January 11th, 2011

Final Proposal

Unionville High School
Additions and Renovations

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Executive Summary

This **Final Proposal** has been compiled to outline and describe areas of research to be studied for this Thesis regarding the Unionville High School Building Additions and Renovations. The goal of each analysis area is to improve the project and the process used during construction.

Analysis 1: Façade Redesign

With a tight schedule on this educational project, time is of the essence. The originally designed stick-built façade presented the opportunity for schedule acceleration. A precast façade panel system will be designed with the goal of reducing the façade's installation timeframe and ultimately reducing the schedule. Also included in analysis 1 is Breadth 1, which will focus on the analysis and redesign (if necessary) of the structural system to support these precast panels.

Analysis 2: BIM Implementation – 4D Phase Planning

With no BIM use on this project at all there is room for coordination improvement. BIM implementation is a critical industry issue and provides a valuable area of research for this project. 4D Phase Planning will be researched and applied to the project based on individual phases, resulting in planning models and safety plans for each individual phase.

Analysis 3: Sustainability – Renewable Energy Implementation

Although a basic LEED analysis was performed during the design of the UHS project, no renewable energy was incorporated into the project. Renewable energy options will be researched and a renewable energy system will be applied to the project. Breadth 2 focueses on the energy savings based on the selected renewable energy system (Solar or Wind) and any resulting changes to the structural and/or mechanical system.

Analysis 4: Delivery Method Study

With a Single Prime delivery method system, the UHS project is unique as most Pennsylvania schools require a multiple prime approach. The difference between the two systems will be studied and a determination of the superior method for this project will be highlighted.

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Project Background

Overview

Located at 750 Unionville Road in Kennett Square Pennsylvania, the Unionville High School Additions and Renovations project consists of new construction as well as the demolition and renovation of existing spaces. With a total size of 319,000 square feet and 3 stories, the new building is set to house not only Unionville High School but also the Unionville-Chadds Ford School District Administrative Office (Figure 1). Unionville-Chadds Ford School District, MM Architects, Inc., and Wohlsen Construction have teamed up to complete this large educational project.

Figure 1: Unionville High School

As is true with many education projects, especially renovations, there are many challenges throughout the project. The primary issue during the project is limiting the contractors' interference with the students and faculty that populate the building. Many spaces throughout the building must remain in use as adjacent spaces are built or renovated. To achieve as little interference as possible, an elaborate phasing system has been developed. With four main phases and sixteen sub-phases throughout the project, the project team aims to complete the project as smoothly as possible while creating as little of a disturbance as possible to the building occupants.

Many new spaces are planned as a result of this large public education project. Wrestling, physical education, and fitness and weight room space are set to replace half of the existing gymnasium as a new gymnasium is constructed on the West side of the building. The existing auditorium is to be renovated into classroom space as a brand new 1,200 seat auditorium set to be built at the North end of the building, certain to become the new focal point of the building. Although no specific rating has been specified, the building team agreed to aim for LEED certification when all is said and done. The total construction cost of this Hard Bid Public Works project comes in at $52, 895,000 with a total project cost of around $71 Million.

The tables below outline the phases and subphases, as well as schedule dates for each phase.

Phase Descriptions

- **Phase 1**: Construction of the New 3 story addition, set to house the Unionville-Chadds Ford School District Administrative Offices, Classrooms, and Science labs.
- **Phase 2**: Construction of the New Auditorium, Art rooms, and Family and Consumer Classrooms.
- **Phase 2A**: Renovation of existing Large Group Instruction, Library, Faculty Restrooms, Cafeteria, and Kitchen.
- **Phase 2B & 2C**: Renovation of existing District Administrative Offices into High School Offices, Science Labs, and Classrooms.
- **Phase 2D**: Renovation of existing High School Offices, Music Area, and Faculty Dining.
- **Phase 2E**: Renovation of existing Science Labs and Classrooms.
- **Phase 2F**: Renovation of existing Classrooms
- **Phase 2G**: Renovation of the existing Computer Applications Labs and Classrooms.
- **Phase 2H, 2I, 2J**: Renovation of existing Classrooms.
- **Phase 3**: Renovation of existing Auditorium into Choral Room and Tech Ed Classrooms.
- **Phase 4:** Demolition of existing Classroom and Tech Ed Wing and Weight Room.
- **Phase 4A**: Renovation of existing Gymnasium, Locker and Team Rooms.
- **Phase 4B**: Demolition of existing Auxiliary gym.

