Thesis Proposal

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[FISK CORPORATE HEADQUARTERS]

Houston, Texas

Executive Summary

With the completion of the Fisk Corporate Headquarters project taking place just over a month ago, a fantastic opportunity exists to study the various challenges and complications that were realized over the course of the project's construction. Through careful study and analysis, these issues can be isolated, addressed, and a solution can be provided in an effort to minimize the chance of the complication repeating on another project. The purpose of this proposal is to outline the four different construction analyses, two breadth studies, and a master's integration examination that will be completed in an effort to present feasible solutions to some of the main Fisk Corporate Headquarters project obstacles.

The first Analysis seeks to lower the cost of construction to the owner by shortening the project schedule. Because Fisk Electric carried the cost of general conditions on their project, any decrease to the construction schedule would result in a direct savings for the owner. This analysis will attempt to shorten the schedule by re-sequencing some of the construction activities to allow for overlap and by eliminating unnecessary float.

Analysis 2 attempts to improve the perceived quality of the building by examining the feasibility of achieving a LEED rating through a change in some of the construction methods employed on the Fisk Corporate Headquarters project. This analysis will also be supported by a lighting breadth that will try to increase the energy efficiency of the building through the installation of a daylighting controls system. When combined with the improved lighting system, the goal in changing some of the construction methods is to achieve a LEED silver rating for the facility.

Analysis 3 is unique to this report due to the author's Penn State Architectural Engineering coursework in electrical system design. Because of this, Analysis 3 will be a redesign of the facility's electrical system in an effort to lower the system's cost. This distinctive analysis will be supported by a full constructability, cost, and schedule review of the new system in an attempt to provide a business case for the system redesign.

The final analysis is a research topic that will attempt to incorporate a critical industry issue and the integration of a master's course together via the implementation of a BIM process on the Fisk project. Due to an unusual curtain wall installation sequence, some of the trade contractors involved with the process ended up incurring added costs due to the difficulty of transferring information from one trade to another. This analysis seeks to analyze whether or not attempting to solve this issue via BIM technology would have helped to minimize those losses.

Upon completion of the previously mentioned technical analysis studies, the results produced will give insight as to whether or not the ideas presented in each study would have been feasible to incorporate on the Fisk Corporate Headquarters project. The feasibility of each individual study will be judged based on the business case presented by the findings of the final thesis report either for or against the idea investigated. These 4 unique analyses are expected to improve the quality of Fisk Electric's new facility while lowering the project's overall construction costs.

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Analysis 1: Project Sequencing Improvements

Problem Identification

As stated in the previous Technical Reports regarding the Fisk Corporate Headquarters project, Fisk Electric placed a much greater emphasis on cost and quality than the overall project schedule. As such, the construction manager produced the construction schedule in a way that would minimize risks and maximize labor efficiencies by adding schedule float. While this practice may have minimized scheduling risks, it lengthened the overall schedule, and as a result, substantially increased the cost of general conditions. Normally these costs would be incurred on the general contractor, but in the case of the Fisk Corporate Headquarters, Fisk Electric decided it would be in their best interest to carry the cost of general conditions. This analysis will strive to find a way to shorten the project schedule, without adding any scheduling risks or increased costs.

Background

Once the problem was realized, background research was conducted to determine which areas within the schedule contained this float. This research illustrated that in many areas, gaps actually existed in the schedule between activities. During these gaps, no workers were present on-site and no work was completed. Unfortunately for Fisk Electric, during these scheduled gaps they were still paying full price for general conditions.

