

AC 2008-1382: WORKING WITH INDUSTRY SPONSORS IN A MULTIDISCIPLINARY SENIOR DESIGN PROGRAM

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Working with Industry Sponsors in a Multidisciplinary Senior Design Program

Abstract

This paper will present the advantages and disadvantages of involving industry in engineering senior design projects and courses. There are many issues and concerns that must be addressed when working with companies, since the underlying cultures of academia and industry are distinctly different. Further, each organization develops different goals and objectives with respect to their participation in the program. The following topics are addressed:

- **Pursuing Company Sponsors:** There are many important attributes of potential participating companies: size, proximity, connections to the university, number of alumni, and ability to financially participate. Examples of ways to reach and interest industrial sponsors are listed.
- **Statement of Work:** While a company may identify a project, a completed project is often a secondary goal. Companies want to identify new employees, and a senior design project is one way to meet graduating seniors and assess their ability to work in their organization. Still, a viable statement of work must be written so that the students can work on a real-world engineering problem.
- **Intellectual Property:** While a senior design project usually does not create valuable intellectual property, there is a possibility the work may be patentable. Who owns this work? This section describes several examples of assigning or identifying ownership BEFORE the work is done.
- **Company Involvement:** One of the most difficult parts of an industrial-based senior design program is ensuring the company employees actually participate. They have so little time, and if a project is to have any hope of success, a company employee must help define and/or guide the work. This section describes activities we use to increase company/student communication and contact.

This paper will present observations on each of these topics from the University of North Carolina at Charlotte's programs. Student outcomes are also identified.

1. Introduction

Senior design capstone courses offer engineering students an opportunity to apply the skills they have learned throughout their undergraduate education to an applied engineering project in a team environment. The University of North Carolina at Charlotte College of Engineering has integrated a multi-disciplinary senior design program that spans all of the engineering departments. Industry sponsors have been identified and incorporated into the program to allow students to work on real world problems. These sponsors are afforded the opportunity to initiate elective research projects in their respective areas of interest while working closely with seniors that the company may be interested in recruiting.

Due to the different cultures and timelines between industry and academia, there are many issues and concerns that must be addressed to make a successful partnership¹. Varying levels of corporate involvement and expectations can make managing each project unique. However, taking the time upfront to define the boundaries of the relationship and address the potential shortcomings that all projects may face can help to avoid many pitfalls often encountered with this type of endeavor and establish relations between industry and academia that continue to flourish.

2. Soliciting Company Involvement

Another term for this activity is *marketing*. How do you successfully market this opportunity? The first requirement is a good document or brochure that expresses the value of the relationship. The primary objective of this document is to introduce a company to the new idea of a university/company relationship using engineering students as company resources. The secondary purpose of the brochure is to provide enough detail to answer most of their initial questions: How much will it cost me? How long do the projects last? What is my true time involvement?

Once the document is complete, in our case it is a four-page color brochure, we needed to send it to people who we knew would be interested in reading about the program. We sent the brochure via e-mail to a several thousand engineering alumni. We introduced it as an opportunity for the school to do something for the companies; in this case, provide low cost development labor. We also asked for ideas for our departmentally sponsored projects. This opened up the communication lines between the program and working alumni. Since the program is relatively new, we fielded many responses from alumni who did not know of the program, and most thought it was an excellent addition to the curriculum. Although the percentage of responses was low (3%), we did make contact with some excellent prospects.

Another source of prospects is to contact any company in the area that hires engineers. This list is publicly available through a “Book of Lists” that is published by a national newspaper chain, the American City Business Journals (www.bizjournals.com). A database was created with these company names and addresses, their websites were visited and contact information extracted. Directors of Engineering and Human Resources were added to the database along with the type of work the company performed and the disciplines of engineers they had recently hired. Using the database, customized letters were created, attached to the brochure and were sent using hand written envelopes to the prospective sponsors. Those that responded were immediately categorized as “prospects” and communication continued until a project was sponsored or the organization indicated that they were not interested. Those who did not respond are placed on a prospect list until the next year. The types of project sponsorships for the current academic year are shown in Figure 1, illustrating the balance between new and repeat sponsors, along with the portion of sponsors with more than one active project. Additional methods were used to recruit potential sponsors including reviewing existing relationships with companies and those who participated in various recruiting events (picnic, job fairs, mock interview days, speaker panels, job postings).

