Thesis Proposal

Twin Rivers Elementary & Intermediate School

McKeesport, PA

This proposal outlines the construction analyses and related breadth that will be studied during the Spring 2014 semester on the Twin Rivers Elementary & Intermediate School.

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Executive Summary

The purpose of Thesis Proposal is to identify and overview four research analyses areas to be performed over the duration of spring 2014 on the construction of Twin River's School project. For each analysis topic, the problem and goal are stated. Possible research and analysis components are found. Expected study results are stated.

Analysis 1: BIM Implementation

As studied in Technical Report Two and Three, there were several key activities and change of design that caused increased costs and schedule delays. These problems could have been overcome with greater utilization of BIM to facilitate cooperation between different trades. BIM could be used as an alternative construction method through phase planning and information management. This is one of the leading industry trends as discussed at PACE Roundtable Conference. The implementation of BIM would also help to realize owner's goal to make this project a role model of high performance educational facility.

Analysis 2: LEED Implementation

One of the owner's goals for Twin River's School project is to build a district scientific educational facility as well as housing two schools. This project is aiming for a LEED Gold Certificate by completion. There are a lot of LEED features incorporated in the design. However, in current design some LEED features are only incorporated for showcase purpose. It is proposed to have the renewable energy design to produce energy for the project. Life cycle cost analysis will be conducted to compare the cost and benefits of both systems. Day-lighting system will also be studied for further improvement.

Analysis 3: Schedule Acceleration

The construction of Twin River's School is scheduled to be completed within 11 months. Due to this project is the construction of a public school, the substantial completion date was extremely important to the owner. The possibility of rearranging the activity sequences and overlapping activity would be studied for schedule acceleration purpose. Implementation of SIPS method would also be analyzed.

Analysis 4: Value Engineering

The owner, the project team and the designer have worked together on this project to implement value engineering. The areas of value engineering implementation include update material and equipment and update design. However, due to the limitation of planning time, some value engineering ideas is restraint to be update of material. The possibility of cost reduction from combining two 120V distribution systems into one 480V distribution system without changing EMT conduits to MC cables will be studied. The potential cost saving from re-design the roof with light-weight metal decking instead of doing multiple roof structural system makeover would also be considered.

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Project Background

The construction project of McKeesport Elementary/Intermediate School is a public school construction project on the site of demolished Cornell Elementary School at McKeesport, PA. The project has two stories above ground with a clearstory level.

The building structure is almost symmetric with the central core and two wings housing the elementary school and the intermediate school separately. The construction started in February 2013 and is planning to be completed by January 2014. Completion date is one of the owner's major concerns since the owner, McKeesport School District, would like to have the project completed and up for running starting the spring school semester in 2014.

Another key feature of this project is LEED implementation. The project is aiming for a USGBC LEED Gold Certificate by completion. There are a lot of LEED features incorporated in the design. Part of the exterior walls is curtain wall to improve day lighting. Grey water capture system will be installed to collect and recycle rainwater for use in toilets. Geothermal system will be utilized in addition to the hot water boilers to support the heating system. Two small-scale pole mounted wind turbines will be installed to the northeast corner of the building for educational usage.

Other than project schedule, cost is also one of the owner's major concerns. There have been several implementation of value engineering.

Analysis 1: BIM Implementation

Problem Identification

As stated in Technical Report Three, there was a lot of waste of time when the project team, the owner and the designer are trying to communicate and collaborate due the issue of the ownership of the model and information on Twin River's School Project. One of the biggest risks to project completion is that half way through construction, the project team received a request of change of design from Pennsylvania's Department of Environmental Protection due to the deficiency of design in sediment and erosion control which ended up with $156,275.00 addition of project value. There have been other changes of design on the project due to different reasons. Lead times of the material, redesign and the approval of submittal caused an approximate delay of total 4-5 weeks.

