February 11th, 2013

SENIOR THESIS PROPOSAL

PENN STATE SENIOR THESIS

REPLACEMENT HIGH SCHOOL

MARYLAND

BRADY SHEERIN

CONSTRUCTION MANAGEMENT
ADVISOR: CHIMAY ANUMBA

Executive Summary

This senior thesis proposal will serve to identify four possible analysis topics that will be further investigated during the following semester. Each analysis will address problems or opportunities within the building by proposing changes to the existing processes and or systems. Each analysis will address some of, or all of, the following core areas of investigation: Critical Issue Research, Value Engineering Analysis, Constructability Review, and/or Schedule Reduction/Acceleration Proposal. The goal of these analyses is to identify and research possible areas that would create a more efficient means of construction for the project team as well as more adequately meet the owners' goals.

Analysis #1: Mechanical System

The proposed mechanical system for the replacement high school is a geothermal system with over 437 wells all at a depth of 400 feet. A system of this magnitude comes with a significant upfront cost for installation. To curb this cost I will look into implementing a hybrid geothermal system so that the owner will still receive the benefits of using geothermal wells, but will have additional funds to allocate elsewhere.

Analysis #2: Solar Energy Conversion System (SECS)

The current design for the replacement high school pays little attention to the possibility for implementing solar devices. Due to the location of the school and lack of surrounding structures the use of photovoltaic panels could prove to be beneficial to the owner. I will look into potential arrays for this building and determine the feasibility.

Analysis #3: Alternate Delivery Method

Due to a two month delay on the Notice to Proceed, a lot of additional pressure was put on the CM agency. I will investigate an alternate design build approach to construct this school to see if and how some of these pressures could be alleviated. To do this I will compare Hess Constructions current contractual agreements with one of their typical design build contracts.

Analysis #4: Façade Prefabrication

A large portion of the exterior façade is made up of hand laid ground face CMU. In an effort to decrease the schedule I will investigate the implementation of a precast façade. I will have to look into the logistical issues associated with doing this.

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Project Background

This project is a 255,000 square foot replacement high school that is being constructed for Prince George's County School District by Hess Construction + Engineering Services. The overall project duration is 3 years, but the school has to be completed within the first 18 months. The original schedule allotted for the school to be built in 20 months but a two month delay on the notice to proceed shortened that schedule.

The roughly 75 million dollar project consists of the demolition of an existing school that was completed in 1959, and the construction of a new state of the art high school. The new building is being constructed within close proximity of the existing school because the gymnasium, which was built in 2003, is incorporated into the design of the new school. The high school will have the capacity to hold 1,200 students and consist of two, three story classroom wings, a connecting atrium, a cafeteria, administrative offices, culinary labs, an auditorium, and auxiliary gym facilities. In the center of the school is a large rotunda and spiral stair case topped with a curtain wall which serves as an architectural feature.

The demolition of the existing school will start after the new building is turned over to the owner and the space has been occupied in August of 2013. After the building has been removed a permanent parking lot and bus loop will be installed. It is also during this time that the sports fields will be completed.

Figure 1: Progress Photo 07/14/2012

Technical Analysis #1: Mechanical System

Problem Identification:

In order to complete this project with the provided budget the owner had to value engineer out a lot of high end features and equipment that they wanted to keep. To address this I would suggest tweaking the current mechanical system because it has one of the most significant costs associated with the new high school. The current mechanical system is a geothermal system consisting of 437 wells all at a depth of 400 feet. By switching this to a hybrid geothermal system the owner will still get the benefits associated with geothermal wells, but should have money left over to add value to their building. This reduction in cost would be related to the need to drill less wells, which are very expensive.

Research Goal:

The goal of this topic is to perform a value engineering analysis of the current mechanical system. To do this I will further investigate geothermal systems and hybrid geothermal systems. I will propose reducing the number of wells and modular geothermal heat pumps to reduce the costs of the mechanical system. To regain the loss in heating and cooling capacity that this will cause I will implement a cooling tower and boiler into the system. At this point I will determine if there are benefits associated with sizing down the geothermal fields and the implications that this would have. I will then perform life cycle cost analyses of the two systems to determine the validity of this approach. At this point, if there are any savings, I will determine what items they could be applied to that the owner had to value engineered out.

Research Steps:

- Investigate the current geothermal well system
- Determine the size of cooling tower and boiler needed for a revised hybrid geothermal systems
- Redesign geothermal system by decreasing the number of wells and increasing the size of the mechanical equipment
- Contact project team for cost information
- Perform cost analysis
- Determine constructability issues, possible schedule impacts, and perform a life cycle cost analysis

Resources and Tools to be used:

- Hess Construction contacts
- Industry professionals
- Project owner
- Applicable literature
- Mechanical classmates
- AE department faculty

Expected Outcome:

Upon the completion of this analysis, it is expected that the money saved from changing the current mechanical system will allow the owner to allocate funds to items they had to previously value engineer out.