19	Office Building Foundations and Structure Begin	0 days	Mon 12/12/11	Mon 12/12/11
20	Drill & Pour Caissons	5 days	Wed 1/4/12	Tue 1/10/12
21	Rebar/Form & Pour Pile Caps/Grade Beams	6 days	Fri 1/13/12	Fri 1/20/12
22	MEP Underground Rough-In	13 days	Wed 1/18/12	Fri 2/3/12
23	Place Type 2/Visqueen/Sand	2 days	Thu 2/23/12	Fri 2/24/12
24	Form, Rebar, Pour SOG	5 days	Mon 2/27/12	Fri 3/2/12
25	Shop Drawings - Structural Steel	17 days	Mon 12/12/11	Tue 1/3/12
26	Shop Drawings Approval - Structural Steel	21 days	Fri 12/16/11	Fri 1/13/12
27	Mill Order Steel	0 days	Fri 1/13/12	Fri 1/13/12
28	Fabrication - Structural Steel	15 days	Mon 1/16/12	Fri 2/3/12
29	Erect Structural Steel/Stairs	13 days	Mon 3/5/12	Wed 3/21/12
30	Plumb, Bolt, and Weld	14 days	Fri 3/9/12	Wed 3/28/12
31	Install Metal Deck, Shear Studs	12 days	Tue 3/13/12	Wed 3/28/12
32	Edge Form & MEP Rough-In Deck	4 days	Mon 3/26/12	Thu 3/29/12
33	Form, Rebar, Pour SOMD - Level 2	7 days	Fri 3/30/12	Mon 4/9/12
34	Form, Rebar, Pour SOMD - Roof	4 days	Fri 4/6/12	Wed 4/11/12

Figure 1: Project Schedule Cut-out

Figure 1 depicts the schedule from the start of foundations to the completion of the erection of the structural steel. This entire sequence spans approximately 3 months, or 30% of the overall project schedule. As evidenced above, virtually no construction activities overlap one another. While this does minimize risk, overlapping activities is a common construction practice that could have been utilized by the project team to shorten the schedule. In addition, there are many instances throughout this sequence where no work would be completed of any kind. For instance, between activities 20 and 21, a two day gap exists where no work is being completed. However, this gap is not required for a successful system installation and could have been eliminated if the schedule needed to be compressed.

Potential Solutions

In coming up with ways to compress and shorten the schedule, it was important to ensure that these potential solutions would not add any costs to the owner. After careful study and deliberation, the following solutions were realized:

- Sequence the construction activities in a manner that allows overlap between trades and activities wherever possible.
- Eliminate all unnecessary schedule float between activities where no work would be completed.

For instance, if the second solution was implemented on the Fisk Corporate Headquarters project for the sequence depicted in Figure 1, it would eliminate approximately 15 working days off the schedule. When general conditions are billed on a week to week basis, reducing the schedule by three weeks would lead to substantial savings for the owner.

Analysis Steps

In order to complete the analysis and determine if the schedule could be shortened without incurring any costs to the owner, the follow steps would need to be executed.

- Locate all unnecessary gaps in the schedule.
- Conduct research via industry professional interviews and independent research to verify that these gaps are not required for a successful system installation.
- Re-sequence the schedule and calculate the potential schedule savings.
- Research areas in the rescheduled sequence that could be condensed by producing trade overlap.
- If any of these areas exist, re-sequence the schedule to reflect these possible changes.
- Calculate that total time saved through the elimination of gaps and the changes to the activity sequencing.
- Multiply this schedule savings by the cost of general conditions over this period to determine the total potential money that could be saved by the owner.

Expected Outcome

Overlapping construction activities and not having gaps in a construction project's schedule are generally normal practices in the construction industry. Therefore, it is expected that few barriers will exist that inhibit the execution of these practices on the Fisk Corporate Headquarters project. These potential scheduling changes should help shorten the overall project duration which will lead to a substantial decrease in the general conditions cost on the project and save the owner, Fisk Electric, a significant amount of money.

Analysis 2: Implementation of LEED

Project Identification

Another potential opportunity on the Fisk Corporate Headquarters project is the potential LEED certification the building could have achieved. Fisk Electric and the entire ownership team decided that the added costs associated with achieving a LEED rating on the project outweighed the benefits they would receive. However, it was believed by many members of the project team that Fisk Electric could have made minor tweaks to their project plan, incurred very few additional costs, and still been able to achieve LEED certification. In fact, some believe that one of the biggest costs they would have been forced to adopt would have been the costs associated with the LEED application paperwork.

