decide the rank on a scale where 1 is most regularly used, write the sources on the same row. Please spell out possible acronyms.

1. 
2. 
3. 

Comments:

12. What kind of information is most difficult to get hold of?

13. What kind of information is most useful within your job assignment?

14. What kind of information is least useful within your job assignment?

16. How frequently in the last 12 months have you contacted (by visit, mail, fax, telephone or other) the corporate library or had someone else make the contact on your behalf?

( ) once a week or more often
( ) at least once a month, but not weekly
( ) at least once during the last 12 months, but not monthly
( ) not at all during the last 12 months

Thank you for answering the survey!
15. Thinking of your normal pattern of getting hold of information during work task performance, where would you usually go to obtain information? Indicate your usage by “(fairly) often” “sometimes” or “(almost) never” whatever alternative describes your actual usage best. If possible, please give a few examples of the sources you use.

<table>
<thead>
<tr>
<th>Source</th>
<th>Fairly often</th>
<th>Often</th>
<th>Sometimes</th>
<th>Almost never</th>
<th>Never</th>
<th>Example/s</th>
</tr>
</thead>
<tbody>
<tr>
<td>Bibliographic databases (electronic)</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Bibliographic databases (printed)</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Conference/meeting papers (electronic)</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Conference/meeting papers (printed)</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Discussions with colleagues/experts in the organization (electronic)</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Discussions with colleagues/experts in the organization (oral)</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Discussions with experts outside your organisation (electronic)</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Discussions with experts outside your organisation (oral)</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Government technical reports (electronic)</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Government technical reports (printed)</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Handbook and standards (printed)</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Handbooks and standards (electronic)</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>In-house technical reports (printed)</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>In-house technical reports (electronic)</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Librarians and information specialists (electronic)</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Librarians and information specialists (oral)</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Professional journals (electronic)</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
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<tr>
<td>Professional journals (printed)</td>
<td></td>
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<td></td>
<td></td>
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<tr>
<td>Textbooks (electronic)</td>
<td></td>
<td></td>
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<td></td>
<td></td>
</tr>
<tr>
<td>Textbooks (printed)</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Trade/promotional literature (electronic)</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Trade/promotional literature (printed)</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Other</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
</tbody>
</table>
Appendix 9 Date & time registration
Clarifying note concerning date and time in the work task diary

a. If you already have started to note the time that you spend on working with the task diary you can continue doing so, be sure to be consequent on what you are registering in the work task diary.
b. If you have not started to note time in the work task diary you can consider the following:
   a. Note the occasions you are working on the technical report even those when you are not searching for information i.e. when you only are writing and editing in your report.
   b. If you are working on the technical report in e.g. 2 hours and only occasionally consult your notes, you register the 2 hours that you have been working on the technical report.
   c. If you e.g. work for 2 hours writing your technical report and during that time you consult another report or information resource for about 15 minutes, you make a note of 2 hours. You are not required to estimate the time for information searching in the work task diary.
## Appendix 10 Faceted classification of task

Table 9 A faceted classification of task adopted form Li and Belkin (2008, p. 1834)

