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CARDEROCK SPRINGS ELEMENTARY SCHOOL

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CONSTRUCTION MANAGEMENT

REVISED THESIS PROPOSAL

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A. EXECUTIVE SUMMARY

This proposal will provide a summary of the topics that will be researched in the Spring 2010 semester and will serve as the guide to the research into the topics discussed in this report. The areas of research will include Building Information Modeling and its potential impact on small scale projects, relocation of underground storm water retaining system, a redesign of certain structural systems, and the impact the addition of solar hot water heating and rain water reclamation will have on the project. The goal in all of these analyses will be to identify how BIM can assist in streamlining processes and add value and savings to the project.

Analysis 1 will focus on Building Information Modeling and the benefits of 3D coordination. This research will focus on cost effective ways to implement BIM on smaller projects. Particular areas of research will concentrate on outsourcing of modeling, contracting options to minimize risk, and specific areas in which BIM can assist the other proposed analyses.

Analysis 2 is the relocating the Underground Storm Water Storage System to a new location. The goal of this proposal is provide value and cost savings to the project. It also has potential to accelerate the schedule. Primarily it will focus on site utilization, cost of moving the system, and schedule acceleration scenarios. Another research topic will be how 3D site coordination can be used to propose the best locations for underground utilities outside of the building.

Analysis 3 will change the structural system in the Gymnasium and Multipurpose room from CMU load bearing walls to structural steel. This analysis will attempt to minimize trade coordination and provide opportunity to save time in the schedule. It also as the potential to save the project money since steel is less labor intensive than masonry. This analysis will demonstrate breadth in structural analysis.

Last, Analysis 4 will research how the addition of solar hot water heating and rain water reclamation systems can increase the sustainability of the project and also provide opportunities to add value with potential for long term reduction in energy and water utility bills. These proposals will also look into how 3D coordination of building systems can assist in locating areas for these systems. This analysis will also demonstrate breadth in mechanical systems

B. Introduction and Relation of Proposed Analyses

The analyses that are being introduced in this proposal are designed to help add value to the owner at minimal cost or disturbance to the project. The different analyses also interconnect with each other in different ways. The recurring theme that is guiding this has to deal with advances in the industry with using Building Information Modeling.

Although BIM is becoming increasingly more popular, there seems to be less application on smaller projects such as a $21 million elementary school. One critical item to be researched will be to find reasons for this trend. With all of the progress in BIM, it seems practical that every project could use it in some way or another.

BIM will also be present in the solutions of the other analyses being proposed. For example BIM can be used in applications of 3D site utility modeling to identify the best locations for an Underground Storm Water Retention System. It also can be used to help identify the best structural systems to be used to minimize impact to other building trades and increase constructability. Last, BIM and more specifically energy modeling can be used to help choose sustainable building systems to increase the efficiency of the building.

All of the topics identified have potential to benefit from Building Information Modeling. While researching the following proposals, good effort will be spent toward identifying areas in which processes and solutions can be enhanced through BIM. The final effort in research will be to identify how smaller projects can benefit from the technology. The research will try to identify the advantages and disadvantages and how BIM can be applied to add maximum value with minimal cost implications.

C. ANALYSIS 1: Implementation of 3D Coordination

Problem Statement:

The construction industry is currently undergoing great changes in the way it utilizes technology to assist in the construction of buildings. One tool that is becoming increasingly developed is the use of 3D modeling to assist with the coordination of MEP and structural systems. Using 3D modeling can greatly reduce time and money it takes to ensure that all building systems can be installed without clashing with another system and reduce the number of change orders and field problems that occur due to clashes.

Research Goal:

The goal of this analysis will be to show how the use of 3D coordination can help streamline the coordination process through identifying problematic areas of MEP construction before it occurs in the field at a premium cost. Included in this research will be guidelines and processes for communication amongst required trades and designers throughout the coordination process. The use of 3D visuals allows for a better understanding of the project amongst all team members and can ultimately allow for a better quality product to be delivered to the owner. Another aspect to be explored will be contracting techniques and outsourcing of modeling that can be used to minimize risk and maximize project efficiency. These topics will be researched to learn why smaller projects do not use 3D coordination as much as larger projects.

Research Steps:

Step 1 – Review the BIM Project Execution Planning Guide created by Penn State faculty and graduate students to identify strategies for 3D coordination implementation on the project.

Step 2 – Conduct interviews with professionals to identify strategies and techniques currently being used on construction projects.

Step 3 – Conduct interviews with contractors to gauge level of current knowledge about the 3D coordination process.

Step 4 – Identify similar projects that have used a 3D coordination processes.

Step 5 – Research the cost and availability of outsourcing modeling.

Step 6 – Create a 3D coordination plan to be used for the implementation of BIM on the project.