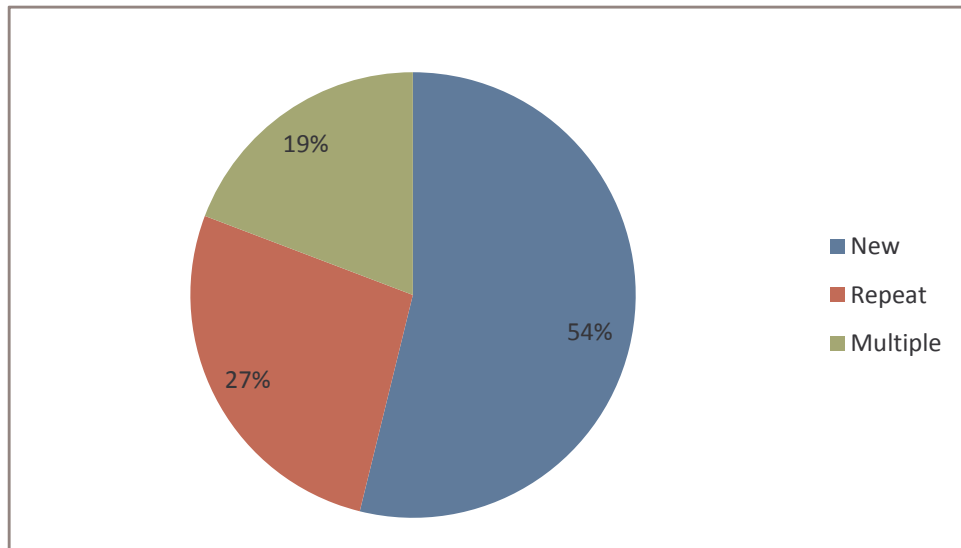


Figure 1: Sponsor participation frequency in the UNC Charlotte Senior Design Program, Year 2

Companies that show interest are invited to the end of semester activities that demonstrate the capability of the students. This usually results in the companies having a positive reaction to the program, and agreeing to sponsor a future project.

Another source of prospects is the business section of the local newspaper. Watching for companies that are expanding or moving into the area is a great source of potential relationships.

It is important to be aware of existing relationships when soliciting senior design projects. Each company in the database is checked across the University, through the development office, to insure that no existing relationship will be jeopardized by a Senior Design campaign. When existing relationships are found to be in place, these faculty can be leveraged to create additional opportunities.

3. Identifying the work

Statements of Work (example Appendix A)

Once interested companies have been identified, the next step is to have the course instructors' work with those companies to create a statement of work that defines the scope of the project. Some of the details that should be included are the project's objectives or goals, background on the subject, a description of what the project will entail, an estimate of the number of person hours required, and the contact information of the person within the sponsoring company that will interface with the students. Defining a clear statement of work is an important step in maintaining a good relationship with the industry sponsor since it provides a guideline to the expectations of the final project outcome to which both parties have agreed. The course instructor must become familiar enough with the scope of the project to:

1. Determine if the project goals are obtainable within two semesters
2. The level of funding required to reach those goals
3. The type of student expertise required (i.e. electrical engineering, mechanical engineering, etc.)
4. Decide how many team members would be required based on a time expectation of 10 hours per week per student.

Typical student team sizes range from 2 to 4 students, meaning the expected man hour contribution ranges from 500 to 1000 hours. Class time and time devoted to weekly planning meetings with faculty mentors are also factored into these time estimates which can reduce the amount of time directly spent on the project.

The statement of work is distributed to all of the students enrolled in the course at the beginning of the first semester, and posted on the course website. Therefore, it does not contain any sensitive material (i.e. trade secrets) that the company would not want to disclose to the general public. For many companies, the projects identified are elective research efforts that are not on a critical path or a key to the company's success. Rather, the project provides the sponsoring company the opportunity to review the talent pool of soon-to-be graduating engineers while at the same time benefiting from the student research. However, there are times when a company does involve student teams in projects that are on a critical path and the project's outcome may have an impact on the direction a company chooses to take in the future. For this reason, it is essential that the intellectual property rights of the project be clearly defined during the development of the statement of work.

Research Agreements and Non-Disclosure Agreements

One of the most challenging aspects of soliciting sponsors for Senior Design projects is determining the ownership of the Intellectual Property (IP). Since many of our buildings are new and supported by public bonds, the State mandates that University work done in them must be owned by the University. Note the absence of the word "solely". Hence, our standard IP agreement provides "joint" ownership of all IP developed as part of the project only if the company provides some collaboration in its development. Work done solely by the University students is owned solely by the University. We do, however, recognize that the sponsoring company provided the idea and financial assistance so we will provide a perpetual license to use the IP to that company.

