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Final Proposal

Penn State AE Senior Thesis

New Indian Valley High School

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Executive Summary

Senior Thesis Final Proposal reviews the four analyses that are contained within the final thesis report. Each analysis centers on a specific construction industry scenario unique to the research building, the New Indian Valley High School. This thesis analysis specifically looks at improving efficiency and critical issues within the construction industry by further exploring areas such as: Sustainability, Value Engineering, Critical Industry Issues and Schedule Acceleration. Proposed analyses are geared to encompass multiple areas so that thorough research may be attained.

Analysis #1: Feasibility and Design Study of Sustainable Energy

The New Indian Valley High School project will not achieve a LEED Certification upon completion. However, few sustainable techniques were used to attempt to achieve LEED certification. The goal of this analysis will be to produce a feasibility study that illustrates how the integration of systems such as photovoltaic panels and windmills into the current buildings energy system will provide the owner with sufficient gains in the future. Additionally, an electrical breadth study to investigate potential system tie-in requirements for the sustainable systems will be conducted.

Analysis #2: Elimination of Geothermal Mechanical System

Unforeseen project delays arose during well drilling for the geothermal mechanical system. Due to the scope of excavation and site work to be performed on the project that lies on the critical path, eliminating extra drilling that has caused delays may be an area to investigate. The goal of this analysis is to replace the geothermal mechanical system for a more traditional system that would be used on a similar sized project. Alternative time and costs scenarios investigated with future investment and cost of delays will better illustrate the true value of the geothermal mechanical system. This will also serve as a basis for a mechanical breadth that will compare the size and placement of all requirements of a more traditional mechanical system and how it compares to the elements of a geothermal system.

Analysis #3: Short Interval Production Schedule Development

Many areas of two phases of the construction are similar and repetitive. This provides a unique opportunity to implement Short Interval Production Scheduling (SIPS) on a smaller scale. The goal of this analysis will show how the SIPS will provide ways to raise work efficiency and quality due to repetitive nature of the work.

Analysis #4: Building Orientation/Re-Design Excavation Effects

Site properties open a door for potential building re-orientation/footprint redesign due to the amount of excavation work. The ridge line north of the current high school serves as the new location of the new high school. This ridge line consists of a moderate slope which requires extensive excavation, grading, earth reinforcement and the placement of retaining walls to prepare the site for use. The goal of this analysis will be to re-orient the building on the site to see if a potential savings in cost could be attained without sacrificing owner expectations.

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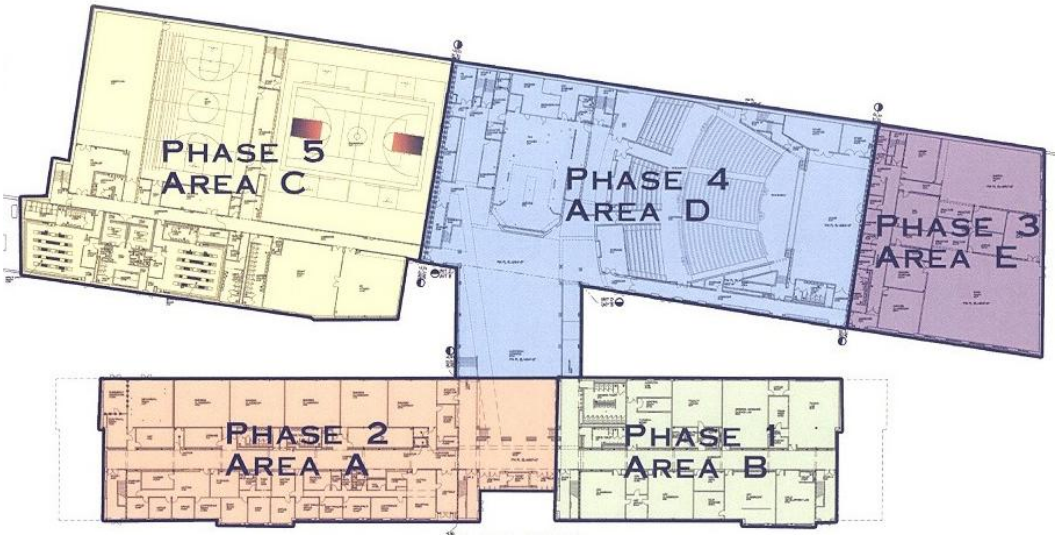
Project Overview

Indian Valley High School (IVHS) is one of two public high schools in Mifflin County, Pennsylvania, within the Mifflin County School District. The decision to build a new high school has been in deep thought of the minds of school board members since 1999, when the first feasibility studies were conducted for schools within the district. Mifflin County is a rural/Amish county consisting of roughly 45,000 people. The decision to build a high school is a major decision for the small community making cost, quality and longevity driving factors.