Step 7 – Summarize the results of the research identifying key advantages and disadvantages of the analysis for use on the project.

Expected Outcome:

This analysis is intended to identify the advantages and disadvantages of 3D coordination on less sophisticated MEP projects. Although the complexity of the MEP and structural systems are minimal on an elementary school, clashes still occur in the field resulting in change order that comes at a premium cost to the owner. Since 3D modeling and BIM is being greater utilized in the industry, implementation costs will become lower with time like any other technology. This research is also intended to identify opportunities to outsource the actual modeling to an overseas agency for the initial creation of the model. Through preliminary research that was completed, the cost of outsourcing to another country is much cheaper than using companies based in the United States. The final research will result in an implementation plan to be used that can weigh the advantages and disadvantages 3D modeling can have on smaller scale project.

D. ANALYSIS 2: Relocation of Underground Storm Water Storage System

Problem Statement:

Carderock Springs Elementary School is attempting to achieve a LEED Silver Certification from the USGBC. One of the design considerations is the reduction of storm water runoff from the site to prevent erosion control as well as monitoring the volumetric flow rates of water into the municipal storm water management system. The design implemented was an underground retention system (UGS) that will both filter and control volume of storm water that leaves the project site. The current location of the UGS is at a high elevation compared to the rest of the site, thus requiring deeper excavations to achieve the correct slopes for drainage. Also, it currently sits very close to the footprint of the building which creates site utilization issues.

Proposed Solution:

While conducting the interview for Technical Report 3, the construction team identified that additional value could be given to the owner by relocating the system. By moving the UGS, to a lower elevation, shallower excavations would be required to install the large diameter pipes and water retaining structures underground. This will decrease cost by using less manpower, less time, and less equipment operating costs. Another advantage will be the ability to better utilize the space adjacent to the building footprint for material staging, parking, and equipment. This would potentially allow more activities to occur simultaneously on the schedule reducing the overall construction schedule early in the project.

Research Steps:

Step 1 – Identify new location for UGS at a lower site elevation.

Step 2 – Perform detailed takeoff of the excavation requirements of the new location.

Step 3 – Perform detailed cost and production analysis of the work required to install UGS system.

Step 4 – Re-route underground storm piping to new location of UGS.

Step 5 – Identify new quantities of piping or storm water inlets that will increase/decrease the cost of materials.

Step 6 – Analyze the schedule to identify how greater access near the building footprint can accelerate building construction activities.

Step 7 – Create new site utilization plan to support schedule acceleration activities.

Step 8 – Create final schedule and cost reports to compare the proposed analysis to the actual construction performed.

Expected Outcome:

Relocating the UGS will add value to the owner by directly reducing costs and schedule time of completing the work without deviating or sacrificing the original design intent of the system. Indirectly, this will allow a better utilization of the site near the footprint which could create opportunities for more construction to occur inside the building simultaneously. An analysis of construction activities and the schedule could result in additional time savings which ultimately will impact the cost of the project. Reducing the time of construction will reduce general conditions and save the owner money without impacting the quality or original design intent of the building or UGS.

E. ANALYSIS 3: Change of Load Bearing CMU Walls to Steel

Problem Statement:

The Gymnasium and Multipurpose Room in the school are spaces with large open floor plans. Their structural systems consist of CMU load bearing walls which support long span joists. Constructing the masonry walls is also a very labor intensive activity. Additional to the masonry is the grouting that must occur to allow the walls to reach their maximum strength to transfer roof loads from the joists.

Proposed Solution:

Switching from CMU walls to steel columns in these locations would help save time and money compared to CMU load bearing walls. This would allow for faster erection of the structure and overall decrease the time of the critical path. Additionally this switch would decrease constructability and coordination issues on the project. These activities help to minimize risk for all parties involved.

Research Steps:

Step 1 – Estimate the cost and time it takes to complete the construction using the original method.

Step 2 – Re-design the Gymnasium and Multipurpose room using steel.

Step 3 – Analyze the cost and schedule differences for comparison.

Step 4 – Estimate cost of standard non-load bearing CMU walls for enclosure of the spaces.

Step 5 – Identify advantages and disadvantages of the different structural systems. Research other alternative methods of spanning large open spaces for comparison.

Step 6 – Analyze best choice and calculate the impacts on the cost, schedule, and constructability of the new system.

Expected Outcome

Changing the structural system for the joist support in the Gym from load bearing masonry to steel will reduce the critical path on the schedule. It will allow steel to be erected without the constraining factors and coordination required by the masonry contractor. This will minimize risk to all contractors. There will also be a reduction in the amount of labor required to change the enclosure to standard non-load bearing masonry construction. There will be less labor for the grouting and reinforcing of the wall. Ultimately it will reduce the cost of the masonry contract with a minimal increase to the cost of steel. However, the ability to reduce the schedule and critical path would lead to lower general conditions from all contractors on the project resulting in a lower overall cost to the owner.

