Mid-Atlantic Data Center
Ashburn, Virginia

Revised Thesis Proposal

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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 MADC project. The topic areas include the effects of the current economy on the industry; the cost and schedule impact, trade coordination, and constructability with the utility distribution; 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 MADC was recently suspended, research on the economy's effect on the industry, mainly MADC, would be quite beneficial to the owner and industry professionals for current and future times.

Analysis II

The current utility distribution design includes the entrance of main feeds underground for electrical conduits and aboveground via trenches for chilled water piping. These trenches require added excavation, materials, and time to construct. An alternative slab design that would eliminate the cost, schedule, constructability, and efficiency issues provided with the current design will be analyzed.

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, research will occur involving the possibility of harvesting solar energy and coupling it with the existing energy source to reduce MADC's dependency on power from the grid.

This analysis will include both breadths for the research assignment, 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 Mid-Atlantic Data Center (MADC), 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, MADC 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 MADC project has been suspended until further notice.

Other areas that will be analyzed include the cost and schedule impact, trade coordination, and constructability with the utility distribution 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, MADC 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 MADC, the workforce, value engineering, and energy efficiency 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.
- Analyze energy efficiency and develops ways to reduce energy costs.

Preliminary Resources and Tools

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

Expected Outcome

Through research, it is expected that a plan will be developed that would allow the project to be completed without any major 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 MADC.

Analysis II | Alternative Utility Distribution

Problem

Figure 1 - Mechanical trench in a computer room.

Underground and aboveground conduits make up the existing utility distribution for the MADC. All electrical main feeds have been located underground below the slab and concrete trenches within ductbanks and the earth itself. Mechanical main feeds are housed aboveground within trenches located along the computer room walls. These 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. 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.
- Review Chicago Data Center case study.

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 be more efficient and produce material, cost, and schedule savings. 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, MADC 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 MADC 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, reducing the building's dependency on energy from the grid, creating a more energy efficient building, 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
- Analyze payback period of the solar energy system and research funding opportunities.
- Analyze the cost, schedule, and lead time impacts.
- Determine if the long-term benefits, efficiency, and costs outweigh the upfront costs and schedule impacts
- Calculate the solar energy system structural and electrical load and analyze how the existing structure is affected.

Preliminary Resources and Tools

- Contact solar energy system manufacturers and consult for design implementation.
- Industry Professionals
- Structural and Electrical Engineering Faculty
- CCG Facilities Integration, Inc. (MEP Engineer on the project)
- Relevant literature.

