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Mohammad Alhusaini
DR. DAVID RILEY
CONSTRUCTION MANAGEMENT

Moore Building Addition & Renovation
University Park, PA 16802

Senior Thesis Proposal Rev. 2

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 *three* 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 I**.

Again, since the Moore Building Addition can greatly benefit from a reduction in time, **analysis II** 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.

Analysis III 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 a design-assist contract with the steel prime contractor.

Finally, **analysis IV** looks at the option of how to have the PSU AE department to collaborate with OPP to crate useful campus models and what criteria are involved as well as the benefits, drawbacks, shortcomings and unforeseen issues with such an approach. It hopes to delve into the process and creation side in order to create an effective tool for the parties involved.

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 I: Demolition

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 and is an independent structure, so, there will not be a need for any structural ties to the new structure that will be built around it.

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.

Analysis' Importance

Although the Moore Building Addition is scheduled to be both on schedule and under budget, it's a building long over-due, and its early completion can begin to bring both research and revenue to the department of psychology at Penn State. The idea is not simply for profits, but the Moore Building's operation is symbolic of the department's growth as well a new beginning for the program at the university. So, a building handed over early means that the next phases of construction can begin early as well, since there is an entire renovation of the existing building that follows the construction of the new building.

Proposed Solution

The proposed solution to the issue at hand – finishing the building earlier – is to, instead of stripping down the North Wing of the existing building to its structural steel and concrete decks, demolish it and build it back up as part of the new structure. The idea focuses on seeing the entire new portion of the building as one new piece, and treating it as that instead of reducing the North Wing and then rebuilding around it and renovating it.

Possible Drawbacks to Solution

Since this solution proposes to demolish the existing structure, there may be more foundation work involved with the new building, and a possible redesign may be imminent. Also, the demolition may cost more than would be beneficial to the project and cause a large amount of waste on site, which would contribute to the cost of the demolition, making it less cost-effective. Finally, the process requires very specialized companies to carry out the process, since the North Wing is attached to the current Moore Building and a Demolition may require extra attention as not to compromise the structural integrity of the building through a miscalculated demolition, or careless preparations. In other words, there are quite a few risks involved with the operation that may render it useless.

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 16,000SF 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.

Resources/Tools

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

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 II: Façade

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 that the process is time-consuming. The ability to mitigate this can prove to be very beneficial to all those involved in the project.

Analysis' Importance

Although the Moore Building Addition is scheduled to be both on schedule and under budget, it's a building long over-due, and its early completion can begin to bring both research and revenue to the department of psychology at Penn State. The idea is not simply for profits, but the Moore Building's operation is symbolic of the department's growth as well a new beginning for the program at the university. So, a building handed over early means that the next phases of construction can begin early as well, since there is an entire renovation of the existing building that follows the construction of the new building.

Proposed Solution

A prefabricated façade system may be extremely beneficial to the Moore Building Addition; it may potentially reduce the time taken for erecting the façade whilst eliminating a lot of the waste involved with erecting the façade on site. This, along with the reduction in congestion is a very appealing combination and could potentially accelerate the schedule as well as improve the overall safety of the site.

Although not the most important benefit, the decongestion of the site that will occur is typically very noticeable on the project. It will allow for much better coordination between the trades and reduce coordination time between them, and that alone may be worth the benefits.

Possible Drawbacks to Solution

Some concerns of the proposed solution is that the transportation may cost a significant amount, and the size of the trucks may be a concern in that the roads leading to the Moore Building Addition are very tight and can pose a safety hazard as well as logistical issues. Also, the picks must be coordinated thoroughly as well as the possible laydown areas for the façade pieces that are fabricated off site and brought to the campus.

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.

Resources/Tools

- 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

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 III: Structural Steel

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.

Proposed Solution

Solving this problem may be in the hands of PSU; if OPP were to award a design-assist contract to the steel prime contractor, then they would be on board about the time that the CM agency is, allowing for a head-start on the design and implementation of the structural steel.

