

Methods for Enhancing Knowledge Sharing among Departments
at the University of Tennessee

Capstone Design Project for the
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Abstract

Methods for promoting collaboration and knowledge sharing between academic departments at universities need to be established. This study uses the industrial engineering department at the University of Tennessee as a case study. This study analyzes the use of Communities of Practice to strengthen collaboration and knowledge sharing. Additionally, this study explores the use of the latest technologies, such as portals, to aid in collaboration across departments. The portal developed promotes knowledge sharing by supplying news feeds in expertise areas, tools to solve simple problems, and a wiki to be a common area for the transfer and storage of knowledge. One of the tools is an expert locator, which is an information system that allows users the ability to find experts in specific knowledge areas. A survey was performed to identify the expertise areas and collaborating departments for the case study.

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Introduction

Knowledge sharing across academic departments at universities can be enhanced through the promotion of Communities of Practice. Being able to leverage work and research done in one department could greatly benefit other departments. However, in some cases that knowledge created through work and research may only be kept within the individual departments or the individual people. Better methods for sharing knowledge across academic departments are needed. The methods must consider ways of sharing both explicit knowledge and tacit knowledge. This research attempts to identify some of the commonalities between the industrial engineering department and other departments at the University of Tennessee. Some methods to promote knowledge sharing, such as the development of a portal, are used to promote knowledge sharing among the departments.

Description of Problem

An initiative to promote Communities of Practice among academic departments is needed. There are many factors which may limit the amount of collaboration between academic departments. In order to identify some of these factors, an Ishikawa (Fishbone) diagram was constructed. Four causes have been identified, which are people, tools, knowledge, and environment. People are the faculty members within the departments who wish to collaborate. Tools are the media that allow the people to connect with each other, such as e-mail, phone, hard copy mail, and other Internet collaboration tools. The material that needs to be shared is knowledge. Knowledge may be explicit (easily codified) or tacit

(difficult to codify). Explicit knowledge can be easily transferred and stored, once extracted into a recorded medium. Tacit knowledge requires experience or hands on training to transfer, so it is not easily transferred or stored. The last cause identified is environment, which condition in which collaboration takes place. The environment can consist of both tangible and intangible factors.

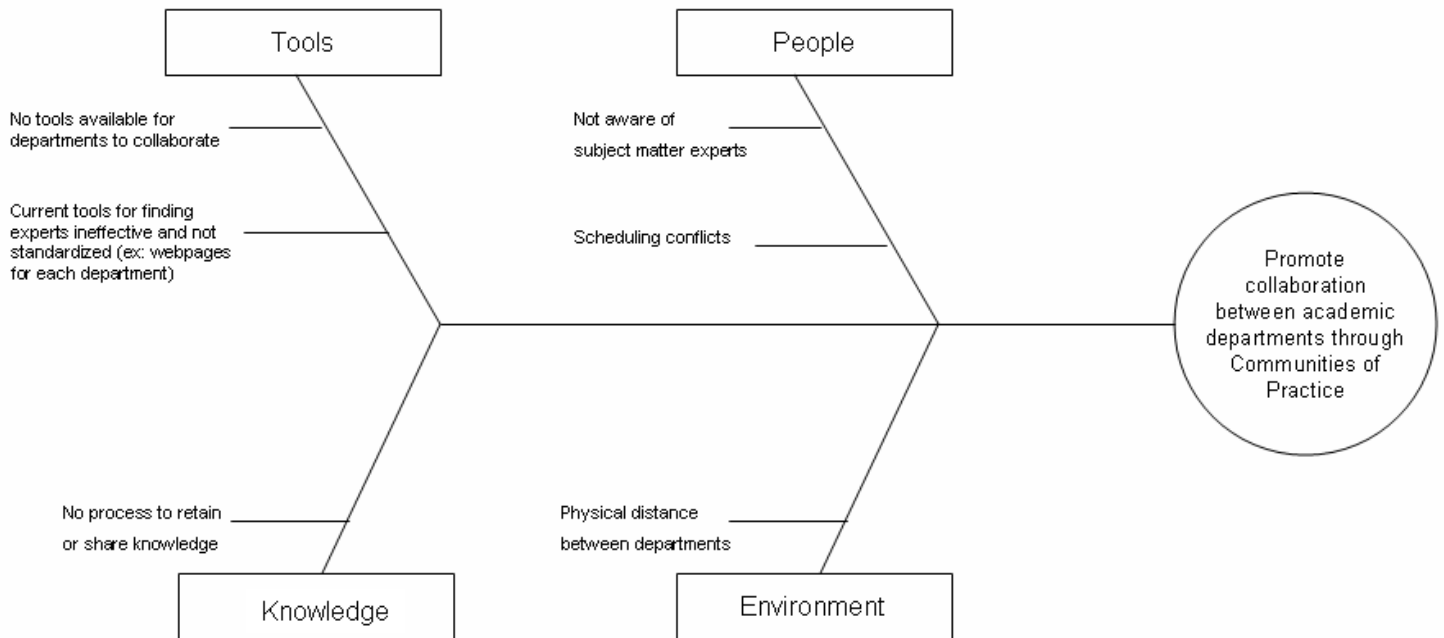


Figure 1. Ishikawa Diagram

A possible reason why collaboration may not take place between academic departments is because the faculty members from one department are not familiar with the expertise areas of faculty in other departments. A method for finding knowledge experts across departments is needed. If one faculty member is aware of the knowledge expert that needs to be reach, other obstacles such as scheduling conflicts may prevent effective collaboration.

Improving the tools available to collaborate could also promote collaboration. At the University of Tennessee, the primary collaboration tools are e-mail, phone calls, and a collaboration tool called Blackboard. There is no tool which serves as a repository of knowledge, which is updateable by all faculty members. Additionally, there are no tools for finding knowledge experts from other departments. Each department has its own website, which usually lists faculty members and their interest areas. However, there is not a single source of information for all expertise areas of all faculty members.

A program to establish a standard process to retain and share knowledge would also promote knowledge sharing. The process should include identifying what knowledge to retain, how long to retain the knowledge, where to store the retained knowledge, and how to share the knowledge.

The environment can also be a factor that prevents effective collaboration between faculty members. The University of Tennessee employs over 1,400 faculty across four main campuses across the state. The industrial engineering department has faculty located in Knoxville, Tullahoma, and Oak Ridge. Therefore, the needed expert may be miles away. Many technologies exist that can aid with collaboration between faculty at remote locations.

Improvements to a system are always the result of a problem, opportunity, or directive. Currently at the University of Tennessee, the ability to improve collaboration is an opportunity. In order to get full support among all university faculty, and directive may need to be established by a senior university official, such as the president, in order to get all faculty to participate.

Planned Goals

The purpose of this design project is to identify knowledge sharing across academic departments, using the University of Tennessee as a case study. The project will use the perspective of the industrial engineering department, and how its members collaborate with other departments. Current technologies will be used to implement tools to promote knowledge sharing among departments.

A planned project schedule was developed as a rough estimate for when each deliverable was to be completed (Table 26). All project work must be completed by April 11, 2008, which is the day of the presentation of the project to the graduate committee. Levi Smith will deliver a final written report (this document) to his graduate committee on or before the day of the presentation. The final report shall adhere to the guidelines defined in the industrial engineering master's handbook. The project presentation will cover the content covered in the paper, and shall last approximately 20 to 30 minutes.

Literature Search

Communities of Practice (CoPs) is a concept of knowledge sharing between people in an organization for the transfer of tacit knowledge. According to the Jean Lave and Etienne Wenger, who defined the concept of Communities of Practice, CoPs can not be established or created. CoPs occur naturally, through people who share common interests and specialization areas. Since it is not possible to mandate CoPs, managers can only provide a good environment and tools to help promote the existence of CoPs.

CoPs can have both short term and long term benefits for an organization. Short term benefits are results such as people being able to get an answer to a problem quickly (Wenger 2002). Long term benefits include the accumulation of experience throughout the organization (Wenger 2002). CoPs can produce tangible results such as quality documents or deliverables (Wenger 2002). Intangible results, such as trust and innovation among people in the organization, are also gained (Wenger 2002). CoPs can be a small group of people or can consist of hundreds of people (Wenger 2002). The lifetime of CoPs can also significantly vary (Wenger 2002). Some CoPs only exist for a short period of time such as a few weeks to complete a project (Wenger 2002). Other CoPs may exist for centuries, such as skill sets being passed on from one generation to another (Wenger 2002). CoPs can be homogeneous, which consists of people with similar skills (Wenger 2002). CoPs can also be heterogeneous, which consists of people with different skill sets, but the people are trying to solve a common problem (Wenger 2002). Seven principles have been proposed for designing a CoP, which are design for evolution, open a dialogue between inside and outside perspectives, invite different levels of participation, develop both public and private community spaces, focus on values, combine familiarity and excitement, and create a rhythm for the community (Wenger 2002). Five stages have been suggested as the stages of community development, which are potential, coalescing, maturing, stewardship, and transformation (Wenger 2002).