So far, all of the sponsored projects have had collaboration by the companies so we have not had to deal with licensing issues. In fact, many companies elect to have the work performed at their locations, using their equipment and will therefore own exclusive rights to the IP. Our IP agreement is highly customizable and we work together with sponsors to solidify the agreement before presenting the projects to students. Figure 2 shows the distribution between project for this academic year between custom, standard and special IP agreements.

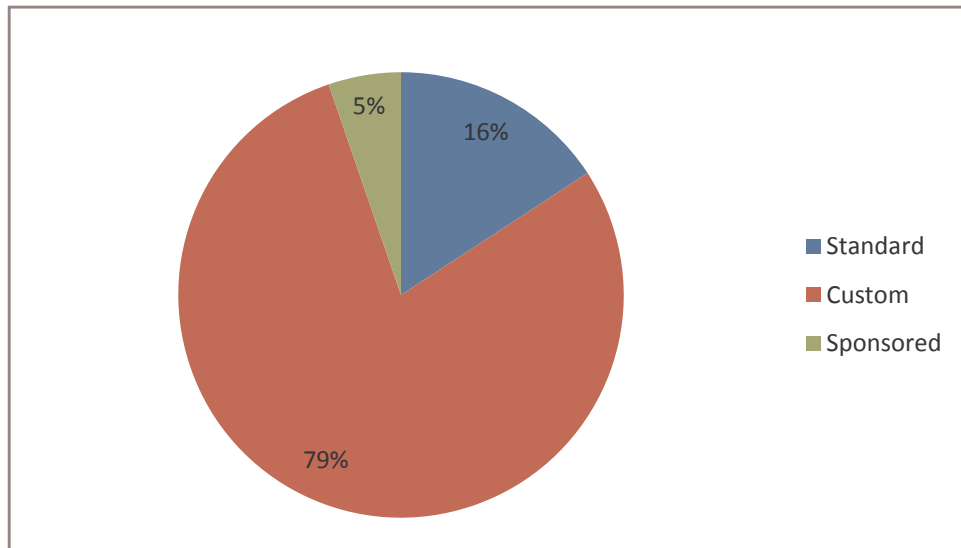


Figure 2: UNC Charlotte/sponsor intellectual property agreement types

We understand that when doing innovative work, especially when designing new features for an existing product, the student teams must understand how the existing product was designed. They are often subject to proprietary intellectual property by the sponsoring company. To protect our students and the company, each of the students and the faculty mentor are required to sign a Non Disclosure Agreement (NDA) indicating that they will not disclose any of the identified proprietary property to anyone outside the company. We also direct that the student posters and displays be reviewed by the sponsoring company to insure that no proprietary information is presented.

We believe that establishing a valid research agreement and insisting on the use of an NDA by the students and faculty indicates our commitment to industry to provide quality and safe design work. As our reputation builds and the number of returning sponsors increases, their feedback tells us we are working in the right direction.

Pairing Students with Companies

Once the statements of work and intellectual property agreements have been received, they are distributed to all of the students on the first day of class during the first semester of the senior design course. The students are asked to review all of the statements of work that pertain to their discipline and choose the top three projects that are of most interest to them. A company profile is usually included with the statement of work to provide the students more insight into the industry sponsor. An informal poll is taken during the second week of class to give the students an indication of the level of interest in each project and to avoid everyone choosing the same project. If the informal poll reveals too much interest in one project, the students have the opportunity to reconsider other projects before making their final selections. This approach helps to insure that all students get to work on a project of their choice and not one in which was of little interest to them.

On the third week of class each student submits a resume and cover letter applying for their top three project choices. Writing resumes and cover letters is reviewed during the first week of class, and each of their submissions should emphasize why they are the best candidate for that particular project. The students indicate on the cover letters whether the project is their first, second, or third choice, and each cover letter and resume is placed in a folder with the project's name written on the outside to help streamline the sorting process. An electronic copy of each submission is also provided to the course instructors.

The course instructors review all resumes and cover letters, and forward an electronic copy of the top candidates to the respective industry sponsors for their input in the selection process. A spreadsheet is used to track all of the applicants for each project and the priority assigned by each student. If a student does not get assigned to one of their top three choices, they are contacted by the course instructors and presented with other project choices that may better fit their talents. Finally, the groups are formed and students are notified of the team selections. Figure 3 shows the allocation of projects by student preference for the current academic year.

