June 2009

Engineering Resources

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Project Number: HXA0802

Information Resources Utilized by the Engineering Design Community

An Interactive Qualifying Project Proposal
submitted to the Faculty
of the
WORCESTER POLYTECHNIC INSTITUTE
in partial fulfillment of the requirements for the
Degree of Bachelor of Science
by

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Date: May 24, 2009

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1. Networking
2. Online Communities
3. Mechanical Design

Abstract

The goal of the project was to investigate and determine what types of information practicing mechanical designers and design engineers utilize throughout the design process, and what sources are used to locate that information. Research was done to review existing catalogs, books, journals, engineering communities, online material databases, online vendors and other resources used by design engineers. A survey of practicing design engineers was conducted to identify the information resources used by designers and design engineers. A follow-up interview was also performed to determine why and when certain resources were used throughout the mechanical design process. The data collected were organized and analyzed to see if there were any clear trends among the mechanical design engineers based on size of company, length of career and internet usage. A list of their needs and preferences was also compiled.

Acknowledgements

We would like to express our sincere gratitude to our SolidWorks liaisons, Marie Planchard, Johnny Kim and Bruce Holway. They donated their invaluable knowledge and time throughout the course of the project and were ever willing to help when needed. In addition, the alumni office personnel Anastasia Schelkin and Maureen Maynard for their help in distributing our survey to a host of WPI alumni, Kelly Donahue in the ISGD office, and Ellen Lincourt at the ATC. Our advisor Professor Holly Ault who was indispensable and kept us headed in the right direction. Finally to all of the mechanical design engineers who participated in our survey and interview process.

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1 Introduction

Mechanical engineers contribute to society by playing roles in automated manufacturing, environmental control, transportation, fossil fuel, nuclear power, computer fields and biomedical fields (Costantine, 2003). Through the use of extensive research, development, design, manufacturing, and testing, mechanical engineers produce mechanical devices to improve industry and society. While the involvement of mechanical engineers within the world is extensive, continual access to information is essential to satisfy society's changing needs. However, since engineering encompasses worldwide and not just local industry, mechanical engineers must effectively communicate using the latest technological resource, online communities.

Within mechanical engineering online communities, engineers are able to share knowledge regarding particular products, materials, and project plans. In addition to providing information, these online communities allow engineers to posts inquiries and receive not only professional, but reliable advice during all stages of engineering design. As determined in the IEEE online networking seminar (Susman, 2006), online networking itself is building long-lasting mutually beneficial relationships for exchanging information. Along with the usefulness of the online communities in engineering and design, international networking is accessible at any time.

Several drawbacks exist that may inhibit the engineer from utilizing online communities as a resource. Engineers relying on online communication instead of meeting in person may have difficulties articulating and formulating the information to be transferred. Thus, information can become skewed and unreliable to the engineer requesting assistance. Furthermore, perhaps one of the most obvious setbacks for engineers using online communities is the fact that not all engineers are capable of conveying their academic and professional knowledge over the internet. Some engineers may be extremely successful in their engineering career but not have the knowledge of the internet or the availability of internet access.

The goal of this project was to determine what information resources are utilized by practicing designers and design engineers. Our team investigated the use of existing online communities for mechanical engineers and the effect and impact of these resources on the practice of engineering design. The investigation involving local and international communities that currently exist in the mechanical engineering domain allows for the determination of online functioning, efficiency and drawbacks.

2 Literature Review

For this project to be successful it is critical to understand the background and development of online communities as well as their functionality, use, and domains. We started by investigating both social and professional online communities . The search was then focused on online communities used mainly by mechanical engineers. From there we compared and contrasted the individual websites' functionality and what they each offered to mechanical engineers in terms of information and features.

2.1 Online Communities

As computer technology advances, workplace communications via the internet are expected to expand as well. In order for companies to grow, it is necessary that their professionals interact and share knowledge with others in all diverse fields. Specifically, in the field of engineering, there has been much innovation regarding the development and organization of online communities. Tasks that were once too difficult to perform due to inaccessible and/or inadequate resources are now possible because of online engineering communities. However, while online community sites help engineers acquire information and complete projects, a more in-depth analysis of the topic must be made to understand to what extent these existing online communities are effective. In order to obtain this information, there must be a clear focus on the types of online communication that are currently being used by engineers; communication in all facets of industry, professional societies, and continuing education.

Definition of Online Communities

By definition an online community, also known as a virtual community, is a group of people who interact in a virtual environment. According to *Online communities, Designing usability, supporting sociability*, the members of the online community have a purpose, which is directly supported by technology, and are guided by norms and policies (Preece, 2000).

The term *online community* is extremely broad as there are a number of factors that shape the makeup and purpose of each community. The function of the community (e.g., health support, education, business, neighborhood activities) and the software environment supporting it (e.g., list server, bulletin board, chat, instant messaging) greatly influences the nature of the community. In other words, each online community is varied and depends exclusively on its members' needs. The community's governance structure and the types of norms and rules that evolve within the community provide a framework for social interaction within the community and among associated members. Other factors that contribute to the variability of online communities include the size of the community (small communities of fifty people are very different from those of 5000 or 50,000); the age members; the culture of the members of the community (e.g., international, national, local as well as influences that may be related to politics, religion, gender, professional norms, etc.), and whether the community has a physical component as well as the virtual one (Lazar, 1999).

A vast array of online communities has been made available to all categories of users such as educational communities, social communities and office communities. While many of these communities are established to help professionals in their field, our main concern and focus for this study is to investigate on-line communities for mechanical designers and design engineers. These communities have become more than just informative websites; mechanical engineers utilize these communities as a tool to perform many tasks such as searching for parts and components, and seeking professional assistance. Currently in today's global industries, mechanical engineers are now members of online communities to assist with, and expand upon, their professional experience.

Growth and Effect

The internet has already proven that if a group of people is given the means to communicate freely, they will willingly form and maintain societies that share common interests. Since the development of the internet, online users have been affected by these communities. Many of these online communities have created a large impact on social, educational and professional communication. One might think that people just use online communities for social networking, but this is absolutely not the case (Jackson, 2004). Mechanical engineers, who are also part of what are defined loosely as 'social communities', do more than just chat with their colleagues. These engineering members specifically seek to obtain information about design and engineering applications, a purpose much more defined and useful for the workplace and growth of academic knowledge.

One main reason for the rapid growth of social online communities is their ability to allow people to stay connected with others who share similar interests. In particular, Facebook and MySpace are two current examples of the popularity and growth of online communities with the younger generations. Due to the extensive publicity of these two sites, it appears that these communities are the primary communities that attract internet users seeking communication. However, many other on-line communities exist, but are not as well publicized as Facebook and

MySpace. The reason that little is heard of professional communities is because the members of these types of communities have a different purpose than just social networking.

One of the main differences between popular social communities and professional communities is simply size and purpose. Today, given the fact that most sites on the internet are equally visible and available to users of the community, several issues arise. Early online communities were self-selected groups of those interested in technology. Members used the online community with a purpose. However, much has changed and today new members can include just about anyone who can point and click a mouse. As a result, this group of diverse members either holds back or expands the growth and effectiveness of an online community.

Mechanical engineers seek reliable assistance from their colleagues while performing a variety of engineering tasks. However, problems and issues arise when they obtain incorrect or unreliable information. When there is an open accessibility to online communities for different people and internet users, the reliability of the information found within these communities is often jeopardized.

An excellent example of unreliability within an online community is Wikipedia. A ‘wiki’ allows a group of people to enter and communally edit bits of text. By clicking an "edit" button on an article, one can edit the article's text and add or change anything within that specific article. So when a person accesses a wiki, he or she is able to read what the wiki's community has written. Although the information found on this site may be useful for a quick reference or a starting point for possible research topic, this site has been found to be one of the most unreliable sources one can use (Denning, 2005). Thus, what might appear as a helpful resource is really not that effective because these bits of text can be viewed and edited by anyone who visits the wiki.

The simplicity and the complete openness of a wiki have caused nearly all academic and professional institutions to reject the use of such a resource. As long as members can edit such information, wikis will never become credible resources to any user (Denning, 2005).

However, Wikipedia is one of the first to appear in a search box when one is acquiring information. This may result in obtaining inaccurate information that is extremely hazardous to a project's potential. Therefore, there is no place for unreliable resources and even the smallest issues should not be neglected. If one minor error in a design (caused by inaccurate information) transpired, the recall of a product that was shipped throughout the world may occur. In extreme instances, the lives of those who used such a product would also be affected drastically, like in the cases of failure of poorly designed toys, cars and structures. For these reasons and many others, when the mechanical engineer is in need of professional assistance, the resources and the on-line communities that he or she explores have to be reliable and accurate. Information provided by online communities such as Facebook, MySpace or even Wikis can appear to be very believable yet may in fact be untrustworthy. The availability of the information to be edited by any person make Wikis, a type of online community, unreliable especially in the engineering field where accuracy is critical. Fortunately, several online communities exist in the current engineering network. These communities have been designed to be accessed and used specifically by practicing engineers.

Existing Engineering Networks

Practicing mechanical engineers that need further information during the process of design and development of a project can seek professional help within special on-line communities for engineers. These communities have been specifically designed and set up to provide reliable assistance a mechanical engineer needs. EngTips (ENG-Tips Forums, 2009), SolidWorks (SolidWorks, 2009), and Design News (Design News, 2009) are just a few of the companies and publishers that host networking websites created specifically for engineers. These sites attempt to aid the engineer in various facets of his or her career. More precisely, whenever engineers or designers are having issues executing a project, finding products, and searching for solutions they utilize these websites and other similar ones for further support.

A very interesting online community is sponsored by SolidWorks, a solid modeling software vendor (SolidWorks, 2009). SolidWorks has developed an online webpage that allows the community to share their discoveries, their needs and their experiences as professionals. The community webpage of the SolidWorks website has several sections that allow engineers and designers to post their inquiries and responses. One section is a user-supported software help source, with categories for the various functions of the software such as assemblies, sketching or part modeling.

The SolidWorks website also employs user blogs; this section is filled with commentaries that explore topics ranging from tips and technology to events and breaking news. The SolidWorks Express Bi-Weekly Newsletter includes all of the technical information a mechanical engineer would need to keep up to date with the latest SolidWorks technology. A last popular sector of the SolidWorks community is the 3D Content interface. 3D Content is a free service for locating, configuring, downloading, and requesting 3D parts and assemblies, 2D blocks, and library features. Many designers and users share their knowledge and designs in that significant section of the SolidWorks online community.

Autodesk (Autodesk, 2009) is another site in relation to design innovation technologies that also sponsors an on-line community. The online community webpage is primarily divided in three distinct sections: users, developers, and partners. The first two sections are of the most interest to this project. The first section addresses all users of any Autodesk product such as AutoCAD Mechanical, AutoCAD MEP and many more. Like the communities mentioned above, the users section in the Autodesk online community allows mechanical design engineers to access articles and discussion groups along with rating, commenting, and networking with peers. Also, this section is divided in many subsets such as 3D Animation, Manufacturing, Industrial Design, and Students and educators. This structure makes it easier to browse and easily locate the potential division where answers and assistance could be found. Another advantage of this on-line community is found in the second section, the developers section. In this section, the Autodesk Developer Center was created for software developers who communicate with a variety of mechanical design engineers in order to improve tools and technologies to produce superior design.

A community called Design News (Design News, 2009) is another site where engineers can access webcasts, technical literature, and other material involving their work. It’s very effective and successful to solve engineering problems while working with professionals who had similar issues and already found solutions for them. This website allows an engineer to pose questions on the webpage as well as answer questions posted by other engineers or designers.

Engineering Tips (ENG-Tips Forums, 2008) offers access to a forum-based community. The site is a link-based site wherein a user follows links until he or she is presented with a discussion site. The discussion site, called a forum, is where a user can post and receive answers to questions. The links represent the forums and they are displayed by categories. The categories represent the type of forum and they are separated by professional fields, such as civil, mechanical or industrial engineering. Since the site is supported by the community the speed of response and validity of the information is relative to the knowledge and experience of the community. The content of the site is incredibly varied, ranging from questions of proper hazardous material procedures to the construction of a transmission.

Knovel is another interesting online resource that helps engineers find reliable technical information quickly (Business Wire, 2009). Knovel is an online library comprised of technical texts. Using its reliable content, optimized search, and interactive tools, engineers solve problems faster utilizing answers at the point of need. In fact, Knovel has been proven to significantly increase productivity of mechanical engineers according to American Society of Mechanical Engineers (ASME) Member Study (Business Wire, 2009). Knovel also powers ASME's e-Library, providing 127,000 ASME members with relevant and reliable technical information to help solve engineering challenges as they arise. The member study demonstrated that the ASME e-Library is frequently used and highly valued by ASME members. The findings show activities for mechanical engineers related to process design, product design and material selection. Additional findings also include statistics related to usage of the on-line library:

a. “80 percent of respondents reported that using Knovel increases productivity by at least 10 percent--equating to 4 hours saved per week.

b. 34 percent of respondents stated productivity increases of at least 20 percent with Knovel.

c. 81 percent of respondents use Knovel and directly apply findings to a specific engineering project.

d. 91 percent of respondents find the resource to be a useful professional development tool " (Business Wire, 2009).

This study confirms that the ASME e-Library powered by Knovel is a very valuable tool for mechanical engineers to solve problems, complete projects and move on to their next task.

Another unique feature is that Knovel provides interactive graphs and tables that enable users to interact with and export relevant data which makes it a big help and support for mechanical engineers during project completion.

Such online communities like EngTips, SolidWorks, Knovel, and Design News have and will continue to provide reliable and helpful assistance for practicing mechanical engineers. EngTips, SolidWorks, and Autodesk offer an online community, social networking and professional discussion forums for further help and questions. These networking sites and others created with the same intent will ensure that correct and accurate information is used so that engineers can create a safe and sound product for the corporation and the consumer.

2.2 Material Databases and Vendors

Material databases and vendor websites are crucial resources for the design engineer. Whether it is data on material properties or a specialized component, much of the engineer's time and effort are spent searching for the correct information. The two needs are so similar that many sites offer both. The information displayed is supplied by the either the distributors or manufacturers and the site facilitates finding the desired information or product, usually with some sort of search capability. Material property databases compile properties of products and materials while online vendors serve as a facilitator to the engineer for acquiring products.

