Thesis Proposal
Construction Management
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Upper Dublin High School

Upper Dublin School District
Fort Washington, PA

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Executive Summary

The analysis topics written in this report are based off of the Upper Dublin High School Construction project. This is a 368,000 square foot high school building currently being built on the site of the existing Upper Dublin High School. This project, which started in 2008, has a four year long construction schedule. There are two major phases of construction, with each phase further split into sub-phases. This is necessary in order to provide a place for the high school students to continue to attend classes while the new school is being constructed. One of the major goals of this project is to obtain LEED Silver Certification. In order to do this, sustainability had to be taken into great consideration during design.

Deciding to pursue LEED adds a new level to a project. Every aspect of the building design has that extra sustainable aspect added to it, requiring a greater attention to detail. This leads into my first analysis topic. For my first analysis, LEED will be examined from the standpoint of how this affects a construction project. When deciding to create a sustainable building, what has to be done differently? Also, how does this change the day to day activities and skill sets of the project team?

One of the interesting parts of this project is the geothermal well system of heating and cooling the building. This will be the topic of my second analysis. For analysis two, the value of incorporating geothermal heating and cooling in a building will be researched, as well as the cost and payback expected for this system. As one of my breadth topics, an alternate energy efficient mechanical system will be selected and compared to the geothermal well system. If a suitable system cannot be found that could replace geothermal, instead a supplemental system will be looked into.

Water used from activities such as flushing toilets can account for more than 40% in a building. With the use of a rainwater collection system, this number can be significantly reduced, especially with the amount of roof area on this particular school. For analysis three, the type and benefit of a rainwater collection system will be taken into consideration. Also, the constructability of implementing this product will be researched.

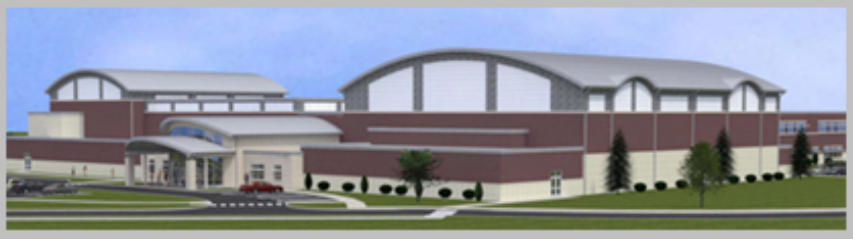
Finally, analysis four will take a look at the efficiency of the current lighting system used in this building. The total energy consumption and constructability of this system type will be accounted for. As my second breadth topic, an alternate lighting system will be created for this building. The alternate system will then be compared to the existing system to see how other options may apply.

As can be seen from the previous paragraphs, the main critical industry issue that I will be working with is sustainability in the construction industry. This is a topic that is becoming increasingly more popular and being implemented more often into projects. The value of using sustainable design on a construction project will be analyzed throughout each of my four analysis topics. Also, the ideas of value engineering, constructability, and schedule reduction will be analyzed for each of these analysis topics. The final product will supply a very in depth look at the overall value of designing and constructing a "greener", more energy efficient building.

Upper Dublin High School

Fort Washington, PA

● Stephen Kelchaw ● Construction Management ●



Building Statistics

-Size: 368,000 sf
-Height: 2 Stories
-Project Cost: ~$119.2 M
-Construction Dates: Phase I: Aug '08 - Dec '10
Phase II: Jan '11 - Aug '12
-Delivery Method: Design-Bid-Build

Project Team

-Owner: Upper Dubllin School District
-Architect: Gilbert Architects
-CM: D'Huy Engineering
-Site/Civil: CMX Engineering
-Structural: Baker, Ingram, & Associates
-MEP: Snyder Hoffman Associates
-LEED: 7 Group

Building Envelope

-White single-ply flat roof
-Standing seam curved metal roofing
-Brick and stone masonry facade with CMU back-up wall
-Cast stone profile separates brick and stone facade