Phase Timelines

Design	**June 16th 2008 – June 12th 2009**
Phase 1	**June 15th, 2009 – June 25th, 2010**
Phase 2	**June 9th 2010 – June 23rd 2011**
Phase 2A	**June 2nd 2010 – July 28th 2011**
Phase 2B & 2C	**June 30th 2010 – December 31st 2010**
Phase 2D	**January 6th 2011 – June 27th 2011**
Phase 2E	**January 3rd 2011 – January 21st 2011**
Phase 2F	**January 24th 2011 – February 11th 2011**
Phase 2G	**February 14th 2011 – March 4th 2011**
Phase 2H	**March 14th 2011 – April 1st 2011**
Phase 2I & 2J	**April 4th 2011 – June 3rd 2011**
Phase 3	**June 9th 2011 – December 30th 2011**
Phase 4	**July 7th 2011 – April 27th 2012**
Phase 4A	**May 24th 2011 – September 28th 2012**
Phase 4B	**April 30th 2012 – June 29th 2011**

Analysis 1: Façade Redesign – Precast Panel Façade System

Problem

Based on the initial design, the façade for the new additions to the Unionville High School building is to be a stick-built rock faced CMU and brick façade system. With each piece of this system to be installed separately by workers on site, the original system takes a significant amount of time to erect and adds congestion to the project site. A stick built system such as this can lead to unnecessary site congestion, unsafe working conditions, and decreased productivity.

Research Goal

Research will be conducted to determine the feasibility of replacing the existing façade system with a precast façade panel system. Furthermore, a cost and schedule analysis will be performed to determine the benefits and negatives associated with making this switch. Any changes to the structural system will be studied and necessary additions will be designed. Mechanical loads will also be studied to determine the differences between the originally designed system and the newly prefabricated façade panels.

Research Methods

- **Study current rock face CMU and Brick façade assembly**
  - **Determine exact construction methods**
  - **Determine structural properties**
  - **Determine thermal/mechanical properties**
  - **Analyze architectural properties**
- **Determine duration and cost of existing façade system**
- **Study potential precast panel façade systems**
  - **Utilize past studies on implementation of precast panels**
  - **Locate precast panel manufacturers**
- **Determine which precast panel façade system to use**
  - **Select system based on price, lead time, usage on similar projects**
- **Analyze resultant effects on existing structural system**
- **Design any necessary additional structural connections**
- **Analyze effects on mechanical properties of the façade system**
  - **Aim to improve thermal/mechanical properties with implementation of precast façade panels**
- **Study feasibility of precast system**
  - **Cost, Schedule, Constructability, and Quality to the Owner**

Resources

- **PSU AE Faculty and peers**
- **UHS Project Team**
- **MM Architects (project Architect)**
- **Industry professionals (with precast façade experience)**
- **Precast façade panel manufacturers**
- **Structural system analysis software**
- **Relevant studies, publications, and documents**

Outcomes

Ultimately, a precast panel façade system will help to shorten the overall project duration without diminishing the quality of the project. The cost for the new system is likely to be comparable to the existing system, and any cost increases will be outweighed by the savings to the schedule. With three new additions, each with similar façade systems, the project has significant possibility for schedule reduction via a change from a stick build façade to precast façade panels.s

Analysis 2: Safety and Phase Planning – 4D Phase Planning

Problem

As a project containing both new additions as well as renovations, safety of building inhabitants as well as contractors at UHS is an added constraint. No BIM was used on the project as originally designed, and no site safety plan or phasing safety plan was created for the faculty and students within the existing UHS building.

Research Goal

The PSU BIM Execution plan will be utilized to determine the feasibility of incorporating BIM on the project. 4D Modeling and Phase planning specifically will be explored and if possible, implemented on the project. From this, a 4D Phasing Plan and Safety plan will be explored in hopes of providing value to the owner and the inhabitants within the building.

Critical Industry Issue

Much of the discussion at the 2011 PACE Roundtable centered on BIM implementation. As a project without BIM implementation, studying the applications available to the project provide a unique analysis opportunity.