Registration or subscription is required to view the data sheets, in some cases, but there are also free sites.

Material Property Databases

MatWeb (2008) is a database that compiles data sheets of material properties. The site can be accessed without being a registered user but registered users receive extra features such as an advanced search and comparison abilities of selected materials. The site's centerpiece is its search engine but they offer other search capabilities; three quantitative searches and four categorized searches. The quantitative search includes alloy composition, physical properties and an advanced search while the categorized search includes material type, manufacturer name, trade name and metal UNS number. Locating the desired information using any of the search capabilities requires a fair knowledge of the desired information but the categories and advanced search help in the absence of the knowledge. The site also offers material data export capabilities into seven different CAD/FEA programs. Once a product or material is located information is displayed including material notes (define how the material properties were tested), physical properties (both metric and English), mechanical properties, electrical properties, thermal properties, processing properties, comments on the materials, and links to find vendors of the materials.

Granta: Material Intelligence (2008) offers aid to the engineer in the entire process of collecting and optimizing material data. Granta develops software for materials properties, accruing and storing online databases, and assists in managing the information, analyzing critical materials data and deploys materials information specific to the consumer's needs. This site caters to larger corporations, with a large number of engineers employed and therefore a need to relay the data to the engineers. However Granta also offers an educational resource for materials data tailored to both students and educators. Similar to a large corporation, an educational institution would need to relay data efficiently and quickly but with varying types of data, specific to different engineering degrees.

An elastic and thermal property database exists through a software company called JAHM (JAHM Software, 2008). The software itself provides easy access to over 2,500 materials and 20,000 sets of temperature dependent data for elastic modulus, thermal expansion, thermal conductivity, S-N fatigue curves, and stress and strain curves. It lists materials by properties from linear expansion to viscosity. A user can search the site for a material to see if the database contains the material. JAHM is just one of the examples of a company that designs databases that contain specific information such as elastic and thermal property databases.

Other than sites hosted by industry, there are also sites that are supported by the public sector. The International Nuclear Safety Center (INSC, 2008) materials database operates under the guidance of the U.S. Department of Energy (DOE) and has been compiled by the Nuclear Engineering Division at Argonne National Laboratory. Information cataloging and database maintenance are performed with automated database management systems and the website provides an interactive information resource and communications medium for researchers and scientists (INSC, 2008). The site is link-based and offers the search by way of material type and material properties. The material types listed are fuel, cladding, absorber materials, structural materials, coolants, and concretes. The material properties given are thermodynamic properties, transport properties, and mechanical properties.

Similarly the National Institute of Standards and Technology (NIST, 2008) operates a materials database indexed by discipline such as biometrics and construction. This site operates under the guidance of the U.S. Department of Commerce and carries out the research that yields material data. There is no search engine; instead there are categories within each discipline. The site also has vendor listings for certain materials as well as software for several fields.

Online Vendors

Physical properties are an important part of the engineering design process, but once a material is identified the next step is to purchase the product or material. Thomas (ThomasNet, 2008) is an industrial resource that utilizes a search engine to list manufacturers, distributors, and service providers. The site offers the ability of a search with a search engine or a categorized search of more than 67,000 categories/products from actuators to zirconium. The search engine has the ability to narrow a search by state. The site compiles products and services, catalogs, brands, company names, and CAD models. Once a product is chosen, the website displays a list of companies that offer the product. The companies listed are companies that advertise with Thomas. When the user follows a link to a company's product the product information is obtained directly from the manufacturer. The site of the distributor allows the user to purchase the material. As the site is vendor supported, the information is limited by the availability of the companies participating with the site.

Another vendor site similar to Thomas is GlobalSpec (GlobalSpec, 2008). The site contains over 24,000 catalogs that represent over 2.3 million products. The search engine allows for a query of products and services, part number, application notes, material properties, patents, and standards. The categories are extensive, ranging from building and construction to semiconductors and sensors. Once a product is located a list of vendors will appear with part numbers and information links. The differences between the two sites are in their functionality. GlobelSpec has extra search capabilities, once a product or material is located and there is a list of companies, the site allows the further filtering by specifications. This allows the engineer to filter through the companies faster than on Thomas.

2.3 Other On-Line Resources

In previous sections the importance and functionality of on-line communities and databases were discussed. In the world today, mechanical engineers seeking information can access a variety of on-line sites and search through extensive existing databases to find answers to their questions ranging from specifications on different types of materials, to questions on software applications, to locating and purchasing the products that they need. This plethora of information and easy accessibility has aided mechanical engineers immensely, turning a time-consuming search through physical manuals, catalogs and textbooks into a relatively quick and easy internet search, where the search engines of the various sites sort through and compile almost instantaneously all of the information one is searching for based on a simple key word or key phrase search. However online communities and databases are not the only technologies used by mechanical engineers for gathering information. In the following section the use of other on-line technologies are briefly described.

Online Libraries

The goal of the engineer is to find necessary and relevant information and analytically solve problems. A tool used to gather information is on-line libraries. These libraries contain journal articles, books, periodicals, conference papers, and codes and standards. There are numerous libraries on the internet. The libraries compile information relevant to a specific need and allow for the search of the database. Some sites require subscription or registration to view the data while others require purchase of the data. Still others operate as an open site with no requirement of payment or registration. The information is either offered as hardcopy (if it was published that way), a digital file, or in some cases both.

One example is Genamics (Genamics JournalSearch, 2008). The site offers options that allow the user to fully integrate his or her research; including a journal seek, collaborative abilities (with other research) and software seek. There are almost twenty categories from aeronautics to nanotechnology. A user has the ability to follow links to locate journal articles to find the location of a desired entry or to search by the ISSN number, which identifies journals worldwide. The site is hosted by a firm whose goal is to be an educational resource to the scientist. The University of Illinois at Urbana-Champaign operates a site that lists different libraries by state (Grainger Engineering Library, 2008). Each link brings the user to a different library. The American Society of Mechanical Engineers offers a library for mechanical engineers (ASME, 2008). This library operates as a purchase site. The journals and book entries are available but the user must purchase to view the entire article. Another company offering engineering libraries is McGraw-Hill (Digital Engineering Library, 2008) with 227 titles to purchase. The search engine is a keyword search or there is the option to narrow a search down by category.

Webinars

The term webinar comes from the words "**web**-based sem**inar**"**.** A webinar is a presentation, lecture, workshop or seminar that is transmitted over the web. A key and valuable feature of a webinar is its interactive elements; such as the ability to give, receive and discuss information. This is in contrast with a webcast, in which the data transmission is one way and does not allow interaction between the presenter and the audience (Webopedia, 2009).

A big advantage of conducting a webinar is that there is no special conferencing equipment needed. Participants can watch a webinar on their own computers, hear the presenter speaking live via telephone or with VOIP (Voice Over IP) and can ask questions either through an online chat that all participants and presenter can see or by phone. The presenter of a webinar has the freedom to start and stop the presentation as much as necessary to give answers to real-time questions from the audience (Gordon, 2008). Webinars are useful tools when it comes to communicating with an existing customer or client base and the virtual presentations are a valuable tactic for fighting customer attrition and earning repeat sales (Gordon, 2008).

Creating a webinar requires two components. The first component is a slideshow software program such as Microsoft PowerPoint. The second component necessary to deliver the finished product via the web to the end user is the services of an online meeting provider that includes telephone conferencing for webinars (Gordon, 2008). Products that these online providers offer include Cisco Webex, Citrix GotoMeeting, Microsoft Office Live Meeting and IBM Lotus Sametime Unyte (Boulton, 2009).

It is necessary for a presenter or corporation to subscribe to a webinar service provider in order to receive the capability to transmit the webinars. The cost these services run from approximately $40 to $50 per month for unlimited meetings with up to 15 participants, $60 to $75 for unlimited meetings with up to 25 participants, and finally around $100 per month for unlimited meetings with up to one thousand users. Some providers do offer the ability to pay for webinars on a per minutes basis as well. For example individual users can pay 33 cents per minute to use WebEx (Boulton 2009).

Companies and corporations are finding it advantageous to host webinars in order to train large amounts of personnel versus the traditional cost of transportation, food and lodging. Demand for Web conferencing and broader unified communications and collaboration software packages are strong among companies executing mergers and acquisitions in different industries (Boulton 2009).

For the 2009 Special Olympics Winter Games, the staff of over 5,000 volunteers was trained exclusively with on-demand webinars and presentations. Instead of several training sessions per week in classrooms, volunteers for the World Winter Games trained in their homes. The trainees simply registered on the Special Olympics website and went through the training at their pace, at their convenience (Associations 2008). Heather Hill, vice president of marketing for the Special Olympics 2009 Winter Games said that utilizing the webinars made it much easier for the volunteers to make the commitment and push through the training process faster than they could have if it was done in person (Associations 2008).

3 Methodology

The goal of the project was to create a template for an online engineering community tailored to the information needs of practicing mechanical designers and design engineers. The raw data has helped in the design of an online network for mechanical designers and design engineers. The project was developed through four stages. The first step was to gain a broader understanding of current online database, community structures, and resources being used by engineers through a literature review. The second step was to develop both an online-survey and a more in-depth follow-up interview. The information obtained by the survey and interview helped to identify informational needs of mechanical design engineers. Correlations in the data obtained from the survey and interviews were found between the demographics of the engineers and the use of different resources. The surveys and interviews also helped in locating other online resources not studied in the literature review. A list of these online resources was compiled. The third step was to analyze and sort the data and the final step was to assemble all the pertinent information into a final report which includes, the research results and a list of resources used by the design engineers.

Figure 1 is a flow chart depicting the process of the study.

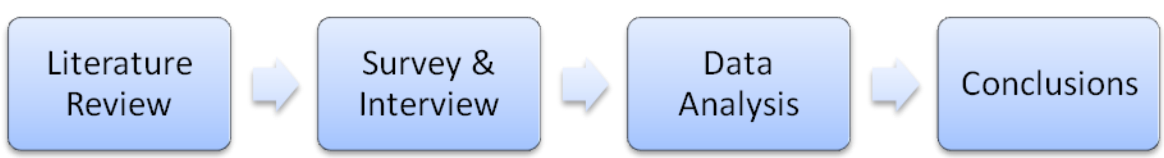

Figure 1. Flow Chart of Project Process

3.1 Conducting Background Research

The history and growth of online communities and the effects they have on society was reviewed. This helped to gain an understanding of the structure and functionality associated with online communities. A short questionnaire was distributed to a small group of engineers and designers at a software user group meeting to ascertain what online resources they used. A copy of the questionnaire can be found in Appendix D. This was one of the methods used to locate the sites researched in the literature review. Another method was by an internet search. Current networks were located with keywords such as "mechanical engineering communities", "mechanical engineering networks", and "mechanical engineering forums". The networks were compared and contrasted and important features were discerned. Libraries and webinars were also researched to gain an understanding of other available resources.

Since one of the goals of the project was to survey and interview a number of engineers, a certain level of knowledge was needed pertaining to design engineers. One of the needs a design engineer has is the need for readily available data on material properties and another is the need to acquire products from a distributor or manufacturer. Therefore an attempt was made to locate online material databases and online vendors. Some sources were identified through the short survey. By locating and using each of the websites, an understanding of the process of navigating the sites was obtained as well as identifying what resources the sites provide. Keywords such as "material properties databases", "material characteristic databases" and "material databases" located the material properties databases. Another search was performed to locate vendors using keywords particular to products and materials. Although "material vendors" was used other words such as generators or fasteners located the online vendors. Many of the sites offered some form of vendor and/or database capability. Similar to the databases, use of the website helped to gain knowledge about navigating the site and the resources provided.

3.2 Survey of Designers and Design Engineers

Surveys are a systematic process of collecting information about a group of people. There are many things to take into consideration when designing a survey. Important steps to ensure a successful survey include: defining the survey objectives, determining who will be sampled, creating and testing the instrument, data collection, and analysis (Matthis, 2009). Within each step there are criteria that if well defined will increase the success of the survey. There are also limitations and errors that can exist in the survey process not only in the design of the questions but also in the collection of the data. The desire was to eliminate as many errors as possible and to work within the limitations of the study.

We thought of two important topics when defining the survey objectives: specifying the population of interest and choosing the type of data to be collected. The population refers to the entire group of people responding to the survey. Within the population there is a target population. The target population is the part of the population that best defines the group of interest. Survey Methodology (Matthias, 2009, pg. 67) states that target populations should be "finite in size (can be counted)…have time restrictions (they exist within a specified timeframe)….they are observable (they can be accessed)" and that consideration of these aspects achieve a clear understanding of the data collected. The target population for this study was all mechanical designers and design engineers. The population from which the respondents were obtained was a closed population, which for this survey means the population was obtained from an organization with a list of the associates' emails. A request was given to the Alumni Office at

Worcester Polytechnic Institute to contact the mechanical engineering alumni. The request can be viewed in Appendix A. Since the alumni office can identify the respondents, at least by their degree obtained, there existed a higher percentage of the respondents fitting into the target population. The population used was "all mechanical engineers". From this overall population, mechanical designers and design engineers would be identified by their responses.

Determining who was to be sampled required the definition of a sampling frame. A sample frame identifies the elements within a population. The total of the elements equals the population. In this study, the population was practicing mechanical engineers and the target population mechanical designers and design engineers; the elements was the distinction between the engineers' job duties and industry, length of career and number of engineers at the respondent's company. The current categories used for job duties were design, administrative, industrial, consultant and not engineering. There can be numerous elements within a population.

Choosing the data to be collected had the greatest effect on which questions were asked. If the data the survey intended to collect could be well defined then the questions asked could be narrowed down and the information extracted would be concise and pertinent. The data that were collected from the surveys and interviews defined the engineers' job duties and industry, size of company, and length of career. The data identified what resources the engineers use and how important they are in their day to day job activities as well as how much time is spent gathering information from the resources.

