Information Seeking Behavior of Engineers

By

Saurabh Koparkar
Elaine Meyer
Megan Morrissey

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Introduction

Engineers are largely specialists trained in areas such as mechanical, chemical, and electrical engineering, yet they work in a broad range of environments. Engineering encompasses a wide array of functions such as research and development, design, testing, manufacturing, construction, management, consulting and sales. Engineers need to seek highly specialized information when working in the industry. Engineers are professionals who need information to provide a product, system, process or service to their customer, rather than new knowledge in the form of a report or paper. The purpose of this study is to understand how engineers find the information they need to effectively perform their job.

This study was chosen because one of the authors has had past experience as a professional engineer, and wanted to explore the research associated with engineers, reflect on her past experiences as an engineer, and conduct interviews to see if the theories from research are correct. Her most recent experience was as an Applications Engineer in a small technical company. Her department was cornerstone to the organization and retrieval of company information; she had to find accurate and useful information to recommend solutions for her customers, and she had to find it on demand. She mostly turned to her own internal knowledge, manuals, and specifications as her primary source for information, then next to other application engineers and design engineers. What sources do most engineers turn to first and why? Do they depend on their corporate library, do they subscribe to databases? Do they read reports, catalogs, handbooks, and trade journals? From her experience, most engineers may not even have a corporate library; they try to keep information at their fingertips. The faster they can find it, the better. Ideally they would prefer to find the information from the resources in their company (people, intranet, journals, etc), or on the internet. How do engineers organize their own information - do they form their own systems for papers, computer files, drawings, etc? Are there any cultural barriers that impede their search for information?

This study was also chosen because there has been much literature produced and studies done on the information seeking habits of engineers. By studying engineers, we would

like to try to understand how they solve their problems when searching for information at work. This study would give us a good insight into the information-seeking techniques and methods used by engineers whether it may be technical or of any other nature. The rich literature present on the information-seeking behavior of engineers would also help us in understanding their behavior to a good extent by guiding us in the research study effectively. Hopefully this study would lead to new findings and discoveries or if not that, it would re-establish the previous research done about the information seeking behavior of engineers.

Literature Review

The results of the study done by Fidel and Green (2004) give some idea of how to examine specific factors that motivate an engineer to prefer one source over another to minimize efforts during information seeking. The study also indicated that accessibility of human sources was different from that of documentary sources. This particular finding was observed in our study of engineers. The concept of accessibility and factors affecting selection of information sources that were studied in this paper were encountered by us while understanding how engineers seek information.

The Kwasitsu (2003) study demonstrated that job responsibilities and academic qualifications influence information seeking behavior and attempted to find out whether there are differences in the information seeking behavior of design, process and manufacturing engineers. Important sources of information found for the population surveyed in this study were people in their own business groups, their own memory and personal files and the Internet while accessibility and availability followed by technical quality and relevance were important factors in the selection of information sources. We found similar themes in our information seeking behavior study of engineers. It was observed that engineers gave importance to relevance, accessibility, their team members, their own memory and organizational abilities plus the Internet to seek information.

Kraaijenbrink's study (2007) discusses information gaps in the usage of the web by engineers. A model of the information usage process which suggests where to look for

information gaps has been used in the study. The model has three stages which are *Identification*, *Acquisition* and *Utilization* of information. These gaps in the usage of the Internet were not prominently encountered by us in our study of engineers with respect to their web information seeking habits.

The purpose of the research done by Bruce, et al, (2003) paper was to study, using Cognitive Work Analysis technique, situations where members of a team are searching, seeking and using information in a collaborative manner. Since we did not interview teams of engineers, the actual collaborative behavior of engineers was not witnessed, though it was evident from our study that our subjects relied heavily on their team members or colleagues to resolve information issues at various stages of the information seeking process.

The Leckie, et al, (1996) article presents a general information seeking model for professionals, specifically engineers. Engineers work with a specific objective in mind - the particular product or device to be delivered to the client. This implies that accuracy, reliability of information is paramount. Information needs of engineers also vary by age, primary role and career stage. Oral communication is predominantly used to gather knowledge. These aspects of information seeking were observed in our study too. Communication via telephone and face-to-face was considered important. It was also seen that experience affects the strategy chosen to seek information.