The new high school will be situated on the hill just north of the current high school, on property already under the ownership of the Mifflin County School District. Indian Valley High School will be transformed into a 250,000 square foot upgrade providing new facilities and opportunities for the youth of the rural area. The new building will serve as the new home of the Indian Valley Warriors who have inhabited the old Chief Logan Senior High School building since the warriors origination/consolidation of Chief Logan and Kishacoquillas High Schools in 1988. The present Indian Valley High School building is roughly 60 years old, small and provides little opportunity for future renovation/expansion efforts.

Excavation efforts critically drive early phases of the construction process. The site is located on a ridge north of the current school. Shown in the figure, extensive excavation and site work need to be completed before building construction can begin. Site work for this project also includes the drilling of wells for the geothermal mechanical system. The location of the site also calls for a long retaining wall along the north edge or rear of the site. The construction team chose a soil nail retaining wall design that was then fitted with an architectural face. This wall design was influential because the construction on the building could begin while the wall was being installed only a short distance away.

Building Construction was sequenced into five building phases. Phases A and B, which make up the educational classroom areas, and Phases C, D and E, which hold the gymnasium, cafeteria, library and music suite areas. The building consists of structural steel members and load bearing masonry walls for support. Surrounding the CMU exterior walls is a face brick masonry façade with aluminum glazing. The progression of construction is Phase B, A, E, D and finishes with C moving south to north across the site.



Construction on the New Indian Valley High School is set to be complete in December 2010. The January 2011 move-in during the middle of the academic year has been a calculated impact that the school district is familiar with. Previously, upon move-in of a recently completed elementary school, occupants moved into the new school in Janurary after a previously established lengthy school break. This then allows a more flexible delievery schedule that proved to be useful.

Analysis #1: Feasibility and Design Study of Sustainable Energy

Problem Identification

The New Indian Valley High School project will not achieve a LEED Certification upon completion. Cost factors denied the small community exploration into sustainable features. There are sustainable techniques not used that could potentially be proven beneficial to the owner for years to come. Features such as photovoltaic (PV) panels and wind mill energy technologies are potential ideas that provide unique opportunities based on the geometry of the site. Longevity, future expansion and renovation concerns prove the necessity for consideration into sustainable concepts.

Research Goal

The goal of the sustainable analysis is to perform preliminary design of photovoltaic panel and windmill energy systems. The analysis will determine financial feasibility of each system including the incorporation into the existing power plan and the possible return on invest to the owner.

Methodology

- Research sustainable PV and windmill technologies
- Determine quantities of each/energy to be produced
- Analyze how the sustainable systems will connect to current system
- Perform life-cycle analysis on cost/rate of return of investment for the owner

Resources and Tools to be used

- Industry Professionals
- AE Faculty – Electrical, Sustainable design techniques
- Cost Evaluation/Estimation Data
- PACE Round Table Discussions

Expected Outcome

Research is expected to provide data that shows that the use of integrated energy systems will provide a financial benefit to IVHS, however, will not be able to fully replace the use of the public power grid system. A financial model derived from research data will prove the affordability and feasibility of the implementation of such systems.

Analysis #2: Elimination of Geothermal Mechanical System

Problem Identification

Drilling of the geothermal wells proved to be a major challenge facing the construction team onsite. The geothermal mechanical system of the school relies on these wells that must be drilled during the completion of site work, before building construction can begin. Unforeseen conditions led to delays in well drilling, which affected the entire project.

Research Goal

The goal of this analysis is to perform a preliminary design of a traditional mechanical system used in similarly sized high schools to determine the impacts on schedule and costs associated with the geothermal system and delays.

Methodology

- Research current geothermal mechanical system and equivalent alternatives
- Estimate costs for each system including return on investment
- Determine schedule impacts based on system implementation
- Analyze schedule and costs scenarios for each system

Resources and Tools to be used

- Industry Professionals
- AE Faculty – Mechanical
- Cost Estimation Data
- Applicable Literature

Expected Outcome

Thorough research into the future benefits of geothermal mechanical systems may reveal that the investment made into the system may not have been fully worth the price due construction delays and rate of return. The implementation of a traditional system would avoid the issue of unforeseen drilling conditions and project delays, requires less excavation and costs less. The only benefit would be proving the rate of return is greater than all financial factors associated with alternative construction of the system.

Analysis #3: Short Interval Production Schedule Development

Problem Identification

Phase A and B of the New Indian Valley High School project house the majority of all classrooms in the building. The phases come together to form the front wing of the building creating a long corridor that stacks three times on itself. Minor variances between floors in this area of the building presents the same repetitive work on each floor.