Creating and testing the instrument included choosing the response mode (mail, web, etc.), drafting the questions and pre-testing and revising the survey questions. The response mode was through an online questionnaire. The alumni office at WPI emailed its list of alumni, filtered by our alumni request criterion, with the message presented in Appendix B; the email message described the goals of the survey and presented the link to the online questionnaire. Also the email aided in further filtering the population by defining the response criteria to mechanical designers and design engineers.

Drafting the questions required an initial draft and a final draft. The drafts were analyzed to remove possible errors or limitations. Branching was also utilized to filter out answers. Branching refers to the process of asking a follow up question dependent on the response of the first question. Since the response mode was via the web special consideration had be taken in the visual design of the survey. The survey layout was made so that there were only three questions per page to mitigate scrolling. A survey progress bar was located at the top of the survey to indicate completion percentage of the survey. A question was added at the end of the survey asking if the respondent was willing to lend his or her time for a longer more in depth interview. The questionnaire is represented in Appendix C.

The survey was created and supported by QuestionPro (QuestionPro, 2009). The site offers real time summary reports with basic graphs and frequency statistics, and online comparison reports. The comparison report filters through the data to identify demographics of the respondents. Also there was the ability to extract open ended answers to view data verbatim. Finally trends were extracted and the charts and data were imported into Excel and PowerPoint.

3.3 Collecting In-Depth Information

For the follow up interviews, the focus was the engineering design process, why certain sources were used and what information was used at each stage of the design process. Specific information including what made preferred sites better than other sites and what could improve existing sites was obtained as well. The target population remained the same however the population itself changed. The respondents were obtained in part from the questionnaire respondents and in part from team contacts. Some of the contacts were located by calling engineering companies and asking for designers and design engineers. This makes a target population harder to locate. The contacts were identified but there was a number of respondents that did not fit into the desired target population. It was expected that one out of every two engineers would fit into the target population due to the fact that a portion of the contacts will come from the interviews where the target population is already identified. The team expected to interview 30 individuals. The contacts were interviewed by at least two members of the team, one serving as the questioner while the other recorded the answers.

Presented in figure 2 is a Gantt Chart. The duration of days spent working on each task is shown and the tasks are identified by their name and duration dates.

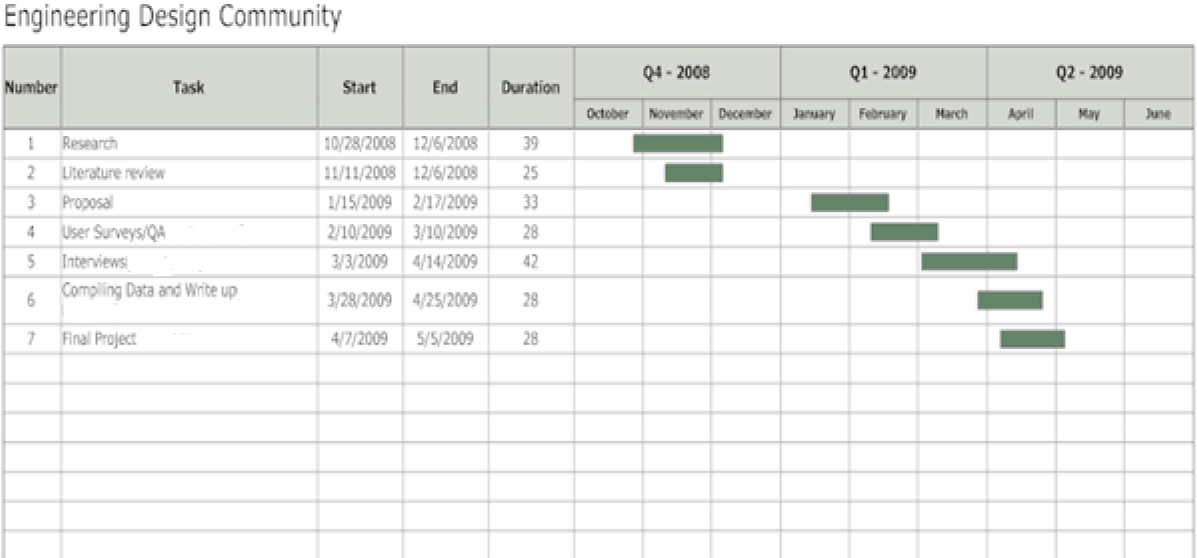

Figure 2. Gantt chart

4 Results

The project objectives were to discover the ways in which mechanical design engineers gather information and knowledge to help assist them in completing projects. Our research uncovered the sources that design engineers primarily utilize to assist them in the design process. From the initial survey the main sources used were material databases, catalogs/vendors, codes/standards; from the interview the main sources used were in-house libraries and data, and customer supplied information. Both the survey and the interview made clear that engineers overwhelmingly sought out the input and guidance of their colleagues, and it was further stressed in the interviews that experienced engineers were resistant to passing on knowledge to others not associated with their company, preferring to keep that information proprietary.

Purpose of Survey and Interview

The main goal of the survey was to generate a broad, inclusive picture of what types of sources a design engineer used throughout the design process and what percentage of those sources were located online. The focus of the follow-up interview was to refine and expand upon the answers that were collected from the surveys .The main objectives of the interview were to discover where design engineers went for their information, what that information was, and why they chose to use specific sources. At the end of the interview the respondents were also encouraged to express their views on what an ideal online medium should include to help streamline and simplify the information gathering.

Overview of Process

The survey was sent out by the alumni office to 2050 mechanical engineers. Of the one hundred fifty-seven engineers that completed the survey, seventy-five were design engineers. Only the survey data from the design engineers was used. The survey was concerned with general background information such as experience levels, internet usage related to work, and number of engineers employed in their company, and sources used to support the design process. Using the results of the survey, a follow-up interview was created to help supplement the survey responses with much more comprehensive information. The goal was to obtain thirty interviews in order to get a representative sampling of mechanical design engineers; the number of interviews actually completed was eleven. Although our underlying results from the interviews may not accurately represent the population of design engineers due to the small sample size, there were clear, consistent trends to responses on particular interview questions that cannot be ignored, and will be discussed further in the report. The interviews not only helped clarify data observed from the survey responses, but also brought to light information and trends that were not apparent from the survey alone, such as the strong reliance the design engineers had on customer information and in-house records and data.

Demographics

The largest groups of engineers to respond were those with one to five years of experience, representing 56%. The second largest group consisted of engineers with six to ten years experience representing 21% of the total respondents. Together this constitutes 77%, or roughly three out of every four engineers that responded. Figure 3 below clearly depicts this.

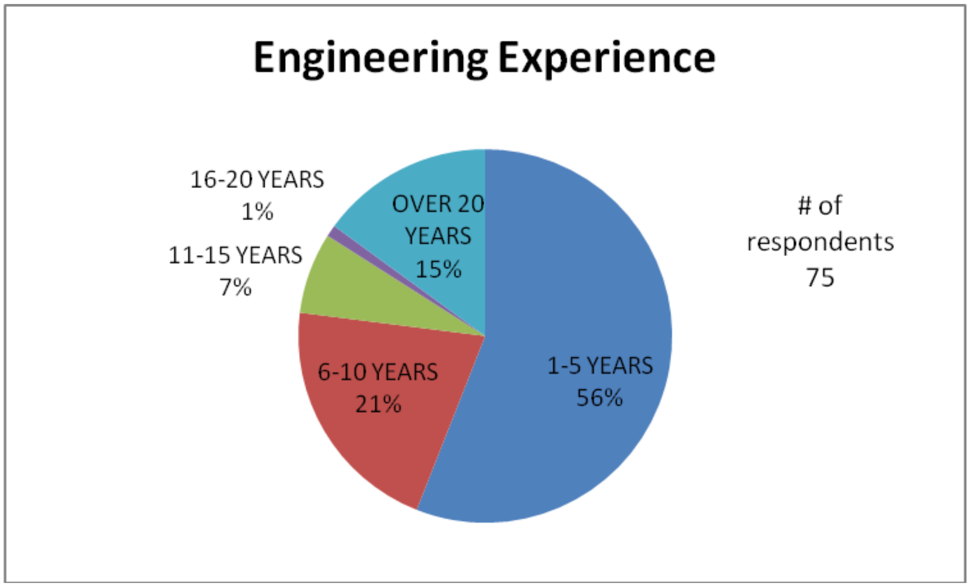

Figure 3. Engineering Experience of Survey Respondents

Of the engineers that responded, 59% of them were employed by companies or corporations which employed ten or more engineers. See Figure 4.

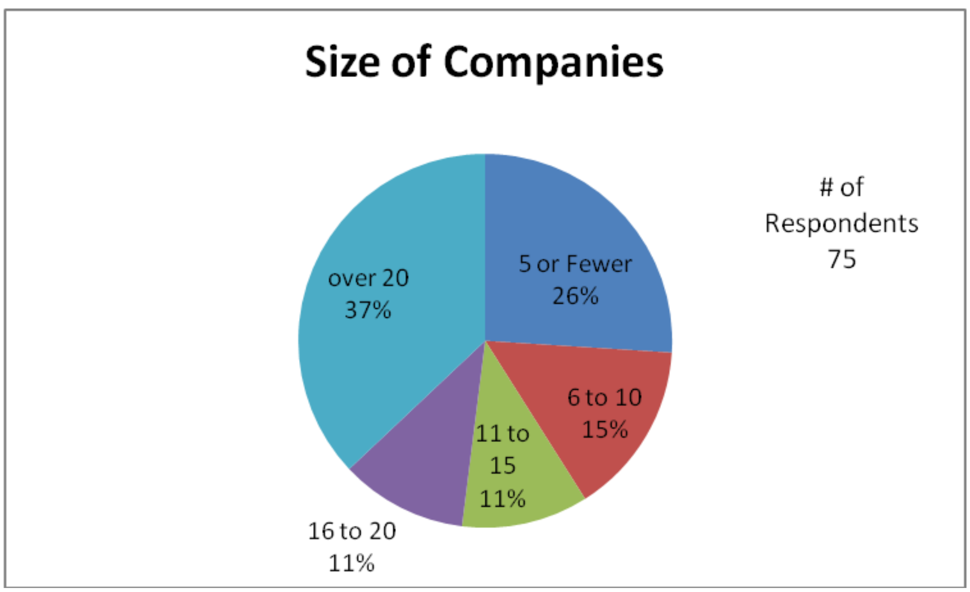

Figure 4. Company sizes

Internet usage

Around 55% of all engineers surveyed used the internet on average of one hour a day and a further 23% used it on average of two hours a day. Only around 12% of all engineers use the internet four or more hours a day. See Figure 5.

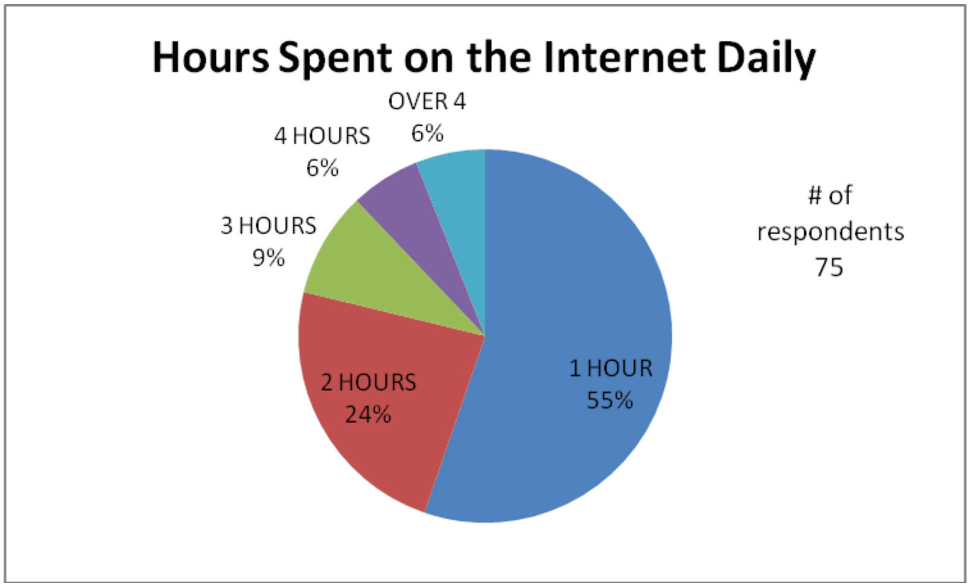

Figure 5. Internet Usage

Sources Used

During the survey the respondents were asked to rate their usage of nine sources from daily to never; and to estimate what percentage of time they found the source through an online medium[1]. All of the following data on source usage can be found in the graphs in Appendix F.

Almost two-thirds of the engineers surveyed used textbooks from monthly to never. In one of the interviews it was mentioned that although textbooks were available in the workplace, the recent trend has been for publishers to post a PDF online or create a website that has the

[1] It should be noted that the survey did not have an option of never used and some internet usage information may be misrepresented

entire text with the ability to search through it with simple key word phrase. The engineer stated that the newer engineers at his company very rarely accessed the actual hard copy textbooks in order to locate information. See Figures 6 and 7.

