Ashburn Corporate Center 5
Ashburn, Virginia

Final Thesis Proposal

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December 12, 2008



Executive Summary

The following proposal is intended to provide an overview of the four topics that will be researched for a final thesis report on the ACC5 project. The topic areas include the effects of the current economy on the industry, the cost and schedule impact of the foundation system, trade coordination and constructability with the slab design, and implementing a building integrated solar energy system as an additional sustainable feature.

Critical Industry Analysis

With money as tight as it is today, it is necessary to exhaustively evaluate a project's current construction and financial status. Since ACC5 was recently suspended, I believe that research on the economy's effect on the industry would be quite beneficial to the owner and industry professionals for current and future times.

Analysis I

During precast erection, it was discovered that several caissons under full loading were sinking. Rework was required resulting in high costs to the owner and a four week delay. An investigation into the soil conditions and design purposes of the existing foundation system will occur followed by the implementation of a new system.

Analysis II

The current slab design includes trenches for chilled water piping. These trenches require added excavation, materials, and time to construct. I plan to investigate an alternative slab design that would eliminate the mentioned cost, schedule, and constructability issues provided with the current design.

Analysis III

Energy conservation and "Going Green" are two highly popular concepts among industry professionals and people everywhere. The owner, DuPont Fabros Technologies, is constantly looking for ways to develop more efficient data centers and distinguish themselves from competitors, as given by constructing what will be the first LEED Gold data center in the country. As such, I intend to research the possibility of harvesting solar energy and coupling it with the existing energy source to reduce ACC5's dependency on power from the grid.

This analysis will include both breadths for my research, which occur in the Structural and Electrical fields. The addition of solar panels on the roof will drastically affect both the structural system, introducing a substantial load on the roof, and the electrical system, implementing a new energy source into the existing electrical power source.

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Project Introduction

The Ashburn Corporate Center 5 (ACC5), located in Ashburn, VA, is a 360,000 square foot, precast data center for DuPont Fabros Technology. The data center houses computer equipment rooms on raised access floor, administrative offices, facility support spaces, and facility infrastructure spaces with extremely intricate mechanical, electrical, and communication systems. Despite being a building that consumes a great deal of energy, a 12,795 ton mechanical cooling load and a 36.4MW total electrical critical load, ACC5 is pursuing LEED Gold Certification at 40 points. Once certified, this will be the first LEED building for the owner and the second LEED Gold data center in the country.

The overall project schedule has an expected duration of 14 months beginning in February 2008 and ending in April 2009 with an estimated budget set at $170,916,000. Up until November 2008, the project was approximately 60% complete with 500 on-site personnel. Unfortunately, due to economical conditions and extenuating circumstances, the ACC5 project has been suspended until further notice.

Other areas that I have decided to analyze include the cost and schedule impact of the deep foundation system, trade coordination and constructability with the slab design, and implementing a building integrated solar energy system as an additional sustainable feature. The following sections provide a more detailed explanation for each analysis.

Critical Industry Issue | Industry and the Economy

Problem

The construction industry has been affected by the current economic recession. Jobs are suspended, shut down, or not even starting and companies have to downsize. Companies are having trouble securing loans and allocating funds. As of November 2008, ACC5 became one of those projects and was suspended by the owner until further notice. [*Note: As previously mentioned in Tech 1, the other two projects occurring concurrently for DuPont Fabros have been suspended (New Jersey and California projects).*] Fortunately, the Owner has several completely leased data centers in full operation that are producing steady revenue.

Goal

The goal of this research is to develop a project execution plan that would expand the construction duration allowing the owner to evenly allocate funds throughout the project's entirety. The research will focus on the evaluation of the industry issues discussed in the problem statement, the immediate need for ACC5, the workforce, and value engineering options.

Methodology

- Analyze the overhead costs in comparison to reducing the schedule acceleration costs (overtime work, shift work, etc.)
- Evaluate value engineering concepts
- Analyze the workforce in terms of manhours, overtime, shifts, etc.
- Research the possibility of phased occupancies in order to garner revenue from tenants throughout the construction process.
- Analyze current and projected revenue to find an optimal pace for construction.