Communities of Practice are defined by three fundamentals, which are joint enterprise, mutual engagement, and a shared repertoire of resources. A case

study was performed by Frances Rock to show how law enforcement officers can benefit from effective CoPs (Barton 2005). The data for the case study was collected between 1999 and 2001 in England (Barton 2005). The case study focuses on the task of explaining the right to silence by the officer, which is called "cautioning" (Barton 2005). Joint enterprise is what the community is about, defined by stated and shared goals, and mutual accountability (Barton 2005). The process of "cautioning" is loosely defined by the official guidelines, but the officers still share the same common goal (Barton 2005). Mutual engagement is how the CoP functions (Barton 2005). The regular interaction between the officers was accomplished by formal mentoring relationships and informal talks at lunch time (Barton 2005). Shared repertoire of resources is the capability produced (Barton 2005). In this case study, the officers shared the same official cautioning guidance (Barton 2005).

Studies have shown that cooperative learning is more effective than other methods. A study of 323 students showed that cooperative methods lead to higher achievement than competitive or individualistic methods (McConnell 2006). The study defined four indices of achievement, which can be used to determine the effectiveness of CoPs (McConnell 2006). The metrics are mastery and retention of material, quality of reasoning strategies, process gains (ability to create new ideas and solutions), and transference of learning (McConnell 2006). In the study, WebCT software was used as the collaboration tool to enable the CoPs (McConnell 2006).

Another successful case of using Communities of Practice and collaboration technologies is the Delft Cluster project in the Netherlands (Kukuric 2001). The goals of the Delft Cluster were to provide support for research, provide stakeholders with access to knowledge, and generate innovative solutions to problems (Kukuric 2001). Since the Delft Cluster members were spread across six projects in different locations, a virtual environment was setup to enhance collaboration (Kukuric 2001). The CoPs and collaboration tools allowed the Delft Cluster to effectively accomplish their goals

Portals are a current technology that can be used to promote knowledge sharing. Portals provide a single point of aggregated content to the user. A portal is not simply a single webpage or homepage. Portals consist of a standard look and feel, centralized location of information, and personalized for each user (Collins 2003). Portals can promote knowledge sharing among users by providing event calendars, discussion forms, feedback forms, FAQs, and other collaboration tools (Collins 2003). Portals usually provide the ability to search for content in the system (Collins 2003). Learning is achieved on portals through simulations, online wizards, and job learning aids (Collins 2003).

Two types of portals exist, which are called horizontal portals and vertical portals. Horizontal portals serve to share general information across an organization. Horizontal portals support business intelligence, collaboration and communities, content management, and learning (Collins 2003). Vertical portals support more specific functions, processes, and applications (Collins 2003). Vertical portals require that the user authenticate ("log in") to gain access (Katz

2002). Vertical portals know information about the portal user, and display information relevant to the user.

A portal usually consists of many portlets, which are complete applications having multiple states and views. A portal should allow the user to choose which portlets they wish to view. Most portlets are developed using Java Servlets, and a specification named JSR168 exists which defines how portlets are developed. However, a portlet can be developed using any technology as long as it meets the definition of a portlet. Portlets usually have a titlebar, window controls to maximize, minimize, close, and perform other configuration options (Polgar 2006). Some examples of portal server software are Sun ONE Portal Server, Web Sphere Portal, Apache Portal Tools and Server, Microsoft SharePoint, and SAP Enterprise Portal (Polgar 2006).

One valuable tool that should be included in a portal is an expertise locator, which can be used to aid in distributing tacit knowledge. Expertise locators can connect people who would have otherwise never met (Ackerman 2003). A study has shown that teams that could effectively find and contact experts to solve problems were much more successful than those that could not (Ackerman 2003). Some of the requirements for designing an expertise locator are that it must be fast and easy to use, it must produce reliable search results, and it must be scalable (Ackerman 2003). One problem when designing the expertise locator is deciding how to represent knowledge and skill areas, which can be defined at either a high or low level (Ackerman 2003). In some organizations, a person's title may give clues about their expertise areas

(Ackerman 2003). Ratings can also be applied towards the level of knowledge of each area for each expert, but that rating would be somewhat subjective since there is no quantitative metric for determining a person's knowledge in an area (Ackerman 2003). The data in the expertise locator must be maintainable and kept up to date (Ackerman 2003). One solution to that problem is to provide an interface to allow the experts to update the information themselves (Ackerman 2003).

The company Accenture found that the development of an expertise locator tool, Knowledge Xchange, was very valuable (Morrissey 2005). The tool allowed people to find experts by specific project (Morrissey 2005). Accenture employs over 100,000 people in 48 countries, so the expert locator greatly benefits employees to quickly find the correct expert (Morrissey 2005).

Methodology

A questionnaire was given to many of the IE faculty, asking for the departments that they collaborate. The questionnaire also asked for the specific areas where knowledge sharing occurred with the other departments. The questionnaire is shown in Appendix G. This information was gathered from the questionnaire results, and from common areas identified through research. For each department, specific topic areas are identified where knowledge sharing may occur. A total of nine faculty members responded to the questionnaire. If more time were available, acquiring this information from the remaining IE faculty and faculty from other departments would provide a more complete view of the knowledge sharing between the departments. Since the collection of this

information requires each participant self identification, an IRB Form B was completed and submitted to the IRB for review and approval. An IRB Form B must be completed for collection of information from human participants, who are not anonymous. Figure 2 shows a hypothesized view of the primary departments collaborating with industrial engineering, along with commonality areas where knowledge sharing takes place.

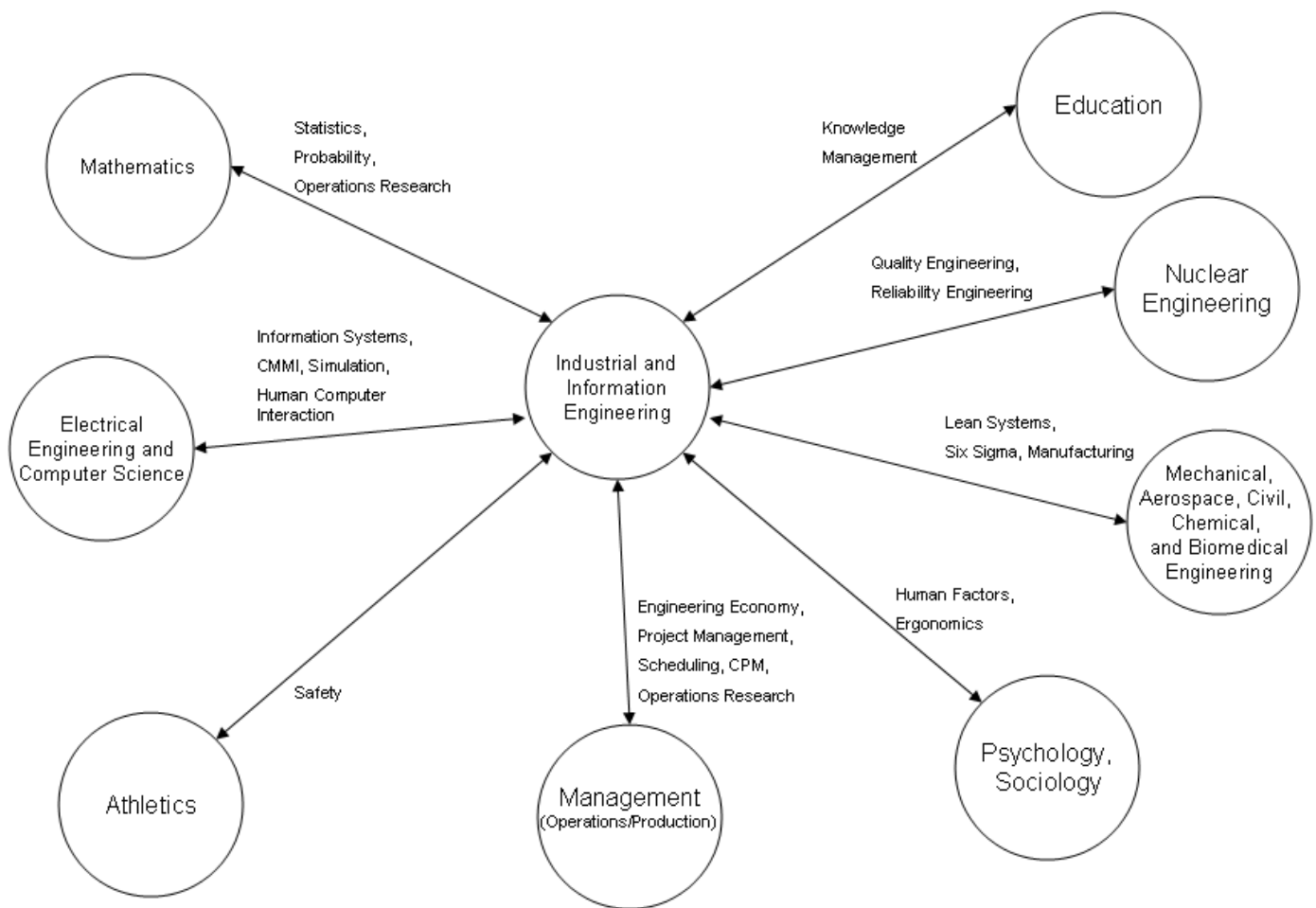


Figure 2 Collaborating Departments

The UT IE Portal is an attempt to take the traditional portal technology and framework and apply to an academic setting. The IE portal will provide news, tools, and collaboration pertaining to industrial engineering topics. The user will be able to customize their portal similar to a mainstream portal. People outside of the industrial engineering department can view the portal to get a general idea about some of the topics that industrial engineering covers.

