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Moore Building Addition & Renovation
University Park, PA 16802

Senior Thesis Proposal

Penn State AE Senior Thesis

Executive Summary

The Senior Thesis Proposal describes the analyses that will be performed in the spring semester in greater detail than their counterparts in Technical Assignment Three. Its main focus is to bring out a direct plan of the work to be undertaken in the coming semester by laying out all the pieces required to come up with a conclusion to each of the four chosen analyses, and they are as follows:

With the Moore Building Addition being a high priority building on the Penn State campus, its early completion can be very beneficial to the program, whose wait has been past due. One aspect of the project that presents one with an opportunity to better the project is the North Wing; a 13,000SF center section of the new addition that will be left intact structurally and will be built around during the construction of the rest of the building. The option to tear it down seems like a more resourceful approach to the addition's construction and the most likely outcome would be time and money savings to the owner. This will be the focus of **analysis 1**.

Again, since the Moore Building Addition can greatly benefit from a reduction in time, **analysis 2** focuses on just that, and a critical industry issue; pre-fabrication. This comes in the form of pre-fabricating the façade of the building in order to both save time and possibly reduce cost of the project. The current façade system looks like a simple façade to pre-fabricate and can prove very useful. This analysis will also be used to demonstrate two breadth topics, with the first being a study to determine if the façade system will cause any additional strain to the structure, and if so, a redesign of the system. The second breadth topic is a mechanical one that aims to determine the change in efficiency of the new pre-cast system and ways that the money saved can be put to further reduce the long-term cost of the project.

All in the name of increased efficiency of the construction process, a trend with analysis has formed. This trend applies to **analysis 3** as well, which focuses on BIM integration into the project from the planning stages of construction as opposed to the current introduction at the later stages of design with 100% complete construction documents. The expected outcome would be a reduction in RFIs, change orders which would ultimately lead to reduced costs and time savings.

Finally, **analysis 4** looks at methods to accelerate the procurement of structural steel on the site of the Moore Building Addition. The issue is that steel is the single most important critical path item, and it opens the doors for all other work to begin. With previous attempts by the construction manager to reduce the procurement time in vain, a new method is proposed for this analysis; it looks at the possibility for the owner to hold the contract with the steel fabricator earlier than the rest of the subcontracts and before the CM is chosen. The expected result of this is that the steel would be procured early and the project can, as a result, finish early.

Contents

The Moore Building Addition

Moore Building is an existing building on campus and it houses the department of psychology. Throughout its existence, the program has grown at a steady pace and so has its faculty and students. Interest in the field is much greater than it was when the Moore Building was initially constructed, a few decades ago. With the department of psychology now being one of the largest departments on the Penn State University campus, an equally monumental expansion was due; The Moore Building Addition & Renovation.

Split into two phases, this structure will be constructed to the highest standards, and satisfy the needs of the entire department, whilst keeping in mind economic decisions and "green" construction and operation practices.

The Moore Building Addition is located on the intersection of Fischer Road and Allen Road on the university campus of The Pennsylvania State University, on the Northeast side of campus. Logistics will be an easier task than previously anticipated due to the student traffic in the area which is much less than that of central campus. This is also in-part due to the fact that the building is close to Park Avenue, which is connected to the highway and where some material may find itself coming through. Although the roadways leading into and out of the areas are tight, the utmost effort will be put forth by all parties to ensure the success of the project.

Building Statistics

Building Name	Moore Building Addition
Building Location	University Park, PA 16802
Occupancy	Department of Psychology
Classification	B (Business)
Building Size	57,000 SF + 13,000 SF North Wing
Project Start/Finish	06/2010 – 01/2012
Building Cost	$26.1 Million
Project Delivery Method	Design-Bid-Build

Table 1: Building Statistics

The building's design sports the new Penn State trend of modern mixed with historical architecture. This is primarily evident in the extensive use of red brick infuse with aluminum paneling and glass curtain wall systems (Figure 1). Its design allows the building to stand out and provide more for the image of the university, while maintaining its function very well.