Preliminary Resources and Tools

- Owner Representatives
- Industry Professionals
- Current Events and Literature
- MS Project

Expected Outcome

Through research, I expect to develop a plan that would allow the project to be completed without any setbacks. This execution plan would provide a better route for the owner, given the time and nature of the economy, as opposed to pushing the typical fast paced construction in order to obtain tenants and future revenue. Through this plan, the owner would base the completion of the project more heavily on current revenue than on the payback of future revenue from ACC5.

Analysis I | Alternative Foundation Design

Problem

Figure 1 - - Temporary support for the sinking column E-12

The current foundation system includes CIP concrete piers and caissons. Some of the caissons rest on solid rock, while others are on soil providing the necessary bearing capacity. Half way through the precast erection process, one of the columns appeared to be sinking and leaning, eventually up to 3". At the time, the column was supporting half of its intended load. Shortly after, another column along the same line was exhibiting the same problems. The actual problem was that the caisson supporting the column was sinking. The field fix involved removing the precast pieces and columns, excavating down to solid rock, and placing spread footings and piers below the precast columns. At this point, the real reason for failure is unknown and could be linked to soil conditions in that exact location. Nevertheless, the remaining columns in the building did not experience such a problem.

Goal

The main focus of this study would be to investigate the current foundation system design and determine whether it was designed for strength or for settlement. The goal is to provide a more stable foundation system that would have had less cost and schedule impacts on the owner and project.

Methodology

- Contact all trades involved to interview them about the sinking caisson issue and consult them for other options.
- Analyze the constructability of the current system vs. alternative system.
- Analyze the schedule delays resulting from the rework and compare to the construction duration for an alternative system.
- Analyze the cost required to disassemble the structure in order to construct a new foundation and reconstruct the structure.
- Compare the cost of the alternative system to the rework cost.

Preliminary Resources and Tools

- Geological reports
- Industry professionals
- MS Project

Expected Outcome

Through this analysis I expect that an alternative foundation system would have not been affected by the unsuitable soil conditions if designed accordingly, thus eliminating the rework that occurred. In addition, I expect to reduce the overall project duration and cost.

Analysis II | Alternative Slab Design/Mechanical Layout

Problem

Figure 2 - Mechanical trench in a computer room.

ACC5 has a flat slab on grade with mechanical trenches, which houses the chilled water pipes located along the computer room walls. The trenches contain spills from the pipes, lower the piping so the access floor can easily clear the pipes, and provide ample underfloor space for other conduit, such as fire alarm and security.

The trenches pose an issue with the placement of pedestals for the access floor. Steel channels must bridge the trenches to provide support for the pedestals. This requires a large amount of steel to cover all trenches, which also requires more coordination and labor. In some cases, once tenants move into the space, the Power Distribution Unit (PDU) layout may occur over the trench, requiring additional steel channels to support the PDU stands. This underfloor area above the trenches then becomes quite cluttered.

Goal

This analysis would involve a redesign of the slab to be a completely flat slab in lieu of the trenches and to manage the underfloor layout. The benefits of the new design and layout will be researched, including reduction of materials, cost savings, and installation and schedule impacts.

Methodology

- Analyze the constructability of the flat slab vs. slab with trenches.
- Calculate any cost savings resulting from changing to a flat slab.
- Analyze the schedule impacts of the flat slab system.
- Contact MEP trades for assistance with the undefloor layout.

Preliminary Resources and Tools

- Industry professionals
- MS Project
- AutoCAD MEP/AutoCAD 2007
- Navisworks Manage 2009

Expected Outcome

Although the current floor slab design is a highly effective design, the expected results of this analysis would show that utilizing a flat slab would produce material and cost savings, as well as a schedule reduction. Moreover, the constructability review of the alternative design would result in providing easier coordination for future tenant build-out.

Analysis III | Building Integrated Solar Energy System

Problem

As previously mentioned, ACC5 will be a highly green building, LEED Gold, and much more efficient than most typical data centers. However, in the big picture, a data center consumes a great deal of energy and continues to struggle with efficiency issues. The original design for ACC5 included a DC power plant and distribution, but was eventually removed since the servers did not require DC power and could be run using AC power. Currently, there is interest among the industry to utilize large DC producing solar arrays with a DC power distribution. It is a way to combine renewable energy with a more efficient power structure.

Goal

The goal of this analysis is to implement solar energy into the existing power plan for the data center as a means of utilizing renewable energy and reducing the overall energy costs for the owner.