The Hertzum and Pejtersen study (2000) proposed that engineers get most of their information from colleagues and internal reports. It was found that communication is a crucial part of engineers work – studies show they spend 40-66% of their time communicating in order to get the necessary information. This finding about the importance of communication was observed in our study too.

The information seeking behaviors of different kinds of engineers are remarkably similar. As discussed in Hertzum (2002), engineers are most likely to obtain their information from internal sources and oral communication, rather than seeking external sources and written correspondence. These findings are echoed by the engineers interviewed during the course of

this project, all of whom followed the principle of least effort when seeking information and sources.

Yitzhaki and Hammershlag (2004) gathered data through a structured questionnaire, which they then used to compare the information seeking habits of software engineers and computer scientists. The results of this study showed verbal discourse with colleagues, professional journals, and printed textbooks were seen as the most accessible and often used information sources. The findings in the article were gathered using purely quantitative data and further exemplified engineers' use of readily accessible internal sources for information. This article provided us with solid background data and methodology, and validated information source findings taken from our interviews.

The distinction between engineers and scientists is explored in Pinelli (2001). This study notes that engineers use their information to produce designs and products, not facts and knowledge. Pinelli's article supported earlier readings by acknowledging repeatedly that engineers are most likely to trust and use the information resources that are most immediately accessible. This article explains the role of the engineer as a high volume information processor, helping to further clarify information seeking behaviors that favor rapid access to materials. Pinelli was informative because his article provided a comprehensive examination of engineers and their habits, and offered substantial background knowledge on engineers and their information seeking behavior.

The work of Gralewska-Vickery (1976) examines the information needs and communication patterns of engineers. The author conducted a lengthy series of interviews "to investigate [information] needs in relation to the environment in which the engineer lives and works his organization, team, and leadership (Gralewska-Vickery, 1976)." This article examines the behavior of the engineer at multiple career stages, and a communication pattern arises. Whatever their role, the engineer gains some information and knowledge from interpersonal communication with teachers, and colleagues, and also benefits from access to written documentation. Although this article is thirty years old, its findings and descriptions of information seeking methods still mirrored evidence given in many of the newer articles. Reading Gralewska-

Vickery gave us a sense of the history of engineers and their information seeking behavior, and showed that many of the common information seeking methods used in 1976 are still relevant today.

Methodology

After our literature review, we began to generate questions based on the readings about how engineers find the information they need for their jobs. Our questions were also influenced by an in-class exercise our team and several other students in our 551 class participated in to learn more about how engineers find information.

Interview Questions

Our interview questions were tailored to answer one primary question: how do engineers find the information they need to successfully do their work? To do this, what sources do they use and why? What information do they need and how do they find it? Our interview questions were organized into five main categories:

1. Job Details: Learning about their daily activities, tasks and overall purpose at their job

2. General Information Source Questions

3. General Information Organization Questions – how the engineer organizes their own information in their own workspace.

4. Information Tools and Sources Provided by Employer

5. Cultural Influences on Information Seeking Behavior

The interview categories are meant as a guide to conduct a semi-structured interview. We wanted the interview to feel like a natural conversation, but we also needed to stay on track and cover the main ideas addressed in our interview questions. The interview questions can be found in Appendix 3.

Recruiting Informants

To help us understand in more detail how engineers find the information they need for their jobs, we found a total of six current or recent engineers to interview. Because our team

consists of three people, each team member interviewed two informants. The informants were contacted directly by e-mail to solicit their participation in our study.

Because two of our team members do not have cars, this limited their interviews to the Ann Arbor area. These two team members focused on contacting current School of Information students that were practicing engineers immediately before going back to school. Through a School of Information student, one group member found a current engineer she could interview by phone. The other team member focused on contacting current engineers she had worked with in the past.

All six informants came from different backgrounds and had different levels of experience at their jobs. Before each interview we asked our informants to fill out a brief questionnaire about their basic demographics. This information can be found in Appendix 1. All six engineers had different amounts of work experience to provide us with a somewhat diverse range of ages and engineering occupations, as well as a range of information seeking experience.