Figure 1: Moore Building Addition

Analysis 1: Demolition

The Problem

The Moore building addition is set to tie into an existing structure of structural steel members. This existing structure is 13,000SF and will be stripped to its structural steel and concrete decks before any work can or will be done. This portion is called the North Wing.

This North Wing will undergo Asbestos removal and abatement during the "Demolition and Abatement" phase of construction. Most of this demolition and abatement phase will be from June 2010 to up until the beginning of September 2010. So, the process will take about 90 days to complete, and whilst that is part of the schedule, there may be room to accelerate the schedule by eliminating this process entirely.

The Potential Solution

The demolition portion of the schedule may be much easier to manage if the North Wing is completely removed. This North Wing can then be completely eliminated from the design, which also removes any design constraints involved with it. Or, the North Wing can be re-built, and that may save time and money used on asbestos preparation equipment as well as the actual removal of asbestos.

The Methodology

- Research and determine cost and schedule time required for Asbestos abatement and removal per square foot.
- Research and determine cost and schedule time required for constructing a superstructure of 13,000SF made up of four levels.
- Research the costs involved with tying in two structures, if any.
- Data of the Asbestos abatement and removal of the current structure will be obtained in order to compare to the researched data, from available documents or from project team on the site.
- Analysis of labor costs of both methods will be evaluated and a comparison made.
- Additional costs due to quality control of tying in will be assessed from current job data and compared to the final costs of both systems.
- A determination will be made as to the cost of a geotextile bentonite layer.

The Resources

- Project Manager at PJ Dick
- Project Leader at OPP
- Available estimates of Moore Building Addition
- Available schedule of Moore Building Addition
- Applicable publications

The Expected Outcome

An expected outcome would be that tearing the entire north wing down and building it back up as part of the entire structure would be a more cost effective option than preserving its structure. Another expected outcome would be that the schedule time would be ultimately reduced as well due to this. This is due to less time spent on the intricate details involved with preserving the structure as well as removing the asbestos in it, and instead, being able to build right up from the site. Also, space on site will be less congested due to this.

Analysis 2: Façade

The Problem

For the façade of the Moore Building Addition all masonry and panel work will be installed on site by masons. This is a time-consuming process that will produce large amounts of waste as well as congestion and possibly quality control issues. However, the most important part of this is the time factor.

The Potential Solution

A prefabricated façade system may be extremely beneficial to the Moore Building Addition; it will reduce the time taken for erecting the façade. This along with the added cleanliness of the site will allow the other trades to better navigate the site and reduce the risks involved with façade construction.

The Methodology

- Research and determine the cost and schedule time required to erect the façade system currently approved for the Moore Building Addition.
- Research and determine cost and time required to pre-fabricate a near-identical façade system through interaction with the industry.
- Determine transportation and erection costs involved with a pre-fabricated façade system as well as schedule time required to erect the system.
- Research and determine any change in structure to the Moore Building Addition that may be required in order for this system to be viable.

The Resources

- Available estimates of façade system
- Available schedule time to erect façade system
- Prefabrication company – façade
- Construction transportation company
- Structural Faculty and/or peers @ PSU AE

The Expected Outcome

The most likely outcome of this research analysis topic would be that the pre-fabricated system's total cost would not exceed the total cost of the currently approved system, and the schedule time would be greatly reduced; enough to create a desirable impact on the project's overall schedule.

Analysis 3: BIM Coordination

The Problem

BIM implementation on the Moore Building Addition was done quite late in the project, in terms of BIM's true effectiveness. With construction documents already 100% complete by the time BIM was introduced, some of the most sought after reasons for using BIM is to streamline processes like the creation of construction documents and having a model that is useable in the early stages of planning and design. However, this was not the case for this project, with BIM being introduced late in the project's life.

The Potential Solution

In hindsight, the implementation of BIM as a contractual requirement in the planning phase could have been more beneficial to the project.