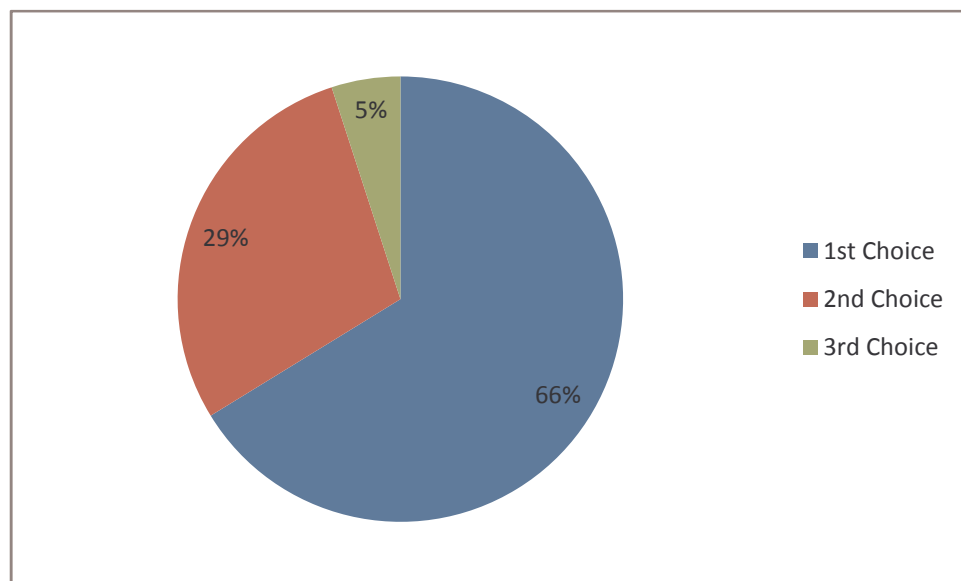


Figure 3: Student allocation to projects by student choice

4. Involving Companies in the work

Involving Companies in Senior Design Projects

Working engineers are, as a rule, stretched for time. Modern hiring practices, increased global competition and increased profit expectations from corporate shareholders all contribute to the reduced staff levels prevalent today. This fact must be considered when recruiting companies to participate in a senior design program. Expectations regarding sponsor involvement must be communicated during the initial phase of the relationship, and both the University and the corporate sponsor must understand the time commitment necessary for a successful project outcome.

Any decision to have the company participate in the senior design program was probably made at a level of management well above the engineer listed as the point of contact for the students, though this is not always the case. It is imperative for not only the students, but also for an affiliated faculty representative or the project mentor to connect with the engineering contact in a personal way in order to get communication started.

Connecting with the contact person can be reliably accomplished in only one way, personal meetings. In this program, social events such as a kick-off breakfast provide a venue for the students, faculty and the company representatives to meet in an informal setting and establish a personal connection. We have found that groups working with companies who attend this function have experienced better communication with their sponsors and have produced superior work product as a result of this contact. Attendance at the event is a good indicator for the importance that the invited attendees place on participation in the project. Every effort should be made to invite the actual point of contact for the student groups, in addition to any decision makers in upper management.

This connection can't be a one-time affair. Just as the students would experience in the workplace, regular meetings must take place to review progress of the work, to set new goals, and to even stretch the project into unforeseen areas. In this program, the lecture schedule is flexible enough to allow the students to make day trips to their sponsor's facilities to attend meetings. Since the program is sponsored, travel expenses can be reimbursed, so there is no financial hardship on the student. If geographic location of the sponsoring organization is a concern, most campuses now have video conferencing capabilities. Even if a conference phone call is the only method of "meeting", this communication tool will help students master meeting modalities that are common in the modern workplace.

The faculty mentor can also help strengthen the lines of communication by being in the loop with the students. As a matter of procedure, all faculty mentors involved in this program are copied on email communications with the engineering point of contact. This lets the working engineer know that the students are not wasting their time, since someone with grading authority reviews the communications. This is increased in effectiveness when the faculty mentor makes suggestions via the email chain, offering a little "free consulting" or restraining an overly exuberant student request. Email communication with the engineering contact originating with the instructor also can reinforce the need for the sponsor to respond to email when the student project gets put on the "back burner" or in some cases when the sponsor expectations cross into an area not appropriate for student work.