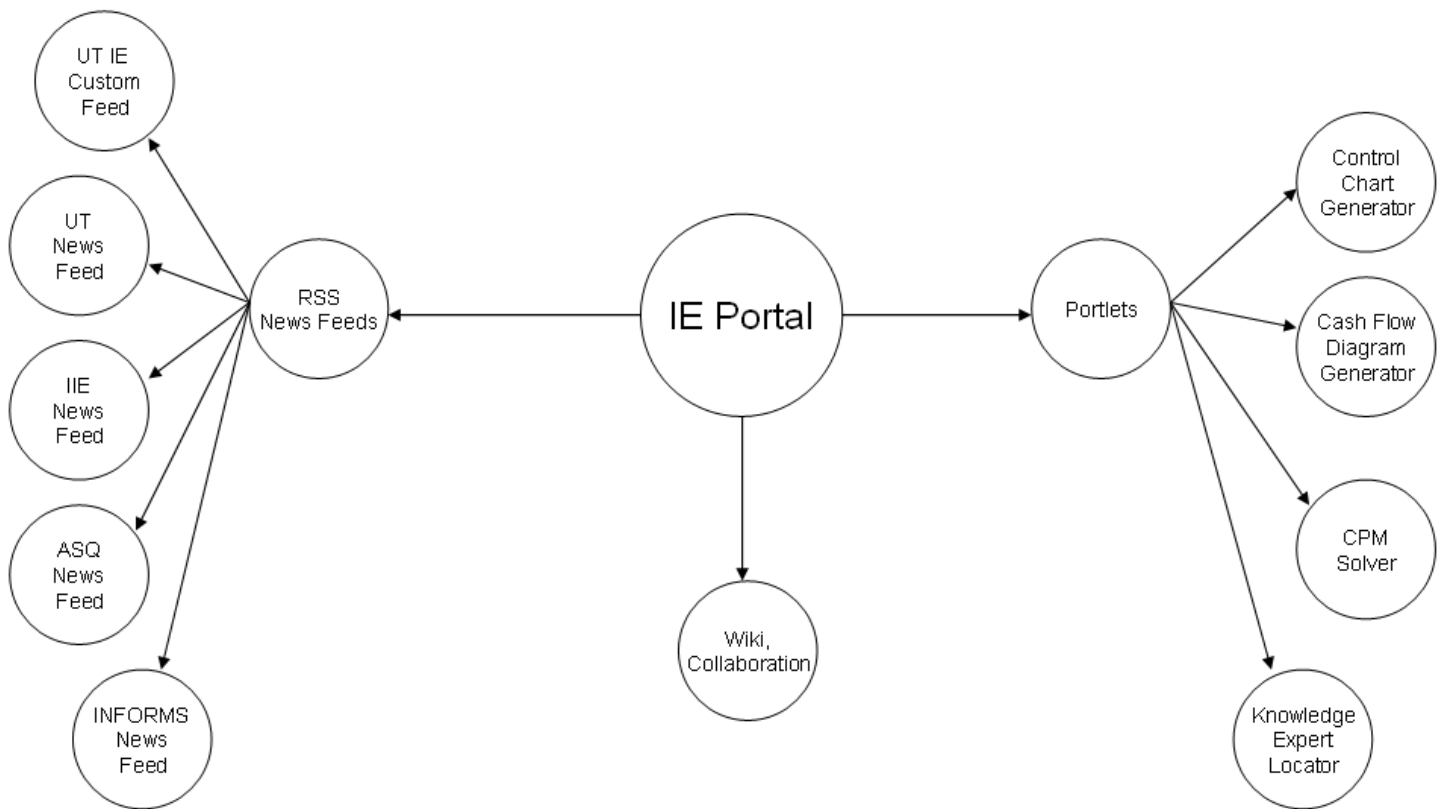


Figure 3. Portal Architecture

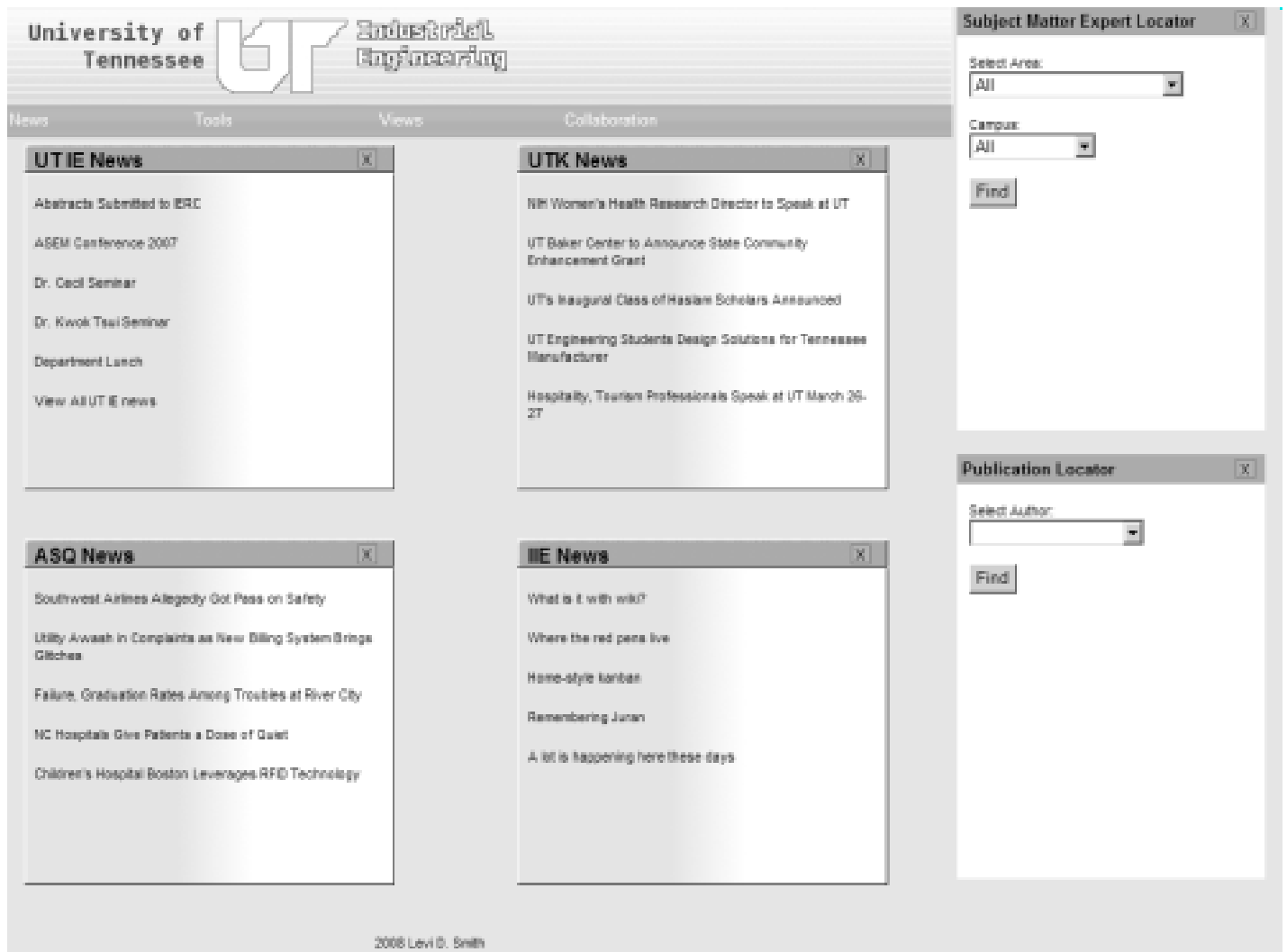


Figure 4. Portal Display

The primary portal display consists of a menubar at the top of the screen below the title graphics, news items below the menubar, and the tools to the right of the menubar and news items. Both the news items and tools are portlets. A typical display from the portal is shown in Figure 4. The menubar provides the user the ability to choose functions from four different menus. The first menu consists of news feeds which the user can add to the main display. The next menu allows the user to select new tools to add to the display. The menu to select different views follows. The final menu allows the user to view collaboration

functionality. The user has the ability to remove any news feed or tool from the display by clicking on the "X" box in the title bar of the item to be removed.