<table>
<thead>
<tr>
<th>Facets</th>
<th>Sub-facets</th>
<th>Values</th>
<th>Operational definitions</th>
</tr>
</thead>
<tbody>
<tr>
<td>Generic facet of task</td>
<td>Source of task</td>
<td>Internal generated</td>
<td>A task motivated by a task doer. It is a self-motivated task</td>
</tr>
<tr>
<td></td>
<td></td>
<td>Collaboration</td>
<td>A task motivated through discussion of a group of people</td>
</tr>
<tr>
<td></td>
<td></td>
<td>External assigned</td>
<td>A task assigned by task setters based on their individual purpose</td>
</tr>
<tr>
<td>Task doer</td>
<td></td>
<td>Individual</td>
<td>A task conducted by one task doer</td>
</tr>
<tr>
<td></td>
<td></td>
<td>Individual in a group</td>
<td>A task assigned and completed by different group members separately, though they are in a group</td>
</tr>
<tr>
<td></td>
<td></td>
<td>Group</td>
<td>A task conducted by a group of people (at least two people)</td>
</tr>
<tr>
<td>Time</td>
<td>Frequency</td>
<td>Unique</td>
<td>A task conducted at the first time</td>
</tr>
<tr>
<td></td>
<td></td>
<td>Intermittent</td>
<td>A task conducted more than one time, but assessed by a task doer as not frequently conducted</td>
</tr>
<tr>
<td></td>
<td></td>
<td>Routine</td>
<td>A task assessed by a task doer as frequently conducted</td>
</tr>
<tr>
<td></td>
<td>Length</td>
<td>Short-term</td>
<td>A task which could be finished within a short time period (e.g. less than one month)</td>
</tr>
<tr>
<td></td>
<td></td>
<td>Long-term</td>
<td>A task which has to be finished within a longer time period (e.g. more than one month)</td>
</tr>
<tr>
<td></td>
<td>Stage</td>
<td>Beginning</td>
<td>A task which just launched</td>
</tr>
<tr>
<td></td>
<td></td>
<td>Middle</td>
<td>A task which has been running for a while and in the middle way</td>
</tr>
<tr>
<td></td>
<td></td>
<td>Final</td>
<td>A task which is almost done or has been completed</td>
</tr>
<tr>
<td>Product</td>
<td>Physical</td>
<td>(for WT)</td>
<td>A task which produces a physical product</td>
</tr>
<tr>
<td></td>
<td>Intellectual (for WT and ST)</td>
<td></td>
<td>A task which produces new ideas, or findings</td>
</tr>
<tr>
<td></td>
<td>Decision/Solution (for WT)</td>
<td></td>
<td>A task which involves decision making or problem solving</td>
</tr>
<tr>
<td></td>
<td>Factual information (for ST)</td>
<td></td>
<td>A task locating facts, data, or other similar information items in information systems</td>
</tr>
<tr>
<td></td>
<td>Image (for ST)</td>
<td></td>
<td>A task locating images in information systems</td>
</tr>
<tr>
<td></td>
<td>Mix product (for ST)</td>
<td></td>
<td>A task locating different types of information items in information systems</td>
</tr>
<tr>
<td>Process</td>
<td>One-time task</td>
<td></td>
<td>A task accomplished through one process without repeated procedures</td>
</tr>
<tr>
<td></td>
<td>Multi-time task</td>
<td></td>
<td>A task accomplished through repeatedly engaging in the same or similar process</td>
</tr>
<tr>
<td>Goal</td>
<td>Specific goal</td>
<td></td>
<td>A task with explicit or concrete goals</td>
</tr>
<tr>
<td></td>
<td>Amorphous goal</td>
<td></td>
<td>A task with abstract goals</td>
</tr>
<tr>
<td></td>
<td>Mixed goal</td>
<td></td>
<td>A task with both concrete and abstract goals</td>
</tr>
<tr>
<td>Quantity</td>
<td>Multi-goal</td>
<td></td>
<td>A task with two or more goals</td>
</tr>
<tr>
<td></td>
<td>Single-goal</td>
<td></td>
<td>A task with only one goal</td>
</tr>
<tr>
<td>Common attributes of task</td>
<td>Task characteristics</td>
<td>Objective task complexity</td>
<td>High complexity</td>
</tr>
<tr>
<td>--------------------------</td>
<td>----------------------</td>
<td>---------------------------</td>
<td>-----------------</td>
</tr>
<tr>
<td></td>
<td></td>
<td>Moderate</td>
<td>A task which may involve a few paths, but not significantly more during engaging in the task</td>
</tr>
<tr>
<td></td>
<td></td>
<td>Low complexity</td>
<td>A task which involves a single path during engaging in the task</td>
</tr>
<tr>
<td>Interdependence</td>
<td></td>
<td>High interdependence</td>
<td>A task conducted through collaboration of a group of people (at least two people)</td>
</tr>
<tr>
<td></td>
<td></td>
<td>Moderate</td>
<td>A task conducted by one task doer with suggestions or help from other people or group members</td>
</tr>
<tr>
<td></td>
<td></td>
<td>Low interdependence</td>
<td>A task conducted by one task doer without any help from other people</td>
</tr>
<tr>
<td>User’s perception of task</td>
<td>Salience of a task</td>
<td>High salience</td>
<td>A task assessed by the task doer as highly important</td>
</tr>
<tr>
<td></td>
<td></td>
<td>Moderate</td>
<td>A task assessed by a task doer as moderate importance or the degree of salience of the task depends on specific situations</td>
</tr>
<tr>
<td></td>
<td></td>
<td>Low salience</td>
<td>A task assessed by the task doer as unimportant</td>
</tr>
<tr>
<td>Urgency</td>
<td>Immediate (urgent)</td>
<td>A task assessed by a task doer as highly urgent</td>
<td></td>
</tr>
<tr>
<td></td>
<td></td>
<td>Moderate</td>
<td>A task assessed by the task doer as moderately urgent or the degree of urgency of the task depends on specific situations</td>
</tr>
<tr>
<td></td>
<td></td>
<td>Delayed (not urgent)</td>
<td>A task assessed by the task doer as no urgency</td>
</tr>
<tr>
<td>Difficulty</td>
<td>High difficulty</td>
<td>A task assessed by a task doer as high difficulty</td>
<td></td>
</tr>
<tr>
<td></td>
<td></td>
<td>Moderate</td>
<td>A task assessed by a task doer as moderate difficulty or the degree of difficulty of the task depends on specific situations</td>
</tr>
<tr>
<td></td>
<td></td>
<td>Low difficulty</td>
<td>A task assessed by a task doer as no difficulty or easy to complete</td>
</tr>
<tr>
<td>Subjective task complexity</td>
<td>High complexity</td>
<td>A task assessed by a task doer as highly complex</td>
<td></td>
</tr>
<tr>
<td></td>
<td></td>
<td>Moderate</td>
<td>A task assessed by a task doer as moderately complex or the degree of complexity of the task depends on specific situations</td>
</tr>
<tr>
<td></td>
<td></td>
<td>Low complexity</td>
<td>A task assessed by a task doer as simple</td>
</tr>
</tbody>
</table>