Again, regularly scheduled social affairs cement the bond between student, faculty and sponsors. An end of semester event, such as a design exposition, a formal dinner or some other event creates an opportunity for the students, sponsor and faculty mentor to meet and discuss the project trajectory. These meetings are also a good venue for assessment of the project quality as compared to the work of other student groups, and are an opportunity to show the sponsor that the program in general produces quality work. Figure 4 details the attendance statistics for the current academic year, including attendance by interested, nonparticipating sponsors.

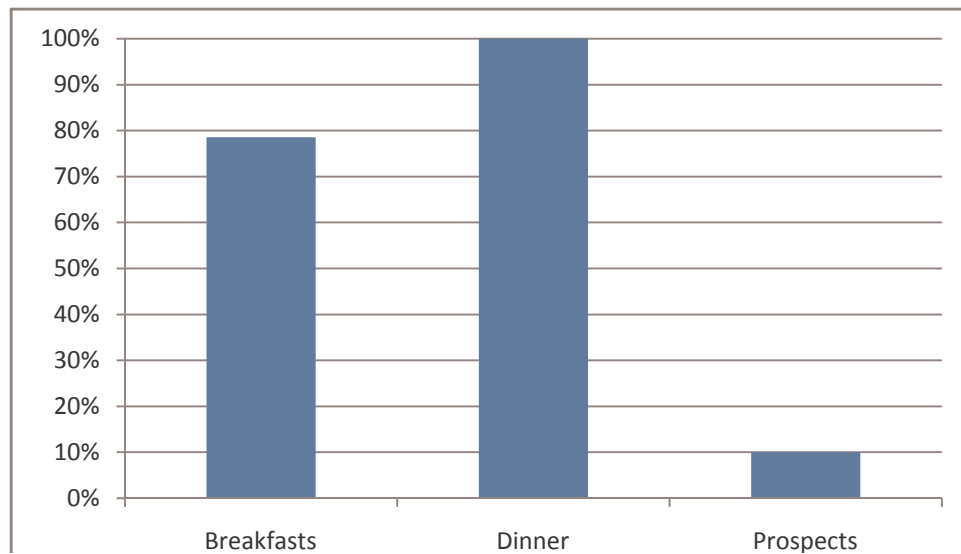


Figure 4

Documents, Reports and Grading

A copy of the course schedule is provided to each project sponsor at the start of the first semester that outlines the course deliverables (i.e. progress reports, project management documentation, etc.) and due dates. As the work is submitted to the course instructors, an electronic copy is also forwarded to the industry sponsor for review. A grading rubric^{3,4} for each document and report is provided to the industry sponsor by the course instructors along with a requested due date. Involving the industry sponsor in the grading process helps insure they are updated on the project's status, and presents an opportunity for the sponsor to raise questions or add clarity. Their involvement also provides the course instructors with a means to gage the level of satisfaction a sponsor has with the student team. A low grade may indicate the need for the course instructor to discuss the team's progress with the industry sponsor and determine what deficiencies need to be addressed.

The level of involvement and input from industry sponsors tends to vary depending on their accessibility and workload. This time commitment should be stressed to the lead industry contact person during the development of the statement of work, as there is a direct correlation between the level of input from the industry sponsor and the output of the student teams. The course instructors need to be sensitive to the industry sponsor's time and streamline the process where possible. For example, each student team identifies one member to act as the principle engineer. All communications between the industry sponsor and student team should go through the principle engineer to avoid multiple emails and phone calls from each team member that often are asking the same questions. Additionally, some of the course-related documentation that is submitted for grades but does not directly apply to the team's project should be graded by the course instructors only.

The deliverables that are graded by the industry sponsors are also graded by the course instructors and faculty mentors. An average of these three grades is then used as the final grade assigned to each document. Having multiple reviewers provides the team feedback from people who all may be viewing the project a little differently. Since many of the projects focus on only one aspect of a larger effort, the industry sponsor tends to view the team's progress from a broader perspective as to how it will be integrated within the overall corporate goal. The faculty mentor views the team's progress based on their individual efforts and the milestones reached on a day-to-day basis. The course instructors can compare the progress of each team relative to the entire class to determine if an adequate level of effort has been put forth.

5. The Final Project Deliverable - The Senior Design Exposition

The culmination of the two-semester course is the Senior Design Exposition. Student groups prepare visual aids, handouts, demonstrations, models, and drawings, along with preparing themselves to present the results of their efforts. The industry sponsors, faculty mentors, and interested parties are invited to attend the Senior Design Exposition to observe and review the prepared products. The students explain their project to observers, how information was obtained and analyzed, how the group worked to find a solution, and how the interaction with the industry sponsor helped to make the project successful. Some of the observers grade the student projects for appearance, for the information presented, and the overall professionalism displayed by the group. There is a cash award to the top three groups based on the evaluation of the observers. Figure 5 illustrates a student team presenting their final project to several members of industry at the Final Exposition.