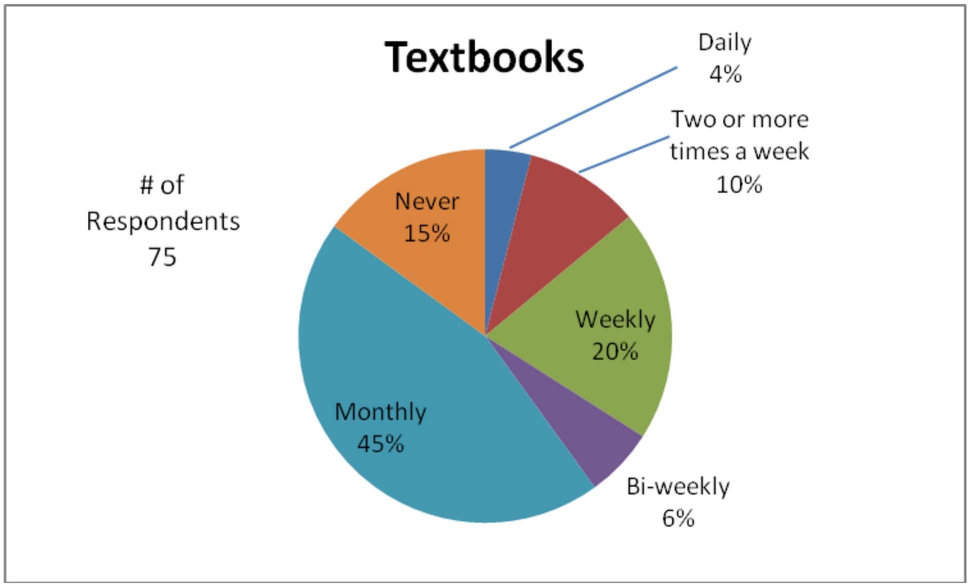

Figure 6. Textbook Usage

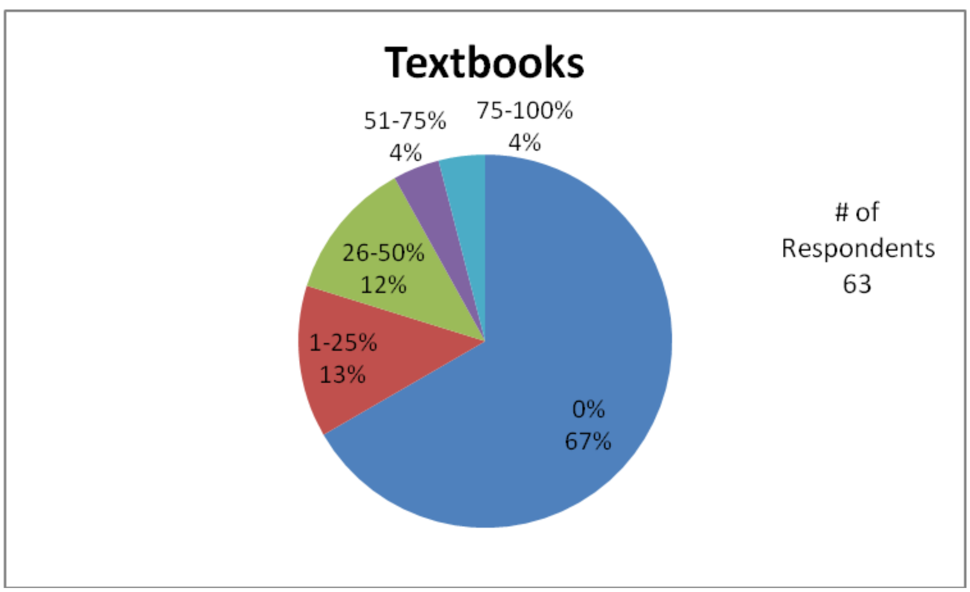

Figure 7. Percentage of Online Access to Textbooks

When asked about their journal usage; 40% of the engineers surveyed said they accessed them on a monthly basis and a further 46% marked that they never used them. Similar to textbooks, for those who used journals, searching for the desired knowledge was found to be easier through an online file and less time consuming than the printed version. Figures 8 and 9 display journal usage.

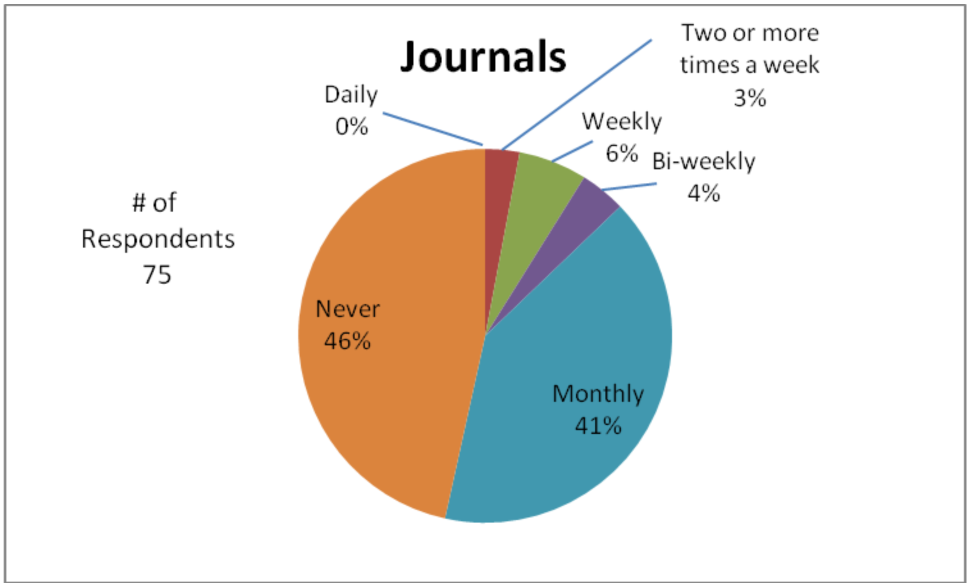

Figure 8. Journal Usage

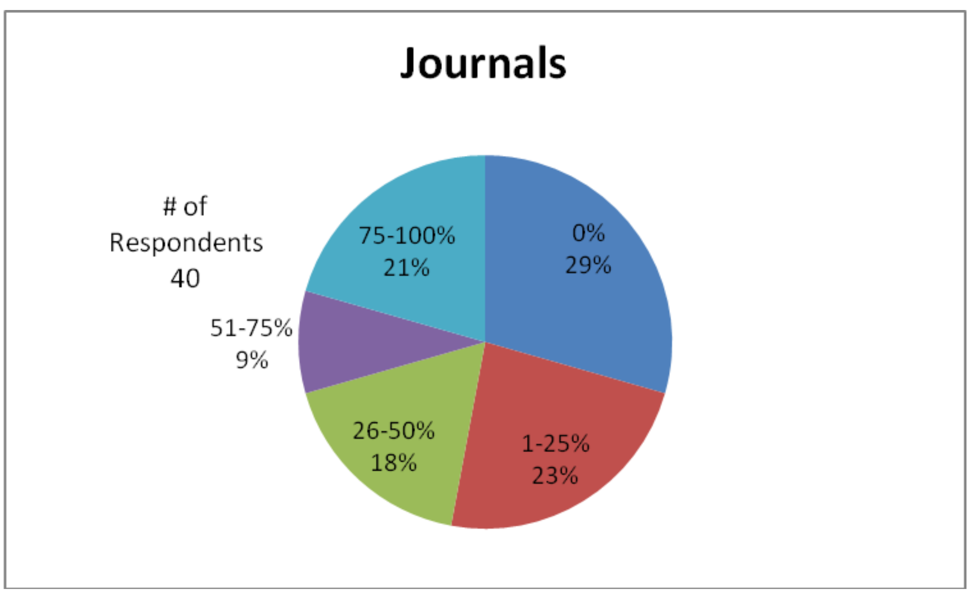

Figure 9.Percentage of Online Access to Journals

Over half of the survey respondents used vendor catalogs at least on a weekly basis, and two-thirds of the respondents went online to use them. McMaster-Carr was listed multiple times in the survey as well as in the interviews as a favorite website. Figures 10 and 11 display catalog/vendor usage.

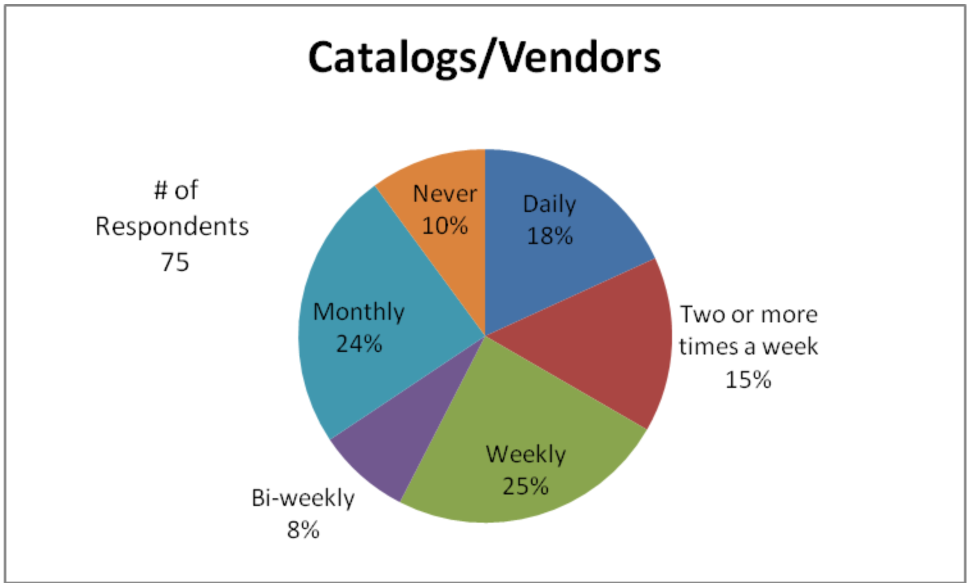

Figure 10. Catalog/Vendor Usage

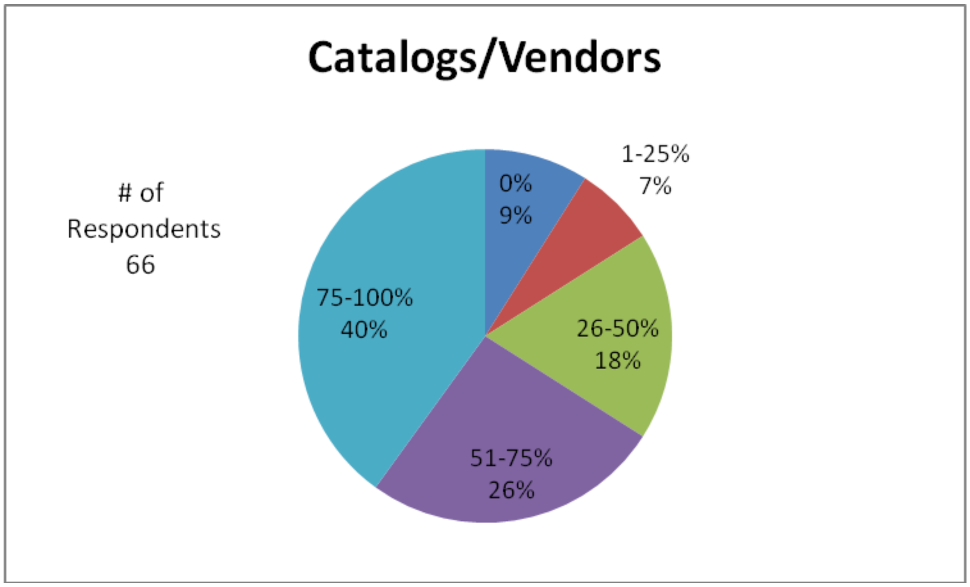

Figure 11. Percentage of Online Access to Vendor Catalogs

Half of the surveyed engineers used codes/standards at least weekly. For codes/standards, the respondents preferred using the internet. The interview respondents supported this result stating that the specific codes/standards were much quicker to locate using key word searches online versus the previous method of having to manually look up the correct information in books. Figures 12 and 13 display Codes/Standards usage.

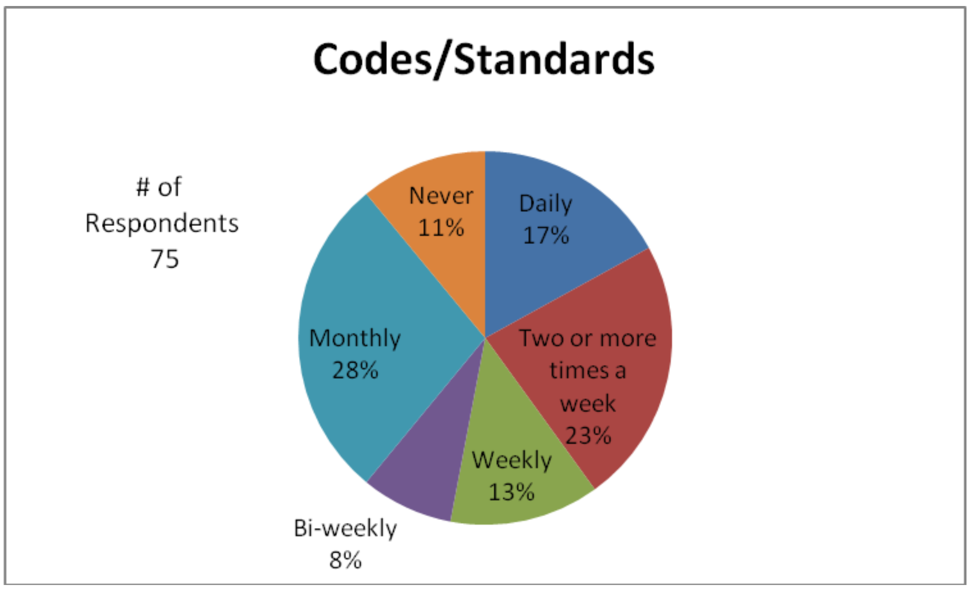

Figure 12. Codes/Standards Usage

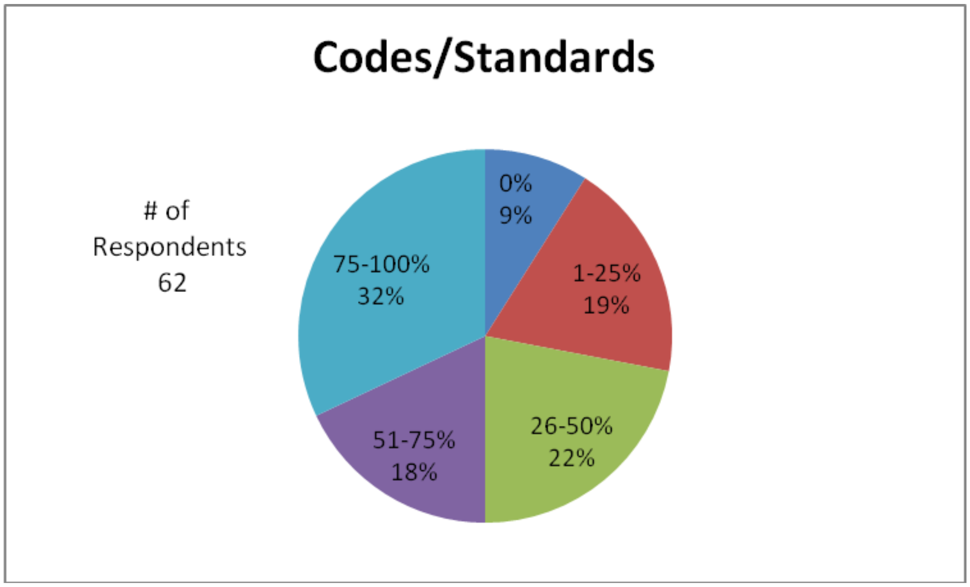

Figure 13. Percentage of Online Access to Codes and Standards

With material databases; the engineers were split with 40% accessing them daily to weekly while a further 38% used them monthly. Forty-five percent of the respondents used the internet as the main source when searching for material databases, while a further seventeen percent used the internet at least half the time in material base searches. Figures 14 and 15 display Material Database usage.