Because of Fisk Electric's involvement in the construction industry, having their corporate headquarters building be a LEED certified building could have gained them prospective clients. By placing an emphasis on their commitment to the environment, Fisk could have gained clients who are also interested in constructing complex, sustainable facilities. Additionally, due to LEED's growing popularity within the construction industry, a LEED certified building is typically worth more than one that is not.

Background

The background research required to identify this problem is fairly complex due to the nature of how buildings are scored in the LEED rating system. The first step in the process was to determine how many points the building could have achieved without making any major system changes. Figure 2 shows how the Fisk Corporate Headquarters facility would have scored using the LEED rating system had the ownership team decided to pay the required costs without making any system changes. Most of the costs they would have needed to incur were actually construction costs. As evidenced by the figure, the Fisk Corporate Headquarters project could have potentially scored 48 points, or a rating of LEED certified had they decided to adopt some of these more sustainable practices.

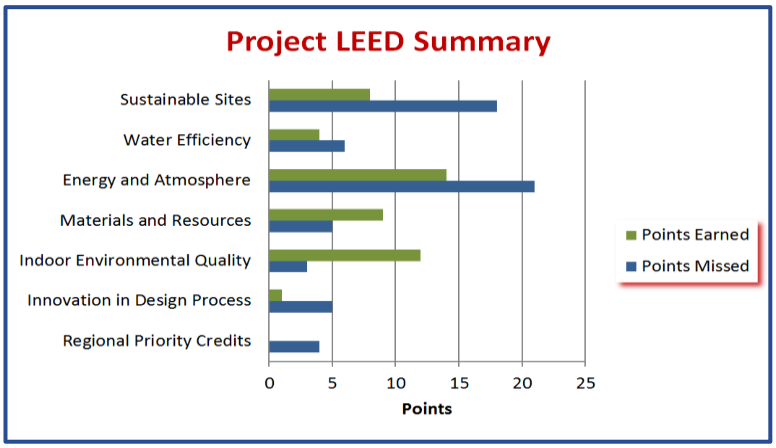

Figure 2: Fisk Electric's Building LEED Summary

Also after conducting many interviews with the project team and the project's lead MEP engineer, it was discovered that by making some minor system tweaks, some of the building's systems could have performed more efficiently. It is believed by the project team that if the owner was willing to make a few of these system changes; the project could have actually achieved a LEED silver rating.

Potential Solutions

If Fisk Electric decided they wanted to improve not only the perceived quality of their building, but also show the industry their commitment to sustainable practices, they would have only needed to make the following changes to their facility's construction plan.

- (2) points in construction waste management
- (2) points in the reuse of materials
- (2) points in recycled content
- (2) points in regional materials
- (2) points in certified wood

Furthermore, the Fisk Corporate Headquarters building could have gained an additional 2 points by making some minor mechanical system changes. For the purpose of this proposal, these potential tweaks will be discussed in greater detail later under the breadth sections of the proposal.

Once the project team had adopted these changes, they would have only needed to spend the money to apply for certification to achieve a LEED rating.

Analysis

To verify the feasibility of Fisk Electric altering their construction practices in an effort to achieve the desired LEED rating, the following analysis steps will be performed:

- Conduct research to verify that all the aforementioned LEED points would be potentially attainable on the Fisk Corporate Headquarters project via team member interviews.
- Accumulate and report the direct costs associated with executing the planned changes and applying for a LEED rating via RSMeans and various project team members.
- Analyze how changing the construction plan to reflect these changes would affect the project's scheduling and address any new constructability concerns. If any changes would have to be made, analyze the extent of these indirect costs and add them to the direct costs.
- Develop a business case for achieving LEED certification by conducting surveys and interviews of knowledgeable industry professionals to compare the perceived added value of a LEED rated building to one that is not to justify the additional costs that would need to be paid for by Fisk Electric.