Developing portal software is time consuming, but not an impossible task. Ensuring that all functionality is distinct and loosely coupled is very important. Session variables can be used to keep track of which portlet items the user wants to view, and which items should be hidden. Each news item and tool is assigned a unique identifier. The identifiers for the active portlets are stored as a variable, which lives throughout the user's session. The portlets can be written as separate web applications, and the portlets are shown on the main portal window using iframes. Iframes is a standard HTML tag supported by all modern browsers that allows a web page to be shown within another web page. A typical waterfall lifecycle model was used for the development of the IE portal, which includes defining requirements, design, implementation, and testing.

The news feeds provided on the portal will help IE faculty stay current with the latest events in their expertise field. Visitors from other departments can view the news feeds to learn more about the latest topics in IE. The news feeds use the RSS standard for transferring the news information. RSS (really simple syndication) provides a standard for transfer of news related information. Many news readers support the RSS standard. RSS is implemented using XML files, which are pulled down nightly to reduce traffic and slowdown. News from some predominant IE societies, such as IIE (Institute of Industrial Engineers), ASQ (American Society for Quality), and INFORMS are included as selectable news

sources. Additional news sources can be added, as long as their news feed adheres to the RSS specification.

A UT IE news feed was developed to share news information at the industrial engineering department at the University of Tennessee. Currently, news is distributed through email which may not reach all of the intended recipients. An IE department newsletter is usually published biannually, however a news feed could be updated daily.

Two tools were developed to help faculty from other departments find the knowledge they wish to obtain. One tool helps find knowledge experts and the other helps find publications. Additional tools were developed to solve IE problems. In case one of the IE knowledge experts is not available, these tools can solve simple problems while the expert is away. The tools developed can help solve engineering economy, quality, and project management problems. Data for these tools will be stored in a relational database, so that anyone who is familiar with relational databases can update and maintain the information.

The knowledge expert locator allows users to find a faculty member that is an expert in a specific area. For instance, if someone in the mechanical engineering department wanted to collaborate on lean manufacturing techniques, then they could use the knowledge expert locator system to find someone in the IE department who is an expert in lean manufacturing. The knowledge expert locator tools allows the results to be filtered by location, since some of the IE faculty are located on the main campus in Knoxville, while other faculty are

located at the UT Space Institute in Tullahoma. Additional locations may be added to include the growing presence in Oak Ridge.



Figure 5. Expert Locator Displays

The knowledge expert information was collected by providing a short questionnaire to many of the IE faculty, shown in Appendix G. The questionnaire asked to faculty to check off the areas that they considered themselves to be experts. The questionnaire also provided an "Other" option, which allowed the faculty member to specify other expertise areas that may have been missed. The information was gathered, and entered into the system. In the future, an automated process should be developed so that faculty can view and update their expertise areas online.

The Cash Flow Diagram tool is an update of a tool that was written in 2004. The benefit of the new tool is that it is accessible over the Web as a portlet, so that the user is not required to download any software. The cash flow diagram tool allows the user to enter cash flow values for each period. As values are entered, the present worth (PW), annual worth (AW), and future worth (FW) are dynamically updated. At any time, the user can change the interest value, and the calculated values will also update. For simplicity, the user can not modify cash

flow values entered. The user must clear all values and restart if a mistake is made.

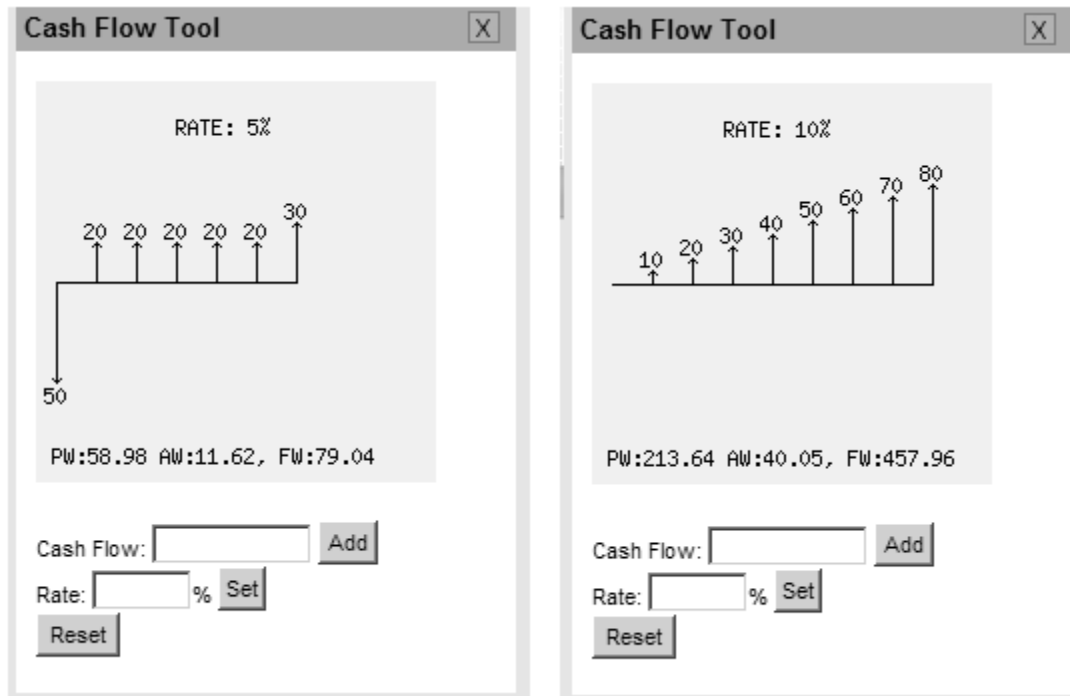


Figure 6. Cash Flow Tool Displays

The publication locator system was originally developed for another research project. The information stored in the publication locator system could be beneficial to others who wish to learn about publications from the industrial engineering department at the University of Tennessee, so it was included in the IE portal. The original system was implemented as a Microsoft Access database with VBA forms for an interface. The data was easily exported into a mySQL database, and a new front end was written in PHP. Since the information is now accessible through a Web interface, the information can be distributed without installing software on the user's client machine. The publication locator promotes

all of the articles that have been published by the IE students and faculty.

Publication information was acquired from the UT IE newsletters.

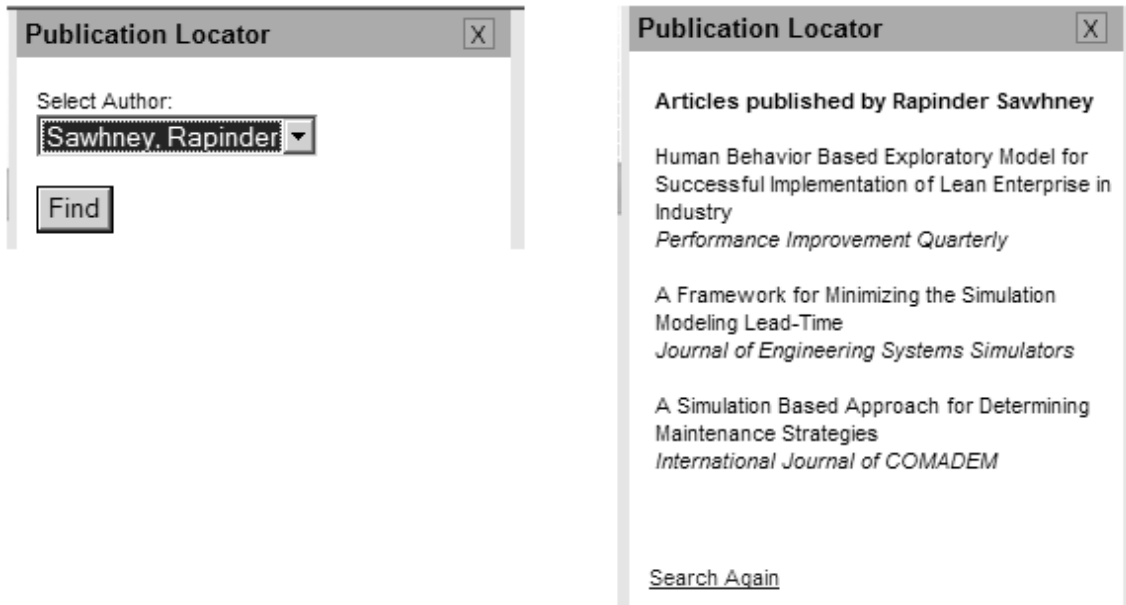


Figure 7. Publication Locator

The control chart generator allows the user to enter various values. Based on the values entered, a chart is dynamically constructed showing the mean value (a red line), and the various sigma limits. Using this simple tool, the user is able to see any run conditions in their data.