Figure 5: A senior design team presenting their project to industry members at the Final Expo.

The Senior Design Exposition also demonstrates to the industry sponsors the commitment the college makes to supporting the students and appreciating the participation of the sponsors. Potential sponsors are invited to the Senior Design Exposition to expose them to the opportunities the college may offer. The Senior Design Exposition helps to facilitate lines of

communication between sponsors, potential sponsors, and the college. Having faculty and university officials at the Senior Design Exposition provides an opportunity for sponsors and potential sponsors to talk about important issues such as intellectual property rights, university responsibilities, and sponsor expectations.

6. Student Outcomes

Students participating in the industry sponsored senior design program are expected to produce industry-standard deliverables throughout the two-semester course. The documents include⁴:

- Requirements and Capabilities
- Work Breakdown Structure
- Schedule (Gantt Chart)
- Risk Assessment and Mitigation Plan
- Project Budget
- Bill of Materials
- Purchase Orders
- Project Design Documentation
- Status Reports
- Change Requests
- Final Project Report

Our industry sponsors insist that a graduating engineering student should have some level of project management and corporate operation knowledge and experience before they enter the workforce². As a result of working on an industry-sponsored project, the students, by virtue of instruction and document development, gain this experience. End-of-semester grading shows that nearly all students understand the need for and have mastered documentation concepts.

Student evaluations submitted at the end of each semester also provide insight on the benefits of working with companies. Student comments include:

- This was a very good class. Everything will be very beneficial for our future careers.
- I love the multidisciplinary idea; it is so much better than the normal senior design.
- I learned a lot about the business end of industry about a Work Breakdown Structure, a Bill of Materials, Requirements Documents, etc. A very interesting class that gave me a little bit of industry experience.
- This class really gives students an unforgettable experience. They gain experience in industry, documents (business) required, & w/developing posters. This class should continue.
- Our company did not seem fully prepared at the beginning of the semester. Overall, the format of the class is excellent and I enjoyed working with the company.

7. Conclusion

While the history of this course is not long, an additional benefit to students and sponsors is the ability to find out about each other. Several students have been offered positions with the company that sponsors their project upon graduation. With the current demand for engineers, the Senior Design Exposition provides an opportunity for sponsors, students, and college officials to find out about each other and, hopefully, establish and strengthen relationships.

This course is a capstone course. It is important to have faculty and administrators participate in all levels to show the students that the college believes this is an important part of their academic career. Students have to manage the projects, including maintaining communication between the sponsor, the faculty mentor, and the group members. Past experience shows that groups that do not maintain good communication typically result in poorly planned and executed projects.

The successfully completed Senior Design Exposition provides the “final stamp” on an intense project, on a college education, and a first step into the post graduate career for the students

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9: Appendix A

Example Statement of Work

Title: Datacenter Cooling System Proposal

Sponsor: xxxxxx, Inc.

Faculty Mentor: Prof. xxxxxx

Personnel: 2-3 ME/ MET's.

Expected person-hours: 500-750 person hours

Deadline: xx/xx/08

Background:

Company is upgrading the systems at the Main Street datacenter. The new data center has much smaller mainframe computers and rows of servers setup for "hot aisle"/ "cold aisle" cooling. There are eighteen 20 TON chillers on the raised floor using chilled water.

Currently the Data Center is equipped to support an equipment load of 57 watts per square foot. Future growth projections show that this metric will need to increase. The projected load of 100 watts per square foot will be needed in the next 5 to 10 years.

Statement of Work:

- Review and document the current room and cooling system noting the location and type of venting floor tiles and any air flow deflection devices under the raised floor.
- Understand the cooling requirements of all the equipment currently on the floor and those planned for the next 24 months.
- Gather the requirements for the hot aisle/ cold aisle cooling for the server racks installed. Understand what air deflection devices are currently available and how to implement them for maximum efficiency of the chillers.
- Provide a proposed plan, including calculations, drawings and placement of floor venting tiles, airflow deflection devices, and relocation of any existing equipment and location of future equipment.
- Provide future equipment changes (chiller, piping, raised floor configuration) to support the projected equipment load.