Expected Outcome

It is anticipated that all of the potential construction installation practice changes that could have been made to the Fisk Corporate Headquarters project in order to help it achieve a LEED rating will indeed be feasible changes. While these construction changes should incur both direct and indirect costs, it is assumed that none of these costs will be substantial, nor will the project's overall schedule be compromised by the changes. Due to LEED's growing popularity within the industry, it is also anticipated that these additional costs will be outweighed by the perceived increase in value of Fisk Electric's new building had it achieved a LEED rating.

Analysis 3: Electrical System Redesign

Problem Identification

Due to the author of this proposal's extensive studies of electrical system design within the Penn State Architectural Engineering curriculum, one of the construction analyses will heavily focus on an electrical redesign. As such, this analysis will delve into the constructability, cost, and schedule impacts of the redesigned electrical system.

As previously outlined in Technical Report 1 and 2, the cost of the electrical system for the Fisk Corporate Headquarters building is significantly higher than what would be expected of a system in a similarly sized building. While some of this can be attributed to the unique desires of an electrical contractor owning the building, this thesis project will seek to make some system design adjustments that will maintain the systems intended use, while increasing the quality and lowering the cost.

Background

As previously stated, research has been conducted through an overall electrical system cost evaluation in Technical Report 1 when it was first discovered that the electrical system appeared to be overpriced for the given facility. Further study was completed in Technical Report 2 where the entire electrical system was broken down into components and a detailed estimate was completed in an effort to discern where the increase in cost was stemming from. Once broken down, it became more apparent that the system costs were actually much higher than they were originally represented.

For instance, the generator on the project was not actually purchased by Fisk Electric. Rather than spend thousands of dollars for a new generator, Fisk ultimately decided that they would rather save money than buy a new generator. Had they bought a generator like most owners moving into a new facility would have, the price of their electrical system would have been substantially higher.

Potential Solutions

Because the owner prized both the quality and cost of their new facility, they would definitely value the quality of their electrical system increasing or at least staying constant while lowering the overall system costs. In order to do this, a few potential solutions are possible.

- Switching out some of the system components for lower cost components that maintain the same level of efficiency.
- Layout the system in a different manner that limits the quantity of required distribution equipment by adjusting the loading on various panel boards and main switchboards.

Analysis Steps

The following steps would need to be taken to discern which potential solution would be the most feasible and save the owner the most money.

- Research the various system component specifications to gather insight as to the intended design and efficiencies of all the components.
    - Research alternate equipment manufacturers who offer equipment of a similar or improved quality gear at a lower price.
    - Calculate the total cost savings incurred by swapping out the various pieces of gear.
- Perform load calculations to discern whether or not it would be possible to layout the system in a different manner that limits the number of distribution gear pieces.
    - If possible, layout the system to depict these potential changes and calculate the total cost savings.
- A detailed comparison of the two new systems along with the original electric system with regards to construction costs and scheduling will be completed in order to make an informed recommendation for the owner, Fisk Electric.

Expected Outcome

It is expected that both of the potential solutions will prove to be valid ways to maintain the integrity of the electrical system while lowering the cost. However, it is anticipated that the second option will produce greater savings and require more time to complete the analysis. Due to the nature of electrical system components, it will be difficult to find system components that are more economical without losing efficiency. As such, potential solution two will probably produce better results than simply switching out components.

Analysis 4: BIM for Façade Coordination

Problem Identification

In Technical Report 2, one of the constructability challenges faced on the Fisk Corporate Headquarters project, per the project manager interview, was the manner in which the curtain wall and steel contractors were requested to coordinate together in order to construct the exterior façade. In typical construction installation practices, the structural steel contractor will first frame-out the various curtain wall openings. The curtain wall contractor then takes measurements from framing provided and manufactures his window panels to fit within the frame. However, in the case of the Fisk Electric curtain wall, this process was reversed, causing both trade contracts discomfort and some major coordination concerns.