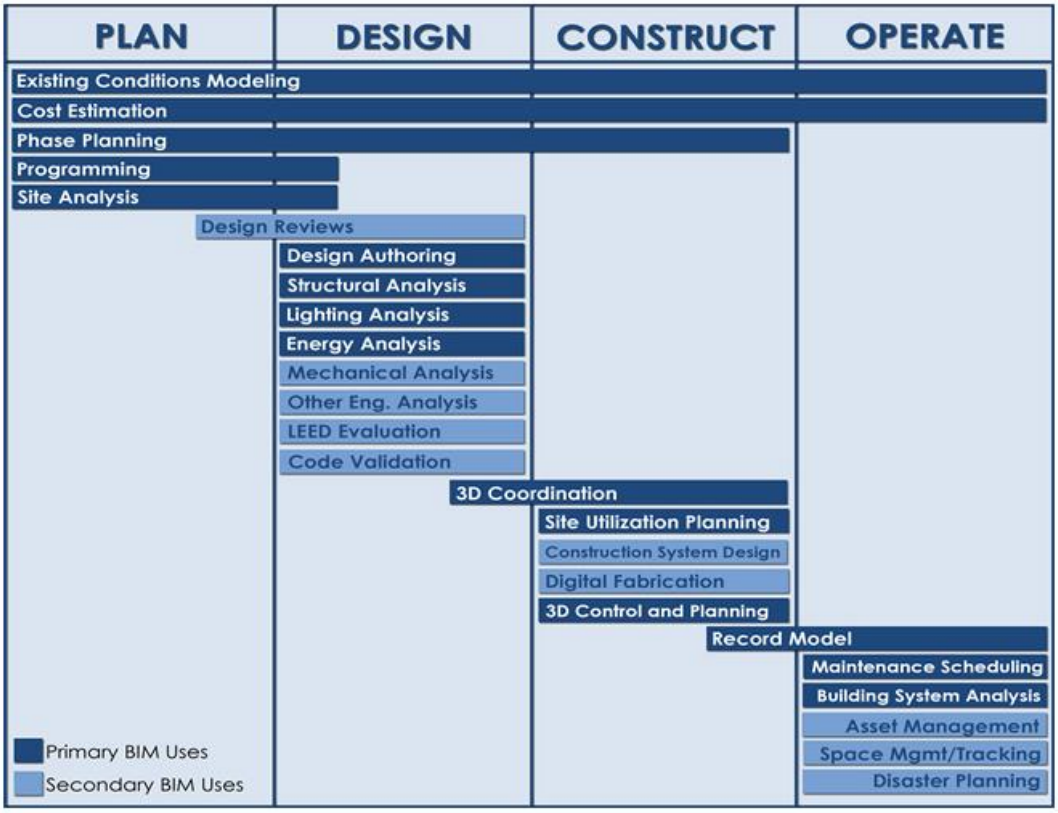
Background Research

A background research was conducted after this problem was identified. The primary reasons caused the design changes and delay is the lack of cooperation between different trades. Also, there was no plan regarding site work under extreme weather conditions. The application of BIM could have benefited the overall project cost and schedule. Different BIM uses including clash detection will be considered and compared in terms of potential benefits and ability to increase project value by reducing schedule and reduce unexpected add of project value. The Pennsylvania State University BIM Execution Planning Guide will be used to facilitate the analysis. The possible benefit of reduction of operation and maintenance cost after the project's completion date will also be studied.

Analysis Components

Case studies of public educational facility using BIM will be researched. The analysis of BIM implementation will focus on information management systems on the project to improve the collaboration between different trades and subcontractors. Schedule improvement from BIM compared to the original schedule will be examined. Possible ways to standardize the information management system, ownership and access to the central model, drawings, as-built drawings will be considered. The cost difference and other benefits of using synchronization of programs and tools for information

management will be studied. A project remediation plan should be prepared between different trades using BIM method as a reference for extreme site conditions.



Methodology

The following steps will be taken to successfully conduct this analysis:

- Collect information and documentation of current contractual agreements on the project
- Research two to three case studies demonstrating successful educational facility construction projects with BIM Implementation
- Interviews will be conducted with at least two members of the project team to specify potential risks and benefits of BIM approach. The interviews will be conducted concerning:
    - Have you personally had experience with BIM implementation towards the construction of education facility?
    - If yes, is that facility public or private?
    - Do you find the BIM implementation beneficial or risky?
    - What aspects of the BIM implementation do you find the most beneficial?
- Create a spreadsheet documenting advantages and disadvantages between conventional approach and BIM approach towards the construction project of educational facilities

- Study the two cases for possible cost savings in construction and in operation and maintenance after BIM implementation and use the result to study and analysis this project
- Develop a conclusion to specify if BIM implementation are recommended for this project