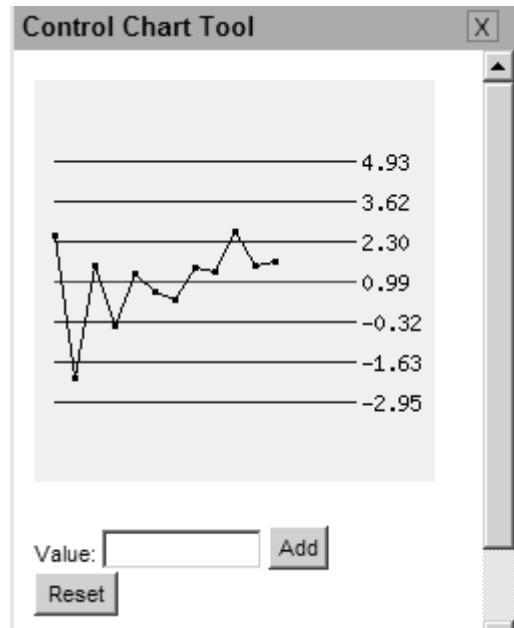


Figure 8. Control Chart Tool

The CPM tool allows the user to enter various activities, along with durations and dependencies. Based on the values entered by the user, the tool will generate a chart listing the early start, late start, early finish, late finish, and slack of each activity. The user will have the ability to specify multiple dependencies for an activity.

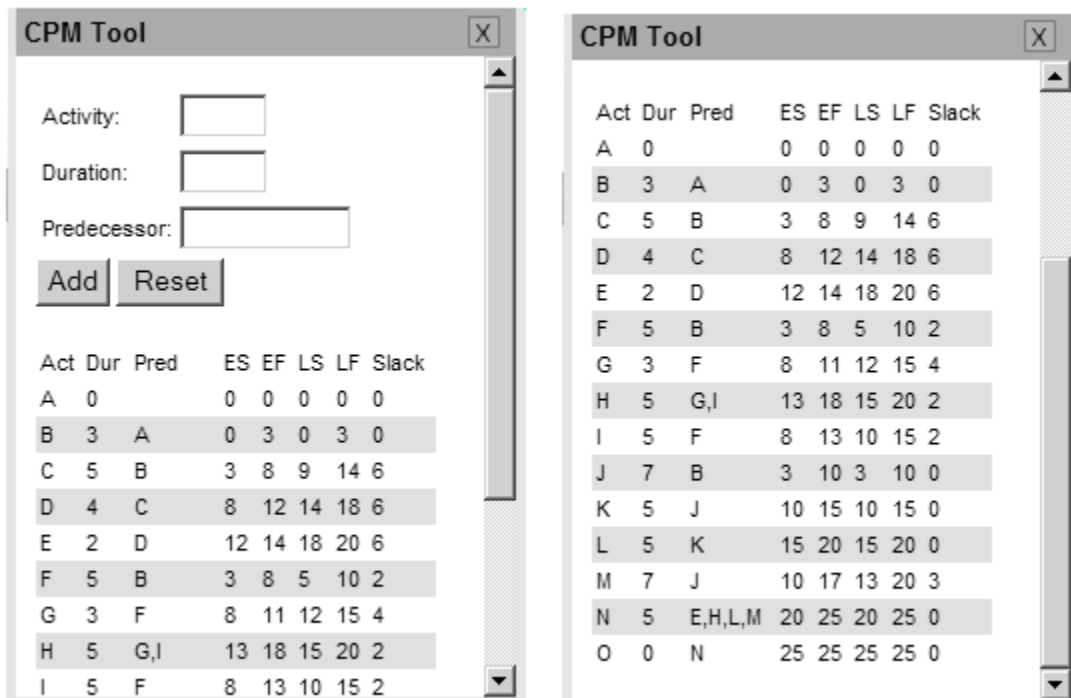


Figure 9. CPM Tool Displays

The Box Plot tool constructs a box plot based on the numerical values entered by the user, which is shown in Figure 10. When the user enters a value, the display updates to show the median, the first quartile (25th percentile), the third quartile (75th percentile), the total range, the interquartile range, the smallest value that is not an outlier, and the largest value that is not an outlier. Currently, the tool does not show outlier values, which are commonly represented by filled and open dots depending on their distance away from the first and third quartiles. The box plot tool is very effective in calculating measures of dispersion.

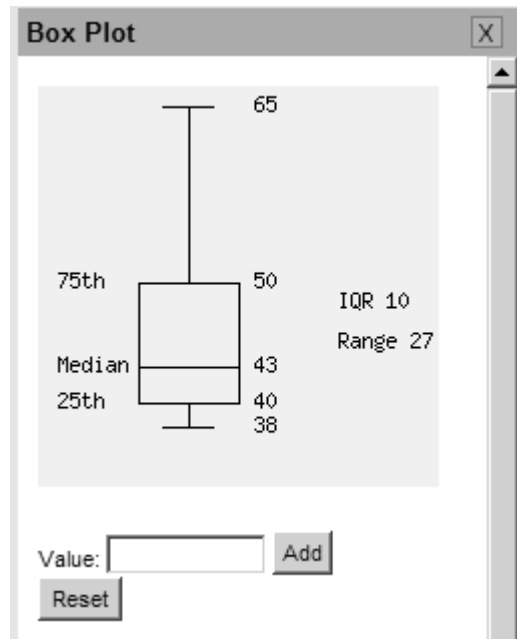


Figure 10. Box Plot Display

The user is able to select various views of the portal. For instance, if the user is only interested in seeing information related to engineering management, then they can choose the engineering management view. Then they will only be shown news feeds and portlet tools related to engineering management.

The wiki allows faculty at UT IE to share information on various topics. The wiki will promote sharing of information across the various departments. The wiki is updateable by all UT IE faculty, and their collaborating partners in other departments. Adding information to the wiki is a simple process, and it does not require the user to be a technical expert to update the content on the pages. The wiki does not require any additional tools to update content. Media Wiki was used as the wiki software, since it is popular, and the same software that one of the largest wikis (Wikipedia) uses. Media Wiki is relatively easy to install, and works with an Apache Web server.

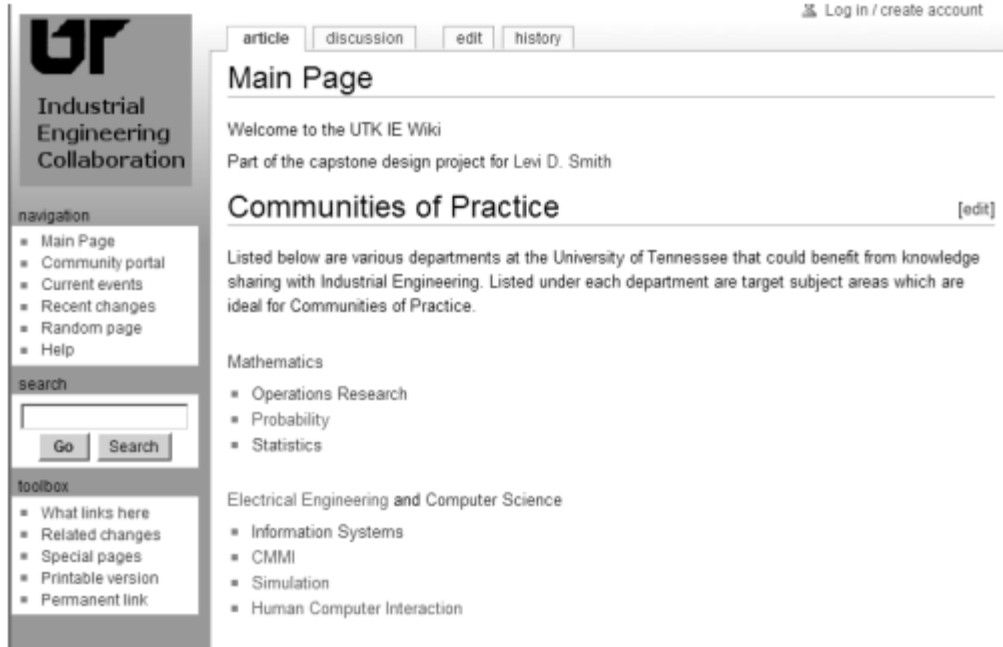


Figure 11. Wiki Display

A feasibility analysis was completed to determine the best technologies to use for the development of the IE Portal and portlets. The AHP (Analytical Hierarchy Process) was used to determine which web development language, database software, wiki software, and portal server software to be used. AHP is used to calculate weights for each of the factors for each alternative. Scores are given for each factor for each alternative and then multiplied by the calculated weight. The values for all the factors are summed for each alternative, which gives an overall score for each alternative. The alternative with the highest score is the recommended alternative to implement. A spreadsheet was created in Microsoft Excel to perform the calculations, and the results are shown in Appendix A, B, C, and D.

The alternatives for the development language are shown in Table 1. Five factors were used to determine which Web development language to use for the

development of the portal. Server setup difficulty is the amount of time and effort required to setup the environment needed to run the code. Almost all web development languages require interpreter software to run the code. The cost of the interpreter software and server are included in the cost factor. Portability is the ease at which the code can be moved from one platform, such as Windows, to another platform, such as Mac. Code execution speed is the amount of time that it takes for the server to render the code to a user. Most users are not willing to wait more than 7 seconds for content to load. Dynamic content generation is the ability of the language to render pages based on the current state of the system, opposed to static content which never changes. The final AHP calculations can be found in Appendix A. Since PHP development language has the highest calculated overall score, it was chosen to be used as the development language.