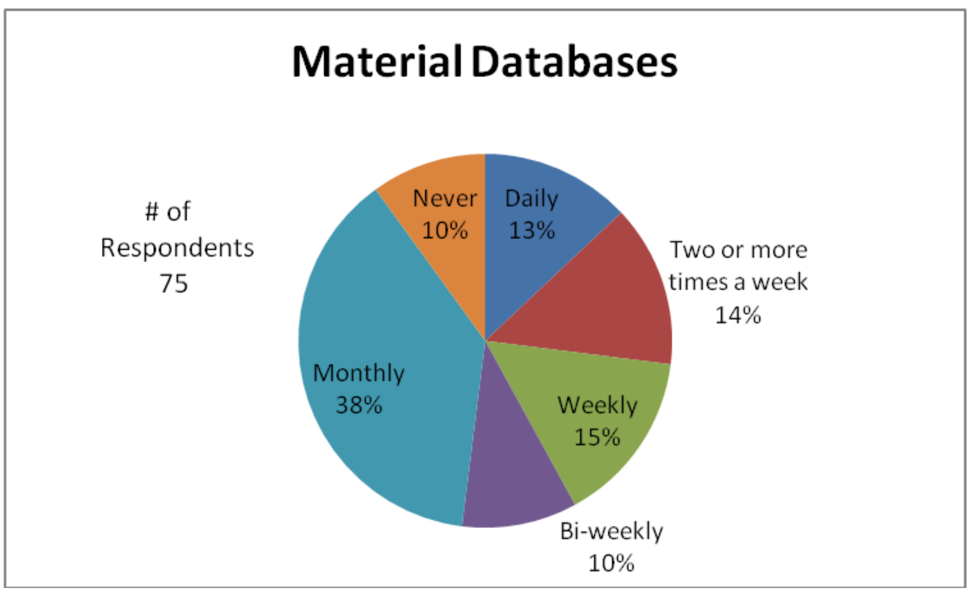

Figure 14. Material Databases Usage

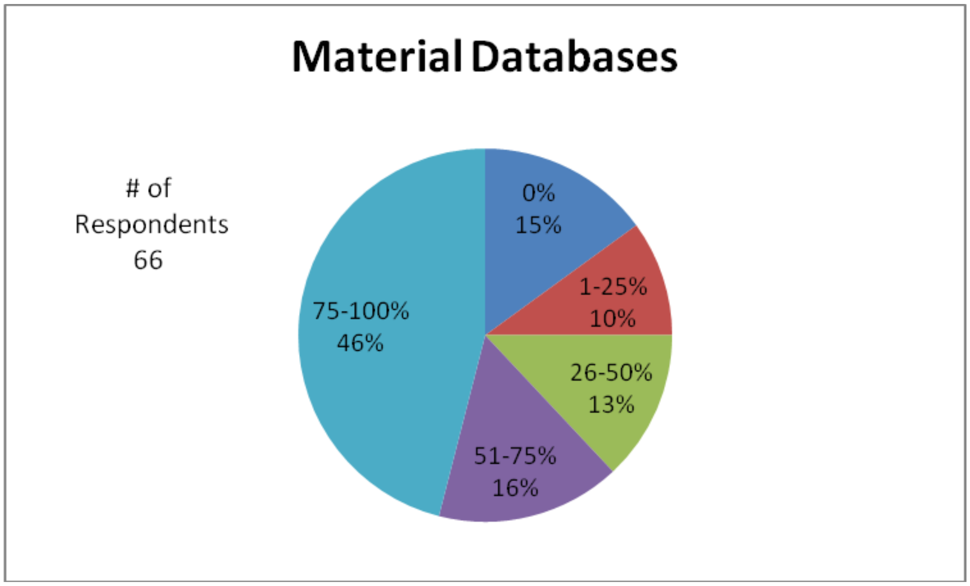

Figure 15. Percentage of Online Access to Material Databases

Very few of the respondents claimed to use information obtained from software vendors; 47% of engineers never used this source, and a further 34% sought information from software vendor websites only on a monthly basis. Figures 16 and 17 display Software Vendor usage.

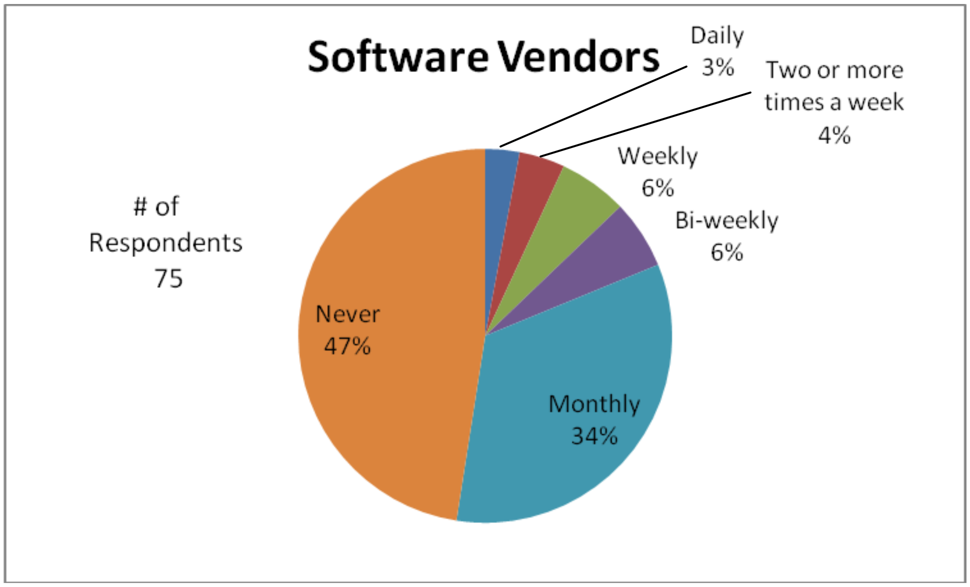

Figure 16. Software Vendor Usage

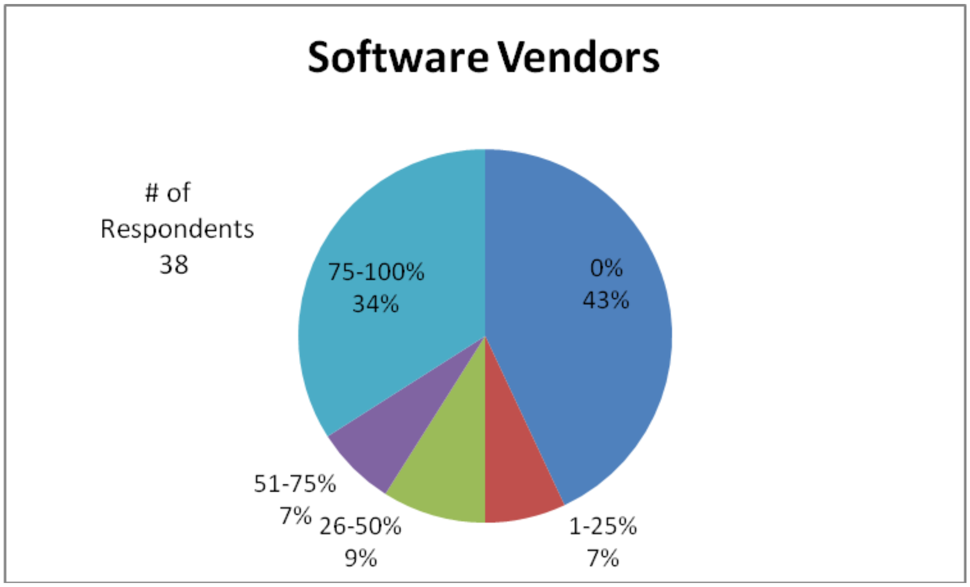

Figure 17. Percentage of Online Access to Software Vendor Data

For CAD part libraries, 30% of engineers never used them while 44% used them between daily and weekly. See figures 18 and 19.

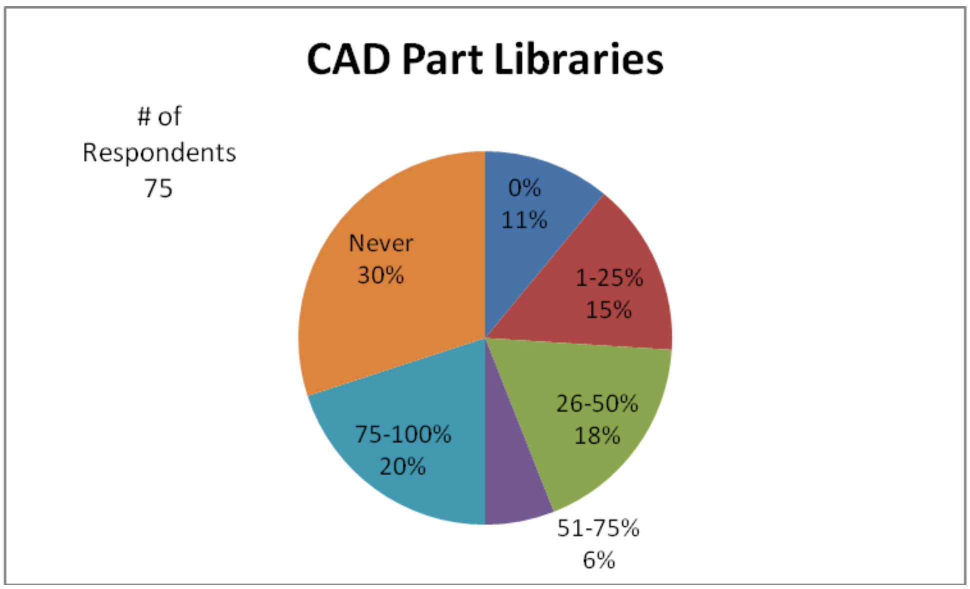

Figure 18. CAD Part Libraries Usage

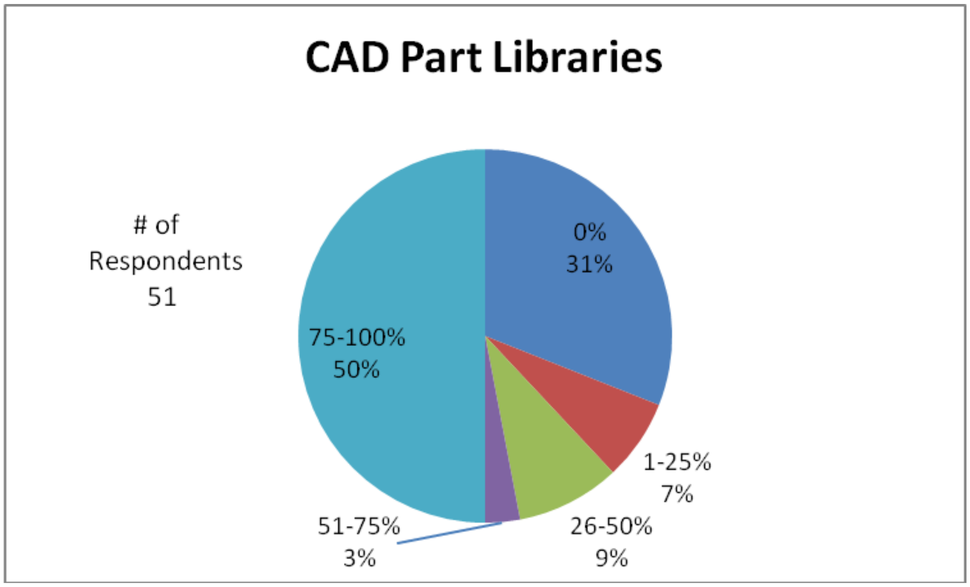

Figure 19. Percentage of Online Access to CAD Part Libraries

Seminars were used on a monthly basis by around forty-three percent of respondents and a further fifty percent never used them. From the interviews it was found that seminars were time consuming and too costly to attend on a regular basis. One engineer mentioned that seminars he had attended would take one to two days to complete. No data were recorded in the survey response for internet usage.

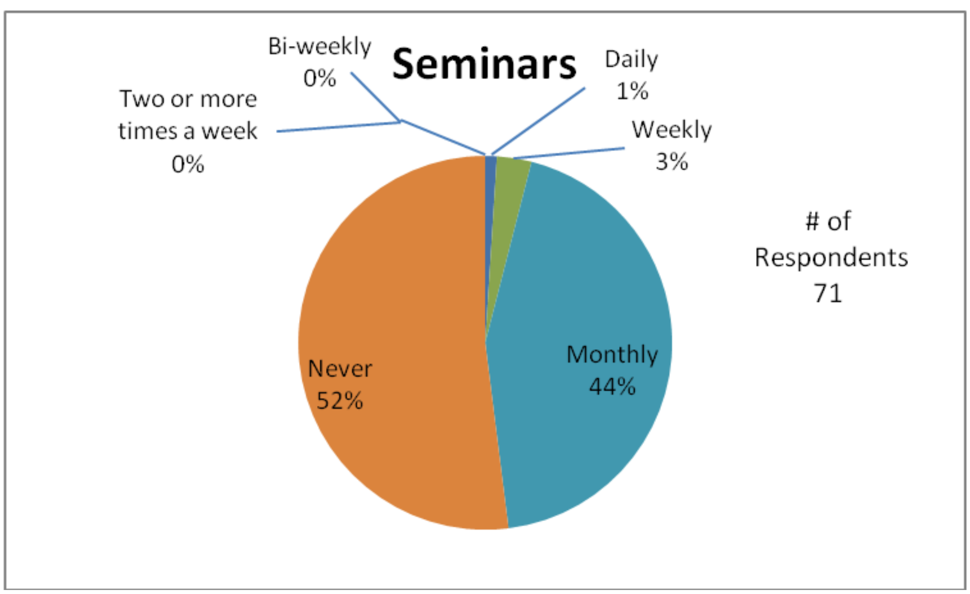

Figure 20. Seminar Usage

The final source used was colleagues, with almost 85% of the engineers using this source at least bi-weekly. No data recorded in survey for internet usage. The data from the survey is supported strongly by comments from the interviewees. Most interviewees stated that a majority of the information they used throughout the design process came from either their own personal experience or the personal experiences of their fellow company engineers. One interviewee stated that if he had trouble finding specific information he could quickly find the answer he was looking for with just two or three phone calls to other engineers in his company. Figure 21 displays how often colleagues are used as a source of information throughout the design process.