- EO1 is a 24 year old male with a recent occupation of a Programmer Analyst Intermediate position. He has a bachelor's degree in computer engineering. He started working full time on this job after he graduated from college in 2006 and completed 1.5 years at the job. He works for an open-source software foundation. His job functions consisted of developing open-source applications.

- EO2 is a 30 year old female with a current occupation of CAD designer, who has a mechanical engineering bachelor's degree. She has 8 years of experience at her current job. She works at an engineering design consulting firm in metro Detroit, with customers from all over the country. Her company also has several branches from around the country.

- EO3 is a male with a current occupation of "Performance Test Engineer" for an automotive company. He has a mechanical engineering technology bachelor's degree. He is 29 years old with 3 years experience at his current job, and 6 years engineering experience overall.

- EO4 is a 39 year old male currently working as a product design engineer in an automotive part supplier. He has been employed by this same company for the last 15 years. He does a great deal of CAD design work.

- EO5 is a male who is 23 years old. He graduated with bachelors in Computer Engineering. He worked for nine months as a satellite engineer. His main job functions were analyzing, supervising and configuring satellite technologies in various countries.

- EO6 is a 25 year old male student in the School of Information. His degree is in electrical engineering, and he worked previously for two years at a Chinese engineering firm as an IT consultant. His primary duties were consulting with clients to offer software solutions and web upkeep for his own company.

Conducting Interviews

After interview informants were identified, the ethnographic interviews were conducted in neutral settings such as a conference room or the informant's home. Three informants were interviewed in a conference room at West Hall – EO1, EO5 and EO6. One of the current engineers, EO4, was interviewed by phone because of the traveling limitations of both the interviewer and the informant. Two current engineers, EO3 and EO4, were each interviewed in their home. For confidentiality reasons we were not allowed in the current engineers workplaces. Each interview lasted approximately 45-60 minutes, and all six interviews were conducted within a week. Although we were unable to view their real work setting, the neutral environment was helpful because we did not have any interruptions.

To record the interviews, one team member used a handheld recorder, and then recorded those interviews into an audio software program called "Audacity" to create a digital file. This is free software, which can be downloaded at www.audacity.com. Another team member used Audacity directly for both interviews and the third used Audacity for one interview and an informant's audio program for the last interview.

Data Analysis

The audio recordings collected from the interviews were used to transcribe the interviews to plain text for coding. For coding we identified main themes to pull out from our interview transcripts to analyze further. Our coding scheme can be found in Appendix 4. Similarities between interviews, and patterns of information seeking behavior related to our research questions were extracted from the coded data. This information led to an evaluation how well the information seeking behaviors of our informants supports the information seeking behavior research we found for our study.

Results

The findings discussed in this section refer to the six interviews that were analyzed. It was a benefit to us in this research to have the opportunity to interview such a diverse group of engineers, in regards to specific type of job, type of tasks performed, different specializations, age, and number of years of work experience as an engineer. This gives us a broader view of the information seeking behaviors of a professional engineer.

Preferred Information Sources of Engineers

While researching the information seeking behaviors of engineers, a distinct pattern of their preferred sources emerged. Nearly every article that we read displayed similar findings: engineers prefer sources that are close at hand, especially the advice of colleagues and internal written reports. During the course of our interviews, it became clear that practicing engineers do tend to choose their sources based on ready access. In addition to gaining an understanding of engineers' preferred sources and information seeking methods, we also tried to find out how subjects organized their own personal information systems.

During each interview, the subject was asked about the sources that they used most often, and where they obtained these materials. All of the informants reported that they procured their print resources from company intranets, libraries, and personal file archives. Subjects also reported utilizing their coworkers' expertise as a source of information, citing convenience and accessibility as key motivators of this system.

E02 explained that their duties consisted of drafting design drawings on the computer using a three dimensional design space. When asked how they found the information necessary to create these drawings, the engineer cited a readily accessible source: "a lot of times since we're packaging stuff a lot of the models that we get we download from customer websites or customers will send us the models they have, (E02, personal interview, March 26, 2008)." While describing their work process and preferred sources, E02 showed a clear reliance on internal sources when seeking information.