Technical Analysis #2: Solar Energy Conversion System (SECS)

Problem Identification

The owner's goal for this project was to create a state-of-the-art educational facility, particularly in the field of science and technology. To do this many innovative design processes were incorporated into the plan for the school. However there was little emphasis was placed on solar design. With that mind, if a photovoltaic array were incorporated into the building it could possibly serve an educational function while saving money on utility bills.

The use of a PV system for this project is ideal because the owner is a school district and they will own and operate the building for years and years to come.

Research Goal

The goal of this analysis is to see if the use of a photovoltaic array would be beneficial on this project. It will determine whether or not it is feasible, what the advantages and disadvantages associated with it are, and the associated costs of a PV array. This analysis will determine the amount of power that can be generated from the use of an array based off of a typical solar year. That information will be translated into potential monthly savings. This analysis will cover the upfront costs of the system including installation, and determine what the payback period will be. It will also determine the most viable roof locations for implementation.

The intent of this analysis is to show that a PV array would prove to be a beneficial investment for the owner. The overall goal is to find out if the long term benefits of a PV system can outweigh the upfront costs for the given local.

Research Steps

- Determine solar angles of the given local
- Pick equipment
- Evaluate optimal PV array (quantity, size, cost)
- Perform payback analysis

Tools

- EGEE 437 class material
- System Advisory Model (SAM)
- Project Team

- SECS textbook
- Faculty
- Industry Professionals
- Google SketchUp
- University of Oregon Solar Radiation Sun Path Chart Program
- Scilab

Expected Outcome:

It is expected that a PV system will prove to be a good investment for the owner. This will be determined by the cost of the system and the payback period.

Technical Analysis #3: Alternate Delivery Method

Problem Identification:

The project had a late start due to a two month delay on the notice to proceed. This reduced the time that the project staff had to complete the high school because it still had to be open for classes in August of 2013. Unfortunately for Hess, the CM agency, the subcontractors were only required to perform their work to meet the original schedule. This caused problems when Hess tried to accelerate the schedule.

Research Goal:

The goal of this analysis is to analyze the contractual differences between the current CM agency at risk delivery method and a design build approach. To assist in illustrating the differences two process maps will be made; one of the current delivery method and one of the proposed method. This will help show the differences between communication and coordination throughout the life of the project.

Research Steps:

- Contact Hess Construction and obtain a design build contract.
- Analyze both contract documents
- Create process maps for the project using models
- Explain conclusion of research

Resources and Tools to be used:

- Project Staff
- Industry professionals
- Relevant Publications
- Microsoft Visio
- AE department staff

Expected Outcome:

I expect that this analysis will show that a design build delivery method would have been very advantageous to use on this project. I believe it will show that the major players will have more "skin in the game" and that resolving complications as they arouse would become easier to deal with.

Technical Analysis 4: Façade Prefabrication

Problem Identification:

As was mentioned earlier in this proposal the schedule for this job is under a tight time constraint. For that reason I will analyze the effectiveness of utilizing prefabricated CMU panels for the building façade. Two separate ways of connecting these panels to the structure will have to be investigated because there are areas where the façade is either connected to bearing CMU walls or structural steel.

Research Goal:

Determine the ability for schedule acceleration and the related cost impacts of façade prefabrication.

Research Steps:

- Investigate current façade schedule
- Research prefabricated panel systems and their connections
- Talk to industry professionals about installation time for typical panels
- Update schedule to coincide with a prefabricated façade installation

Resources and Tools to be used:

- Industry Professionals
- Project staff
- AE department staff
- Applicable research
- Microsoft project/primavera

Expected Outcome:

It is expected that by implementing this process that the critical path on the project can be significantly reduced. Cost implications could either be beneficial or detrimental. When the impact on cost has been determined the outcome will be evaluated based on whether or not it is seen as acceptable.

Spring Semester Timetable

***Reference Appendix B for the Spring Semester Timetable**

To ensure I stay on track next semester a timetable was produced outlining all of the major tasks that I'll have to complete. It is essential that this table be utilized when working on my thesis so that I dedicate adequate time to each area of study. It will serve to keep me organized throughout the semester.

Conclusion

Investigating the aforementioned analysis topics will provide an in-depth look at the core areas of investigation; Critical Issue Research, Value Engineering Analysis, Constructability Review, and Schedule Reduction/Acceleration. The goal of these analyses is to investigate means and methods to create a project which more adequately meets the goals of the owner, enhances collaboration, and streamlines the construction process. It is not geared toward finding errors or problems within the existing project. Instead, it is meant to investigate potential opportunities that, if implemented, could potentially be beneficial to the project team and owner.