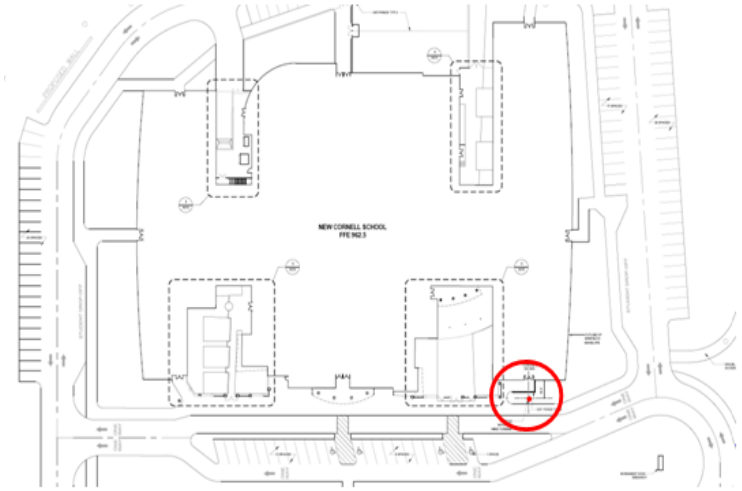
Expected Outcome

As discussed at the PACE Conference, possible solutions for information management are to develop mutual agreement on the ownership of the drawings and model to minimize the inconvenience. This study is expected to show a result of improvement of project schedule and reduction of project cost for activities due to lack of coordination. Differences between the traditional construction method and building information model construction method will be thoroughly studies in terms of site planning, information management, as-built drawings construction system design and operation and maintenance plan.

Analysis 2: LEED Implementation

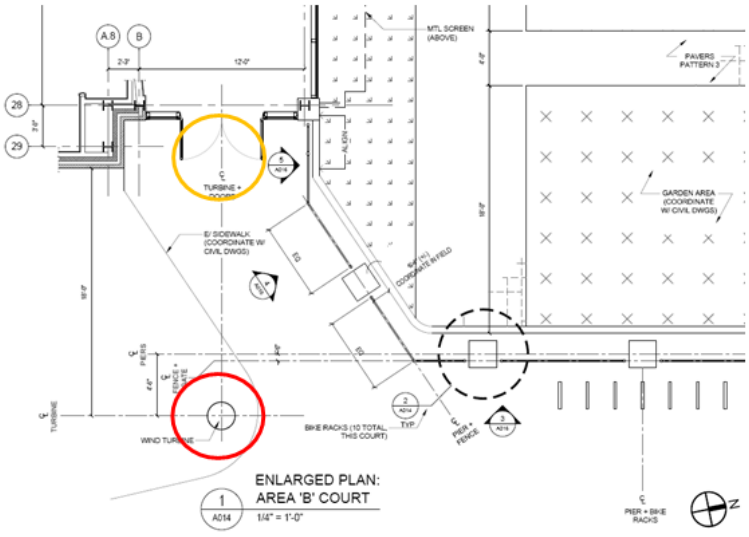
Problem Identification

One of the owner's goals for Twin River's School project is to build a district scientific educational facility as well as housing two schools. This project is aiming for a LEED Gold Certificate by completion. There are a lot of LEED features incorporated in the design. Part of the exterior walls is curtain wall to improve day lighting. Grey water capture system will be installed to collect and recycle rainwater for use in toilets. Geothermal system will be utilized in addition to the hot water boilers to support the heating system. Two small-scale pole mounted wind turbines will be installed to the northeast corner of the building for educational usage. However the wind turbines will only be used as showcase purpose. Since the pole-mounted wind turbines are already incorporated in the design, there is a possibility of produce energy out of it without too much additional cost.



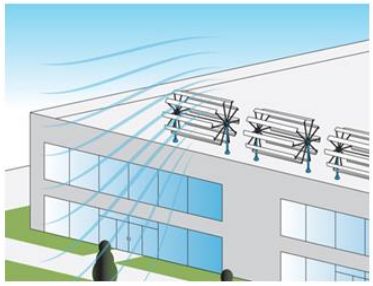
Background Research

The rooftop wind turbine units have relatively low initial and maintenance costs compared with pole-mounted units which are already incorporated in current design. They also have the advantage of easy installation for multiple units. The addition of rooftop wind turbine units should be able to greatly increase the amount of self-produced energy and reduce additional energy purchase; thus reducing building operation cost in the long run.



The current design of the building enclosure is curtain wall with metallic shading panels on partial of wall system to enhance day-lighting. A study of day-lighting improvement will be performed.