Background

After learning about the unique manner in which the project team was forced to install the Fisk Corporate Headquarters' curtain wall, research was compiled in an effort to determine the extent to which this anomaly affected each contractor involved. While being able to manufacture the curtain wall prior to the installation of the structural steel framing did not negatively affect the curtain wall contractor, it caused many problems for the structural steel contractor. The first way it hurt the steel contractor was the increased level of coordination that was required between the steel contractor and the curtain wall contractor. This increased coordination requirement slowed the framing contractor's overall process, costing valuable time and money. The structural steel contractor also suffered due to the unusually small tolerances the steel contractor was forced to work within. Ironworkers typically work within much larger tolerances than curtain wall contractors. As such, the required increase in attention to detail forced the ironworker's labor force to slow down their productivity below the rates at which they estimated the job.

Potential Solutions

One way that this unusual coordination process could have been aided is through the use of building information modeling technology. Even though Fisk Electric did not mandate that BIM be used on their project, the architect and structural engineers decided to make a model for their own design purposes. This fully developed architectural model showed the locations of all curtain wall openings on the building façade. Had the project team decided to advance the model further, they could have virtually constructed the connections between the structural steel frames and the curtain wall pieces. Once virtually designed, the team could then simply supply both involved contractors' labor force with the dimensions from the model, therefore reducing the necessity for increased communication and coordination between the two trades.

Analysis Steps

In an effort to complete an analysis of how implementing a BIM process in the curtain wall construction could have benefitted the structural steel contractor, the following steps would need to be executed:

- Research via contractor interviews the total amount of time lost by the contractor during coordination due to the unusual installation process opposed to a normal one.
- Research through contractor interviews and document any rework that needed to be completed due to miscommunication during the coordination and installation process.
- Research how the project team could have saved money during coordination and construction of the curtain wall by studying case studies where similar techniques were used in an effort to aid in this process. Also, document the additional costs the contractors would have incurred by adopting a BIM process to aide construction.
- Produce a comparison between the actual costs incurred on the Fisk Corporate Headquarters office during the process to the projected savings they would have realized by using BIM as a tool on the project.

Expected Outcome

It is anticipated that by utilizing a BIM process, the construction team would have been able to save money during the curtain wall installation. The only way this may not be the case is if the cost increase associated with adopting a more advanced technology would not outweigh the potential benefits on a smaller project.

Critical Issues Research

BIM is an ever-evolving part of the construction industry. Every year, more and more owners want BIM practices to be implemented on their projects. As such, the increase in demand has caused the price of implementing a BIM process on various projects to decrease. However, it is a critical industry issue because a debate always exists as to proper time to use BIM and what are the most efficient applications. Questions always arise as to when does a building become too small for the construction benefits of using BIM begin to outweigh the costs. The industry also goes back and forth regarding how BIM should be used on a project. Some applications, like clash detection, are already widely considered to be beneficial but virtual construction is still a relatively new industry technique. The research in this thesis will seek to provide an insight as to whether or not implementing BIM in a smaller facility for a smaller purpose is a profitable business investment through an extensive case study review process. If the research turns out to be positive, it could show future owners of smaller facilities that they can still execute beneficial BIM practices, regardless of building size and complexity.

Conclusions

The aforementioned four technical analyses, combined with the two breadth topics described in Appendix A, all focus on ways to either maintain or improve upon the Fisk Corporate Headquarters project's perceived quality while attempting to reduce the total construction costs. Whether it is through the implementation of sustainable construction practices, a system redesign, or a way to portray information smartly using advanced technologies, the analyses maintain the integrity of Fisk Electric's desired design intent while attempting to improve upon some of the construction methods. It is anticipated that through extensive research and study, these four analyses will produce results that would have benefited the Fisk Corporate Headquarters' project team.

Appendix A: Breadth Topics and MAE Requirements

The following breadth and master's integration topics seek to contribute to the four previously mentioned analyses. These topics will be technical studies aimed at illustrating the wide variety of knowledge and skills learned by Penn State Architectural Engineering students beyond just construction management.