E06 stated a similar reliance on internally written materials and colleagues when asked about their primary information sources, echoing the points made by Hertzum (2002). This subject stated that their mentor taught them all of the basic elements of their job, including where to start looking when they needed information. E06 said that they relied on their company's intranet when seeking information, as well as a large servers containing many technical forums. The informant stated that they preferred to use this server because it contained a vast store of information relevant to their everyday information needs, and perhaps most importantly, because the server and its contents were immediately available. The need for rapid accessibility is a key factor in the preference for internal resources, as it is often necessary for engineers to find reliable information quickly to facilitate results and production of deliverables.

Interview subjects also spoke of using their colleagues and team members as sources of information. E03 described their work group as a small performance testing group, consisting of four engineers and two managers. This team works together to prepare vehicles for testing, determining the necessary equipment and type of test that will be run on the vehicle. In extemporaneous circumstances, engineers are likely to rely first and foremost on their team members and close colleagues because successful job performance depends on acquiring useful information quickly. In this instance, utilizing team members' expertise is a necessary component of effective information seeking behavior because "There are specifications, guidelines for each standardized test that we do. There are a lot of instances where tests are not standard so we make them up as we go (E03, personal interview, March 25, 2008)." This behavior supports the

information seeking behaviors described by Pinelli (2001), who explains that engineers must process a high volume of information on a near constant basis.

In addition to print sources and colleagues, our interview subjects described using the telephone as part of their information seeking behavior. When asked, E04 asserts frequent telephone use: "[the] number one [phone use] is conference calls. We [my company] have a limited travel budget, so we usually have four conference calls a day, sometimes six (E04, personal interview, March 29, 2008)." E01 also uses the phone, though for different information purposes. Where E04 relied on the phone a great deal for off-site communication, E01 used the phone "When I run into something that I don't know and it's something that's more urgent that I need to know right now. [When this happens] I need to call my coworker (E01, personal interview, March 28, 2008)."

In addition to company servers and fellow engineers, the subjects interviewed for this study also had extensive personal information collections that they often referred to. The subjects' personal information collections often influenced the physical arrangement of their workspace. E04 relies on a mostly paper-based personal document collection that is kept in their office:

> "I have help folders for specific customers, broken down by vehicle application. And then from there broken down into testing or application information, customer information warranty, or just general customer question. [Physically] I use the pile system. I have a pile for this project and a pile for that project. It's ugly but effective (E04, personal interview, March 29, 2008)."

E06 also holds an extensive personal library of materials, including several handbooks that offer instruction on running the Java Application, as well as "reference books, tutorials, documents I have found, and bookmarks from Slashdot and other good sites (E06, personal interview, March 25, 2008)." E06 explained that their company workspace was bare and most of their documents were stored on the hard drive of their computer because they traveled frequently.

Perceived Authority

Throughout the range of information sources discussed with the informants, information authority was an important factor that influenced their decisions regarding if they would use particular information for their job. For instance, E06 expressed "Every project I need to trust the data 100%." In the following sections we will explore different sources of authority and why the informants placed authoritative value on them.

Familiarity and Past Success

From the interviews we found that engineers look to themselves frequently for information based on their own knowledge and experiences. Because they can trust themselves and know where they got their information, they consider themselves a reliable source. As E04 said, "It has to be reasonable and based on your knowledge and experience. It's a personal choice whether you trust it or not." E06 also said to trust technical information he must "test it by myself".

Many of our informants expressed that information authority was granted more easily to sources they had successfully used in the past. From prior successful use, the informants could more readily trust and accept the source as a quality source. E03 mentioned his strategy for finding reliable sources:

> "You know who to go to for better information, you also know where to look better and how. I don't want to say how, but which sources are the best to look for there's…I mean some favorite websites that I use that tend to have better information then others. Certain magazines cover certain aspects of a vehicle better. So you learn that over time."