Mechanical

-304 Geothermal Wells with a water/glycol mix
-Eleven (11) Energy Recovery Units (ERU)
-Twelve (12) Heat Recovery Units (HRU)
-Temperature controlled through ATC system
-Ductless Split-System Air Conditioning Units
-VAV and Fan-Powered VAV boxes

Lighting/Electrical

-Typical lighting consists of surface mounted T8 fluorescent and CFL's
-480Y/277V and 208Y/120V distributed throughout building
-More than 90 panel boards
-Lighting controlled with occupancy sensors and photosensors

Structure

-Classroom live load: 40psf
-Spread footing support columns
-1st Floor: 4" SOG with 6x6-W2.9 x W2.9 WWF on drainage fill and vapor retarder
-2nd Floor: Structural steel framing with slab on metal deck
-Load-bearing CMU walls and steel joists

http://www.engr.psu.edu/ae/thesis/portfolios/2010/slk5030

Figure 1: Thesis Building Abstract

Project Background

The owner of the new Upper Dublin High School is the Upper Dublin School District. The school is located in Fort Washington, PA on the site of the old, and still in use, high school. Upper Dublin is the home of the Cardinals and enrolls approximately 1,500 students with a 99% graduation rate. The mission statement can be seen written below:

"The mission of the School District of Upper Dublin is to provide a safe, supportive environment for all students to become lifelong learners and contributing members of a changing society. Additionally, UDHS works very hard to ensure that its points of pride are maintained and/or exceeded during the course of the year, including:

- *Blue Ribbon School of Excellence*
- *Graduation rate of 99.9%*
- *College Placement of 96% enrolled in post-high school education*
- *Graduates admitted to high-level and elite universities, service academics and university honors programs*
- *18 AP and 29 Honors courses*
- *10% of class achieves National Merit recognition*
- *Ranked 8th in Philadelphia Magazine's 100 Best Public and Private Schools*
- *Named best High School in Montgomery County by Philadelphia Inquirer*
- *2012 completion of state-of-the-art high school with cutting-edge instructional space"*

The purpose for the construction of a new high school is ultimately to update the old and outdated high school that was built in 1948. This new high school will add much needed space and better facilities to help reach the goals mentioned in the mission statement.

During construction, UDSD would, above all, like an on-time, on-budget project that takes special care not to disrupt students in adjacent spaces throughout the entire process. Work on a construction site can be very loud. This is something that must be taken into account as school will be in session during a large part of construction. Another goal for the owner would be to have certain spaces in the new high school available before the entire process is complete. By the end of this year, construction of the gymnasium and natatorium will be complete and ready for use by the owner. This is very important to meet the deadlines set forth by many of the athletic teams in the high school. Since LEED is sought after in this project, quality is expected to be extremely high.

The schedule for this project is extremely important due to the phased occupancy requirements. As part of the new building is completed and ready for use, another section of the old building will be torn down. Coordination of these activities is extremely important to ensure that the students and faculty have all the resources they need throughout the entire process.

Background

As environmental concerns and energy costs continue to rise, people are increasingly seeking new measures to ensure that the products they buy and buildings they use help counteract these problems. This is true in the case of the new Upper Dublin High School. One of the goals of this high school construction project is to reach a LEED Silver certification for the end result. This adds a new dimension to the project, creating another level of discussion and planning to reach the above mentioned goal successfully. For this reason, it will be interesting to see what it actually means to implement LEED on a project.

Problem Statement

When an owner says that they want their project to be "sustainable" and obtain LEED certification, it can be unsure what this will actually entail. The question at hand is how does implementing LEED affect the overall project? Also, how does this change the project structure and timeline?

Solution Methods

The impact of implementing LEED values on a project, more specifically in the case of the Upper Dublin High School Project, will be thoroughly analyzed as of how this affects the overall project. Some areas of research will include, but is not limited to, how this changes the skills required by the project team, what has to be done differently, and how this affects the total cost and schedule. The end result will include the overall value of LEED on a project, as well as how and what factors this will change.