Possible Drawbacks to Solution

The biggest concerns with this approach to reduce schedule time are the risks involved with holding separate contracts and trying to coordinate more than one at the same time. Although it is a very doable concept, the increase in risk may prove to be costly, since the structural steel is the single most important critical path item on the project.

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.

Resources/Tools

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

Expected Outcome

The outcome expected of this analysis would be that if OPP was to award a design-assist contract to the steel prime contractor, 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.

Analysis IV: BIM through AE (Critical Industry Issue)

The Office of Physical Plant has been expanding its use of BIM by recently writing guidelines, contract language and leading the way in terms of the implementation of BIM. However, they need lots of help to generate models of all the buildings on campus and utilize them for all sorts of BIM applications.

Proposed Solution

As has been requested before, the OPP would like, through the AE department at Penn State, to utilize some of the classes in the AE course in order to produce BIM models for some existing buildings. The collaboration of the two entities would not only be beneficial to the OPP but also to the students partaking in the classes.

Possible Drawbacks to Solution

Some of the drawbacks may be rooted in the inexperience of the students in creating models at some of the earlier stages of their college life. This may emanate through models with insufficient detail, and lack of other details as well as the possibility that some of the more "slacking students" produce completely inadequate models.

Methodology

- Research requirements of a model by OPP's standards, and what is useful and what isn't.
- Research which classes may be available to take on BIM model producing and the experience of students required in order to ensure decent models are produced.
- Conduct interviews to understand the typical problems with this approach and where there would be lost time and money.
- Determine which level students are better suited to produce what type of models; architectural vs trades.
- Research the amount of money that would come into the department due to this collaboration and how this would affect the AE program as well as possible incentives for very knowledgeable and experienced students to get paid in order to privately create models.

Resources/Tools

- Professor Paul Bowers PSU
- Dr. Ed Gannon OPP/PSU
- Dr. David Riley PSU
- Mr. John Bechtel OPP
- Colleen Kasprzack OPP/PSU
- Other PSU and OPP BIM professionals involved

Expected Outcome

The expected outcome is that there is a very realistic and possible method to intertwine some of the classes at PSU AE with the production of models that can be used to benefit the OPP and university as well as the students through real BIM exposure.

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	5%	15%	10%	5%	**35%**
Façade	5%	5%	10%	5%	**25%**
Structural Steel	5%	10%	-	10%	**25%**
BIM	15%	-	-	-	**15%**
TOTAL	**30%**	**30%**	**20%**	**20%**	**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 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, it will be determined if there is a need to connect the new system in a different way or if the current method will suffice.