Methodology

- Research DC Power Distribution for Data Centers
- Compare the use of AC Power vs. DC Power to determine if DC is needed and more efficient with solar arrays
- Contact solar panel manufacturer and consult for design implementation.
- Calculate the solar panel load and analyze how the existing structure is affected.
- Calculate the amount of power generated by the solar panels and analyze how the existing electrical system is affected.
- Analyze payback period of the solar panels and research funding opportunities.

Preliminary Resources and Tools

- Industry Professionals
- Structural and Electrical Engineering Faculty
- CCG Facilities Integration, Inc. (MEP Engineer on the project)
- Relevant literature.

Expected Outcome

Through research and a thorough analysis, I expect to find that implementing solar arrays would provide a cost and efficiency benefit in the long run. I do not expect that the solar arrays would provide enough energy to solely power the data center; however I do intend to prove that the solar arrays will diminish ACC5's dependency on power from the grid.

Timetable

The schedule below is a breakdown of the overall amount of time that I will be working on my research.

Task Name	Duration	Start	Finish
Thesis Research Schedule	**90 days**	**Mon 12/15/08**	**Fri 4/17/09**
Critical Industry Issue Research	**35 days**	**Mon 12/15/08**	**Fri 1/30/09**
Literature review	7 days	Mon 12/15/08	Tue 12/23/08
Interview owner reps, industry professionals, and project team	4 days	Tue 1/6/09	Fri 1/9/09
Analyze cost allocations	5 days	Mon 1/12/09	Fri 1/16/09
Develop execution plan	6 days	Wed 1/14/09	Wed 1/21/09
Summarize and document results	5 days	Wed 1/21/09	Tue 1/27/09
Review results with Dr. Messner	1 day	Wed 1/28/09	Wed 1/28/09
Revisions	2 days	Thu 1/29/09	Fri 1/30/09
Analysis I Research	**48 days**	**Mon 12/15/08**	**Wed 2/18/09**
Review and analyze current design	5 days	Mon 12/15/08	Fri 12/19/08
Interview project team	5 days	Mon 1/26/09	Fri 1/30/09
Develop new design/analyze impacts	8 days	Wed 1/28/09	Fri 2/6/09
Summarize and document results	5 days	Mon 2/9/09	Fri 2/13/09
Review results with Dr. Messner	1 day	Mon 2/16/09	Mon 2/16/09
Revisions	2 days	Tue 2/17/09	Wed 2/18/09
Analysis II Research	**55 days**	**Mon 12/15/08**	**Fri 2/27/09**
Review and analyze current design	5 days	Mon 12/15/08	Fri 12/19/08
Interview project team	5 days	Mon 2/9/09	Fri 2/13/09
Develop new design/analyze impacts	8 days	Wed 2/11/09	Fri 2/20/09
Summarize and document results	5 days	Wed 2/18/09	Tue 2/24/09
Review results with Dr. Messner	1 day	Wed 2/25/09	Wed 2/25/09
Revisions	2 days	Thu 2/26/09	Fri 2/27/09
Analysis III Research	**40 days**	**Mon 2/2/09**	**Fri 3/27/09**
Literature review	10 days	Mon 2/2/09	Fri 2/13/09
Interview industry professionals	10 days	Mon 2/16/09	Fri 2/27/09
Develop new design/analyze impacts	15 days	Mon 3/2/09	Fri 3/20/09
Summarize and document results	10 days	Wed 3/11/09	Tue 3/24/09
Review results with Dr. Messner	1 day	Wed 3/25/09	Wed 3/25/09
Revisions	2 days	Thu 3/26/09	Fri 3/27/09
Compile Final Report	5 days	Mon 3/30/09	Fri 4/3/09
Presentation	**8 days**	**Wed 4/8/09**	**Fri 4/17/09**
Final Thesis Report Due	1 day	Wed 4/8/09	Wed 4/8/09
Revision & Presentation Practice	2 days	Thu 4/9/09	Fri 4/10/09
Presentations w/ Faculty Jury	5 days	Mon 4/13/09	Fri 4/17/09