From the comments of E03, we can infer that his knowledge of where to go for the best information sources of people and documents is because E03 has six years of automotive engineering related experience looking for sources. He has had time for much trial and error on different projects to help him judge which sources will be better for which situations. From informant E05, once he understood where to look for information on the company intranet, the general internet and other documentation, he spent less time on seeking information again later on. This also reflected how his experience helped him know which sources to go to first. In addition E02 knew from prior experience she could save all her e-mails in her e-mail system and then just search for specific e-mails when she needed them. Even though these e-mails weren't

organized in any specific way, she learned to depend on finding things later by using the search functionality provided by her e-mail system because it worked well for her.

Authority from coworkers

We found that many of the informants would put much trust into their supervisors, and also their coworkers that had a different specialty then themselves. For instance E03 needed information regarding the automotive lab (he refers to it as a "shop"), "Typically if it's somewhere in the shop or related to the shop the technicians tend to know the [contents] most." If E03 has a question regarding something that is not his specialty, he would first go ask another engineer. He would do this because "each engineer is more or less specialized or is considered in charge of a certain product or a certain area of a vehicle." Their specialization would grant them authority on their topic. This also applied to principle engineers, who have had more experience and more training in their specialty, who E03 would go to first for information about a particular car. "I would kind of ask the principle engineers whichever engineer is responsible for that particular vehicle with that particular engine."

Authority from systems

We found that many of the engineers we interviewed have to depend on software systems provided to them by their work, to help them do their jobs. They have to input information into these systems, and depend on the information they find in these systems to get valid information out. For instance informant E02 worked as a CAD (Computer Aided Design) Designer. Much of her work involved making 2D and 3D drawings to design parts for systems. She was also a team leader responsible for checking the drawings of many of her colleagues and being accountable for the drawings that are sent to customers. Her perception of the accuracy of the drawings reflected somewhat on the systems they used to create these drawings, as well as the people making the drawings. The following quote reflects her frustration with trusting the information from their CAD software package which lacks the functionality of "checking in" and "checking out" drawings (where only one person can work on the document at a time):

> "Solid Works is really frustrating because there is no drawing management. Like in other
> CAD packages there's management software where you have to check out a drawing
> and modify and you have to check it back in. So usually that will give you a revision
> history and it allows you to know who did what and when but, Solid Works doesn't do

> that, the drawings are just like a folder full of word documents. Anybody could go in and change them, and you don't necessarily know who changed them. So, it's hard sometimes."

This is especially pertinent because drawings are so detail orientated and must be absolutely correct for manufacturing purposes.

Another main system that engineers use regularly for information is the internet. E03 is responsible for competitor analysis, and needs dependable information. He frequently surfs a blog called "AutoBlog" and competitor websites. For his common resource of AutoBlog, he said that his trust of the site "depends on the references they source such as press releases or auto shows". For competitor websites he typically ignores the marketing jargon, and he's "Typically just looking for the basic specifications and options available and when things will be released and like for sale dates and things like that are typically close to accurate."

Using Standards for Authority

Some engineering companies have standards for some of the work they do, and some companies do not, as we found in our interviews. If there is a standard for doing a task, the engineers are more likely to trust that information because it has been used before and is certified by the company.

For instance E03 said, "There are specifications, guidelines for each standardized test that we do. If there aren't standards for testing, we make them up as we go." If a standard is not set ahead of time, the engineers must do research on how to properly administer the test. If a standard is in place, they trust the standard and just go ahead with the test.

E02's company standards were different because they serve different clients with different needs. "We don't have any standards on how to do things, because they are all project specific. So it all just depends how the customer wants it." They might find the standards on the company website or through their customer contact to get the right information. Those people and websites are used because they are the authoritative source representing the client.

Accessibility

Accessibility can be defined as the effort required to find as well as use a source of information. It is the measure of how easy it is to find and utilize the information source; in short, convenience and usefulness of an information source indicate accessibility. We observed certain themes that stood out with regards to accessibility of information sources.