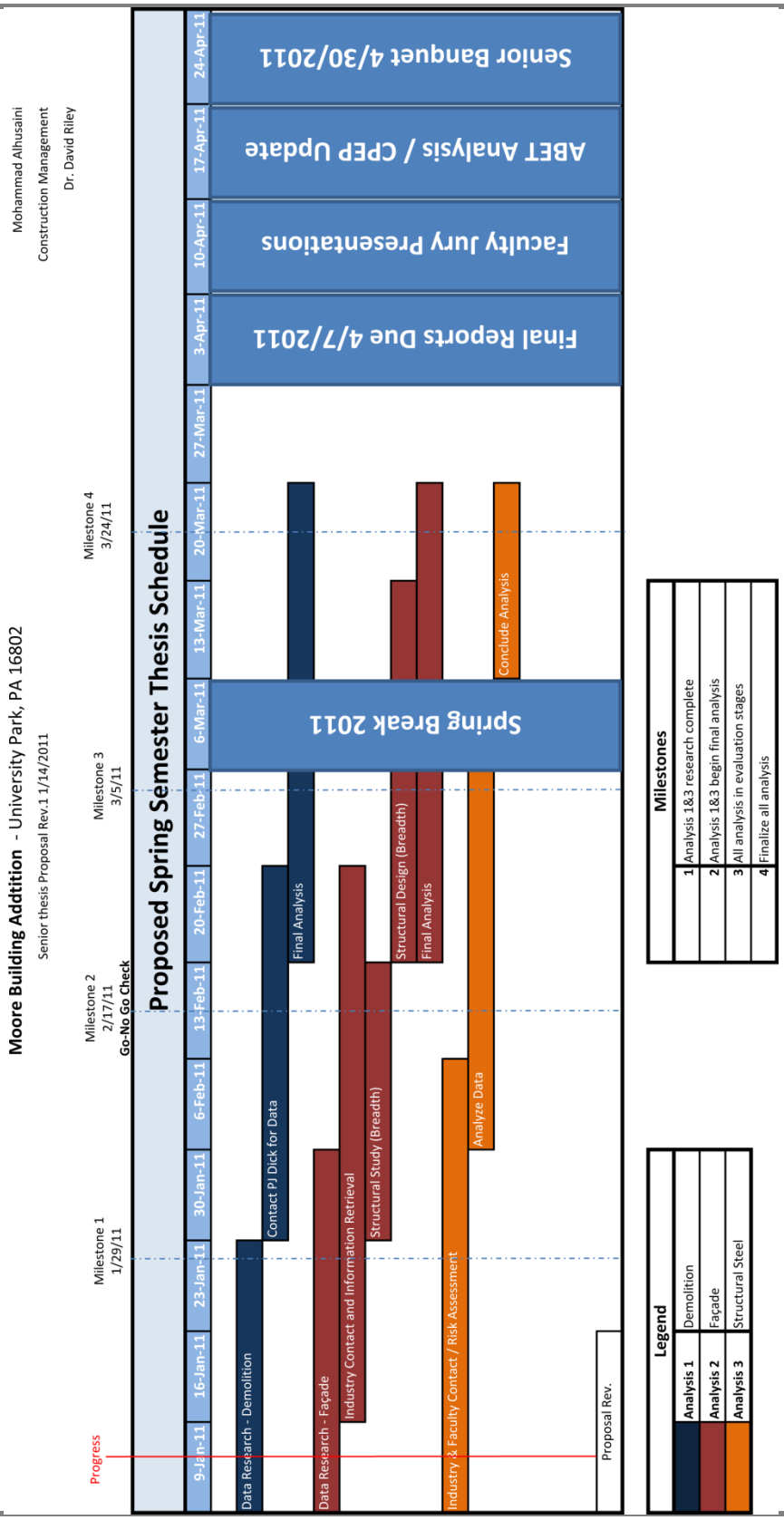
Mechanical Breadth: Based on Analysis 2

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 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 brick, 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 Rev.1 1/14/2011
Mohammad Alhusaini
Construction Management
Dr. David Riley
Proposed Spring Semester Thesis Schedule
Progress
Milestone 1 1/29/11
Milestone 2 2/17/11 Go-No Go Check
Milestone 3 3/5/11
Milestone 4 3/24/11
9-Jan-11
16-Jan-11
23-Jan-11
30-Jan-11
6-Feb-11
13-Feb-11
20-Feb-11
27-Feb-11
6-Mar-11
13-Mar-11
20-Mar-11
27-Mar-11
3-Apr-11
10-Apr-11
17-Apr-11
24-Apr-11
Senior Banquet 4/30/2011
ABET Analysis / CPEP Update
Faculty Jury Presentations
Final Reports Due 4/7/2011
Spring Break 2011
Data Research - Demolition
Contact PJ Dick for Data
Final Analysis
Data Research - Façade
Industry Contact and Information Retrieval
Structural Study (Breadth)
Structural Design (Breadth)
Final Analysis
Industry & Faculty Contact / Risk Assessment
Analyze Data
Conclude Analysis
Proposal Rev.
Legend
Analysis 1 Demolition
Analysis 2 Façade
Analysis 3 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