Research Goal

The goal of this analysis is to prove that the repetitive nature of the work involved in phases A and B, provides an ideal opportunity for the implementation of a Short Interval Production Schedule (SIPS). This process is used when the same processes are repeated; to streamline and make work more efficient.

Methodology

- Analyze phases scheduling for further SIPS implementation
- Identify milestones in proposed phases
- Identify all trades involved in SIPS
- Establish project specific sequence of work for typical unit
- Establish Standardized work durations
- Develop the Short Interval Production Schedule
- Compare the SIPS with existing project schedule
- Evaluate cost implications

Resources and Tools to be used

- Industry Professionals
- Critical Path Project Schedule
- Cost Estimation Data
- AE Faculty – Construction Management
- AE 473: Building Construction Management & Control

Expected Outcome

A Short Interval Production Schedule will result in schedule acceleration scenarios not previously explored. Work progression through phases A and B is extremely repetitive, which if efficiently scheduled will produce a much more cost effective workforce. More predictable work allows for faster and easier communication/coordination between trades which will maintain the highest quality and the fastest pace.

Analysis #4: Building Orientation/Re-Design Excavation Effects

Problem Identification

Site properties open a door for potential building reorientation/footprint redesign due to the amount of excavation work. The ridge line north of the current high school serves as the new location of the new high school. This ridge line consists of a moderate slope which requires extensive excavation, grading, earth reinforcement and the placement of retaining walls to prepare the site for use. Investigating potential changes in building orientation or footprint size on site could dramatically affect the excavation and lead to different possible scenarios for achieving the equivalent structure size and expectations by altering the original set up.

Research Goal

The goal of this analysis is to perform initial building design feasibility scenarios similar to those of the design team, and determine if re-orientation/development of the building due to extensive excavation is a viable alternative to reducing construction costs.

Methodology

- Produce feasibility information
- Develop new excavation strategies
- Develop new building footprint equivalents
- Produce estimations of proposed changes
- Analyze costs effects compared to original costs

Resources and Tools to be used

- Industry Professionals
- AE Faculty – Architecture (Prof Holland), Construction Management
- Arch 444 (Studio)
- Previously conducted feasibility studies
- Owner Requirements
- Cost Estimation Data

Expected Outcome

Extensive research into feasibility studies and site dynamics will allow for alternative design ideas. A reduction in excavation will ultimately achieve a lesser construction cost, however, determining whether it is possible to do so while adhering to owner requirements still needs to be proven. Extensive excavation leads to the suggestion of site re-orientation.

Analysis Weight Matrix

The weight matrix below illustrates how each of the four core areas of investigation will be divided by percentages for the upcoming semester.

Analysis Description	Research	Value Engineering	Constructability Review	Schedule Reduction	Total
Sustainable Energy	10%	10%	-	-	20%
Mechanical System	-	10%	10%	10%	30%
Short Interval Production Schedule (SIPS)	10%	-	10%	10%	30%
Building Re-Orientation/Design	-	10%	10%	-	20%
Total	20%	30%	30%	20%	100%

Conclusions

Extensive research into the investigation of the proposed thesis analyses will supply a comprehensive review of techniques to improve efficiency in the construction industry. It is expected that the integration of a sustainable energy source will provide the owner with lower energy costs and add sustainable features to add value to the future of the school. Though problematic at times the geothermal mechanical system will be beneficial for years to come. It is expected that the return of investment will be achieved throughout the life of the school, just at a later date due extra unforeseen costs during the installation. Repetition in the classroom areas allows for the experimental use of SIPS on a smaller scale project. Utilizing SIPS will allow classrooms to be completed much faster and more efficiently due to the repetition of similar tasks. Finally building re-orientation design would certainly result in less excavation, resulting in a lower cost to the current construction. Implementing this strategy must be done very carefully to assure that owner expectations would still be met.

This proposal is intended to be a working submission with revisions expected based on feedback from the thesis consults.

Appendix A: Breadth Topics

Breadth Topics

The following topics attempt to include a more thorough investigation into the different disciplines within the Architectural Engineering program at Penn State. Topics below relate to previously introduced analyses in the proposal.

Renewable Energy/Electrical Breadth: Discussed in Technical Analysis #1

The power distribution designed for the New Indian Valley High School is a 480Y/277, 3-phase system supplied from the public power grid. Requirements needed to integrate current energy and sustainable energy systems will be explored to provide the direct energy savings to the owner.

Mechanical Breadth: Discussed in Technical Analysis #2

The current mechanical system is a geothermal mechanical system that proved to be problematic during construction. The substitution of a more traditional mechanical system would eliminate the unforeseen well drilling issues and delays. Exploration into impacts of mechanical systems load and housing of potential additional equipment must be considered to determine if true sustainable value can be found in the geothermal mechanical system.