Internet – a highly accessible source

It was seen that the Internet was considered as a ubiquitous and fast resource for seeking information. The main reason for this was its high availability in the organizational setting of our interview subjects. One informant commented that if one knew what they were looking for, then using Google Search was the fastest and easiest way to obtain that information from the Internet. The following quote by E02 supports this finding, "If you know what you're looking for you can find it fast. Go to Google even if you're looking specifically for something, like if I wanted to find the Society of Manufacturing Engineers website I could, I would go to Google and type that and it would bring up that website for me. Even stupid stuff. Just go to Google first."

Another informant told that the fastest and easiest way to get certain work-related information was to go to the company website and download technical and other work-related documents. These are the informant E03's quotes from the transcript, "There's some things it's not really considered hoarding if I'm looking for a user manual for a particular piece of equipment that I don't know how to use a lot of times it's just easier to go to the manufactures web site and pull up the user manual so I'll just save it to my computer so I'll have a copy of it."

Interpretation of accessibility according to the informants

When the informants were asked what accessibility meant to them, we observed that accessibility meant convenience or ease of searching for information, the accuracy of the information retrieved and the least cost required to obtain this information.The quotes from informant E04 which suggests these findings are "(Information should be) Immediately accessible and free. Our company is not going to pay for individuals to purchase technical papers or anything. If anyone needs a purchased document, then we'd have to go to our librarian and the librarian will decide weather or not if it's worth buying and putting into our library."

With regard to the importance of having minimum costs during any information seeking activity, E04 said that "... if you are talking paying for information we don't do that. There's really no cost of searching information, it's the time and convenience, and how clear and precise it (information) is."

Timeliness or seeking information in time was also an important factor which affected accessibility of information. If the time required to find information was beyond a certain threshold, most of the times, the information search activity was abandoned, postponed or the strategy was modified. E01 mentioned this aspect by saying that "I mean you mention time management, I think that is kind of an issue. Like being a student and working like a barrier to getting things done. Trying to investigate things and finding the time to get things done."

Intranets and knowledge management systems afford accessibility

We asked our subjects if they used and relied on a company intranet or a knowledge management system for information seeking and if such a system made accessing information easier. Not all of the informants used intranets at work for seeking information. But one informant EO4 said that their company had a People Finder feature made accessing information faster and easier as this feature supported email, employee details like phone number, location, etc. as well as other work-related documents. In his own words, E04 said that "(In) The people finder, we keep all of our drawings with a data base that's on the intranet, and standards, test procedures, organizing tests, and retrieving the test data is all on the intranet. People Finder is basically e-mail where you can search someone's phone number, e-mail, location, Job function, who they work for, where they're located". Another informant E03 used IBM Lotus Notes which supports email, file cabinets, databases and other knowledge management features which aid easy accessibility of work-related information in terms of time and effort. This idea can be explained in E03's words as "Um, there's … within Lotus Notes there's file cabinets and other databases that have been created for storing different information. (Lotus notes contains) All of the business reports or any report that's written by anyone in the company and stored on the database that's searchable by author, subject or date." One informant E01 mentioned that their team used a WIKI to collaborate on using information collectively. This patron worked in a University Library for

developing a course management project and hence not in a corporate setting. Thus a WIKI provided easy and fast access for information seeking. In E01's words, "As far as organizing files and content on the WIKI that's a much more organic, we try and keep it organized. I am actually very interested in the WIKI, and contribute a lot there. Try and clean up things and keep it in order."

Barriers to accessibility

The engineers did not want to incur extra costs while seeking information. This was evident from the fact that one informant E02 who was a CAD Designer said that the lack of standards and licenses in their organization created a barrier in the accessibility of information. E02's following quotation explains this theme "Well, the biggest issue is there are so many standards out there in the automotive and aerospace world. And we don't have purchased any licenses to use. And that's a big problem for me."

We came across one finding in which accessibility became an issue in the use of the company intranet because though the information was readily available on the intranet, it was not easy to find or locate because of the improper structure of the knowledge management system in place. A quote for this finding obtained from E06's transcript is, " ... too many folders (in the Intranet), the Intranet, its really information rich but its really hard to find, there are folders, subfolders, its like a tree there are trunks all over very hard to find."

There was another accessibility barrier which was faced by E05 in which E05 had to work with engineers who were local to a region where he was working. E05 faced a language communication barrier while interacting with these local engineers. This factor made it difficult to access information from local sources.