Analysis Components



The possibility of adding rooftop wind turbine units to increase the self-produced energy will be studied. An initial cost versus life cycle analysis will be performed to examine the chances of cost reduction in energy purchase for this project. Additional electrical distribution panel may be beneficial for the electricity produced in the showcase room to be distributed for building use. LEED implementation among northeastern public schools will be studied. The effectiveness of the current design compared to the design with intelligent dynamic day-lighting system will be analyzed. The ControLite® Intelligent Dynamic Day-lighting Systems is proposed to substitute the curtain wall with metallic panels.

Methodology

The following steps will be taken to successfully conduct this analysis:

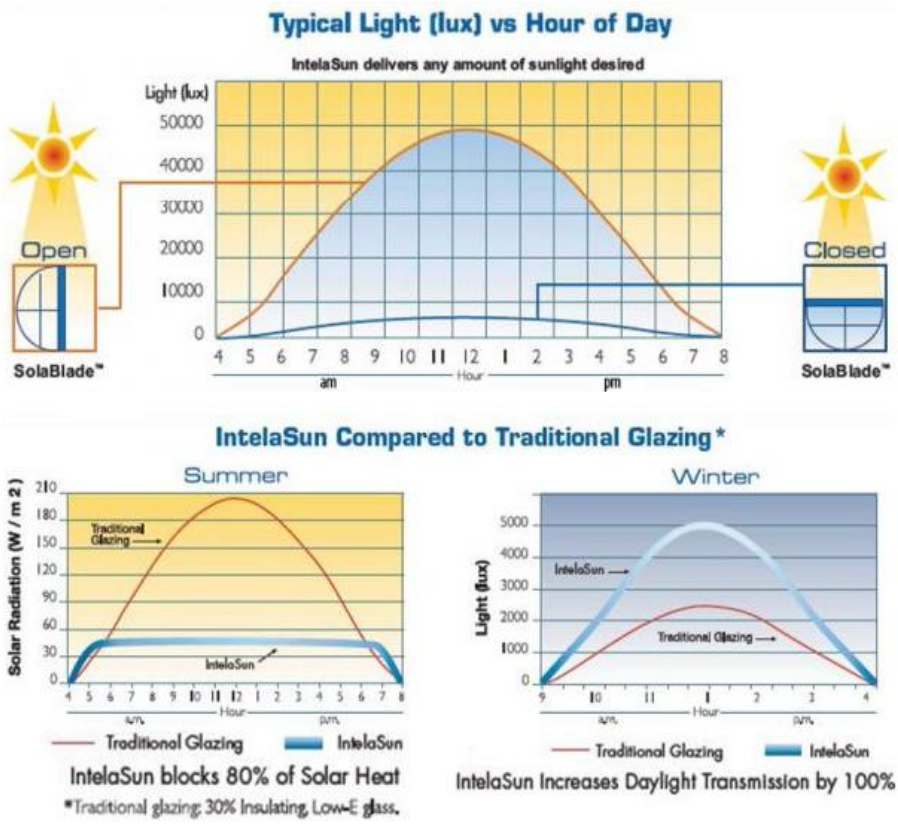
- Collect cost and electricity production information of current design of wind turbine
- Research two to three case of public school with LEED Sliver, Gold or Platinum Certificate
    - Develop a case study comparing the energy cost and other cost savings with or without the LEED system
- Create a spreadsheet documenting the potential initial cost savings and life cycle cost savings
- Research the possible equipment for the rooftop wind turbine units and the additional electrical distribution panel
- Interview at least one member of the construction team and one member of the electrical construction team regarding the advantages and disadvantages of re-design or re-routing of the distribution system
- Interview the member of the construction team regarding the constructability concerns of installing rooftop wind turbine units and updating the distribution system in terms of project schedule and constructability problem

- Study the life-cycle cost in comparison to the original design without updating the LEED components
- Recommend improvement of LEED components for this project

Expected Outcome

On-site renewable energy production is expected to help the project to gain additional LEED points in sustainability category. Public schools' part in advancing the changing over from conventional energy source to renewable energy will be studied. The purpose of the study is to seek potential life time cost saving and to establish a role model for sustainable educational facility.

The purpose of this study is to examine the possible increase of energy lost in winter or waste of cooling energy in summer from the design of curtain wall systems. The possible cost saving from energy usage versus the additional cost of the dynamic day-lighting system will be studied. This could also help with the owner's goal of creating a community science education center and enhance the LEED implementation on the project.