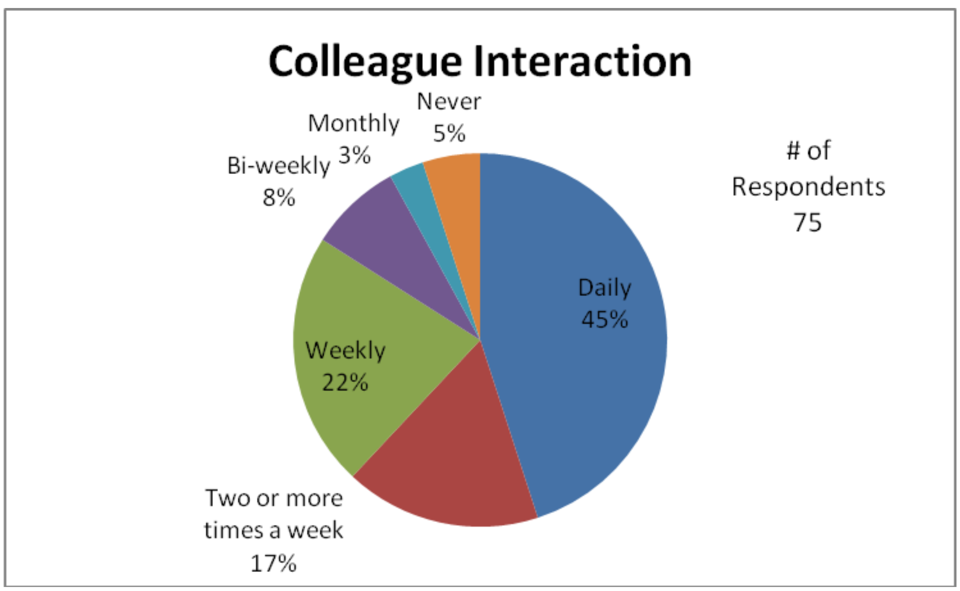

Figure 21. Colleague Interaction

The focus of the follow-up interviews was the engineering design process and why certain sources were used and what information was used at each stage of the design process. The data for the interviews can be found in Appendix E. The initial expectation was that the engineer would make mention of the sources cited from the survey such as textbooks, material databases, CAD part libraries, and help us understand when in the process they were used. Right from the start it was noted that the sources from the survey actually played a minor, secondary role. In fact, over half of the respondents to the interview stated that when they began the design process on a brand new product, or a revision of a product already being produced, they received the specifications and parameters directly from the customer. Also nine out of eleven interviewees listed in-house records and/or company databases and either their own personal expertise or the expertise of other company-employed engineers as major sources of information. In the early stages of a project engineers tended to use the internet and online searches only as a means of checking competitor websites for general ideas on what was already being offered. In the latter stages of the design process the engineer would start using manufacturer's sites, material databases, and part suppliers. Again, most of the other sources from the survey were not mentioned at all. Since over 70% of survey respondents stated that they used their colleagues as a source at least twice a week, the interviews included additional sources not covered in the surveys, such as forums, online engineering communities and webinars to see if a pattern for communicating with other engineers could be found.

In both the survey and interviews, a variety of sites were listed as being used to help find information. Many of the engineers went directly to manufacturer and vendor sites of the companies they did business with. The sites that came up frequently were McMaster-Carr in the catalogs/vendors category, MatWeb for material databases and Google for general searches.

McMaster-Carr Supply Company is a supplier to industrial and commercial facilities worldwide, specializing in materials and supplies. McMaster maintains over 465,000 products in their catalog and offers a collection of mechanical, electrical, and utility hardware. All respondents who visited McMaster-Carr found it to be the best website available for parts and it also included a great variety of downloadable models. One engineer mentioned that if McMaster-Carr does not carry the part it is either a specialty item or does not exist. The reasons for the overwhelming praise for this site include a quick and easy-to-use search engine, and recently updated user interface. One respondent felt that the McMaster-Carr website could be improved with the addition of a set of calculation tools and a more complete downloadable model library. When searching for specialty parts or for a manufacturer that can create those parts a few of the interviewees mentioned searching with ThomasNet but with less than pleasing results. As mentioned in the literature review, ThomasNet is an industrial resource that utilizes a search engine to list manufacturers, distributors, and service providers. The site offers the ability of a search with a search engine or a categorized search of more than 67,000 categories/products. The companies listed are companies that advertise with Thomas. As the site is vendor supported, the information is limited by the availability of the companies participating with the site. ThomasNet was cited by two engineers as an example of an online site that was difficult and unwieldy to use. One engineer mentioned "he hated" ThomasNet. A key problem with the site is that there is no due diligence done by the ThomasNet website to ascertain whether or not companies really do provide the services they profess on the site. One engineer mentioned that there are companies that list that they specialize in various categories when in fact upon calling or emailing said companies they have little to no experience in such categories.

Forums

Of the eleven interviewees, only seven have ever used a forum and of those seven only one had ever posted to a forum or responded to another person's question. The main issue raised by both users and nonusers was reliability. In most cases forums are open to the public and there is no way to validate any data found. For those who do visit the forums only one interviewee said that he found them effective. He found it quicker to find the information he needed reading through the forums than actually going to the vendors' websites; if he could not find the answer he would post a question, but that was very rare. The others found forums to be difficult to navigate, searches ended without results being garnered, and only general information was available. For those who do not use the forums at all it was an issue of not wanting to share proprietary information coupled with lack of reliability inherently found in such sites. The majority of the interviewees mentioned that they usually went directly to or called colleagues that they knew and trusted to find the answers rather than actually going to the internet forums.

Online Engineering Communities

Online Engineering communities were included in our investigation because we felt that the engineers would trust and use websites that were specifically designed with engineers in mind. When asked about whether or not they belonged to online engineering communities the vast majority surprisingly said no. The engineers interviewed largely agreed that using the online communities as a source of information gathering was time consuming and ineffective. The forums are hard to navigate, posting questions and receiving answers can take hours if not days and the validity of the information posted is questionable. Only three of the engineers interviewed had ever belonged to a community, and their experience was mixed. One had belonged to eFunda. It is a website where engineers can find information to meet their daily reference needs. It is also an online publisher, not a collection of hyperlinks. The website professes that everything available on eFunda is original content. Each article, each table, and each illustration were created by the staff. The engineer in question had found belonging to eFunda to be an awful waste of money as nothing the site offered could not be found somewhere else for free, and the site was poorly updated. Two other engineers mention that they belonged to Eng-Tips also known as Engineering Tips, which is a free engineering based site. Eng-Tips offers access to a forum-based community. The site is a link-based site wherein a user follows links until he or she is presented with a discussion site. Since the site is supported by the community the speed of response and validity of the information is relative to the knowledge and experience of the community. Both engineers liked Eng-Tips but did not give any specifics. One mentioned that he read the forums and that was all. Belonging to the communities was stated by all three as being a social outlet but not necessarily as a means to facilitate or assist with the design process. Those who had not belonged to an online engineering community had no desire to join one in the future stating that they felt either the communities were an unreliable source of information or that they could get the information just as easily from other engineers they either knew or worked with. Figure 22 clearly shows that the majority of interviewees do not use online engineering communities.

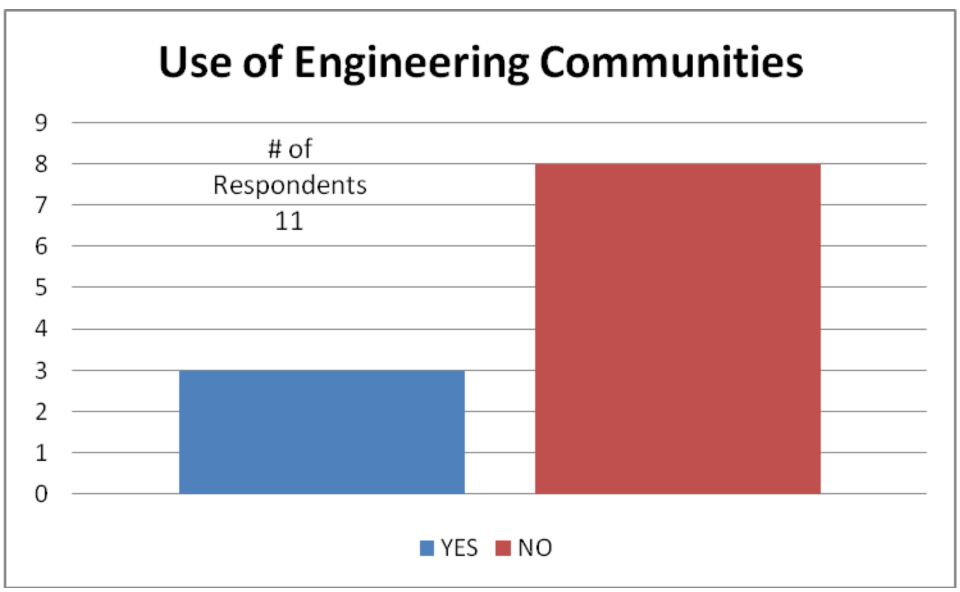

Figure 22. Engineering Community Usage

Webinars

Eight of the eleven interviewees stated that they had used webinars. The frequency with which they participated ranged from once a year to daily. Of the eight, only one found the experience to be unhelpful; stating that the potential for large audiences made it difficult for the webinars to specialize on the exact needs of individual participants. The rest of the participants all had good things to say about their experiences, finding webinars to be useful and effective in conveying a message to the end user quickly and conveniently. In many cases the engineer's cost was covered by the company. Overall the consensus was that webinars were a much cheaper and quicker way to exchange information than traditional seminars or face-to-face meetings.

5 Conclusions

After looking through both the survey and interview data some clear trends can be seen. With the exception of colleagues and vendor catalogs, most engineers utilized each source primarily on a monthly basis. The large majority of mechanical design engineers surveyed and interviewed sought the assistance of their colleagues for work-related information at least on a bi-weekly basis. Although the engineers agreed that they used their colleagues as a source, very few actually went online to forums or online communities to find them. Most preferred to speak directly to the engineers that they knew and trusted; this ensured not only that the information was relevant to their work but that it would be found in a relatively short period of time. Another fact that can be drawn from the data is that webinars are becoming an effective and cost efficient way in which companies and engineers can transfer information and receive training. Online communities and forums were seen by the majority of those interviewed as time consuming and unreliable mediums to find information. Websites like McMaster-Carr which were easily navigable and constantly updated and maintained received the highest praises and marks. Any website which is constructed must address the issues and concerns expressed by the engineers surveyed and interviewed. These include the relevance and reliability of the information contained in the website and the ease with which it can be found.

References:

Adkins, Sam S.. "The Brave New World of Learning." 01 06 2003 28-37. 23 Jan 2009

All Conference Service.2009.All services Sys. 12 Jan 2009.<www.allconferenceservices.com>

Argonne National Library "International Nuclear Safety Center".
(11-12-2008) {http://www.insc.anl.gov}

ASME International. "ASME.org". (11-17-2008) {http://www.asme.org}
Autodesk. 2009.Autodesk Software.<http://www.autodesk.com>

Automation Creations, Inc.. "MatWeb: Material Property Database. (11-10-2008)
{http://www.matweb.com}

Boulton, Clint. "Web Conferencing fills void in tight times." eWeek 05 Jan 2005 14-16. Accessed 6 Jan 2009

Brown, Lorra. "Internet protocol." Tactics of public relations (2008): 24.

Business Wire, "Knovel Significantly Increases Productivity of Mechanical Engineers According to ASME Member Study." (26/01/2009

Design News. 2009. Reed Business Information. 14 Dec 2008. <http://www.designnews.com/>

ENG-Tips Forums. 2009. Tecumseh Group. 15 Oct 2008. <http://www.eng-tips.com/>

Denning, Peter . "Wikipedia Risks." COMMUNICATIONS OF THE ACM Dec 2005

Genamics. "Genamics JournalSeek". (11-22-2008) {http://journalseek.net/index.htm}

GlobalSpec. "Global Spec". (11-14-2008) {http://www.globalspec.com}

Gordon, Kim T.. "Marketing Presentations Go Virtual." Entrepreneur Dec 2008: 79.

JAHM Software. "JAHM Software". (11-07-2008) {http://www.jahm.com}

Jackson, Peter. "The growth of online communities." 04 Dec 2004 <http://www.pcw.co.uk/personal-computer-world/features/2170092/lurkers-trolls-sock-puppets?vnu_lt=pcw_art_related_articles>.

Knovel. 2008. Knovel Corporation. 22 Feb 2009. <http://www.knovel.com>

Matthias Schonlau, Ronald D. Fricker, Jr. and Marc N. Elliot (2002). Conducting research surveys via e-mail and the web. RAND

McGraw-Hill Companies. “Digital Engineering Library”. (11-12-2008) {http://www.digitalengineeringlibrary.com}

National Institute of Standards and Technology. “NIST”. 11-02-01 (11-12-2008) {http://www.nist.gov}

Preece, J. (2000). *Online communities: Designing usability, supporting sociability.* Chichester,England: John Wiley & Sons.