Conclusion

Engineers display distinct patterns in their information seeking behaviors, preferring to utilize sources and knowledge that are close at hand in their organization. The engineers interviewed for this study exemplified this strategy, telling of how they often relied on internally provided print and electronic sources, with fast access to materials a major priority. Background

readings discussed at length the interactions between colleagues and how they would use one another as resources. These statements were borne out in our interviews: every subject was working or had worked in a team setting, their colleagues and mentors among their most valuable information resources. Our informants must handle great quantities of information, and favored the word of colleagues and print sources that could be quickly accessed, offering the greatest opportunity for success.

As the range of information sources of the informants was discussed during interviews, the theme of information authority was notable in their responses. Authority was an important factor that influenced their decisions about the use a particular information source for their job. Many of our informants expressed that information authority was granted more easily to sources that were familiar to them and that had been used successfully in the past. Engineers also tended to trust respected colleagues, a proven expert a colleague who has provided authoritative information previously. We also found that many of the engineers tend to suspect the authority of software systems, as well as information they find on the internet. Ideally these systems need to be completely authoritative for the engineers to successfully do their job. If there is a standard for doing a task, the engineers are more likely to trust that information because it has been used before and is certified by the company.

Accessibility of seeking information was found to be related to the ease of finding information in terms of the measure of effort required to perform the information-seeking activity. The engineers preferred using information sources which required minimum effort to find and use. Such easily accessible information sources were predominantly the web or Internet and Intranet of the organizations where they worked. The Internet domain for information seeking consisted on using online search engines and corporate or work-related websites. The Intranet or knowledge management features included email, details of employee profiles, company databases and technical documents among many other work-related artifacts. Timeliness was found to be an important factor which made accessing information easier. It was seen that engineers would spend a certain time in finding information and if that time was not sufficient then

the information seeking strategy would be modified. Other barriers faced during accessing information at work were the costs required to find the needed information. Mostly, the companies where these engineers worked would not incur extra costs just to facilitate easy access to information whenever required.

We interviewed a wide range of nationalities for a six person study with the idea of exploring some of the cultural reasons that may help or hinder engineers finding information. However, our research did not yield a great deal of data on cultural aspects, and because our research led us away from this area, we chose not to include it in our final report. The findings of our study were consistent with those of previous researchers of professional engineers. Overall, this study was an excellent exercise because it re-established some of the previous research done on engineers. While conducting this study, we learned that despite a great variation of roles in the industry, most engineers ultimately use similar information seeking behaviors, and true to the practical and grounded nature of their work, professional engineers prefer to follow a logical, established course of action when seeking information.

Appendix 1: Pre-Interview Questionnaire

i. Name: _____

ii. Age: _____

iii. Gender: _____

iv. Education:
  ○ Undergraduate degree, type: _____
  ○ Graduate degree, type: _____
  ○ Doctoral degree, type: _____

v. Current/Recent occupation: _____

vi. Work Experience (in terms of years): _____

vii. Computer Proficiency
  ○ elementary use (i.e. word processing, basic internet use such as email)
  ○ general use (i.e. familiar use of software programs, advanced internet use)
  ○ advanced use (i.e. basic programming knowledge in addition to General use)
  ○ expert use (i.e. advanced programming)

Appendix 2: Pre-Questionnaire Results

	EO1	EO2	EO3	EO4	EO5	EO6
Age	24	30	29	39	23	25
Gender	Male	Female	Male	Male	Male	Male
Education Level	Bachelors	Bachelors	Bachelors	Bachelors	Bachelors	Bachelors
Degree Type	Computer Engineering	Mechanical Engineering	Engineering Technology	Mechanical Engineering	Computer Engineering	Electrical Engineering
Occupation	programmer analyst intermediate	CAD Designer	Performance Test Engineer	Product Design Engineer	Satellite Communications Engineer	IT Consultant
Current/recent	Current	Current	Current	Current	Recent	Recent
Work Experience (yrs)	1.5	8	6	15	1	3
Computer Proficiency	Expert	Advanced	Advanced	General	Expert	Expert

Appendix 3: Interview Questions

1. Introduction
Hello, how are you today? Thank you for taking the time to meet with us. Today we are going to discuss how you find the information you need for your job. Everything we talk about today is confidential and your name or company name will not be used in our study.