Research Methods

- **Study current structure of construction phases**
- **Conduct research on similar projects**
  - **Study similarly phased educational projects**
  - **Determine possible accidents caused to staff and students by unsafe working conditions**
- **Determine hazardous areas for each phase**
  - **Carefully study each phase to pinpoint hazardous areas as well as safe routes to avoid such areas**
- **Develop safety plan/diagram for each phase**
- **Develop 4D Model for all phases**
- **Create individual model for each phase**
  - **A basic model will show each phase, where construction is occurring, and hazardous areas related to that phase**
- **Study feasibility of Safety Plan**
  - **Cost, Learning Curve, and Safety**

Resources

- **PSU AE Faculty and peers**
- **PSU BIM Execution Guide**
- **Industry Members (with relevant BIM experience)**
- **UHS Project Team**
- **Similar Projects**
- **Relevant studies, publications, and documents**

Outcomes

A 4D model for each phase within the entire project will be developed. From this model, a detailed 4D Phasing Plan and Safety plan and diagram will be created. The model and safety plan will help to provide building inhabitants with information regarding areas of the project that are currently under construction. Each phase will have a unique plan, available to both building inhabitants and contractors.

Analysis 3: Sustainability and LEED Study – Renewable Energy

Problem

Although a preliminary sustainability study was performed for UHS and a LEED scorecard was filled out, no on-site renewable energy was designed for this project. The addition of on-site renewable energy for the project will not only reduce the buildings energy usage, but may also vault the UHS project into the LEED Silver range.

Research Goal

The addition and initial design of an on-site renewable energy system on the UHS project will be researched. Solar and Wind systems will be studies, compared, and contrasted. Each system will be analyzed to determine which of the two is more efficient and better suited for application to the UHS project. Cost and constructability will be studied to determine the practicality of adding a system to the project and what savings, if possible, are available to the owner via the integration into the existing power system and reduction of mechanical loads.

Research Methods

- **Research Solar and Wind Energy systems for similar building types**
- **Check for case studies involving similar solar and wind energy applications**
  - **Research similar projects that have implemented this technology**
- **Reach out to renewable energy suppliers to determine feasibility of this application**
- **Determine which system to use and design for proposed system**
- **Determine how this system will integrate into existing electrical system**
- **Determine any changes to the mechanical system**
- **Study any potential changes to structural system**
- **Redesign structural system if necessary**
- **Study feasibility of renewable energy system**
  - **Payback period, Schedule impact, and constructability**

Resources

- **PSU AE Faculty and peers**
- **UHS Project Team**
- **Industry professionals**
- **Renewable energy manufacturers/suppliers**
- **Schools/buildings with similar applications**
- **Relevant studies, publications and documents**

Outcomes

After thorough research on the practicality of integrating the new system, the successful addition of a renewable energy system to the project will provide cost savings and help to build UHS' image through their effort to provide a more sustainable building. While initial setup costs are likely to be high, overall lifecycle costs should provide incentive to incorporate a wind energy system. Depending on the size and production of the system, the project may qualify for a LEED Silver rating as opposed to the currently predicted LEED Certification.

Analysis 4: Delivery Method Study

Problem

Due to legislation in the state of Pennsylvania, most public education projects are delivered using a Multiple Prime contract setup. On this project, Unionville Chadds Ford School District elected to manage the project with an alternate system and use a Single Prime delivery method.

Research Goal

The two delivery methods, Single Prime and Multiple prime, will be studied. Research will be done to determine how UCFSD was able to bypass the Separation of Bidders Act and use a single prime with Wohlsen construction. The reasoning behind using this delivery method will also be studied. The pros and cons of the two systems will be studied, and the ultimate reason for using a single prime approach will be outlined.

Research Methodology

Research Methods

- **Research reason for using Single Prime**
  - **Interview the project team and the owner to understand the reason for using an alternative delivery method.**
- **Study current delivery method**
  - **Research other projects using a Single Prime delivery method**
    - **Projects with similar scopes as well as alternate scopes**
- **Research Multiple Prime delivery method**
  - **Study projects of similar scopes that were delivered using Multiple Primes**
  - **Speak with project teams who have worked on projects using Multiple Primes**
- **Compare/Contrast both methods**
  - **Determine positives and negatives of each system for this application**
- **Determine best system for this project**
  - **Select delivery method that provides the most quality to the owner and also allows for the most efficient completion of this project**
- **Study the outcomes of using a Multiple Prime delivery method**
  - **Cost, Schedule, and Quality to the Owner**

Resources

- **PSU AE Faculty and peers**
- **UHS Project Team**
- **MM Architects (project Architect)**
- **Industry professionals**
- **Projects with similar delivery system(s)**
- **Relevant studies, journals, publications, and documents**

Outcomes

The driving force behind the Single Prime delivery method will be highlighted. Positives and negatives from each system will be outlined and compared, showing the differences between the two delivery systems. A study will be performed to determine whether Single Prime was the most beneficial delivery method for this project. An argument for why the superior system should be the norm for projects of similar scope will be made.