QuestionPro. 2009. {http://www.questionpro.com}

Robert Groves, Floyd J. Fowler, Jr., Mick P. Couper, James M. Leplowski, Eleanor Singer and Roger Tourangeay (2004). Survey Methodology. Wiley

Salim, Nancy. "Engineers: Work on Your Networking Skills." The Institute 05 02 2005, 4 Jan 2009 <http://www.theinstitute.ieee.org/portal/site/tionline/menuitem.130a3558587d56e8fb2275875bac26c8/index.jsp?&pName=institute_level1_article&TheCat=2201&article=tionline/legacy/inst2006/feb06/2w.gold.xml&>-

Solidworks. 2009. Dassault Systèmes. 25 Sep 2008. < http://www.solidworks.com/>

Tecumseh Group. “ENG-TIPS FORUMS”. (11-04-2008) {http://www.eng-tips.com}

Thomas Publishing Company, LLC. “ThomasNet”. (11-14-2008) {http://www.thomasnet.com}

Tseng, Judy Cr., Wen-Ling Tsai, Gwo-Jen Hwang, and Po-Han Wu. "An Efficient and Effective Approach to Developing Engineering E-training courses ." International Journal of Distance Education Technologies. 5(2007): 37-53.

University Library University of Illinois at Urbana-Champaign. “Grainger Engineering Library Web Menu” (11-17-2008) {http://web.library.uiuc.edu/grainger/resrc/englib/Englibge.htm}

U.S Bureau of Statistics Office of Occupational Statistics and Employment Projections, 2009.

U.S. Census Bureau, International Database, and *The World Factbook, 2005*
Granta Design Limited. “Granta: Material Intelligence”. (12-06-2008) http://www.grantadesign.com

Appendix A:

Alumni Relations Information Request

Our Engineer Design Team is currently working on an IQP. In order to gain sufficient background information on our subject matter we would like to send a survey out to a select group of WPI alumni. The target of the alumni relations information request is all mechanical engineers. The survey and letter that we will be sending them is attached to this email. Thank you very much for your time and effort. We will be happy to provide any further information that you require.

Sincerely,

The EDN Team

Appendix B:

Attention Worcester Polytechnic Institute Alumni

The Engineer Design Team from WPI is working on an IQP project that assesses the need for mechanical engineers to obtain practical information used throughout the design process utilizing the internet as a resource. This research includes a host of issues ranging from what sources mechanical engineers utilize when looking for information, to what online engineering communities they might belong to.

We are hoping to augment our research of scholarly journals and texts with actual responses from designers and design engineers in the field who deal with these issues as a part of their weekly, if not daily operations. This research will lead to the development of an online resource site for practicing engineers; created specifically to help the mechanical design engineer.

An integral part of this research depends on your ability to assist us. The more responses we receive in regards to this survey the better able we will be at forming a comprehensive picture on what is available currently, and what is needed or desired in the design process.

Attached is a link where you will find a relatively short survey, please copy and paste the link into your web browser. If you are a mechanical designer or design engineer and would like to participate, or know anyone else who would be able to answer this survey please forward this email to them as well. The project members would be most appreciative for your support. Our email contact is edn@wpi.edu . Please feel free to contact us with any information that you have. Thank you very much for your time and cooperation.

SURVEY LINK = http://www.questionpro.com/akira/TakeSurvey?id=1162463

Sincerely,

The EDN Team

Appendix C:

6%

Engineer Design Team Survey

Thank you for choosing to take our survey. It should take no more than 10 minutes to complete

Questions marked with a * are required

12%

Engineer Design Team Survey

---

1. **What category best describes your work responsibilities?** *

- design
- management
- marketing
- manufacturing
- Other

Questions marked with a * are required

18%

Engineer Design Team Survey

1b. **How long have you worked in your current position?** *

- 1-5 years
- 6 - 10 years
- 11 – 15 years
- 16 – 20 years
- over 20

Questions marked with a * are required

25%

Engineer Design Team Survey

---

2. **What category best describes your industry?** *

- aerospace
- energy
- automotive
- medical
- high technology
- consumer products
- Other

Questions marked with a * are required

31%

Engineer Design Team Survey

3. **How many engineers are in your department?** *

- 5 or fewer
- 6-10
- 11 -15
- 16 – 20
- over 20

Questions marked with a * are required

37%

Engineer Design Team Survey

---

4. **How often do you consult these resources:**

	Daily	Two or more times a week	Weekly	Bi-weekly	Monthly	Never
Textbooks *	○	○	○	○	○	○
Journals *	○	○	○	○	○	○
Catalogs/vendors *	○	○	○	○	○	○
Codes/standards *	○	○	○	○	○	○
Material databases *	○	○	○	○	○	○

Software vendors *	○	○	○	○	○	○
CAD part libraries *	○	○	○	○	○	○
Seminars *	○	○	○	○	○	○

Questions marked with a * are required

43%

Engineer Design Team Survey

4a. **What percentage of each of the following resources do you access online?**

	0%	1-25%	26-50%	51-75%	76-100%
Textbooks *	○	○	○	○	○
Journals *	○	○	○	○	○

Catalogs/vendors *	○	○	○	○	○
Codes/standards *	○	○	○	○	○
Material databases *	○	○	○	○	○
Software vendors *	○	○	○	○	○
CAD part libraries *	○	○	○	○	○

56%

Engineer Design Team Survey

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5. **Please list your most frequented source for each resource, if the source is online please type www before the name of the source**

Textbooks

Journals

Catalogs/vendors

Codes/standards

Material databases

Software vendors

CAD part libraries

Questions marked with a * are required

62%

6. **How often do you get information from your colleagues (to assist with the work process)?** *

- Daily
- Two or more times a week
- Weekly
- Bi-weekly
- Monthly

Never

Questions marked with a * are required

68%

1162463 | 13208593 | false | submit

7. **How many hours/day do you use the internet to obtain information relevant to your re as a designer? (not including emails or company files)** *

- 1 hour
- 2 hours
- 3 hours
- 4 hours
- over 4 hours

Questions marked with a * are required

81%

Engineer Design Team Survey

8. **If possible please list up to five online engineering communities that you use in your work process. (Forums, ASME, etc.)**

1.

2.

3.

4.

5.

87%

Engineer Design Team Survey

9. **Please list other important resources you utilize that have not been mentioned.**

100%

Engineer Design Team Survey

This research will lead to the development of an online resource site for practicing engineers; created specifically to help the mechanical design engineer. An integral part of this research depends on your ability to assist us. Along with this survey the team will be interviewing mechanical design engineers. If you are willing to lend your time for a ten to twenty minute interview please send contact information to edn@wpi.edu include the best time to reach you.
Thank You,
The EDN Team

Contact Information (if you wish to participate in a 10 to 20 minute interview)

Appendix D:

Engineering Design Community Questionnaire

1. Do you use any online material property databases? Please list

2. Do you belong to any online engineering communities? Please list

3. What is the biggest problem with collecting information over the internet?

4. What other resources aid you in your work responsibilities?

The EDN Team is attempting to identify the preferences and needs of the design mechanical engineer. This research depends greatly on the response form the professional community. If you would like to lend your time for a longer interview please leave your information here or contact the team via email. (edn@wpu.edu)

Appendix E:

What Types of Information are Used During The Design Process	
Interviewee #	Response:
1	·Field of view requirements for device ·Parameters ·How Big of a package does customer want·
2	·Largely provided by customer ·Data sheets ·Assembly procedure
3	·Specifications ·Size, materials cost ·Material specifications/shapes specs ·Weld design/material
4	·Issues that need to be solved
5	·Accelerations ·Specs for projectiles
6	·Level of protection needed ·3-d cad models of vehicles
7	·magazine capacity
	·hardness ·customer provided
8	·Stress analysis tests ·What has been done before? Improve on that.
9	·How to orient products ·How to make the smallest footprint possible
	·magazine capacity
11	·Architecture for product ·High level components ·Hand calculations ·General cost estimates ·Competitive benchmarking ·Checking for copyright infringement

Sources Used to find the Information	
Interviewee #	Response:
1	·Largely from the customer ·Educated guesses from observation, or from the news to determine what is necessary ·Handbooks on optical design ·World Wide Web ·Employees Experience
2	·Largely from the customer ·Internet research to check competition ·Use company proprietary information
3	·Customer supplied ·In house
4	·General knowledge ·Company databases
5	·Customer supplied ·Old designs/tests ·In house
6	·From the customer ·Domestic government ·Foreign government ·In house
7	·In house ·Previous models ·Competitors models ·Management ·Shop manuals ·Material companies databases ·Go to technical support (of product) to find specific answers
8	·Past models ·Company databases ·Mill handbooks ·Other engineers in the company
9	·Customer supplied
10	·Company databases ·Competitors models
11	·Checking competitors websites
	·Gym memberships ·Periodicals ·Textbooks

Forum Usage				
Interviewee #	Do you Use Forums?	Do you post to forums?	Do you answer questions on forums?	How effective do you find forums?
1	No	No	No	·Questions reliability/ information is proprietary does not want to communicate with competitors
2	Yes	No	No	·Reads questions- just general information ·Uses forum to point down a direction ·Get ball rolling ·Helps to focus search
3	Yes	No	No	·Uses them rarely, not effective
4	Yes	No	No	·Occasionally reads forums ·Does not post ·Not very effective, finds pertinent info 25% of the time ·Lots of info that isn't reliable
5	Yes	No	No	·Uses as a starting point sometimes to get ideas
6	No	No	No	·Information needed is not located in forums
7	Yes	No	No	·Uses them rarely, not effective
8	No	No	No	·Does not find them useful
9	Yes	No	No	·Looks at forums for ideas ·More effective than going to vendors websites
10	No	No	No	·Information needed not found on forums
11	Yes	No	No	·No one gives away proprietary info/no one does your homework for you ·Likes them to an extent

Webinars			
Interviewee #	Do you use Webinars	How often?	How helpful/effective are they?
1	Yes	monthly	·Works well
2	Yes	rarely	·Last experience was awful ·Potential for incredibly large audience, information presented was at too high of a level
3	Yes	Bi-monthly	·Helpful for current projects, and for developing ideas for future projects
4	No	N/A	N/A
5	No	N/A	N/A
6	Yes	Bi-yearly	Very effective used one consistently everyday for 2 months
7	Yes	rarely	Likes them, but would rather participate in a seminar to get whole experience vs. being distracted in ones office Not much time to review data, over quickly
8	Yes	often	Very useful, uses webex all the time Likes the flexibility of listening when has time
9	Yes	Yearly	More effective than going to seminar Likes them/ puts a lot on your plate
10	No	N/A	N/A
11	Yes	often	Used them for software updates Very effective for software Likes that the content is in bite sized chunks, use at ones leisure Usually free for the engineer, cost covered by company

Internet Sites Used throughout Design Process		
Interviewee #	What Sites do you use?	Comments
1	www.matweb.com	
2	www.matweb.com	
	www.mcmastercarr.com	makes it easy
	various manufacturers sites	
	www.google.com	
3	www.MSEsoftware.com	
	www.matweb.com	
	www.knovel.com	
	www.mcmastercarr.com	
4	www.netscape.net	
5	www.mcmastercarr.com	
	www.matweb.com	okay but slightly confusing
6	www.fedbizopps.com	
	www.google.com	
7	www.mcmastercarr.com	
	www.grainger.com	
	www.globalspec.com	
8	www.knovel.com	
	www.esdu.com	
	AIAA journals	
9	www.google.com	
	www.wimba.com	
	www.mcmastercarr.com	loves it, cheapest and most reasonable. Very nice search engine
	www.thomasnet.com	search takes to much time
10	www.mcmastercarr.com	
	www.grainger.com	
11	www.mcmastercarr.com	no calculation tools, best website overall or getting ideas on what's available, great downloadable models (but they don't have everything)
	www.thomasnet.com	Problem is they allow vendors to list company specialties, queries for a particular item will generate responses from people who have only made part once. Companies make sure they show up in every search/not enough diligence done by thomasnet

www.globalspec.com	
www.knovel.com	considered membership but they charge per category and you cannot choose which categories you get, so charged for everything, even ones you don' t use.

Online Engineering Communities		
Interviewee #	Do you belong to any Online Engineering Communitites?	How helpful/effective do you find them?
1	No	N/A
2	Yes	·Engtips- good, reads the forums
		·Efunda-awful nothing available that wasn't free somewhere else, never updated it
3	Yes	N/A
4	No	N/A
5	No	·Cannot use due to information being sensitive
6	No	N/A
7		N/A
8	No	N/A
9	No	N/A
10	No	N/A
11	Yes	·Engtips

Suggestions		
Interviewee #	Any suggestions for a better site?	Any suggestions for Solidworks?
1	site should be designed to surround user with what they need (all data necessary for particular job)	N/A
	websites should get cooperation of manufacturer to post info on it directly	N/A
	keep things fairly shallow. i.e . Number of levels needed to search through to find part	N/A
2	either mimic McMaster or link into it	loves design intent, make it harder to model without design intent built in
3	N/A	N/A
4		
5	machineries handbook should be online completely, with calculation tools included	N/A
6	N/A	N/A

7	create a search engine that lets you search within a search. Type in key word generate list of possible. Type in a new key word/phrase and now only search within first list. Keep going until search is narrowed down.	N/A
8	create a way to filter information by type such as commercial airplanes vs. Airplane built in garage	
9	N/A	N/A
10	N/A	N/A
11	partner with McMasters versus imitating	3-D content central is a mishmash of good and terrible models, set up a rating system where end users can rate the models for reliability, then list the models based on the rating system.
		tolerance analysis needs to be improved very good finite element analysis, should expand them through webinars. Should tie in more webinars to cosmosworks products calculating sheer center- does not believe solidworks has this feature, if not should add it.