Breadth #1: Architectural, Contributes to Technical Analysis 2

The attempted LEED certification rating analysis described in Technical Analysis 2 provides an opportunity to look at the efficiencies of some of the various affected systems. After consultation with the project's MEP engineer, it was discerned that some minor energy tweaks could be made to push the building from a LEED certified rating to a LEED silver rating. Currently, the building only is able to achieve 7 out of a possible 19 points in terms of energy efficiency. However, if the building was able to gain 2 points, or a 4% increase in energy efficiency, it would become gain a LEED silver rating. This breadth will do a study in an effort to report the potential energy efficiency savings Fisk Electric could have realized if they chose to install energy an architectural overhang above the facility's windows. Currently, no such shading components building's exterior and it is anticipated that by installing architectural overhangs, the building will easily be able to increase its energy efficiency by the required 4% and achieve a LEED silver rating. Three different types of architectural overhangs will be modeled and studied to discern the pros and cons involved with each type of architectural system.

Effects of the new architectural overhangs in terms of construction costs and schedule will also be analyzed and included in the LEED rating construction analysis.

Breadth #2: Electrical, Contributes to Technical Analysis 3

As previously stated, due to the author's extensive study within the electrical systems design curriculum in the Penn State Architectural Engineering department, one of the depth topics covered by the author will seek to complete a partial electrical system redesign in an effort to reduce the overall cost of the system while maintaining the system's integrity. The author will attempt to complete this by both switching out system components and actually attempting to redesign the system distribution. Once complete, both methods of improving the system will be analyzed to determine which method produced a more efficient, economical system. An analysis of the new electrical system with regards to its constructability, cost, and schedule will be completed and compared to the original with the hopes of supporting the value of the altered system.

Masters Coursework Integration: AE570 – Production Management in Construction

One point of emphasis in the AE570 course was the use of a pull system in which individuals or companies employ resources on an as-needed basis. For the purpose of this thesis report, a study will be conducted to examine the feasibility of using the idea of a pull system for transferring the information detailed in Technical Analysis 3. The main idea behind implementing this strategy is that it will minimize the time spent waiting for information between the various team members. Once a study is completed regarding the feasibility of employing this method, another study will be conducted to analyze the effects this idea would have on the overall process's cost and schedule.

Appendix B: Senior Thesis Timetable

Stephen Blanchard
Fisk Corporate Headquarters Project
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Proposed Thesis Semester Schedule

January 2013 - April 2013

1/7/2013	1/14/2013	1/21/2013	1/28/2013	2/4/2013	2/11/2012	2/18/2013	2/25/2013	3/4/2013	3/11/2013	3/18/2013	3/25/2013	4/1/2013	4/8/2013	4/15/2013	4/22/2013
		1/28/2013 Milestone 1			2/11/2013 Milestone 2		3/1/2013 Milestone 3				3/25/2013 Milestone 4				
Analyze Schedule								Spring Break		MCAA Conv.		Final Report - April 3	Faculty Jury Presentation - April 8 - 12		Senior Banquet - April 26
	Resequence Schedule and Document Results	Resequence Schedule and Document Results													
		LEED Cost Research													
			Summarize LEED Outcome, Complete Mechanical Breadth	Summarize LEED Outcome, Complete Mechanical Breadth											
					Electrical Redesign										
						Construction Analysis of Electrical System Redesign	Construction Analysis of Electrical System Redesign								
								Research and Complete the BIM Façade Coordination Implementation Analysis	Research and Complete the BIM Façade Coordination Implementation Analysis	Research and Complete the BIM Façade Coordination Implementation Analysis	Research and Complete the BIM Façade Coordination Implementation Analysis				
											Start/Complete Final Thesis Presentation	Start/Complete Final Thesis Presentation			
												Complete Report			
													Jury Present.	ABET Assessment	ABET Assessment
														Update CPEP Site & Final Report	Update CPEP Site & Final Report

	Milestone	Analysis & Breadths
1	Analysis #1 Completed and LEED Cost Research Complete	Improved Project Sequencing
2	Analysis #2 and Electrical System Redesign Complete	Implementation of LEED (Mech. Breadth)
3	Analysis #3 Complete	Electrical System Redesign (Const. Breadth)
4	Completion of all Analysis and Start of Presentation	BIM Façade Coordination Implementation