The Methodology

- Research projects on PSU campuses that have utilized BIM in planning stages.
- Determine total cost per square foot of BIM utilization on projects.
- Determine time taken for design phase and planning phase with BIM utilized since planning phase as well as all issues/interruptions to project as a result of BIM implementation.
- Use information obtained to compare to current Moore Building Addition cost/SF and schedule times for planning and design phases of construction.
- Analyze all data and compare time and cost of all parameters.

The Resources

- Industry Professionals at OPP – BIM division and construction (design services and construction services)
- Available estimates and data pertaining to BIM
- Information present about similar buildings with defined requirements

The Expected Outcome

Although this may be a very in depth analysis, the expected outcome in terms of the parameters chosen, is that implementing BIM in the earliest stages of construction would result in greater time savings and possibly some cost savings to the project due to reductions in change orders, RFIs and decresed confusion on site in a general manner.

Analysis 4: Structural Steel

The Problem

The structural steel on the Moore Building Addition was and still is the most important critical path item. This is due to the fact that the structural steel opens the doors for every other subcontractor to begin putting work in place. However, with the two failed attempts to have the structural steel delivered early, it is possible that more could have been done to ensure its early delivery.

The Potential Solution

Solving this problem may be in the hands of PSU; if the OPP could have awarded the steel contract to a qualified bidder before selecting the CM firm, then, in theory, steel fabrication could have begun early.

The Methodology

- Research risk involved with owner-held contract to a subcontractor.
- Determine importance of early completion and value in achieving early completion to the owner.
- Research risk involved with design changes to contract after awarding steel contract.
- Research time savings and expense of early fabrication as well as overall impact to schedule.
- Determine risk involved with keeping contract with steel subcontractor in long term case.
- Analyze all risks involved against owner's value for early completion and determine if a separate contract would be feasible.

The Resources

- Industry professionals
- Applicable publications and articles – risk management
- Steel fabrication company
- Available schedule time and estimates for structural steel erection

The Expected Outcome

The outcome expected of this analysis would be that if OPP was to hold the steel contract, as they are well equipped to do so, this would save time and money on the construction of the Moore Building Addition. This is due to the steel arriving earlier on site allowing all other work to begin earlier, which, in turns allows the building to operate earlier which increases the business that it produces as part of its department.

Weight Matrix

As a measure of expected effort, a weight matrix has been used to depict approximate allocations of time and effort towards each of the four main research areas. This is portrayed in table 2.

Description	Research	Value Engineering	Constructability Review	Schedule Reduction	TOTAL
Demolition	-	15%	5%	10%	**30%**
Façade	15%	5%	10%	10%	**40%**
BIM Coordination	5%	10%	-	-	**15%**
Structural Steel	-	5%	-	10%	**15%**
TOTAL	**20%**	**35%**	**15%**	**30%**	**100%**

Table 2: Weight Matrix

Conclusions

By research and a new relationship with the industry, the analysis topics will provide the most face-to-face interactions within the building construction industry. Research will be a major portion of the coming months' work but this will be trumped by methods to further decrease the cost and schedule time of the project.

Appendix A – Breadth Topics

Structural Breadth: Based on Analysis 2

Replacing the façade system currently approved for construction on the Moore Building Addition seems like a simple task, as its primary focus is rooted in the construction management aspect of construction. However, pre-cast panels may also prove to be a more costly option if the structure is to be drastically redesigned in order to support it.

This breadth will analyze the required change in design of the current mullion system that is required, and will determine if the structure is adequate in its current form. Loads of the new system as compared to the current one will be compared, with necessary connection and member changes studied as well. Also, as a common part of precast systems, there will need to be a method of placing these on the building's superstructure, and that will be evaluated in terms of cost and labor as well.

Mechanical Breadth: Based on Analysis 2

As outlined above, the replacement of the façade system with a precast system may present some challenges. However, it may also present the owner with some opportunities and one of these comes in the form of a more efficient glazing system as well as a more efficient envelope as a whole. This may help to reduce the building's ultimate consumption of energy, and, in turn, its carbon footprint.