Table 1. Development Language Alternatives

Development Language	Company / Organization	Servers	Server setup difficulty	Cost of development and server software	Portability	Code Execution Speed	Dynamic content generation
PHP	The PHP Group	PHP	Low	None	High	High	Yes
JSP (Java Server Pages)	Sun Microsystems	Tomcat, Sun Java System Web Server	Low	None	High	Medium	Yes
ASP (Active Server Pages)	Microsoft	MS Internet Information Server	Medium	None	Low (Windows only)	Medium	Yes
Java Applets	Sun Microsystems	None (built into browser)	Low	None	High	Low	Yes
Cold Fusion	Adobe	ColdFusion Server	Medium	High (\$1299)	Medium	Medium	Yes
HTML	W3C	None (built into browser)	Low	None	High	High	No
Flash	Adobe	None (free browser plug-in)	Low	High (\$699)	High	Medium	Yes

Table 2 shows the alternatives for the database to be used for the system.

Five factors were considered for determining which relational database system to be used. A database was necessary for the subject matter expert locator tool and the publication locator tool. The database system is used to store all of the data for those tools. Setup difficulty is the amount of time and effort required to install and setup the database package and the time to ensure that the database is operational. Security is the level of security features provided by the database system to prevent unauthorized access to the data. Cost is the amount of money required to purchase the database software. Portability is the level of ease at which the database system can be moved to other platforms. Interface usage difficulty is the quality of the tools provided by the database system to manage the

data contained in the database. The AHP calculations for the database can be found in Appendix B, and mySQL had the highest overall score.

Table 2. Database Alternatives

Database	Setup Difficulty	Security	Cost	Portability	Interface Usage Difficulty
Oracle	Medium	High	High	High	Medium (SQL command prompt)
MS Access	Low	Low	Medium (\$229)	Low (Windows only)	Low (built in query tools)
mySQL	Low	Medium	None	Medium (Windows, Linux)	Medium (SQL command prompt; query browser addon)
MS SQL Server	Medium	High	High	Low (Windows only)	Medium (SQL command prompt)

The portal will include a wiki, which will promote collaboration and the establishment of communities of practice. Only two alternatives were considered and four factors were analyzed, which are shown in Table 3. Setup difficulty is the time and effort required to make the wiki software operational. Portability is the difficulty of moving the software to another platform. Support is the level of support provided by the developers of the wiki software. Support includes the frequency at which the developers provide updates, bug fixes, new features, and patches. Cost is the amount of money required to purchase the software. Media Wiki is popular wiki software due to the ease of setup and support. Wikipedia is built using the Media Wiki software. Swiki is wiki software frequently used in academic environments, and is written using the Smalltalk programming language. Media Wiki had the highest overall score as shown by the calculations in Appendix C.

Table 3. Wiki Alternatives

Wiki	Setup Difficulty	Portability	Support	Cost
Media Wiki	Medium	Medium	High	None
Swiki	Medium	Medium	Low	None

Three different portal software packages will be considered as alternatives, plus the alternative to custom build the portal. The custom built portal had the highest overall score, which is shown in Appendix D.

Table 4. Portal Alternatives

Portal Software	Cost	Setup Difficulty	Customizability	Development Time
Open Portal	None	High	Low	None
SAP Portal	High	High	Low	None
MS Share Point	High	High	Low	None
Custom Built	None	Medium	High	High

A laptop was procured to be used for hosting all of the software, since the laptop can be transported to various locations. The laptop eliminates the factor of problems with a remote server. If the software were to be used by real users, then more powerful server hardware should be purchased to host the software. Instead of individually installing mySQL, PHP, and Apache, a package called XAMPP was downloaded and installed which includes all of those technologies in one easy to install package. Windows Vista was used as the operating system, since it was the default operating system installed on the laptop, and time was not available to install and test other operating systems on the laptop.

The following requirements were defined for the IE Portal software. A formal test plan could be developed by testing to ensure that the delivered system meets each of the requirements listed below.

IE Portal Requirements

1. Must display news relevant to industrial engineering
 - 1.1. Must use RSS (really simple syndication) as the format for sharing news
 - 1.2. Must be able to display RSS news feeds from other sources
 - 1.2.1. Should be able to view the UT news feed
 - 1.2.2. Should be able to view the IIE news feed
 - 1.2.3. Should be able to view the ASQ news feed
 - 1.2.4. Should be able to view the INFORMS Operations Research news feed
2. Must provide simple tools to solve IE problems
 - 2.1. Should provide a tool to solve cash flow problems
 - 2.1.1. Must allow user to enter cash flow values for each time period
 - 2.1.2. Must allow the user to specify an interest rate
 - 2.1.3. Must display a graphical representation of the cash flow diagram
 - 2.1.4. Must calculate and display the PW, AW, and FW after the user enters values or changes interest rate
 - 2.2. Should provide a tool to solve control chart problems
 - 2.2.1. Must allow the user to enter numerical values
 - 2.2.2. Must calculate and display the mean, +1 sigma, +2 sigma, +3 sigma, -1 sigma, -2 sigma, and -3 sigma control limits when the user enters values
 - 2.2.3. Must show the values that the user has entered
 - 2.2.4. Must allow the user to clear all values and start over
 - 2.3. Should provide a tool to solve CPM problems
 - 2.3.1. Must allow the user to specify the name, duration, and predecessors for an activity
 - 2.3.2. Must calculate the ES (early start), EF (early finish), LS (late start), LF (late finish), and slack as the user enters activities
 - 2.3.3. Must allow the user to clear all activities and restart
 - 2.4. Must provide a knowledge expert locator
 - 2.4.1. Must be able to search for knowledge experts by subject area
 - 2.4.2. Must be able to search for knowledge experts by location
 - 2.4.3. Must be able to search for knowledge experts by a combination of location and subject area
 - 2.4.4. Must display contact information for the experts returned in the results
 - 2.4.4.1. Should display first and last name
 - 2.4.4.2. Should display phone number
 - 2.4.4.3. Should display e-mail address
 - 2.5. Should provide a journal article locator
 - 2.5.1. Must be able to search by faculty name
 - 2.5.2. Should be able to search by subject area
 - 2.5.3. Must display journal name and article title on result screen
 - 2.6. Must provide a wiki for collaboration
 - 2.6.1. Must allow users to be able to update the content
 - 2.6.2. Must setup areas for each Community of Practice area

The knowledge expert locator database consists of three primary entities.

The "area" entity specifies the subject matter areas for which there are experts, such as engineering economy, operations research, and lean manufacturing. The

"expert" is the faculty member, and contains contact information attributes. The "location" is the physical location where the expert resides, such as Knoxville, Tullahoma, or Oak Ridge. A many to many relationship exists between area and expert, since one expert may be knowledgeable in many areas, and an area may be studied by more than one expert. A many to many relationship also exists between the expert and location, since in some cases an expert may reside at more than one location. A location is usually inhabited by more than one expert. Therefore two additional entities were created, "expert_area" and "expert_location," to connect the primary entities. The ER diagram for the Expert Locator is shown in Figure 11. This database design shows that a knowledge expert locator can be created in a relatively short period of time at little cost.

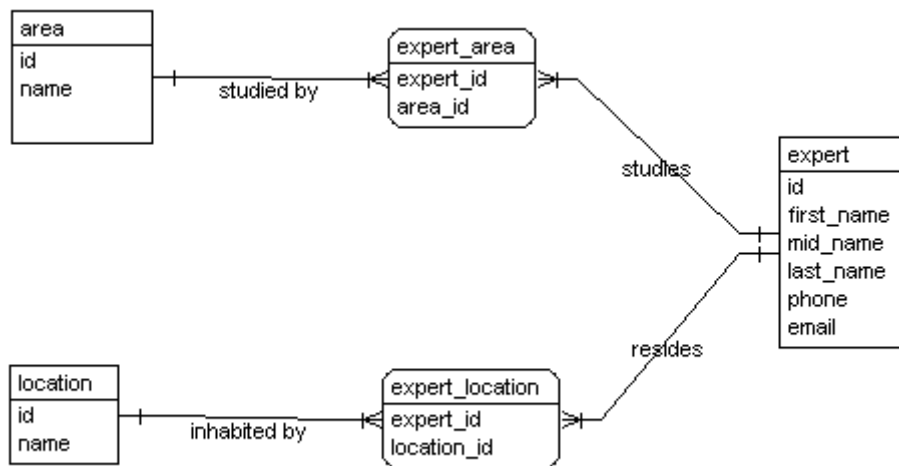


Figure 12. ER Diagram for Expert Locator

As each module of software was developed, unit testing was performed to ensure that the software met the specifications defined by the requirements. Simple black box testing was performed, where data was entered as input and the correct outputs were validated. If the correct values were not returned, then

further white box testing was performed to ensure that the code is executing as planned.

Results

Detailed results for the questionnaire are shown in Appendix E. The totals for each knowledge area are shown in Table 5. The top four expertise areas are productivity and quality, other, lean manufacturing, and engineering management. Table 6 shows that the top 3 collaborating departments are mechanical engineering, nuclear engineering, and computer science. A further analysis should be completed to determine if there is a distinct relationship between expertise area and collaborating department. Since the areas and departments are nominal values, a regression analysis can not be easily performed.