F. ANALYSIS 4: Addition of Solar Water Heating System and Rain Water Reclamation System

Problem Statement:

Carderock Springs was designed with the intent to achieve LEED Silver certification. Although the school is designed to very sustainable, there is potential to receive a higher certification with some improvements. This proposal will analyze the feasibility of adding a solar water heating system and rain water reclamation system.

Proposed Solution:

The addition of a solar hot water heating system will increase the sustainability of the project. It will help to decrease dependence on the energy grid and will decrease overall operational costs. It also allows for the addition of sustainable curriculum for elementary school students to learn about different technologies. It can potentially add value to the students' education and to the bottom line of the operating costs at the school. The rain water reclamation system can help achieve similar results. Clean water is a valuable resource and recycling gray water is a very good way to add sustainable design to the building.

Research Steps:

Step 1 – Research underlying engineering and requirements of solar water heating and water reclamation systems for commercial buildings.

Step 2 – Research the feasibility and heating capacity of solar arrays.

Step 3 – Perform cost studies on both water savings and electrical savings for both systems and compare to the actual design.

Step 4 – Identify placement for water storage tanks on site. Evaluate if other aspects of the building or site design will be affected by the tanks.

Step 5 – Perform LEED checklist analysis to identify the LEED rating potential with these additional systems.

Expected Outcome:

With the addition of solar water heating and rain water reclamation the school will be able to create a more sustainable footprint that will complement the existing green building systems. It will help to lower the overall use of electricity and water by the school. It is expected that these systems will have minimal impact on the existing building design and will add overall value to the school district.

G. Weight Matrix and Conclusions

Weight Matrix:

The following table represents how effort and time will be distributed in the spring semester to analyze the proposed analysis. It demonstrates how time will be spread amongst different construction management topics such as Value Engineering, Constructability, Schedule Reduction, and Research into the feasibility and execution of each proposal on the actual project.

Table 1 - Analysis Weight Matrix

Description	Research	Value Eng.	Const. Rev.	Sched. Red.	Total
Relocate UGS	0%	10%	10%	10%	30%
3D Coordination	20%	0%	0%	0%	20%
CMU Redesign	10%	0%	10%	10%	30%
Add Solar & Recycled H_2O	10%	10%	0%	0%	20%
Total	40%	20%	20%	20%	**100%**

Conclusions:

One of the themes incorporated throughout the proposals is the implementation of emerging technologies in the building construction industry. This includes both sustainability and productivity. It is the goal of these proposals to be realistic and feasible to apply on the project with minimum or no impact on the overall project budget. These topics will also allow me to become very knowledgeable in each proposed area which will assist me as I enter the industry after graduation.

H. APPENDIX 1 – Breadth Studies

Structural:

A structural breadth will be demonstrated in the switching of a CMU load bearing walls to structural steel columns in Analysis 3. In order to make this switch I will have to calculate loads and size structural beams and columns to support the roof over large open areas with long span joists. Also incorporated in this will be the schedule and cost differences of this switch. It is expected that the switch will be cheaper and faster the build than the CMU load bearing system.

Mechanical/Electrical:

A mechanical breadth will be demonstrated through the implementation of solar water heating and rain water reclamation system. The addition of these systems will require the building to have additional water pump requirements and different heating load requirements for the water. Solar panels will decrease electrical load and will also decrease the size of water heaters. The reduction of water from the utility will also be calculated which can result in different requirements for the utility connection. This breadth will be demonstrated in the sizing of water pumps, piping, and size of the rain water storage system for the building.

I. APPENDIX 2 – Proposal Schedule

The following page(s) contain the proposed schedule to complete thesis research analyses in the Spring 2010 Semester.

Table 2 - Research Schedule

LEGEND:

BIM	UGS	CMU Wall	Solar+Rain	All Topics

SCHEDULE

1/10 - 1/16	1/17 - 1/23	1/24 - 1/30	1/31 - 2/6	2/7 - 2/13	2/14 - 2/20	2/21 - 2/27	2/28 - 3/6	3/7 - 3/13	3/14 - 3/20	3/21 - 3/27	3/28 - 4/3	4/4 - 4/11	4/12 - 4/15
Investigate BIM Planning and Execution Guide from PSU													PRESENTATIONS
Perform prelim. Research in solar and rain capture tech.													
		Identify areas in each analysis to implement BIM and initial research											
				Relocate UGS and perform cost analysis									
					Research BIM processes to assit with utility location								
				Change structural wall and perform cost and schedule analysis									
						Summarize and Evaluate results of research							
								Summarize and evaluate results of research					
									Implement design to building and summarize and evaluate results				
											Summarize and evaluate all research. Link and prepare final results for presentation of findings.		