Northeastern Pennsylvania Office Building

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Executive Summary

This proposal is intended to be a detailed outline that will guide research on the Northeastern Pennsylvania Office Building project. The four main analyses encompassed in this proposal include critical industry research, value engineering, constructability reviews, and schedule reduction and/or acceleration pertaining to the following four analysis areas

Analysis 1: Removing the Pre-Engineered Metal Building

Due to delays in the project schedule caused by the PEMB, an analysis will be performed to assess the effects on the schedule and project cost if the building's structural system were to be changed. A preliminary analysis of three building systems will be used to determine the most suitable candidate. Further analysis will be performed to compare the alternate system to the PEMB.

Analysis 2: Design-Build Phase 2 & 3

Since the project team is familiar with the work being designed and constructed on Phase 1, a design-build approach could be used on similar buildings, Phases 2 & 3. A design-build project is expected to accelerate and reduce the project schedule.

Analysis 3: Horizontal Expansion vs. Vertical Expansion

The owner has shown interest in doubling the amount of occupants in the office building. This analysis will be performed to determine whether it would more efficient to expand vertically or horizontally. Analysis areas that may require redesigning include the structure, electrical, mechanical, and HVAC systems.

Analysis 4: Geothermal System

A geothermal system could be installed to warm the slab of the shop building in the colder months of the year and cool the slab in the warmer months. It would reduce the amount of energy consumed to heat the shop space and reduce the amount of exhaust fumes produced by the gas-fired heaters currently being used.

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Project Background

The Northeastern Pennsylvania Office Building is Phase 1 of a 5 phase project on the outskirts of a rural community in Northeastern Pennsylvania. The project consists of two single-story buildings on a nineteen acre project site. Security fencing will surround the site to enclose a gravel laydown yard where the owner will store materials and equipment after project completion. The office building is approximately 11,500 square feet and the shop building is about 14,700 square feet. Together, these buildings are scheduled to be constructed from June 2011 until about March 2012 and cost about $5.4 million.

Both buildings are pre-engineered metal buildings (PEMB) set on concrete pier foundations. The floor systems for both buildings are concrete slabs-on-grade with concrete grade beams. Ten gas furnaces distribute warm air throughout the office building, while the shop building uses a combined system of twelve gas-fired heaters and three large, ceiling-mounted fans to warm the space.

Analysis 1: Removing the Pre-Engineered Metal Building

Issue

The pre-engineered metal building system used for both buildings have not only caused problems in the field with coordination, but it has delayed the project schedule. The general contractor on the project has expressed displeasure with the subcontractor that has been hired to design, fabricate, and install the PEMB for this project.

Line items have been included on the project schedule for reactions (37 days) and fabrication (50 days) in relation to the PEMB. The reactions took over one week longer than expected (45 days), and the fabrication has lasted two days longer than scheduled. These delays subsequently delayed the entire project approximately two weeks. The delays were caused by both a lack of effort from the PEMB subcontractor and miscommunications between the general contractor and the PEMB subcontractor.

Methodology

The first area of analysis that must be performed would be to calculate the costs and schedule impact of the pre-engineered metal building. This will include all costs associated with fabricating and installing the PEMB, as well as the costs endured by the general contractor for not completing the project on schedule. This will provide a baseline for comparison with other structural systems.

The next area of analysis that must be addressed is finding a suitable replacement system. Systems that will be evaluated include a standard steel structure, tilt-up precast concrete panels, and a cast-in-place concrete structure. Each system will be investigated to determine its constructability, its impact on the schedule, and its associated costs.

Finally, once the most appropriate system has been chosen for the Northeastern Pennsylvania Office Building, a detailed schedule and quantity takeoff will be performed and inserted into the project schedule and budget. An architectural breadth study could be performed to evaluate the appearance of the buildings if the PEMB were to be replaced.

Expected Results

This analysis will not only highlight the impacts of the pre-engineered metal building, but it will also suggest an alternate system. The alternate system is expected to be less expensive and reduce the project schedule. Also, depending on which system is chosen, a higher quality of architectural finish is expected to result by replacing the PEMB.