Table 5. Expertise Area Totals

Expertise Area	Count
Productivity and Quality	5
Other	5
Lean Manufacturing	4
Engineering Management	4
Project Management	3
Operations Research	3
Knowledge/Intellectual Properties Management	3
Information Systems	3
Engineering Economics	3
Simulation	2
Industrial Safety	2
Human Factors / Ergonomics	2
Engineering Statistics	2
Reliability	1

Table 6. Collaborating Department Totals

Collaborating Department	Count
Mechanical Engineering	4
Nuclear Engineering	3
Computer Science	3
Operations/Production Management	2
Civil Engineering	2
Safety (Sports)	1
Nursing	1
Management Science	1
Forest Product Center	1
Electrical Engineering	1
Education (Other)	1
Chemical Engineering	1
Biomedical Engineering	1

Conclusions

Through the promotion of communities of practice and use of the latest technologies, knowledge sharing across academic departments can be strengthened. The UT IE Portal should be put on a production system, so that the software is available to faculty across the university. A follow up study should be performed to determine if the development of the portal, tools, and wiki has helped the amount of knowledge sharing across departments.

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Appendices

Appendix A

AHP Calculations for Development Language used to Build the IE Portal

Table 7. Development Language Factor Comparisons

	Server Setup Difficulty	Cost of development server and software	Portability	Code Execution Speed	Dynamic Content Generation
Server Setup Difficulty	1.000	0.333	5.000	0.333	0.143
Cost of development server and software	3.000	1.000	5.000	3.000	0.200
Portability	0.200	0.200	1.000	0.143	0.143
Code Execution Speed	3.000	0.333	7.000	1.000	0.333
Dynamic Content Generation	7.000	5.000	7.000	3.000	1.000
Total	14.200	6.866	25.000	7.476	1.819

Table 8. Normalized Development Language Factor Comparisons

	Server Setup Difficulty	Cost of development server and software	Portability	Code Execution Speed	Dynamic Content Generation	Average
Server Setup Difficulty	0.070	0.048	0.200	0.045	0.079	0.088
Cost of development server and software	0.211	0.146	0.200	0.401	0.110	0.214
Portability	0.014	0.029	0.040	0.019	0.079	0.036
Code Execution Speed	0.211	0.048	0.280	0.134	0.183	0.171
Dynamic Content Generation	0.493	0.728	0.280	0.401	0.550	0.490

Raw scores were given for each alternative. High positive values are given a 3, medium values are given a 2, and high negative values are given a 1.

Table 9. Development Language Raw Scores

Development Language	Server setup difficulty	Cost of development and server software	Portability	Code Execution Speed	Dynamic content generation
PHP	3	3	3	3	3
JSP (Java Server Pages)	3	3	3	2	3
ASP (Active Server Pages)	2	3	1	2	3
Java Applets	3	3	3	1	3
Cold Fusion	2	1	2	2	3
HTML	3	3	3	3	1
Flash	3	1	3	2	3

Table 10. Development Language Weights Applied

Development Language	Server setup difficulty	Cost of development and server software	Portability	Code Execution Speed	Dynamic content generation	Total
PHP	0.265	0.641	0.109	0.514	1.471	3.000
JSP (Java Server Pages)	0.265	0.641	0.109	0.343	1.471	2.829
ASP (Active Server Pages)	0.177	0.641	0.036	0.343	1.471	2.668
Java Applets	0.265	0.641	0.109	0.171	1.471	2.657
Cold Fusion	0.177	0.214	0.072	0.343	1.471	2.277
HTML	0.265	0.641	0.109	0.514	0.490	2.019
Flash	0.265	0.214	0.109	0.343	1.471	2.401

Appendix B

AHP Calculations for Database used to Store Data for the Knowledge Expert Locator

Table 11. Database Factor Comparisons

	Setup Difficulty	Security	Cost	Portability	Interface Usage Difficulty
Setup Difficulty	1.000	5.000	0.333	5.000	0.333
Security	0.200	1.000	0.143	0.333	0.143
Cost	3.000	7.000	1.000	7.000	3.000
Portability	0.200	3.000	0.143	1.000	0.143
Interface Usage Difficulty	3.000	7.000	0.333	7.000	1.000
Total	14.200	6.866	25.000	7.476	1.819

Table 12. Normalized Database Factor Comparisons

	Setup Difficulty	Security	Cost	Portability	Interface Usage Difficulty	Average
Setup Difficulty	0.135	0.217	0.171	0.246	0.072	0.168
Security	0.027	0.043	0.073	0.016	0.031	0.038
Cost	0.405	0.304	0.512	0.344	0.649	0.443
Portability	0.027	0.130	0.073	0.049	0.031	0.062
Interface Usage Difficulty	0.405	0.304	0.171	0.344	0.216	0.288

Table 13. Database Raw Scores

Database	Setup Difficulty	Security	Cost	Portability	Interface Usage Difficulty
Oracle	2	3	1	3	2
MS Access	3	1	2	1	3
mySQL	3	2	3	2	2
MS SQL Server	2	3	1	1	2

Table 14. Database Weights Applied

Database	Setup Difficulty	Security	Cost	Portability	Interface Usage Difficulty	Total
Oracle	0.336	0.115	0.443	0.187	0.576	1.657
MS Access	0.505	0.038	0.886	0.062	0.865	2.356
mySQL	0.505	0.076	1.329	0.124	0.576	2.611
MS SQL Server	0.336	0.115	0.443	0.062	0.576	1.533

Appendix C

AHP Calculations for Wiki Software used for Collaboration

Table 15. Wiki Factor Comparisons

	Setup Difficulty	Portability	Support	Cost
Setup Difficulty	1.000	7.000	3.000	0.200
Portability	0.143	1.000	0.333	0.143
Support	0.333	3.000	1.000	0.200
Cost	5.000	7.000	5.000	1.000
Total	6.476	18.000	9.333	1.543

Table 16. Normalized Wiki Factor Comparisons

	Setup Difficulty	Portability	Support	Cost	Average
Setup Difficulty	0.154	0.389	0.321	0.130	0.249
Portability	0.022	0.056	0.036	0.093	0.051
Support	0.051	0.167	0.107	0.130	0.114
Cost	0.772	0.389	0.536	0.648	0.586

Table 17. Wiki Raw Scores

Wiki	Setup Difficulty	Portability	Support	Cost
Media Wiki	2	2	3	3
Swiki	2	2	1	3

Table 18. Wiki Weights Applied

Wiki	Setup Difficulty	Portability	Support	Cost	Total
Media Wiki	0.497	0.103	0.341	1.759	2.700
Swiki	0.497	0.103	0.114	1.759	2.472

Appendix D

AHP Calculations for Portal Software to be Used

Table 19. Portal Software Factor Comparisons

	Cost	Setup Difficulty	Customizability	Development Time
Cost	1.000	5.000	0.333	1.000
Setup Difficulty	0.200	1.000	0.200	0.333
Customizability	3.000	5.000	1.000	5.000
Development Time	1.000	3.000	0.200	1.000
Total	5.200	14.000	1.733	7.333

Table 20. Normalized Portal Software Factor Comparisons

	Cost	Setup Difficulty	Customizability	Development Time	Average
Cost	0.192	0.357	0.192	0.136	0.219
Setup Difficulty	0.038	0.071	0.115	0.045	0.068
Customizability	0.577	0.357	0.577	0.682	0.548
Development Time	0.192	0.214	0.115	0.136	0.165

Table 21. Portal Software Raw Scores

Portal Software	Cost	Setup Difficulty	Customizability	Development Time
Open Portal	3	1	1	3
SAP Portal	1	1	1	3
MS Share Point	1	1	1	3
Custom Built	3	2	3	1

Table 22. Portal Software Weights Applied

Portal Software	Cost	Setup Difficulty	Customizability	Development Time	Total
Open Portal	0.658	0.068	0.548	0.494	1.768
SAP Portal	0.219	0.068	0.548	0.494	1.329
MS Share Point	0.219	0.068	0.548	0.494	1.329
Custom Built	0.658	0.135	1.645	0.165	2.603