Note: WT = Work task; ST = Search task
Appendix 11 Moderators guide

1. Introduction

This study aims to identify and create an understanding of information-related activities among engineers. The focus of this study has been the work task process surrounding technical reports as a work task and information-related activities connected to those. It is also a purpose to try to understand what kind of work roles that gives rise to different information-related activities. To create an understanding of the existing information practices, i.e. how the work is to be performed.

In this study information seeking among a number of engineers writing technical reports have been documented through task diaries. In order to achieve a deeper understanding of these results and the existing information practices these themes will be discussed in focus groups. The results from all three data collection instruments will thereafter be analysed together.

2. Basic guidelines

Focus groups build on a discussion between the participants and where the moderator has an unobtrusive and listening part. I will present some themes for you to discuss, but not actively participate in the discussion. I may ask for clarifications.

I expect an open, pleasant and orderly discussion, and all participants are expected to participate. It is important that everyone feels that they can and get the opportunity to present their opinions. I am interested in everyone’s opinions, thoughts and ideas concerning the themes that I will present. The ambition is not to reach mutual agreement.

*Your part in the discussion is as experts* – i.e. experts on what kind of information that is relevant, how you can get hold of it and how it is used.

The discussion will be recorded and thereafter transcribed. These recordings will be destroyed when transcribed. Those of you who would like to have a copy of the transcription can have so.

Your participation is based on confidentiality and anonymity. This means that nothing of what you say in this focus group (or task diary or questionnaire) will be traceable to you personally in the reported results.

3. Preliminary observations

The preliminary observations from the task diaries show that there are huge differences between different kinds of technical reports within the R&D centre. The technical reports seem to vary depending on the work task at hand. This in turn affects the information that is sought and used in the reports. The presence of untypical work tasks (technical reports) is low and most work tasks that give rise to a technical report are seen as typical.

A large amount of information is sought among colleagues and the large part of the information used in technical reports is results from different trials/tests/sample-takings i.e. data generated during other work tasks. These are most often collected from internal
4. Group data collection template

Date:
Start time:
Stop time:
Moderator:
Venue:
Participants:

Introducing question
I would like to start with a short presentation from each one of you concerning the kind of work task you perform that results in a technical report. We can start to the right.

Focus questions
Discuss the process of writing a technical report?
Discuss the situational factors that affect the process of writing a technical report.
Discuss the expected/required content in a technical report.
The notions discussed regarding technical reports how well do they correspond to your own notion of how technical documentation should be performed?
Discuss what kind of information that is relevant when writing a technical report.
The understanding of relevant information – how well does that correspond to your own notion of relevant information?