2. Your job
- What is your undergraduate degree?
- What is your job title?
- How long have you worked at company XYZ?
- Do you work alone or in teams - size, hierarchy, informal/formal structure?
- How big were the teams? What was the hierarchy of the teams?
- Can you describe a typical work day?
- For what purposes do you need to seek information to complete your job tasks?
- Were you provided with any training when you started your job?
- When you were hired with company XYZ, were you assigned a mentor? Is this person your boss? How often do you work together? What types of information do you learn from your mentor? Are you still working with this mentor?

3. General Information Source Questions
- How much time do you estimate you spend looking for information each day (or week) at work?
- What 3 information sources do you utilize the most and why?
- What people do you talk to the most and why?
- How much of your information needs are provided by your own experience and knowledge? (Please give a percentage.)
- When do you decide to STOP looking for information?
- How do you decide that you've found what you're looking for? Explain criteria.
- How much of your information needs are provided by your own experience and knowledge? (Please give a percentage.)
- When do you decide to ask other people and when do you decide to look in literature?

4.   **How you organize your information**
- Do you set up your physical work environment to help you find the information you need?
- Do you have your "own library" of personal files on your computer that you reference frequently? What are they and why do you use them? Is this information not accessible anywhere else, or just hard to find?
- How do you organize your own information, say in your own file space or server, etc.?
- How much do you use email to help you find information and keep updated on information? What types of things do you learn from e-mail and how do you apply it?
- Do you use the phone often? For what reason? Do you ever participate in phone conference calls or video conference calls? Why?
- Do you use instant messaging at work? How does this help you find information?
- Do you attend any **trade shows or conferences** to help you keep up with current information in your field? What do you learn?
- Are you a member of any professional group? Do you seek information from them? Why would you look to them? What information are you looking for from them?
- Do you have any ready **reference materials** you use, like an engineer's handbook of some sort?

5. Information tools and sources provided by your work
- Do you use any sort of **company library**?

- Does your company offer an **intranet** for employees? How about a **company website**? Do you use these regularly? What parts of them are useful to you? Why do you use them?
- How much do you use physical drawings or CAD files in your daily work?
- Do you use physical objects for testing purposes (such as testing equipment/products) in your daily work? Why?
- What types of information systems does company XYZ provide for its employees (for instance some sort of knowledgebase)? How and when do you use the system?
- Does your company provide some sort of company newsletter to help you keep updated with company information?
- Does your company subscribe to any **databases** as resources? Do you find these databases hard to use? Why? Can you give an example? Would they be more valuable to you if they were easier to use?

6. Cultural influences on ISB
- Do you think that your information seeking habits are influenced by working at XYZ?
- Do you have lunch with your coworkers, or talk at breaks? What do you talk about? Does this help you learn information for your job?
- Does your team and company overall easily share information with each other? What types of information and why?
- Are there any <u>barriers</u> that prevent you from finding the information you need?
- How much corporate bureaucracy effects how you get the information you need?
- How much of the information at XYZ is confidential/proprietary?
- Do you think your job specialization has an impact on how or where you gather information?

7. More General Questions (if time)
- What have you learned about available resources during your time in the workplace? Do you find now that you utilize different sources or advisors than you have in the past?
- Do you find that your information needs have changed over the course of your career? What about your methods for gathering information?
- How do you know you can trust technical information? What is an example where you had to absolutely trust this data to be correct for your job?

Appendix 4: Coding Scheme

Section	Description
Preferred information sources of engineers	*What type of source? E-mail, verbal, people, documents etc?* Subject mentions a specific source used to seek information.
Perceived Authority	*The reliability of the information source as perceived by the subject.* Subject mentions authority in reference to a source of information.
Accessibility	*Effort required to use a source to retrieve information.* How easy it is to get information, convenience and usefulness of the information source. Subject mentions that a source is easy or difficult to use.

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