

# **Adam Finley**

## **Construction Management Option**

# **Thesis Proposal**



**The Pennsylvania State University  
Health and Counseling Services Building  
University Park, Pennsylvania**

## **Table of Contents**

<i>A. Executive Summary</i>	3
<i>B. Emergency Electrical System- Breadth #1</i>	4
<i>C. Commissioning Process</i>	6
<i>D. LEED Design</i>	8
<i>E. Weight Matrix</i>	10

## **Appendix**

<i>A. LEED Questionnaire</i>	11
------------------------------	----

## **Executive Summary**

Health and Counseling Services is the latest addition to the Penn State's University Park campus. It will replace the aging Riteneour building as a state of the art health and counseling facility near the downtown State College district. This proposal will address three technical analysis areas and one critical issues research subject. The purpose of this report is to clearly identify problems and then layout the associated research and analysis that will be performed to solve the problem. Two of the technical analysis will incorporate a breadth into electrical and structural options. The three technical analysis areas are the emergency electrical system, curtain wall, and commissioning. LEED cost and schedule increases are the focus of the industry research.

The emergency electrical system has been identified through the owner as a potential problem. Penn State wants the building to have the ability to stay in full electrical service in the event of a city, state, or national disaster. At this time, the method to accomplish this is under review by the electrical engineer and Penn State's Office of Physical Plant. The second analysis aims to solve a problem with the cost and schedule of the curtain wall. The curtain wall has been under scrutiny since the bids were received due to the unexpected high cost that all contractors contacted priced from the documents. The last analysis evaluates the commissioning process. Commissioning of new buildings has taken longer and caused delays to project completion on the campus.

The critical industry issue that this proposal lays out a plan for solving is green design and construction cost and schedule increases. As design professionals use less widely known materials and more complicated designs on green buildings, subcontractors have increased their schedules and prices.

## **Technical Analysis #1**

### **Emergency Electrical System- Breadth #1**

Health and Counseling Services will be unique, in the fact that it will have a completely separate power supply that is independent of its normal service on the campus. The intent of this design change is to allow for complete operation of the building in the event of a city, state, or national emergency where power supply would be interrupted for a significant amount of time. The problem that this research will attempt to answer is how to add this system at an affordable cost while keeping the overall schedule on track. Since this will be a unique system and design, there are few similar cost and schedule comparisons that can be made with other buildings. Also, the electrical engineer will be designing redundant systems. In turn, this will require larger amounts of space for the increased amount of equipment.

Future analysis will require study in the following areas:

1. Constructability to determine if there will be enough space in the areas that have been designated for electrical use. Also, the plenum space will be evaluated to determine if there is enough room for the extra wiring.
2. The cost impact of adding the redundant system. Extra electrical equipment and wiring will be needed within the structure. Outside the structure, new utility tunnels will be estimated from a separate power supply.
3. The schedule impact of adding this change in design to the electrical contractor's scope of work will be evaluated. The impact on the schedule, if any, can not extend the project completion past the occupant move-in date of May 31, 2008.

4. The steps required to switch the building over from the normal system to the full power emergency system.

In order to accomplish this analysis, the electrical engineers from B R + A and Penn State will be contacted. Background information regarding the intent of the design change will be gathered first. Information about the secondary power supply is needed to determine the design loads and the distance from the new utility feed so that an accurate cost estimate can be made.

Next, the electrical contractor will be contacted to determine the constructability of adding the redundant system to the building. The contractor will be asked about their opinions on availability of space in the electrical rooms and ceiling plenums as well as the schedule impact that they think will be added to the project.

Once the information has been gathered, R.S. means and appropriate material suppliers will be used, as a base for pricing, to make a detailed cost estimate of the design change. Also, a schedule update will be applied to Whiting-Turner's master schedule to determine whether the solution will stay within the contract constraints. Finally, the process by which the system will transfer from the primary to secondary power supply will be constructed.