Analysis 2: Design-Build Phase 2 & 3

Issue

The Northeastern Pennsylvania Office Building is Phase 1 of a five phase project. It was delivered as a standard design-bid-build project. A preselected list of contractors was chosen by the owner to submit bids for this project. With an almost complete set of drawings and specifications, the contractors analyzed the scope of work and submitted their bid. The winning contractor then sent out the project documents to subcontractors for bids. Once all of the subcontractors were chosen, the project began construction.

Although the timeframe of design is not known at this point in time, the drawings and specifications were issued April 2011. This means there was a three month delay between the contractors receiving the project documents and the start of construction. Since Phase 2 and Phase 3 of this project are nearly identical buildings, they could be delivered as design-build projects with the Phase 1 project team to reduce the schedule and costs of these later phases.

Methodology

It is important to first understand the timeframe involving the design-bid-build process. The design aspect is unknown at this time, but the bidding lasted about three months and the construction of the building is approximated to last nine months. An analysis would be performed to examine the amount of time reduced by using a design-build system. An analysis would also need to be performed to estimate the costs and schedule impacts resulting from designing and constructing two phases that are nearly identical to a previous phase.

Expected Results

Since the project team has performed almost identical work on a previous phase, it is expected that issues in the field experienced in Phase 1 could be avoided in the design of Phases 2 & 3. Also, since the contractors have performed nearly identical work from nearly identical project documents, the work has the potential of being installed more efficiently and therefore quicker and less expensive.

Analysis 3: Horizontal Expansion vs. Vertical Expansion

Issue

The office building portion of the Northeastern Pennsylvania Office Building is currently designed to provide work space for about 50 employees. The owner now believes that they will need to double the office space available to accommodate around 100 employees. The two options for an expansion of this size are to expand horizontally or vertically.

A horizontal expansion means there will be less area in the gravel laydown yard due to the larger building footprint and the addition of a second parking lot. However, the original office building could be constructed and occupied while the second office building is constructed nearby. The building systems that are run underground (water, waste, natural gas) would interrupt work in the gravel yard while they are run across the site.

A vertical expansion would result in an almost complete building redesign. A pre-engineered metal building would not be suitable for a two-story building and would have to be replaced with some sort of steel or concrete structural system. Also, due to the increased loads on the building systems, the mechanical and electrical systems will have to be redesigned. However, other than the addition of a second parking lot, the size of the gravel yard will not be impacted. Finally, although the office building could not be occupied until a later date, work can begin in the shop building as scheduled and will not be interrupted by underground utilities being run.

Methodology

This analysis would require that it be performed concurrently with the cost and schedule impacts of the pre-engineered metal building analysis. If it is determined that the PEMB is the most suitable system for this project, a horizontal expansion may be preferred because it could also be a PEMB. However, if a different system is determined to be better suited, it will need to be designed as both a one-story building and a two-story building to be used in both options of this analysis. An analysis will also need to be performed to determine the new system loads for the vertical expansion. This will inevitably lead to more expensive building systems and an extension to the current project schedule.

Once each analysis has been performed, the data retrieved can be inserted into the project cost estimation and the project schedule to determine which system would be less expensive and have the smaller impact on the project schedule.

Expected Results

It is expected that if the PEMB is determined to be the most suitable structural system in the ‘Removing the Pre-Engineered Metal Building” analysis, then the project would best benefit from a horizontal expansion. This would essentially be repeating the office building and is likely to produce better quality work in a faster manner. However, if a different building system is determined to be the most suitable system for this project, vertical expansion is expected to be better than a horizontal expansion. This is because a vertical may increase the components of the building systems, but a horizontal expansion would double the amount of material required.

Analysis 4: Geothermal System

Issue

The shop building of the Northeastern Pennsylvania Office Building currently utilizes twelve gas-fired heaters that are mounted above each truck entrance to warm the space. Three large ceiling-mounted fans are used to force the warm air down so that the heat does not raise and remain at the top of the building. This system for conditioning the space is not very energy efficient since energy is used to by the gas-fired heaters and also by the ceiling-mounted fans.

Since this project has a large site in a rural area, a geothermal system could be utilized to warm the shop building's concrete slab-on-grade while reducing the energy consumption. In addition to normal heating load requirements, the slab will be experiencing cold temperatures from the ice and snow dropped by trucks making deliveries to the shop building. The geothermal system will not only help melt this snow and ice throughout conduction, but it will also passively radiate heat in an upwards direction to warm the shop space. Although the gas-fired heaters and ceiling fans may still be needed for additional warmth, the energy consumption will be reduced. The reduction in energy consumed will save the owner money and help pay for the system installation.