Summarising question
Considering your own experiences and the way you perform when writing a technical report as well as the discussion in this focus group today – what are the most important things that you see as improvements concerning information management surrounding technical reports.

Concluding question
Is there any subject that you consider neglected in today’s discussion and that you ought to have discussed?

Summary and reflections
Appendix 12 Process and thinking tables

The work tasks analysed in this study were first abstracted into work charts (Figure 5) based on the information seeking model. These abstractions were summarised in process and thinking tables (Table 12-17) for each task category. All tales are presented in this Appendix and discussed in chapter 5.2.

Table 12 Process table for normal information processing tasks

<table>
<thead>
<tr>
<th>Task no.</th>
<th>Participant</th>
<th>Info type</th>
<th>Task time</th>
<th>Info.seek time</th>
<th>Source</th>
<th>Success</th>
<th>Reason</th>
</tr>
</thead>
<tbody>
<tr>
<td>K:1</td>
<td>PhD, ≤5, small</td>
<td>TI&amp;DI</td>
<td>24h</td>
<td>2h</td>
<td>int pers ext edb ext wsite int pcon ext exp int pcon ext doc</td>
<td>ps-a s-a ps-a ps-pa s-a s-a</td>
<td>suitable accurate closest competent knowledgeable feedback</td>
</tr>
<tr>
<td>M:2</td>
<td>PhD, ≤5, half</td>
<td>TI</td>
<td>10h</td>
<td>8h</td>
<td>int trep int me int pcon int pcon</td>
<td>s-a s-a s-a s-a</td>
<td>background get ideas specialist confirmation</td>
</tr>
<tr>
<td>C:1</td>
<td>MSc, ≤5, half</td>
<td>TI&amp;DI</td>
<td>8h</td>
<td>3h</td>
<td>int trep int pers int tres int pcon int pcon int tres</td>
<td>s-a s-a s-a ps-pa ps-pa ps-pa</td>
<td>to copy descr. process shall be reported knows material more experience more skilled shall be reported help interpret comparison for interpretation</td>
</tr>
<tr>
<td>D:1</td>
<td>PhD, 6-10y, half</td>
<td>TI</td>
<td>12h</td>
<td>6h</td>
<td>int pers int idb int tres int pers int pers int idb int tres int pers</td>
<td>s-a s-a s-a s-a s-a s-a</td>
<td>data storage draft report draft report</td>
</tr>
<tr>
<td>D:2</td>
<td>PhD, 6-10y, half</td>
<td>TI&amp;TSI</td>
<td>10h</td>
<td>3h</td>
<td>int trep int pers int tres int pcon int tres</td>
<td>s-a s-a s-a s-a s-a</td>
<td>template obtain data to modify</td>
</tr>
<tr>
<td>E:2</td>
<td>PhD, ≤5, small</td>
<td>TI&amp;DI</td>
<td>31h</td>
<td>15h</td>
<td>int pers int pcon int pcon int idb int pcon int stand int pers int pers</td>
<td>ps-a ps-a ps-a ps-pa ps-pa s-a s-a</td>
<td>- - - - - -</td>
</tr>
</tbody>
</table>

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Table 13 Thinking table for normal information processing tasks

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<th>Task no.</th>
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**Table 14 Process table for normal decision task**

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<th>Task no.</th>
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<th>Task time</th>
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| N:1      | PhD, 6-10y, small | TI&Dl | 40h | 10h | int pcon | ps-pa | task request or clarification |
|          |             |         |          |          | int pcon | ps-pa | responsible |
|          |             |         |          |          | int pcon | ps-pa | data storage |
|          |             |         |          |          | int idb | ps-a | find old tech.rep. |
|          |             |         |          |          | int idb | ps-a | similar tasks |
|          |             |         |          |          | int trep | ps-a | - |

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<table>
<thead>
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Table 15 Thinking table for normal decision tasks
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Note: no. = number; int = internal; ext = external; pcon = people concerned; exp = experts; lit = literature; doc = official documents; trep = Technical report; tres = test results; me = meeting; pers = personal collections; esour = electronic resources; edb = external database; idb = internal database; seng = search engine; wsite = website; exper. = experiments; prev = previous; concl. = conclusions; knowl. = knowledge

Table 17 Thinking table for genuine known decision tasks