Weight Matrix

This weight matrix is designed to plan out which areas of study will receive which level of attention. Based on this initial matrix, research and constructability review are of the most importance. Depending on where research leads, this matrix is fluid and can change if necessary.

Description	Research	Value Eng.	Const. Rev.	Sched. Red.	Total
Analysis 1: Façade Redesign	10	5	10	10	35
Analysis 2: BIM Implementation	5	5	10	-	20
Analysis 3: Renewable Energy	10	5	5	-	20
Analysis 4: Delivery Method Study	10	-	5	10	25
Total	35	15	30	20	100

Conclusions

Research will be conducted to obtain more information on these specified analysis areas. Ultimately, constructability, efficiency, and improving sustainability are the main goals of this research. As the construction industry moves forward, improving processes is what provides a competitive advantage. The precast panels will cut down on schedule time and could clear working space on the project. Implementing BIM will bring value to both the contractor (Phase Planning) as well as the Owner (Phase Planning and Safety Plan). Applying renewable energy to the project will help to improve the buildings sustainability while also reducing energy use. A study of the delivery method will shed light on why a single prime delivery system was used.

Note: This Thesis Proposal is a fluid document and is open to interpretation and change throughout the research process.

APPENDIX A: Breadth Topics

Breadth Topics

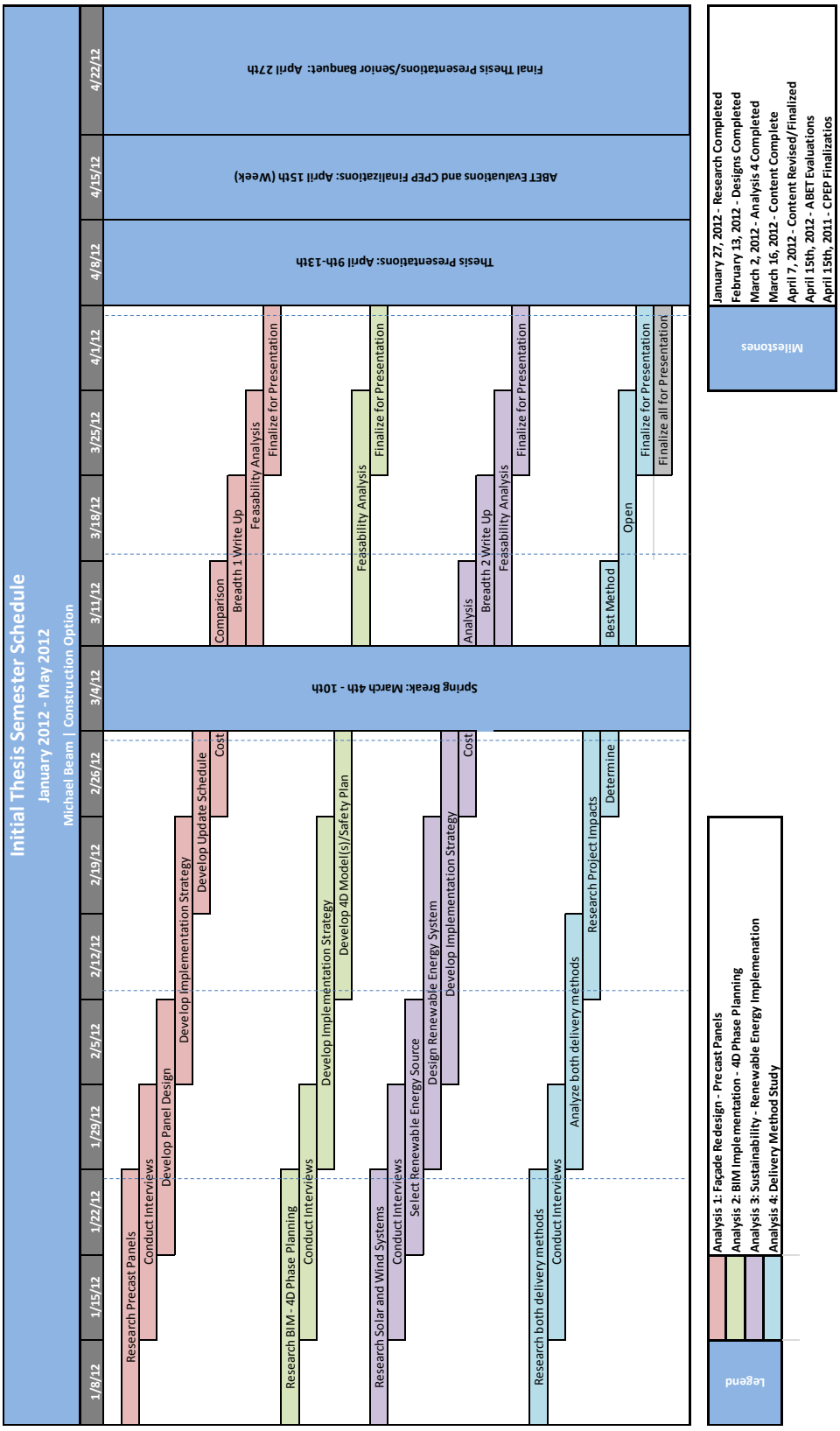
Breadth 1: Façade Redesign - Structural

Breadth 1 will focus on the existing structural system. As a result of an alternate façade design, the structural system must be analyzed. Initially, the façade was designed as a stick-built system consisting of rock face CMU blocks and bricks. Based on Analysis 1, the façade will be redesigned with a design using precast façade panels. The structural system will be analyzed to determine if any changes must be made to the system as a whole, and ultimately, the connection by which the precast panels will be incorporated into the system will be designed. Based on changes to the façade system and structural system, project schedule and cost impacts will be calculated.

Breadth 2: Façade Redesign - Mechanical