The analysis should show a large schedule and cost impact to the project. The redesign of the electrical system should not require a large amount of calculations within the building, but the secondary system from the alternate power supply will be time consuming and use information learned in AE 311. Electrical faculty and Penn State's

electrical engineers will be contracted and asked to assist in the process of adding the system.

## **Technical Analysis #2** **Commissioning- Breadth #2**

All Penn State buildings undergo a process known as commissioning.

Commissioning is the process where at the start-up of a building testing and adjusting HVAC, electrical, plumbing, and other systems is done to assure proper functioning and adherence to design criteria. Commissioning also includes the instruction of building representatives in the use of the building systems. Through the owner's representative, completing commissioning in a timely manner has been identified as a critical problem that Penn State has faced on all new construction. New base buildings have not passed the tests set by their commissioning agent within the schedule time allotted. Examples of problematic buildings on the University Park campus include the Chemistry Building, Life Sciences Building, and the Sala Building. Some buildings have been occupied for use while commissioning was still being completed due to associated delays within the process. It is the hope of this analysis that the problems that have been prevalent on prior projects will not be subject to occurring again on Health and Counseling Services.

One method that will be implemented to improve the indoor air quality step is to add UVGI (Ultraviolet Germ Irradiation) devices to the return air ducts in sensitive rooms. Examples of these rooms include waiting rooms and exam rooms. The purpose of these devices is to instantly kill viruses and bacteria that medication and antibiotics are unable to destroy. The number and locations of each UVGI will be calculated for the most efficient placement at the lowest cost.

The areas that will be analyzed in this section include:

1. The process set into place for commissioning by the owner's agent in comparison to previous projects on University Park campus.
2. The constructability of the building in relation to this process. Specifically, when certain steps are supposed to take place in relation to the construction.
3. The schedule of this process and improvements that can be made to it through construction methods.
4. The addition of UVGI's throughout the space to eradicate viruses.

To accomplish this goal, the owners commissioning agent will be contacted. The commissioning agent will be asked to supply the process by which they will certify the building. They will also be asked to lay out the logic for the steps and sequence they have chosen. Next, the Office of Physical Plant will be asked to supply detailed information about previous projects that have passed and not passed commissioning with the scheduled time for completion. Once the buildings have been identified, the commissioning agents, construction managers, and general contractors that have been involved with those projects will be contacted to gather information about where and why the problems happened. The commissioning steps that were used will be asked for so that a comparison can be made to Health and Counseling Services. Finally, subcontractors that have the most impact of Health Services commissioning will be contacted to identify potential problems they see with the sequence and steps. Problems that are found will be organized and patterns will be identified.

To accomplish the addition of UVGI's to the space, the construction documents will be analyzed to identify critical infection areas. Once this has been completed, calculations to determine the size and number required for each space will be completed. Finally a cost and schedule analysis will be conducted to determine the overall benefit of the UVGI addition to Health Services.

The results will be compiled and a list of necessary adjustments to the commissioning process of Health and Counseling Services will be formalized as well as a list of general rules for commissioning of future projects. Any areas that have been found to be unnecessary or tedious will be analyzed to determine the benefits of the procedure in place. Also, the results of the UVGI addition will be summarized with importance placed on showing the benefits and consequences of this system.

## **Critical Issues Research** **Green Building Design and Construction Practices**

The research topic that has been identified through contact with industry representatives at the PACE Roundtable and from various general contractors is green design and construction. Specifically, the cost and schedule increases that subcontractors have been applying to LEED rated projects. After speaking to Mr. James Bognet, owner of Bognet Construction Associates which is a general contractor in the D.C. metropolitan area, it was made clear that he sees a 10 percent increase in cost and schedule on most projects that are LEED rated in comparison to non LEED rated projects. This was verified as a trend after speaking to faculty within the architectural engineering department. It was suggested that this increase may be due to architects and engineers



including a larger amount of materials and systems in LEED buildings than ever before. This increase and the unfamiliarity of subcontractors with LEED and these new materials may be a large underlying cause of the problem.