Tasks and Tools

The following tasks and tools will be needed to successfully complete this analysis:

1. Interview with the LEED Consultant (7 Group)
    a. Discuss their role on the project.
    b. Discuss sustainable design considerations for the project.
    c. Discuss the impact of these design considerations in relation to cost and schedule.
2. Interview with the Construction Manager (D'Huy Engineering)
    a. Discuss how the implementation of LEED on the project affected their role.
    b. Discuss how managing a LEED project differs from a non-LEED project.
    c. Discuss how this affects the staffing and day-to-day activities of the project.
    d. Discuss the impact of LEED components in relation to cost and schedule.
3. Independent research on sustainable versus non-sustainable projects
    a. Analysis of case studies
    b. Research on LEED project statistics.
4. Final analysis and conclusions

Background

One of the more interesting design features on this project is the use of geothermal wells for heating and cooling the building. Geothermal wells are gaining much popularity as a more efficient and environmentally friendly mechanical system compared to "standard" heating and cooling methods. Although this may be true, there is still the possibility that a geothermal well system will negatively affect other aspects of construction, such as the schedule or cost. Also, site characteristics can determine the possibility of installing this type of system. Figure 1, below, shows a typical geothermal well detail.

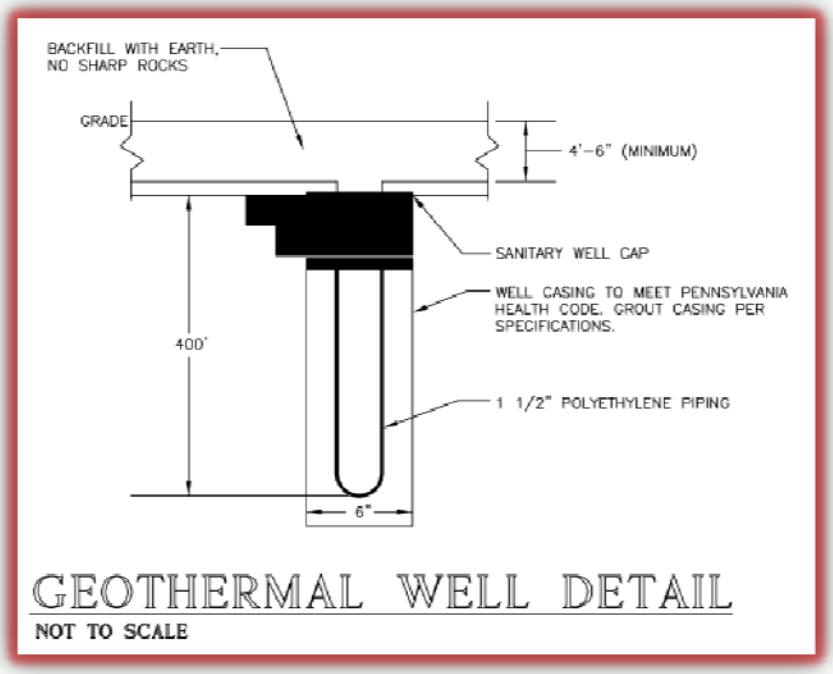


Figure 2: Geothermal Well Detail

Problem Statement

What are the values of installing a geothermal well system compared to a "standard" heating and cooling method? Also, what is the expected lifecycle and payback for this particular system? Finally, how does this system affect the overall construction process, including schedule and cost considerations?

Solution Methods

In order to effectively solve the above mentioned question, the first thing that must be done is to define what a "standard" heating and cooling system is. This will then be used to compare cost, energy use per amount of output, lifecycle costs, etc. This can then be defined even further to the particular system size used for the Upper Dublin High School. Construction methods and durations must also be considered throughout this analysis. The final solution to this problem will show the overall value of using a geothermal system compared to other heating and cooling methods.