Breadth 2 again focuses on the new façade design. The addition of precast panels rather than a stick build façade system allows for the improvement of the building envelope's thermal/mechanical properties. During design of the precast façade panel system, the aim will not only be to save time and potentially money but also to improve the thermal and mechanical properties of the system. By hand selecting materials and potentially altering the surface area and material of glazing used, thermal properties can be enhanced. Based on alterations to the new system, the thermal properties will be compared to that of the originally designed system. Based on these changes, load reduction and the potential resizing of the mechanical system will be calculated. Finally, any cost and schedule impacts based the changes to the mechanical system will be calculated.

APPENDIX B: Research Schedule


Initial Thesis Semester Schedule
January 2012 - May 2012
Michael Beam | Construction Option
1/8/12
1/15/12
1/22/12
1/29/12
2/5/12
2/12/12
2/19/12
2/26/12
3/4/12
3/11/12
3/18/12
3/25/12
4/1/12
4/8/12
4/15/12
4/22/12
Research Precast Panels
Conduct Interviews
Develop Panel Design
Develop Implementation Strategy
Develop Update Schedule
Cost
Research BIM - 4D Phase Planning
Conduct Interviews
Develop Implementation Strategy
Develop 4D Model(s)/Safety Plan
Research Solar and Wind Systems
Conduct Interviews
Select Renewable Energy Source
Design Renewable Energy System
Develop Implementation Strategy
Cost
Research both delivery methods
Conduct Interviews
Analyze both delivery methods
Research Project Impacts
Determine
Spring Break: March 4th - 10th
Comparison
Breadth 1 Write Up
Feasability Analysis
Finalize for Presentation
Feasability Analysis
Finalize for Presentation
Analysis
Breadth 2 Write Up
Feasability Analysis
Finalize for Presentation
Best Method
Open
Finalize for Presentation
Finalize all for Presentation
Thesis Presentations: April 9th-13th
ABET Evaluations and CPEP Finalizations: April 15th (Week)
Final Thesis Presentations/Senior Banquet: April 27th
Legend
Analysis 1: Façade Redesign - Precast Panels
Analysis 2: BIM Implementation - 4D Phase Planning
Analysis 3: Sustainability - Renewable Energy Implemenation
Analysis 4: Delivery Method Study
Milestones
January 27, 2012 - Research Completed
February 13, 2012 - Designs Completed
March 2, 2012 - Analysis 4 Completed
March 16, 2012 - Content Complete
April 7, 2012 - Content Revised/Finalized
April 15th, 2012 - ABET Evaluations
April 15th, 2011 - CPEP Finalizatios