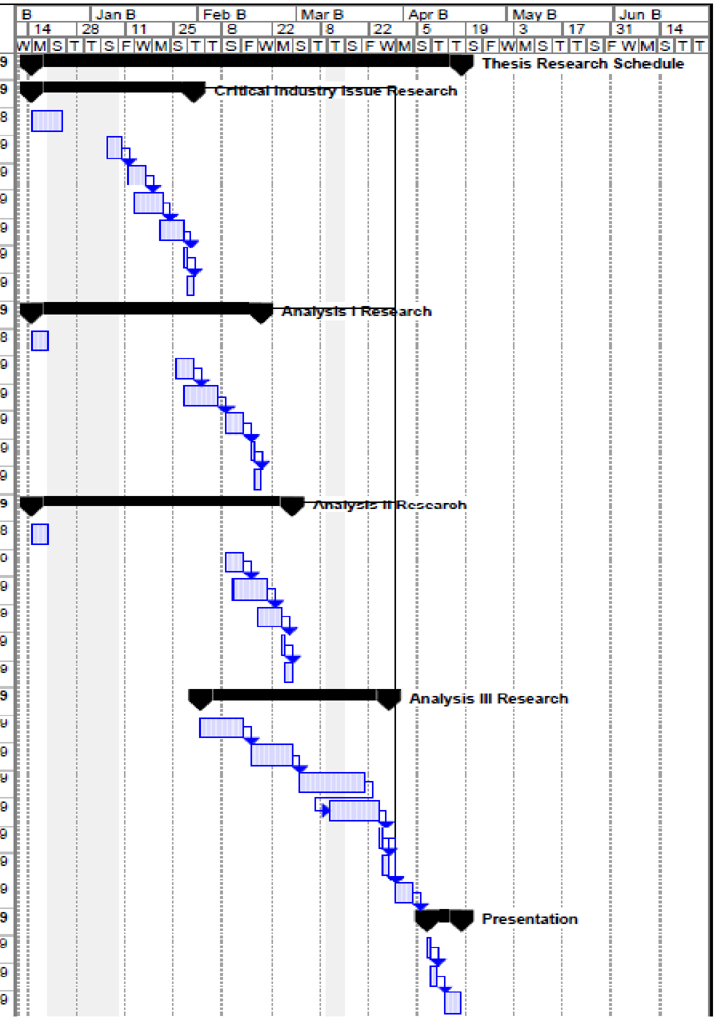

Figure 3 - Semester Research Schedule

Weight Matrix

The weight matrix below represents how I will be allocating my time among the research and analyses previously mentioned within this proposal.

Description	Research	Value Engineering	Constructability Review	Schedule Reduction	Total
Industry and the Economy	25%	10%			**35%**
Alternative Foundation			10%	10%	**20%**
Trade Coordination with Slab Design		10%	5%	5%	**20%**
Solar Energy System	10%	5%	10%		**25%**
Total	**35%**	**25%**	**25%**	**15%**	**100%**

Table 1 – Weight Matrix illustrating time distribution

Appendix A | Technical Analysis Studies

A brief summary defining the technical analyses incorporated within my thesis can be found on the following page.

Introduction

The following topics involve a more detailed analysis of the technical options within the major. In addition, both topics stem from the previously mentioned analysis entitled Building Integrated Solar Energy Systems.

Technical Analysis #1

Structural

Currently, the roof of the building is a 296,000 SF flat roof comprised of a TPO membrane applied to a 3" concrete topping slab on precast double tees. On one portion of the roof, there is a mezzanine level housing (32) engine-generators, approximately 19 tons each, resting on a 6" slab, therefore the roof structure can withstand a great structural load.

As mentioned in the Building Integrated Solar Energy System analysis, I intend to place a large solar array on the roof. The technical analysis will involve determining the effect this array would have on the existing structural system and compare it to the maximum load allowed. If the maximum load is exceeded then I will need to devise a way to further support the roof, such as increased reinforcement, thicker concrete slab, and/or change in the column stress, etc.

Technical Analysis #2

Electrical

For ACC5, utility power will service the data center in two locations each at 34.5kV. That power will then be stepped down to 600V via pad-mounted transformers and fed to the system's UPS. Another step down will occur transforming the power from 600V to 180/208V AC for computer room distribution. Had DC power distribution been utilized, a 600V AC power to DC power conversion would have occurred at this point in addition to the 600V to 180/208 AC step down.

By implementing a solar energy system into the existing electrical system, I would need to determine the effect that the energy generated from the solar power would have on the existing system. I intend to analyze a means of tying together the two systems. Upon researching DC power distribution, if it seems like a more logical design, then I will need to determine a way to convert the utility power to DC power and how to distribute that power throughout the building. This analysis would also involve evaluating the cost effects and constructability of a solar energy system.