Analysis 3: Schedule Acceleration

Problem Identification

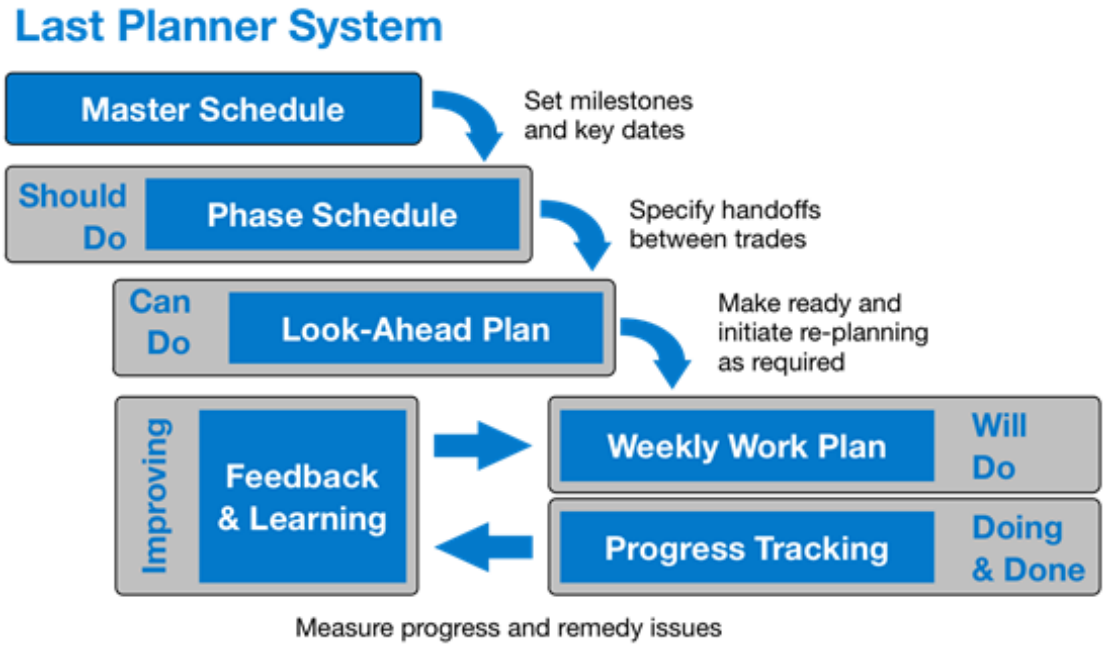
The construction of Twin River's School is scheduled to be completed within 11 months. Due to this project is the construction of a public school, the substantial completion date was extremely important to the owner, the McKeesport School District, so that the school can start on time. 11 months is a rather tight time frame for a high performance education facility.

Background Research

The symmetry of the building structure and similar design of the two wings create the opportunity for several schedule acceleration techniques. Since the two wings of the building are almost identical, it creates an opportunity for the project construction team to assign several crews to specific tasks, working from one zone to another to increase the efficiency and consequently speedup the schedule. The concept of SIPS schedule can be used to help with the schedule acceleration. Current project schedule has shown relatively long MEP fit-out time. The possibility of overlapping activities and re-sequencing MEP finishing activities will be studied.

Analysis Components

The implementation of SIPS (Short Interval Production Schedule) method would also help to improve the safety on the site. Fewer conflicts between different trades are expected. The logistics of material staging will be studied to analyze the pros and cons of SIPS on an educational facility. Lean production principles will be applied to study possible scenarios to improve schedule. Last Planner System utilization cases will be studied to seek opportunity of utilization on this project. The influence of rooftop structural components updates from Analysis 2 to project schedule will be studied. Each trade will be organized by subcontractor and their tasks. The sequence will be presented using a matrix schedule that highlights the presence of work crews in an area and the duration of time spent there. This matrix schedule will also be graphically organized to show the sequence in a section view of the building for better understanding.