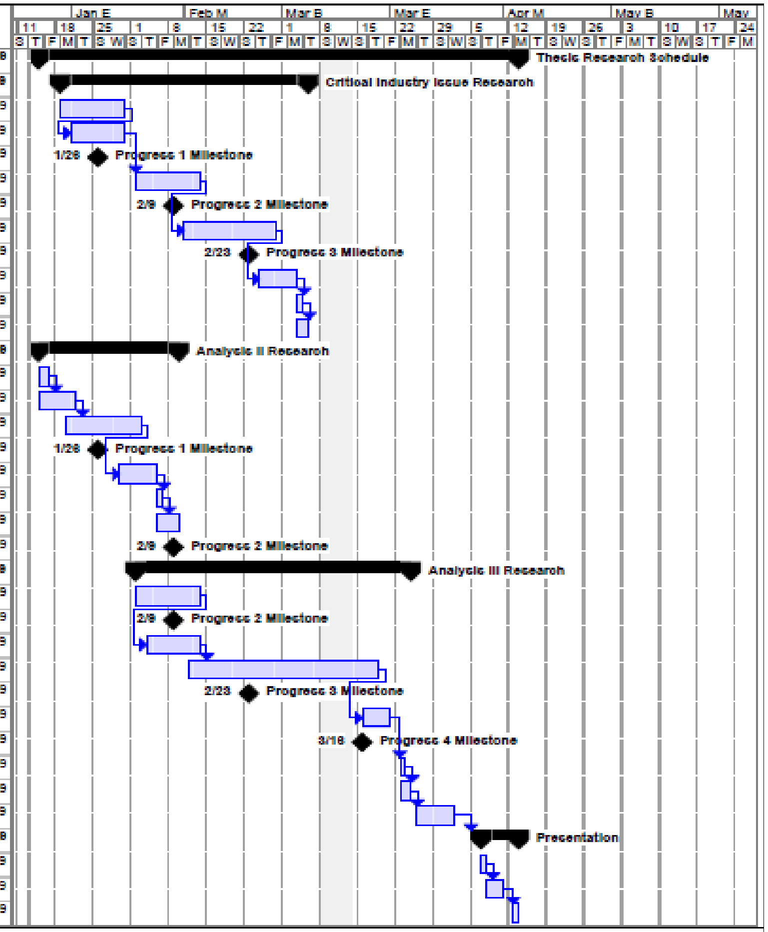
Expected Outcome

Through research and a thorough analysis, the expectation is to conclude that implementing a solar energy system would provide a cost and efficiency benefit in the long run. It is not expected that the solar system would provide enough energy to solely power the data center; however the research is intended to prove that this system will diminish MADC'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.

ID	% Complete	Task Name	Duration	Start
1	0%	**Thesis Research Schedule**	**68 days**	**Thu 1/15/08**
2	0%	**Critical Industry Issue Research**	**34 days**	**Mon 1/19/08**
3	0%	Literature review	10 days	Mon 1/19/09
4	0%	Interview owner, professionals, and project team	8 days	Wed 1/21/09
5	0%	Progress 1 Milestone	0 days	Mon 1/26/09
6	0%	Analyze cost allocations	10 days	Mon 2/2/09
7	0%	Progress 2 Milestone	0 days	Mon 2/9/09
8	0%	Develop execution plan	13 days	Wed 2/11/09
9	0%	Progress 3 Milestone	0 days	Mon 2/23/09
10	0%	Summarize and document results	5 days	Wed 2/25/09
11	0%	Review results with Dr. Messner	1 day	Wed 3/4/09
12	0%	Revisions	2 days	Wed 3/4/09
13	0%	**Analysis II Research**	**18 days**	**Thu 1/15/08**
14	0%	Review and analyze current design	2 days	Thu 1/15/09
15	0%	Interview project team	5 days	Thu 1/15/09
16	0%	Develop new design/analyze impacts	10 days	Tue 1/20/09
17	0%	Progress 1 Milestone	0 days	Mon 1/26/09
18	0%	Summarize and document results	5 days	Fri 1/30/09
19	0%	Review results with Dr. Messner	1 day	Fri 2/6/09
20	0%	Revisions	2 days	Fri 2/6/09
21	0%	Progress 2 Milestone	0 days	Mon 2/9/09
22	0%	**Analysis III Research**	**32 days**	**Mon 2/2/08**
23	0%	Literature review	10 days	Mon 2/2/09
24	0%	Progress 2 Milestone	0 days	Mon 2/9/09
25	0%	Interview industry professionals	8 days	Wed 2/4/09
26	0%	Develop new design/analyze impacts	20 days	Thu 2/12/09
27	0%	Progress 3 Milestone	0 days	Mon 2/23/09
28	0%	Summarize and document results	5 days	Mon 3/16/09
29	0%	Progress 4 Milestone	0 days	Mon 3/16/09
30	0%	Review results with Dr. Messner	1 day	Mon 3/23/09
31	0%	Revisions	2 days	Mon 3/23/09
32	0%	Compile Final Report	5 days	Thu 3/26/09
33	0%	**Presentation**	**6 days**	**Tue 4/7/08**
34	0%	Final Thesis Report Due	1 day	Tue 4/7/09
35	0%	Revision & Presentation Practice	3 days	Wed 4/8/09
36	0%	Presentations w/ Faculty Jury	1 day	Mon 4/13/09



Project: Research Schedule
Date: Tue 1/13/09

Task | Split | Progress | Milestone | Summary | Project Summary | External Tasks | External Milestone | Deadline

Figure 2 - Semester Research Schedule

Weight Matrix

The weight matrix below represents how time will be allocating 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%		5%	**40%**
Trade Coordination with Slab Design		10%	15%	5%	**30%**
Solar Energy System	10%	5%	10%	5%	**30%**
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, a large solar array will be placed 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 further support will be required for the roof, such as increased reinforcement, thicker concrete slab, and/or change in the column stress, etc.

Technical Analysis #2

Electrical

For MADC, 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, the effect that the energy generated from the solar power would have on the existing system needs to be determined. A means of tying together the two systems will be analyzed. Upon researching DC power distribution, if it seems like a more logical design, then a way to convert the utility power to DC power and how to distribute that power throughout the building will be developed. This analysis would also involve evaluating the cost effects and constructability of a solar energy system.