The proposed solution to this cost and schedule increase is to make a quantitative spreadsheet of the problem areas. Through this spreadsheet, areas that subs are having problems with could be solved through green building education. Another solution will be to show how certain materials, building systems, and construction methods impact a subcontractor's cost on a LEED rated project. The LEED credits that are found to be the most problematic and have an impact on the subcontractor's bid will be evaluated to determine what amount of cost, if any, should be associated with them.

This research will benefit all parties involved in the construction process. Primarily, the subcontractors will see the most benefit. With the detailed initial costs that are generated from each credit they will have a better understanding of the associated cost increase due to their specifications. It is the purpose of this research to show how green building construction does not imply a drastic cost increase. Also, architects and engineers will see benefits from this research. The materials, systems, and methods that they have been designing and placing in specifications will be seen with their associated drawbacks from the subcontractor view. While owners will benefit, they will primarily be concerned with the cost and schedule savings.

In order to accomplish these solutions the following steps will be taken:

1. Contact subcontractors from all trades. The contractors will be from the Health and Counseling Services project as well as from outside sources.

2. Depending on location of subcontractor, conduct a phone interview, in person interview, or send survey from Appendix A.
3. Collect information.
4. Organize all results into most common to least common reasons for cost and schedule increases.
5. Determine which LEED credits, if applicable, apply to these results and conduct an analysis of initial construction cost per point.
6. Conduct an estimate on the prices and schedule of materials, systems, and construction methods that are determined to be the most common cost and schedule increases.
7. Create spreadsheet with all information gathered from questionnaires, LEED point analysis, and materials/systems/construction methods analysis.

## **Weight Matrix**

<b>Weight Matrix</b>					
<b>Description</b>	<b>Research</b>	<b>Value Eng.</b>	<b>Const. Rev.</b>	<b>Sched. Red.</b>	<b>Total</b>
<b>Commissioning</b>	10%	5%	10%	10%	35%
<b>Emerg. Power</b>	10%	5%	10%	0%	25%
<b>LEED Design</b>	40%	0%	0%	0%	40%
<b>Total</b>	60%	10%	20%	10%	100%

## **Appendix A**

## **LEED Construction Survey**

**Name:**

**Company:**

**Job Title:**

**Years of Experience:**

1. How many LEED or green buildings have you or your company been involved with?
  
2. Is there a cost increase associated with LEED rated projects?
  
3. If yes, why and what is the % Cost increase associated with LEED Certified Projects?
  
4. Of the additional Cost how much are hard costs and how much are soft costs?
  
5. What are the long term and the short term cost to your firm to build a LEED Project?

6. Is there a schedule increase associated with LEED rated projects?
7. If yes, what are the most common causes?
8. Have you seen an increase in the number of materials, systems, and construction methods associated with LEED and Green buildings?
9. If yes, how has this affected the cost and schedule on LEED projects?
10. What materials, systems, and construction methods do you find the most problematic to LEED construction?

11. Have you or your company noticed any other reasons for the increases in cost and schedule on these projects?

12. What LEED credits do you or your company find the most difficult and expensive to comply with?

13. Would a detailed analysis of these points and the initial construction costs associated with them be beneficial to you or your company?

14. How would you make LEED or green projects less expensive, i.e. changing the system set in place, changing the rules to gain credits, etc.?

15. Have you or your company received training on how to build LEED rated buildings?
  
16. If yes, what additional training was required?
  
17. Do you experience more or less 'Call Back' warranty type issues, after occupancy, on a LEED Project?
  
18. How is your productivity during construction impacted on Leed Projects?
  
19. Has LEED conformance impacted any of your corporate processes, either directly or indirectly, as a result of your association with LEED Projects? I.e. such as traveling via public transportation to construction sites.

Thank you for helping with this research. Please return to [amf232@psu.edu](mailto:amf232@psu.edu) when completed.