Appendix A: Breath Topics

The breadth topics that will be investigated both relate to Analysis #1. This course requires that two in-depth analyses be performed in options other than construction management. The two that will be explored for this proposal are a mechanical and a structural breadth.

Breadth Topic: Mechanical Analysis of Hybrid Geothermal System (Mechanical)

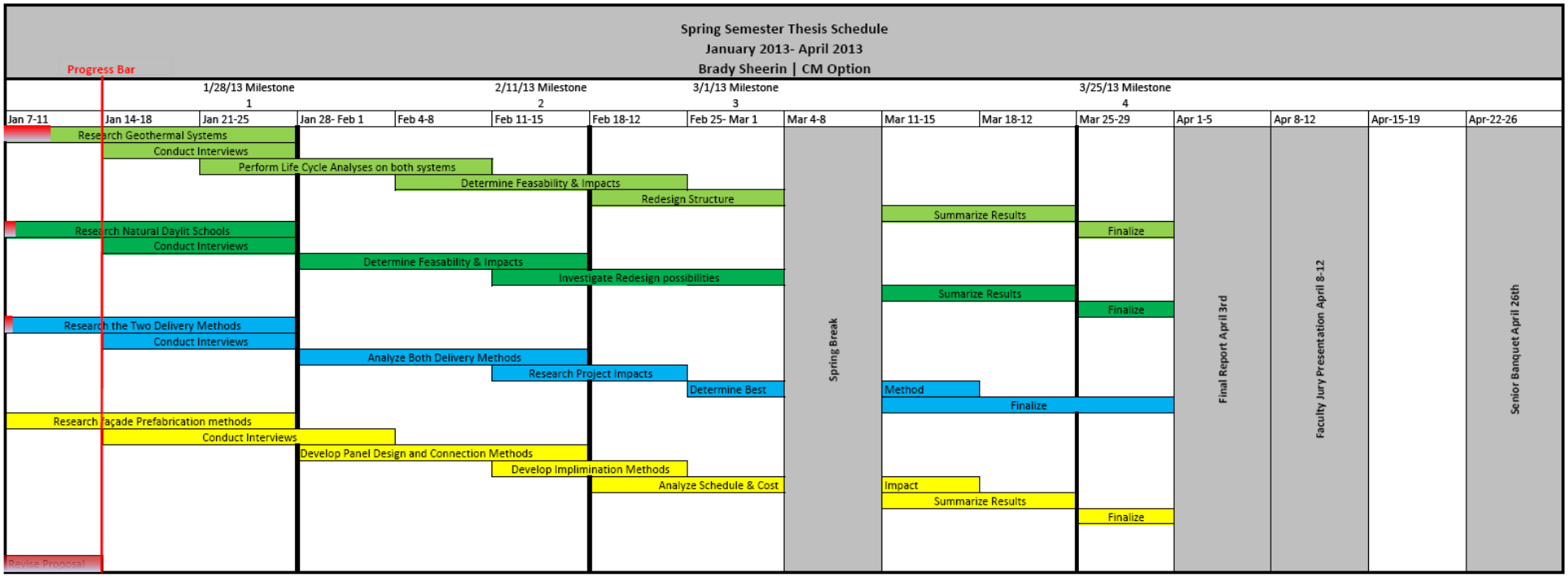
The current mechanical system is comprised of 437 geothermal wells that connect to nine 30 ton water-to-water heat pump modules. To decrease the installation costs associated with this system the number of wells and modules will be reduced. To compensate for the loss in heating and cooling capacity a cooling tower will be implemented on the roof of the mechanical room. Energy modeling will be performed on both the current system and the newly presented one in order to create a life cycle analysis. This analysis will depict the maintenance life, installation costs, differences in energy requirements, and other critical items to adequately compare the two systems.

Breadth Topic: Additional Reinforcement for Mechanical Equipment (Structural)

Because the redesign of the mechanical system will require the installation of a cooling tower on the roof of the mechanical room, a structural analysis will have to be performed. Load calculations will be computed to illustrate the impact of the additional weight on the current roof structure. Once the loads have been determined a redesign of the structural system for that area or the building will be performed. Any costs associated with the change in structure will be incorporated into the cost for changing the mechanical system.

Appendix B: Spring Semester Timetable

Spring Semester Thesis Schedule
January 2013- April 2013
Brady Sheerin | CM Option



Milestones	
1	Research & Interviews Complete
2	Energy Model For Geothermal Complete & Go-No Go Check Date
3	Structural Breadth Complete
4	Report Complete

Analysis Description	
#1	Impliment Hybrid Geothermal System
#2	Analyze Building Envelope for Daylighting
#3	Alternate Design Build Delivery Method
#4	CMU Façade Prefabrication