Methodology

Research would first have to be performed to determine the amount of energy consumption that could be reduced by implementing this system in the shop building. Next, a cost analysis would need to be performed to determine the cost of the installation of this system. Also, the impact of installing a geothermal would have to be assessed with respect to the project schedule. Finally, with the initial costs, schedule impact, and monthly energy savings data available, the payback period can be found to help convey the benefits of implementing this sustainable system to the owner.

Expected Results

It is expected that this building system will be able to deliver enough warm in the colder months of the year to greatly reduce the amount of energy consumed by the gas-fried heaters and ceiling-mounted fans. Although the initial costs and schedule impacts may be high, the payback of a system such as this is anticipated to be beneficial. Also, since this building does not currently have any cooling in the warmer months, this system provides passive cooling if run during the warm months of the year.

Weight Matrix

Description	Research	Value Eng.	Const. Rev.	Sched. Red.	Total
Analysis 1		10%	10%	10%	*40%*
Analysis 2				10%	*10%*
Analysis 3		10%	20%	10%	*30%*
Analysis 4	10%	10%			*20%*
Total	*10%*	*30%*	*30%*	*30%*	**100%**

Conclusion

This proposal is intended to analyze critical industry research, value engineering, constructability reviews, and schedule reduction and/or acceleration pertaining to four separate areas of analyses with regards to the Northeastern Pennsylvania Office Building. These four areas of analysis include removing the pre-engineered metal building, using a design-build delivery system for later building phases, comparing horizontal expansion and vertical expansion of the office building, and installing a geothermal system to warm the concrete slab in the shop building.

Appendix A: Breadth Studies

Structural (Removing the Pre-Engineered Metal Building)

A structural analysis will need to be performed for both the office and shop buildings if the pre-engineered metal buildings are replaced. This will be inclusive of a single-story structure and its foundation system. The alternate system is most likely to either be a steel structure, tilt-up precast concrete panels, or cast-in-place concrete.

Architectural (Removing the Pre-Engineered Metal Building)

Based on the alternate system chosen to replace the PEMB, an architectural analysis may be suitable. The two concrete systems must have a new architectural system analyzed because the currently proposed Galvalume siding is not commonly attached to a concrete structure. If a standard steel structure is chosen, however, Galvalume siding can still be installed if it is preferred by the owner.

Structural (Horizontal Expansion vs. Vertical Expansion)

Based on which system is chosen during the 'Removing the Pre-Engineered Metal Building' analysis, a detailed structural analysis for possibly a one-story and a two-story building with the alternate structural system. The alternate system is most likely to either be a steel structure, tilt-up precast concrete panels, or cast-in-place concrete.