Tasks and Tools

The following tasks and tools will be needed to successfully complete this analysis:

1. Independent Research
    a. Define what a "standard" heating and cooling system is, and what the geothermal well system will be compared to.
    b. Research expected outputs, lifecycle costs, construction methods, etc. of standard geothermal well systems.
    c. Analyze the geothermal well system that was used in the construction of the Upper Dublin High School.
2. Interview members of the project team
    a. Discuss their opinion of installing a geothermal well, including the advantages and disadvantages of using this system.
    b. Discuss any problems that occurred during construction.
    c. Discuss how this installation affected the schedule and coordination involved in the project.
3. Compare and contrast independent research and interview results
4. Final analysis and conclusions

Background

Water use in buildings can be very costly. Flushing toilets can account for more than 40% of the water used. Since it is not necessary to use potable water in fixtures such as toilet, a large reduction of water use in a building can be made by collecting rainwater from the site. Rainwater collection systems can be implemented after the initial design and construction of a project and can be used to supplement the needed water in the building. For such a large high school with over one thousand students and faculty, it can be expected that water use from toilets will be very high. In particular, due to the size of this building, a large amount of rainwater can be collected from the roof surfaces.

Problem Statement

In order to supplement the water use in the Upper Dublin High School, what would be the most effective and cost friendly rainwater collection system to use on this project? Also, how can this be incorporated into the final design of this building? Finally, what would be the benefit of using this type of system?

Solution Methods

To solve the questions set forth in the problem statement, independent research must first be conducted as to different strategies used for rainwater collection in buildings. The costs and paybacks on the investment will need to be calculated, and implementation strategies will have to be created in order to present this as a realistic solution. Any changes to the design and appearance of the building will need to be discussed with the architect and owner, as well as the structural and MEP engineers as needed.

Tasks and Tools

The following tasks and tools will be needed to successfully complete this analysis:

1. Independent Research
    a. Research on different water collection systems.
    b. Research on construction methods to incorporate these systems.
    c. Analysis of case studies.
2. Calculations
    a. Cost of installing the system.
    b. Payback period for the investment.
    c. Duration and schedule implications.
3. Discussion with the owner and project members
    a. Discussion with the owner and architect.
    b. Discussion with the MEP engineer.
    c. Discussion with the structural engineer.
4. Final analysis and conclusions

Background

Another major source of cost on a building project can be from the lighting system used. This is not only from actual energy usage, but installation and material costs as well. Although efficient use of lighting systems by way of low energy lighting and occupancy sensors has been used on this project, there is still more room for research in the area of constructability and actual energy savings.

Problem Statement

How efficient and how much energy savings can be expected from the lighting system used in the Upper Dublin High School? How does this system compare to other lighting systems used in buildings today?

Solution Methods

The lighting system used in the Upper Dublin High School Project will need to be thoroughly analyzed before making calculations as to the amount of energy and cost savings to be expected. This can then be compared to average values used in the industry today. Also, constructability issues and time and materials will be taken into consideration.

Tasks and Tools

The following tasks and tools will be needed to successfully complete this analysis:

1. Analyze the current lighting system
    a. Gather information on the type and quantity of lighting fixtures.
    b. Calculate the total amount of energy that will be required by the lights.
    c. Discuss the installation procedure and any problems that occurred with the construction team.
    d. Discuss the lighting system used with the MEP engineer.
2. Research typical lighting costs and energy usage
3. Compare and contrast the calculated values to the average values
4. Analyze the constructability challenges with the chosen lighting system
5. Final analysis and conclusions

Weight Matrix

The following matrix describes how each analysis I plan to perform will fit in the overall goals of my senior thesis project.

Description	Research	Value Eng.	Const. Rev.	Sched. Red.	Total
Analysis One	10%	8%	5%	5%	(10 to 40%)
Analysis Two	10%	5%	7%	6%	(10 to 40%)
Analysis Three	5%	5%	7%	5%	(10 to 40%)
Analysis Four	5%	5%	7%	5%	(10 to 40%)
Total	(10 to 30%)	(10 to 30%)	(10 to 30%)	(10 to 30%)	**100%**

Critical Issues Research

The critical industry issue that I plan to research throughout my senior thesis studies is sustainability in the construction industry. This is increasingly becoming a more important topic of discussion for projects and is being incorporated into the design more often than ever before. This topic is particularly close to the project I am studying due to the goal of the Upper Dublin School District to obtain LEED Certification, more importantly LEED Silver, for the construction of the new Upper Dublin High School. This is a critical industry issue due to the extra level of discussion and planning it creates for a project. New ideas and technologies will now have to be considered rather than creating cookie cutter type projects with less than efficient systems and designs. All of my analyses are connected through this idea of sustainability. Most importantly, Analysis One will look at this critical industry issue from the standpoint of its effectiveness compared to how it changes the project structure.