Methodology

The following steps will be taken to successfully conduct this analysis:

- Identify the area that can be improved the most from current project schedule
- Research two to three case of construction projects that has implemented the Last Planner System
- Create a spreadsheet documenting the advantages and disadvantages of the system
- Research the possibility of using the system on this project
- Study the possibility of overlapping or re-sequencing the MEP fit-out activities
- Analysis the material staging on site to identify the pros and cons for integrating SIPS methodology on construction project of educational facility
- Study the cost and schedule influence of re-design of the roof structural system by using new material and the its influence to the constructability of rooftop wind turbine units
- Conclude if the update of roof structural system is recommended with cost saving, schedule saving or improve life time energy efficiency
- Conclude if SIPS method and Last Planner System have more advantages than disadvantages towards the construction of public educational facility

Expected Outcome

The purpose of this analysis is to identify the most critical tasks in MEP and finishes and develop a sequence of tasks utilizing a short interval production schedule (SIPS). The detailed duration of time for each task in typical zone on typical floor will be determined and sequenced accordingly. Project schedule is expected to be improved after re-sequencing and arranging the activities.

Analysis 4: Value Engineering

Problem Identification

As analyzed in Technical Report Three, the owner, the project team and the designer worked together on this project to implement value engineering to the construction of Twin River's School Project. The areas of value engineering implementation include update material and equipment and update design. However, due to the limitation of planning time, some value engineering ideas is restraint to be update of material.

Background Research

The material changes on this project include changing the conduits from EMT to MC cables, changing the drywall framing material, updating the audio visual cable in classroom, updating the acoustic ceiling tiles, changing the gymnasium facilities and so on. The biggest update of design is the change of steel support of the clearstory level, the modification of rain water capture system over the music room and the metal decking over the library room towards the west corner of the core of the project. There is a possibility of redesign of the steel deck might bring a lower total cost than a makeover for the decking over library and a different support over clearstory level.

The second highest value of change of design is changing the conduits from EMT to MC Cable. In order to realize the goal of increase project value, to construct a high performance education facility with relatively low cost, it might be a better idea of substitute the two existing 120V distribution panels by one 480V distribution panel.

Analysis Components

The cost difference of two 120V distribution system versus one 480V system and will be studied. An alternative light-weight metal decking system will be considered instead of the current design of mostly wide-ribbed galvanized metal decking. The impact on construction schedule of both changes would be analyzed. The SIPS implementation would be incorporated in the consideration of both systems to optimize the project schedule and add value to the project. The risk of possible higher equipment maintenance cost should also be analyzed.

Methodology

The following steps will be taken to successfully conduct this analysis:

- Identify and study the major value engineering design update for the project
- Research the possibility of updating the two 120V distribution systems into one 480 V distribution system
- Study the schedule change and potential cost savings from the update
- Interview at least one member of the construction team and one member from the electrical designer regarding the advantages and disadvantages of the two options
- Analysis the life-cycle cost for the alternative system
- Studied two cases of Lean method for value engineering purpose on educational facility construction project
- Identify if the current value engineering approach is optimal
- Conclude if the alternative value engineering component is recommended
- Conclude if the current value engineering should be further modified or is recommended

Expected Outcome

The value engineering implementation on this project all correlate with the owner's goal to construction and effective education facility for the school district within the project budget. The update on building material will increase the project value and the project overall quality. The upgrade of design will facilitate the pursuit of LEED Certificate of the project and helps to achieve the owner's goal.

Electrical Breadth: Alternative Distribution System

As studied in Technical Report One, existing design of the electrical system have two power distributions of 208/120V. The possibility of having an additional electric distribution panel there will be analyzed. With the rooftop turbine units and the pole mounted wind turbine, power consumption of the building will decrease and thus reduce the building operation cost in long run. A life cycle cost analysis of the updated system compared to the original design will be done. As noted in Value Engineering section, the second highest value of change of design is changing the conduits from EMT to MC Cable. The possibility of changing of the distribution system into 480V will be studied for cost effectiveness consideration. The cost of designed electrical distribution system on one zone will be calculated. The possible cost of

Structural Breadth: Roof Decking Re-design

Based on the analysis in Technical Report Three, the biggest update of design is the change of steel support of the clearstory level, the modification of rain water capture system over the music room and the metal decking over the library room towards the west corner of the core of the project. There is a possibility of redesign of the steel deck might bring a lower total cost than a makeover for the decking over library and a different support over clearstory level.

Conclusion

Upon completion of the four analyses, alternative construction methods for a high performance education facility will be determined. The goal of these analyses is to suggest areas of improvements in the process of construction and operation of educational facility similar to Twin River's School project. The analyses will be performed involving four core investigation areas including BIM Implementation, LEED Implementation, Schedule Acceleration and Value Engineering. These analyses will be conducted over the duration of spring 2014 and then compiled into a final thesis report. The findings will be presented to the Thesis Jury Panel and AE Faculty at the end of the spring semester.