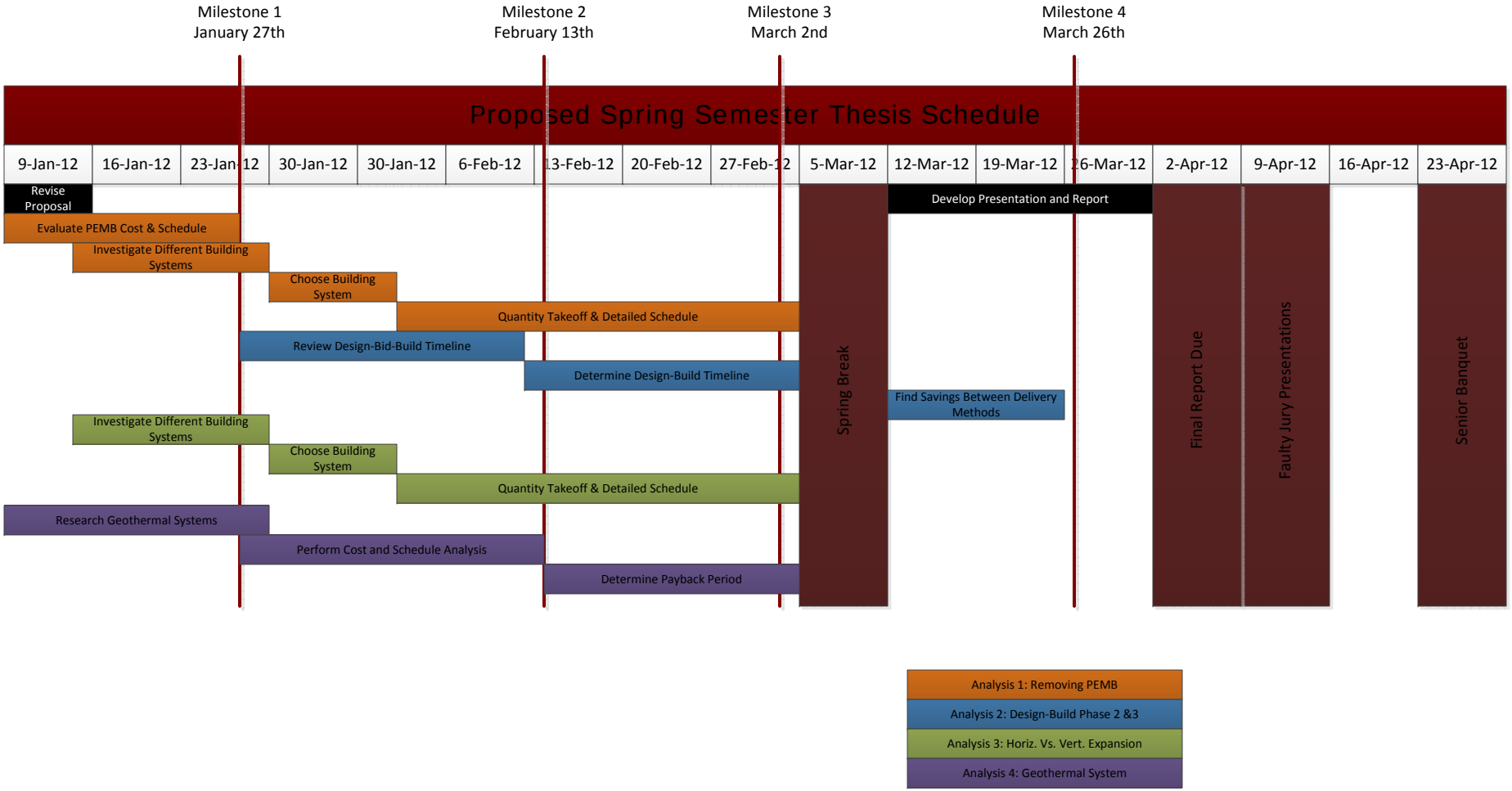
Mechanical (Horizontal Expansion vs. Vertical Expansion)

If a vertical expansion is analyzed, the building systems will incur greater loads from the larger volume of occupants. The electrical, plumbing, and HVAC systems would all be affected by a vertical expansion and would need to be redesigned.

Mechanical (Geothermal System)

The size and type of geothermal system could be determined based on the building loads. Also, since the energy consumption of the current system would be reduced, an analysis could be performed to analyze the load still required by this system and determine how much the system could be reduced in terms of number of heating and distribution components.

Appendix B: Proposed Thesis Semester Schedule


Milestone 1
January 27th
Milestone 2
February 13th
Milestone 3
March 2nd
Milestone 4
March 26th
Proposed Spring Semester Thesis Schedule
9-Jan-12
16-Jan-12
23-Jan-12
30-Jan-12
30-Jan-12
6-Feb-12
13-Feb-12
20-Feb-12
27-Feb-12
5-Mar-12
12-Mar-12
19-Mar-12
26-Mar-12
2-Apr-12
9-Apr-12
16-Apr-12
23-Apr-12
Revise Proposal
Develop Presentation and Report
Evaluate PEMB Cost & Schedule
Investigate Different Building Systems
Choose Building System
Quantity Takeoff & Detailed Schedule
Review Design-Bid-Build Timeline
Determine Design-Build Timeline
Spring Break
Find Savings Between Delivery Methods
Final Report Due
Faulty Jury Presentations
Senior Banquet
Investigate Different Building Systems
Choose Building System
Quantity Takeoff & Detailed Schedule
Research Geothermal Systems
Perform Cost and Schedule Analysis
Determine Payback Period
Analysis 1: Removing PEMB
Analysis 2: Design-Build Phase 2 &3
Analysis 3: Horiz. Vs. Vert. Expansion
Analysis 4: Geothermal System