This breadth will analyze options that seem suitable to a pre-fabricated exterior façade system, and how the system may differ to the current façade system. This is due to the extra bracing, and rigidity of the system, including the glazing, which may also have a different coefficient of thermal conductivity. The analysis will look at difference in conductivity and the effective differences of both systems as a thermal barrier.

Finally, whether the new system is more efficient or not, a determination of the time for a return on investment to make the panels more efficient will be conducted.

Appendix B – Spring Semester Schedule

Moore Building Addtition - University Park, PA 16802

Senior thesis Proposal 12/10/2010

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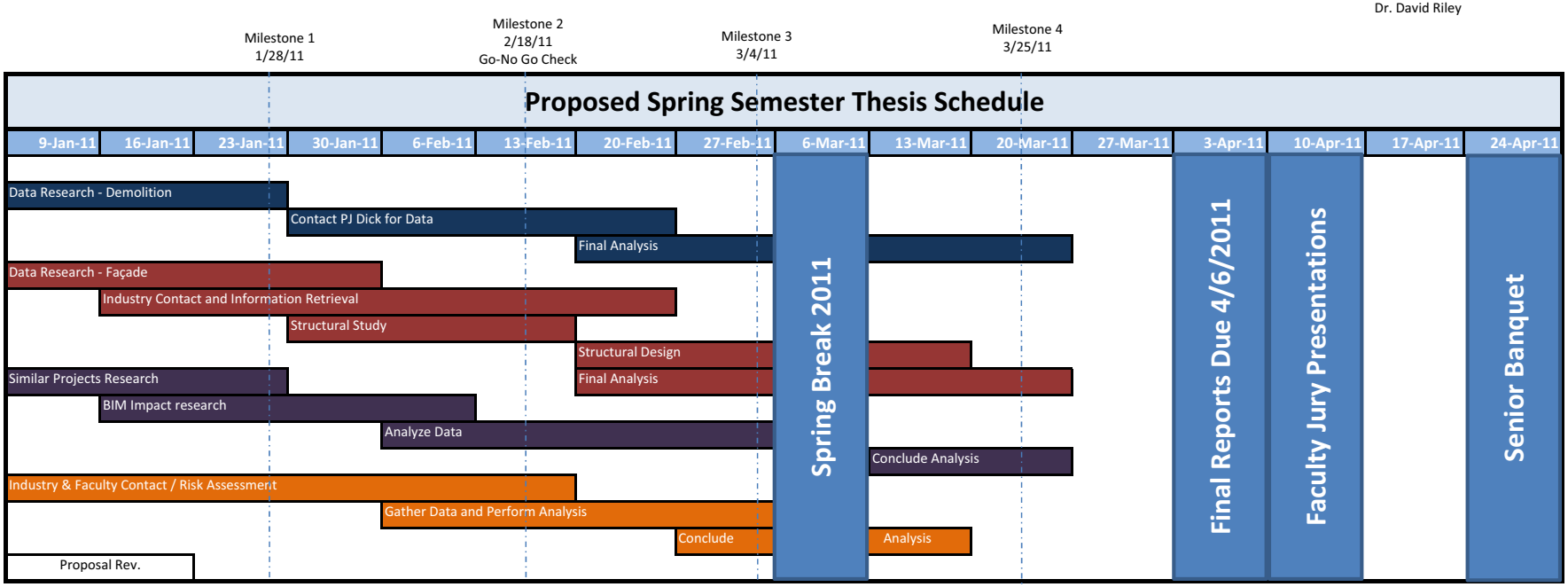

Legend		
	Analysis 1	Demolition
	Analysis 2	Façade
	Analysis 3	BIM Coord.
	Analysis 4	Structural Steel

Milestones	
1	Analysis 1&3 research complete
2	Analysis 1&3 begin final analysis
3	All analysis in evaluation stages
4	Finalize all analysis