Value Engineering Analysis

As was mentioned several times before, one of the main goals of the owner is to create a LEED Silver building. Although this may require higher costs up front, designing the building this way can save the district more money down the road and create a much more attractive building in the process. Two of my analyses, Analysis Two and Four, make way to look for value engineering strategies. Both of these analyses look at the value of mechanical and lighting systems that will be used in the building. Additional research can be performed to find a realistic replacement to these products with will provide the same expected results for less of a cost. Also, strategies for reducing the schedule and increasing the constructability of the product can be considered.

Constructability Review

Constructability issues will be analyzed during my analysis of the geothermal wells, the lighting system, and the research into a supplemental rainwater collection system. Any suggestions made during the final analysis of each of these systems will be made with the goal in mind of creating a more constructible building. This is extremely important, because any process during construction that is made easier can save time and money on a project. This also reduces the overall complexity of a building.

Schedule Reduction/Acceleration Proposal

This topic will be concentrated most heavily in the same three analyses as was mentioned in the previous section, Constructability Review. As strategies are sought after to increase the constructability of a designed system in the building, chances for schedule reduction will also be looked into. Both of these activities go hand in hand and can make a good project even better. The overall success of this project will, in the end, be determined by a project that is completed on time and on budget. That is why it will be an important part to consider all of these components throughout my thesis research.

Graduate Class Incorporation

As is required by the Integrated Masters Program, part of the research made during the analyses will incorporate ideas and skills learned from graduate class work. In particular, the theories and information gathered from AE 597D: "Sustainable Building Methods" will help throughout my senior thesis project. During this class, LEED and its benefits were thoroughly discussed, as well as sustainable technologies and building methods. The topics discussed during AE 572: "Project Development and Delivery Planning" will also benefit my thesis research. This class taught me different methods to describe and calculate the value of different construction elements and will be used during much of the evaluations needed to complete my thesis studies successfully. It also taught me a variety of research methods that will be used throughout my entire thesis project to pull everything together.

Mechanical Breadth

During my review and analysis of the geothermal well system that will be used on the project, an alternate system can also be researched. This system must provide the same benefit expected from the geothermal well system for less cost or better constructability. The same financial calculations will be performed, as well as a constructability analysis. At a minimum, if no realistic system can be applied a supplemental system to the geothermal wells can be incorporated.

Lighting/Electrical Breadth

Analyzing the current lighting system in the Upper Dublin High School brings with it the possibility of a different, more efficient system that could have been used. An alternate lighting system will be considered during the analysis of the current lighting system. This will require calculation of lighting loads throughout the building that will be consumed by this alternate system. This breadth will make use of the topics and ideas learned during the lighting electrical classes.

Overall, Analysis Two, Three, and Four will require some sort of "breadth" study to successfully complete each study. This will require the well-rounded knowledge I have obtained throughout the past five years as a Penn State AE student. This thesis proposal is not limited to my option of Construction Management, but expands upon everything I have learned up to this point.

Appendix B – Proposed Thesis Time Table

Proposed Spring Semester Thesis Schedule						
	Analysis One	Analysis Two	Analysis Three	Analysis Four	Mechanical Breadth	Lighting Breadth
1/11/2010						
1/18/2010						
1/25/2010						
2/1/2010						
2/8/2010						
2/15/2010						
2/22/2010						
3/1/2010						
3/8/2010	Spring Break					
3/15/2010						
3/22/2010						
3/29/2010						
4/5/2010	Final Summary Reports Due - April 7, 2010					
4/12/2010	Faculty Jury - April 12 - 15, 2010					