Appendix E

Questionnaire Results

Table 23. Faculty Expertise Areas

Faculty	Expert Area
Aikens, Hal	Engineering Statistics
Aikens, Hal	Lean Manufacturing
Aikens, Hal	Operations Research
Aikens, Hal	Productivity and Quality
Aikens, Hal	Engineering Management
Dai, Shaun	Information Systems
Dai, Shaun	Reliability
Ford, Robert	Engineering Economics
Ford, Robert	Industrial Safety
Ford, Robert	Project Management
Ford, Robert	Human Factors / Ergonomics
Ford, Robert	Configuration Control (Other)
Halstead, P. D.	Industrial Safety
Halstead, P. D.	Knowledge/Intellectual Properties Management
Halstead, P. D.	Productivity and Quality
Halstead, P. D.	Engineering Management
Halstead, P. D.	Human Factors / Ergonomics
Jackson, Denise	Engineering Economics
Jackson, Denise	Information Systems
Jackson, Denise	Knowledge/Intellectual Properties Management
Jackson, Denise	Productivity and Quality
Jackson, Denise	Project Management
Jackson, Denise	Engineering Management
Li, Xueping	Information Systems
Li, Xueping	Lean Manufacturing
Li, Xueping	Operations Research
Li, Xueping	Simulation
Li, Xueping	Scheduling & Optimization (Other)
Sawhney, Rupy	Lean Manufacturing
Sawhney, Rupy	Productivity and Quality
Sawhney, Rupy	Simulation
Sawhney, Rupy	Reliability (Other)
Sedrick, Gregory	Engineering Economics
Sedrick, Gregory	Engineering Statistics
Sedrick, Gregory	Knowledge/Intellectual Properties Management
Sedrick, Gregory	Lean Manufacturing
Sedrick, Gregory	Productivity and Quality
Sedrick, Gregory	Project Management
Sedrick, Gregory	Engineering Management
Sedrick, Gregory	Technology Based Economic Development (Other)
Zhu, Xiaoyan	Operations Research
Zhu, Xiaoyan	Reliability (Other)

Table 24. Faculty Locations

Faculty	Campus	Department
Aikens, Hal	UTK	IIE
Dai, Shaun	UTK	IIE
Ford, Robert	UTK	IIE
Halstead, P. D.	UTK	IIE
Jackson, Denise	UTSI	IIE
Li, Xueping	UTK	IIE
Sawhney, Rupy	UTK	IIE
Sedrick, Gregory	UTSI	IIE
Sedrick, Gregory	UTSI	EM
Zhu, Xiaoyan	UTK	IIE

Table 25. Collaborating Departments

Faculty	Department
Aikens, Hal	Mechanical Engineering
Aikens, Hal	Management Science
Aikens, Hal	Operations/Production Management
Aikens, Hal	Education (Other)
Dai, Shaun	Electrical Engineering
Dai, Shaun	Nuclear Engineering
Dai, Shaun	Computer Science
Dai, Shaun	Forest Product Center
Ford, Robert	Nuclear Engineering
Ford, Robert	Civil Engineering
Halstead, P. D.	Biomedical Engineering
Halstead, P. D.	Safety (Sports)
Jackson, Denise	Mechanical Engineering
Li, Xueping	Civil Engineering
Li, Xueping	Computer Science
Li, Xueping	Nursing
Sawhney, Rupy	Mechanical Engineering
Sawhney, Rupy	Nuclear Engineering
Sedrick, Gregory	Chemical Engineering
Sedrick, Gregory	Computer Science
Zhu, Xiaoyan	Mechanical Engineering
Zhu, Xiaoyan	Operations/Production Management

Appendix F

Planned Project Schedule

Table 26. Project Schedule

Week	Starting Date	Ending Date	Task Description
1	1/7	1/13	<ul style="list-style-type: none"> Define possible project topics and scope
2	1/14	1/20	<ul style="list-style-type: none"> Develop project schedule Submit potential project topics
3	1/21	1/27	<ul style="list-style-type: none"> Meeting with Dr. Jackson to discuss project topics (1/23) Begin work on revised project statement Begin literature research
4	1/28	2/3	<ul style="list-style-type: none"> Finalize project topic Revise project schedule Submit draft outline Continue literature research
5	2/4	2/10	<ul style="list-style-type: none"> Continue literature research Finalize project goals Complete requirements specification for project deliverables Begin rough draft of research paper
6	2/11	2/17	<ul style="list-style-type: none"> Complete literature research Continue work on research paper Finalize requirements specification for project deliverables Complete design of project deliverables
7	2/18	2/24	<ul style="list-style-type: none"> Continue work on research paper Complete implementation of project deliverables
8	2/25	3/2	<ul style="list-style-type: none"> Continue work on research paper Testing of project deliverables
9	3/3	3/9	<ul style="list-style-type: none"> Begin final draft of research paper
10	3/10	3/16	<ul style="list-style-type: none"> Complete and submit final draft of project research paper to graduate committee Schedule date for project presentation to graduate committee (by 3/13)
11	3/17	3/23	<ul style="list-style-type: none"> Spring Break Begin work on project presentation
12	3/24	3/30	<ul style="list-style-type: none"> Present design project work to graduate committee (by 4/4) Take final oral examination (by 4/4)
13	3/31	4/6	<ul style="list-style-type: none"> Resolve any graduation related issues
14	4/7	4/13	<ul style="list-style-type: none"> Report of final examination (pass/fail) submitted to Registrar's Office (by 4/18)
15	4/14	4/20	
16	4/21	4/27	
17	4/28	5/4	
18	5/5	5/11	<ul style="list-style-type: none"> Graduation Ceremony (Thursday 5/8)

Appendix G

Knowledge Expert Questionnaire

The information gathered from this questionnaire will be used to populate data in the "expert locator" software on the industrial engineering portal, which is in development. This software is being developed as a part of the capstone design project for MS IE student Levi Smith. The purpose of the "expert locator" is to allow students and faculty to easily find experts in a given field, which will promote knowledge sharing internally and externally to the industrial engineering department.

Name: _____ Institution: _____ Department: _____

I. Please select the Industrial Engineering (IE) areas in which you consider yourself an expert. Teaching classes, completing research, publishing articles, or just a general interest in an area are factors that may indicate that you are an expert in an area.

- Engineering Economics
 - Engineering Statistics
 - Industrial Safety
 - Information Systems
 - Knowledge/Intellectual Properties Management
 - Lean Manufacturing
 - Operations Research
 - Productivity and Quality
 - Project Management
 - Engineering Management
 - Human Factors/Ergonomics
 - Simulation
- Others (Specify): _____

II. Please select the departments of faculty outside of IE with whom you have collaborated, and indicate the subject area.

	<u>Department of Collaborating Faculty</u>	<u>Area of Application</u>
<input type="checkbox"/>	Mechanical Engineering	
<input type="checkbox"/>	Electrical Engineering	
<input type="checkbox"/>	Nuclear Engineering	
<input type="checkbox"/>	Civil Engineering	
<input type="checkbox"/>	Other Engineering (Specify: _____)	
<input type="checkbox"/>	Computer Science	
<input type="checkbox"/>	Management Science	
<input type="checkbox"/>	Operations/Production Management	
<input type="checkbox"/>	Computer Science	
<input type="checkbox"/>	Others (Specify): _____	

Figure 13. Knowledge Expert Questionnaire

RESUMÉ

Levi D. Smith

SUMMARY

Background includes software design, development in a wide variety of languages, and systems testing. Familiar with many software technologies for development of security systems, client based applications, web based applications, database systems, portable systems, and graphical applications. Work has included collaborative projects requiring interaction with Department of Energy sites across the nation. Experienced with interacting with customers to deliver production software systems. Knowledgeable in industrial engineering techniques and processes.

EDUCATION

Georgia Institute of Technology: Atlanta, GA

B.S. Computer Science - 5/2002

Major Specialization: Software Engineering

Georgia Institute of Technology G.P.A.: 3.01

University of Tennessee: Knoxville, TN

M.S. Industrial Engineering - Expected 5/2008

University of Tennessee Graduate G.P.A.: 3.45

PUBLICATIONS

"The ENGINEering Economic Analysis (ENGINEEA) Software: Enhancing Teaching and Application of Economic Analysis Techniques." Computers In Education Journal, October - December 2005, pages 32-38.

AWARDS

Georgia Tech Dean's List, four terms

Governor's Scholarship, two years

Retained HOPE Scholarship for all semesters at Georgia Tech

RELATED COURSES

Georgia Tech: Software Engineering, Software Processes, Database Systems, Computer and Digital Fundamentals, Modeling and Design, Control and Concurrency, Programming Language Concepts, Systems and Networks, Computer Law, Real World Lab, Computer Science Theory, Computerization in Society, Computer Graphics, Human/Computer Interaction, Information Security, Software Applications

University of Tennessee: Engineering Economic Analysis, Operations Research, Statistical Methods in Industrial Engineering, Lean Production Systems, Information Systems, Knowledge Management, Productivity and Quality Engineering,

Technical Training Classes: Sun Java Web Services, Oracle Database Administrator, Cold Fusion Development

COMPUTER SKILLS

Skilled in using the following technologies:

Security: Entrust PKI technologies, Sun Java Access Manager, Identity Manager, LDAP Directory, RSA SecurID

Applications Development: Java, C, C++, SmallTalk, BASIC, Perl, Prolog, Lex/YACC, Oracle Forms, Visual Basic, LUA, PDA application development

Web Development: Java Web Services, HTML, CSS, PHP, XML/XSL, Javascript, JSP, Tomcat, Apache, IIS

Database Administration: Oracle DBMS, MySQL, MS SQL Server, MS Access

Graphical Development: OpenGL, Gimp, SDL, ClanLib, Blender

Operating Systems: Windows, Linux, UNIX, Solaris, DOS