Appendix F:

Survey Statistics

Viewed	172
Started	87
Completed	63
Completion Rate	72.41%
Drop Outs (After Starting)	24

- Average time taken to complete survey : 7 minute(s)

1. **What category best describes your work responsibilities?**

Frequency Analysis

	Answer	Count	Percent	20% 40% 60% 80% 100%
1.	**design**	**76**	**100.00 %**	
2.	management	0	0.00%	
3.	marketing	0	0.00%	
4.	manufacturing	0	0.00%	
5.	Other	0	0.00%	
	Total	**76**	**100%**	

Key Analytics

Mean	1.000
Confidence Interval @ 95%	[1.000 - 1.000] n = 76
Standard Deviation	0.000
Standard Error	0.000

1b. **How long have you worked in your current position?**

Frequency Analysis

	Answer	Count	Percent	20% 40% 60% 80% 100%
1.	**1-5 years**	**42**	**56.00 %**	
2.	6 - 10 years	16	21.33%	
3.	11 ? 15 years	5	6.67%	
4.	16 ? 20 years	1	1.33%	
5.	over 20	11	14.67%	
	Total	**75**	**100%**	

Key Analytics

Mean	1.973
Confidence Interval @ 95%	[1.651 - 2.295] n = 75
Standard Deviation	1.423
Standard Error	0.164

Key Facts

- **77.33%** chose the following options :
  - 1-5 years
  - 6 - 10 years
- Least chosen option **1.33%** :
  - 16 ? 20 years

2. **What category best describes your industry?**

Frequency Analysis

	Answer	Count	Percent	20% 40% 60% 80% 100%
1.	aerospace	18	24.66%	
2.	energy	11	15.07%	
3.	automotive	3	4.11%	
4.	medical	3	4.11%	
5.	high technology	6	8.22%	
6.	consumer products	8	10.96%	
7.	**Other**	**24**	**32.88 %**	
	Total	**73**	**100%**	

Key Analytics

Mean	4.205
Confidence Interval @ 95%	[3.626 - 4.785] n = 73
Standard Deviation	2.527
Standard Error	0.296

Key Facts

- **57.53%** chose the following options :
  - Other
  - aerospace
- Least chosen option **4.11%** :
  - automotive

3. **How many engineers are in your department?**

Frequency Analysis

	Answer	Count	Percent	20% 40% 60% 80% 100%
1.	5 or fewer	19	26.03%	
2.	6-10	11	15.07%	
3.	11 -15	8	10.96%	
4.	16 ? 20	8	10.96%	
5.	**over 20**	**27**	**36.99 %**	
	Total	**73**	**100%**	

Key Analytics

Mean	3.178
Confidence Interval @ 95%	[2.795 - 3.561] n = 73
Standard Deviation	1.670
Standard Error	0.195

Key Facts

- **63.01%** chose the following options :
  - over 20
  - 5 or fewer
- Least chosen option **10.96%** :
  - 11 -15

4. **How often do you consult these resources:**

Textbooks

Frequency Analysis

	Answer	Count	Percent	20% 40% 60% 80% 100%

1.	Daily	3	4.23%	
2.	Two or more times a week	7	9.86%	
3.	Weekly	14	19.72%	
4.	Bi-weekly	4	5.63%	
5.	**Monthly**	**32**	**45.07%**	
6.	Never	11	15.49%	
	Total	**71**	**100%**	

Key Analytics

Mean	4.239	**Key Facts** • **64.79%** chose the following options : ○ Monthly ○ Weekly • Least chosen option **4.23%** : ○ Daily
Confidence Interval @ 95%	[3.909 - 4.569] n = 71	
Standard Deviation	1.419	
Standard Error	0.168	

Journals

Frequency Analysis

	Answer	Count	Percent	20% 40% 60% 80% 100%
1.	Daily	0	0.00%	
2.	Two or more times a week	2	2.82%	
3.	Weekly	4	5.63%	
4.	Bi-weekly	3	4.23%	
5.	Monthly	29	40.85%	
6.	**Never**	**33**	**46.48%**	
	Total	**71**	**100%**	

Key Analytics

Mean	5.225	**Key Facts** • **87.32%** chose the following options : ○ Never
Confidence Interval @ 95%	[4.999 - 5.452] n = 71	
Standard Deviation	0.974	

Standard Error	0.116	○ Monthly

Catalogs/vendors

Frequency Analysis

	Answer	Count	Percent	20% 40% 60% 80% 100%
1.	Daily	13	18.31%	
2.	Two or more times a week	11	15.49%	
3.	**Weekly**	**17**	**23.94%**	
4.	Bi-weekly	6	8.45%	
5.	Monthly	17	23.94%	
6.	Never	7	9.86%	
	Total	**71**	**100%**	

Key Analytics

Mean	3.338	
Confidence Interval @ 95%	[2.953 - 3.723] n = 71	
Standard Deviation	1.656	
Standard Error	0.196	

Key Facts

- **47.89%** chose the following options :
  - Weekly
  - Monthly
- Least chosen option **8.45%** :
  - Bi-weekly

Codes/standards

Frequency Analysis

	Answer	Count	Percent	20% 40% 60% 80% 100%
1.	Daily	12	16.90%	
2.	Two or more times a week	16	22.54%	
3.	Weekly	9	12.68%	
4.	Bi-weekly	6	8.45%	
5.	**Monthly**	**20**	**28.17%**	
6.	Never	8	11.27%	

	Total	**71**	**100%**	

Key Analytics

Mean	3.423
Confidence Interval @ 95%	[3.020 - 3.825] n = 71
Standard Deviation	1.729
Standard Error	0.205

Key Facts

- **50.7%** chose the following options :
  - Monthly
  - Two or more times a week
- Least chosen option **8.45%** :
  - Bi-weekly

Material databases

Frequency Analysis

	Answer	Count	Percent	20% 40% 60% 80% 100%
1.	Daily	9	12.68%	
2.	Two or more times a week	10	14.08%	
3.	Weekly	11	15.49%	
4.	Bi-weekly	7	9.86%	
5.	**Monthly**	**27**	**38.03%**	
6.	Never	7	9.86%	
	Total	**71**	**100%**	

Key Analytics

Mean	3.761
Confidence Interval @ 95%	[3.385 - 4.137] n = 71
Standard Deviation	1.617
Standard Error	0.192

Key Facts

- **53.52%** chose the following options :
  - Monthly
  - Weekly
- Least chosen option **9.86%** :
  - Bi-weekly

Software vendors

Frequency Analysis

	Answer	Count	Percent	20% 40% 60% 80% 100%
1.	Daily	2	2.82%	
2.	Two or more times a	3	4.23%	

	week			
3.	Weekly	4	5.63%	
4.	Bi-weekly	4	5.63%	
5.	Monthly	24	33.80%	
6.	**Never**	**34**	**47.89%**	
	Total	**71**	**100%**	

Key Analytics

Mean	5.070
Confidence Interval @ 95%	[4.775 - 5.366] n = 71
Standard Deviation	1.269
Standard Error	0.151

Key Facts

- **81.69%** chose the following options :
  - Never
  - Monthly
- Least chosen option **2.82%** :
  - Daily

CAD part libraries

Frequency Analysis

	Answer	Count	Percent	20% 40% 60% 80% 100%
1.	Daily	8	11.27%	
2.	Two or more times a week	11	15.49%	
3.	Weekly	13	18.31%	
4.	Bi-weekly	4	5.63%	
5.	Monthly	14	19.72%	
6.	**Never**	**21**	**29.58%**	
	Total	**71**	**100%**	

Key Analytics

Mean	3.958
Confidence Interval @ 95%	[3.539 - 4.377] n = 71
Standard Deviation	1.800
Standard Error	0.214

Key Facts

- **49.3%** chose the following options :
  - Never
  - Monthly
- Least chosen option **5.63%** :
  - Bi-weekly

Seminars

Frequency Analysis

	Answer	Count	Percent	20% 40% 60% 80% 100%
1.	Daily	1	1.41%	
2.	Two or more times a week	0	0.00%	
3.	Weekly	2	2.82%	
4.	Bi-weekly	0	0.00%	
5.	Monthly	31	43.66%	
6.	**Never**	**37**	**52.11%**	
	Total	**71**	**100%**	

Key Analytics

Mean	5.408	**Key Facts**
Confidence Interval @ 95%	[5.214 - 5.603] n = 71	• **95.77%** chose the following options : ○ Never ○ Monthly
Standard Deviation	0.838	
Standard Error	0.099	

4a. **What percentage of each of the following resources do you access online?**

Textbooks

Frequency Analysis

	Answer	Count	Percent	20% 40% 60% 80% 100%
1.	**0%**	**45**	**66.18%**	
2.	1-25%	9	13.24%	
3.	26-50%	8	11.76%	
4.	51-75%	3	4.41%	

5.	76-100%	3	4.41%	
	Total	**68**	**100%**	

Key Analytics

Mean	1.676
Confidence Interval @ 95%	[1.409 - 1.944] n = 68
Standard Deviation	1.126
Standard Error	0.136

Key Facts

- **79.41%** chose the following options :
  - 0%
  - 1-25%
- Least chosen option **4.41%** :
  - 51-75%

Journals

Frequency Analysis

	Answer	Count	Percent	20% 40% 60% 80% 100%
1.	**0%**	**20**	**29.41%**	
2.	1-25%	16	23.53%	
3.	26-50%	12	17.65%	
4.	51-75%	6	8.82%	
5.	76-100%	14	20.59%	
	Total	**68**	**100%**	

Key Analytics

Mean	2.676
Confidence Interval @ 95%	[2.320 - 3.033] n = 68
Standard Deviation	1.501
Standard Error	0.182

Key Facts

- **52.94%** chose the following options :
  - 0%
  - 1-25%
- Least chosen option **8.82%** :
  - 51-75%

Catalogs/vendors

Frequency Analysis

	Answer	Count	Percent	20% 40% 60% 80% 100%
1.	0%	6	8.82%	
2.	1-25%	5	7.35%	

3.	26-50%	12	17.65%	
4.	51-75%	18	26.47%	
5.	**76-100%**	**27**	**39.71%**	
	Total	**68**	**100%**	

Key Analytics

Mean	3.809	**Key Facts**
Confidence Interval @ 95%	[3.504 - 4.114] n = 68	• **66.18%** chose the following options : ○ 76-100% ○ 51-75%
Standard Deviation	1.284	• Least chosen option **7.35%** : ○ 1-25%
Standard Error	0.156	

Codes/standards

Frequency Analysis

	Answer	Count	Percent	20% 40% 60% 80% 100%
1.	0%	6	8.82%	
2.	1-25%	13	19.12%	
3.	26-50%	15	22.06%	
4.	51-75%	12	17.65%	
5.	**76-100%**	**22**	**32.35%**	
	Total	**68**	**100%**	

Key Analytics

Mean	3.456	**Key Facts**
Confidence Interval @ 95%	[3.134 - 3.778] n = 68	• **54.41%** chose the following options : ○ 76-100% ○ 26-50%
Standard Deviation	1.354	• Least chosen option **8.82%** : ○ 0%
Standard Error	0.164	

Material databases

Frequency Analysis

	Answer	Count	Percent	20% 40% 60% 80% 100%

1.	0%	10	14.71%	
2.	1-25%	7	10.29%	
3.	26-50%	9	13.24%	
4.	51-75%	11	16.18%	
5.	**76-100%**	**31**	**45.59%**	
	Total	**68**	**100%**	

Key Analytics

Mean	3.676	**Key Facts**
Confidence Interval @ 95%	[3.320 - 4.033] n = 68	• **61.76%** chose the following options : ○ 76-100% ○ 51-75%
Standard Deviation	1.501	• Least chosen option **10.29%** : ○ 1-25%
Standard Error	0.182	

Software vendors

Frequency Analysis

	Answer	Count	Percent	20% 40% 60% 80% 100%
1.	**0%**	**29**	**42.65%**	
2.	1-25%	5	7.35%	
3.	26-50%	6	8.82%	
4.	51-75%	5	7.35%	
5.	76-100%	23	33.82%	
	Total	**68**	**100%**	

Key Analytics

Mean	2.824	**Key Facts**
Confidence Interval @ 95%	[2.397 - 3.250] n = 68	• **76.47%** chose the following options : ○ 0% ○ 76-100%
Standard Deviation	1.795	• Least chosen option **7.35%** : ○ 1-25%
Standard Error	0.218	

CAD part libraries

Frequency Analysis

	Answer	Count	Percent	20% 40% 60% 80% 100%
1.	0%	21	30.88%	
2.	1-25%	5	7.35%	
3.	26-50%	6	8.82%	
4.	51-75%	2	2.94%	
5.	**76-100%**	**34**	**50.00%**	
	Total	**68**	**100%**	

Key Analytics

Mean	3.338	**Key Facts**
Confidence Interval @ 95%	[2.908 - 3.768] n = 68	• **80.88%** chose the following options : ○ 76-100% ○ 0%
Standard Deviation	1.809	• Least chosen option **2.94%** : ○ 51-75%
Standard Error	0.219	

6. **How often do you get information from your colleagues (to assist with the work process)?**

Frequency Analysis

	Answer	Count	Percent	20% 40% 60% 80% 100%
1.	**Daily**	**29**	**45.31%**	
2.	Two or more times a week	11	17.19%	
3.	Weekly	14	21.88%	
4.	Bi-weekly	5	7.81%	
5.	Monthly	2	3.12%	
6.	Never	3	4.69%	
	Total	**64**	**100%**	

Key Analytics

Mean	2.203	**Key Facts**

Confidence Interval @ 95%	[1.856 - 2.550] n = 64	• **67.19%** chose the following options : ○ Daily ○ Weekly • Least chosen option **3.12%** : ○ Monthly
Standard Deviation	1.416	
Standard Error	0.177	

7. **How many hours/day do you use the internet to obtain information relevant to your work responsibilities? (not including emails or company files)**

Frequency Analysis

	Answer	Count	Percent	20% 40% 60% 80% 100%
1.	**1 hour**	**35**	**54.69%**	
2.	2 hours	15	23.44%	
3.	3 hours	6	9.38%	
4.	4 hours	4	6.25%	
5.	over 4 hours	4	6.25%	
	Total	**64**	**100%**	

Key Analytics

Mean	1.859	**Key Facts**
Confidence Interval @ 95%	[1.564 - 2.155] n = 64	• **78.12%** chose the following options : ○ 1 hour ○ 2 hours • Least chosen option **6.25%** : ○ 4 hours
Standard Deviation	1.207	
Standard Error	0.151	