Final Proposal Resubmission

for Spring Thesis Project

January 16, 2009

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I. Executive Summary:

The purpose of this proposal is to provide an overview of the areas of interest that will be researched for my final thesis report on the Integrated Science Center. The three topics covered include Air Handling Unit Redesign, Existing Windows Versus Replacing Windows for Phase II, and 3D Coordination. The common theme for these analyses is their effects on the mechanical system design and installation.

Analysis I – AHU Redesign
This analysis will determine whether the installed AHU system is sufficient to handle the building demand loads as is or would the size, number, and location of the AHUs be impacted if Williamsburg's humid summers were accounted for (Mechanical Breadth). The intention of the AHU redesign is to decrease the amount of moisture formed compared to the currently installed system. The new design cost would be compared to the original AHU cost plus the additional costs necessary to fix the moisture overflow. Impacts on the construction schedule will also be looked at.

Analysis II – Existing Windows Versus Replacing Windows for Phase II
This analysis will explore the benefits of replacing the existing windows with a tinted window system. The current windows require blinds to reduce the amount of glare which reduces the amount of daylight penetrating the building. Replacing the existing windows with tinted ones would decrease the amount of glare without compromising the access of daylight. Daylighting can significantly reduce artificial lighting requirements and energy costs. The new window system would improve efficiency, aesthetics, and quality as well. A comparison will be made between the lighting load requirements and electrical costs for each window system (Lighting/Electrical Breadth).

Analysis III (Critical Issues Research) – Implementation of 3D Design Coordination
Due to the extensive MEP systems required for this laboratory and the limited plenum space, a few major clashes went unseen until discovered in the field. This analysis will attempt to identify the advantages of implementing 3D coordination in the construction industry and offer possible suggestions of encouraging 3D models on projects. A model will be created and specific clashes from the Integrated Science Center building will be presented. The worthiness of having all parties, owners, contractor, and subcontractors on the 3D Design Coordination will be also explored.

This proposal outlines the areas of research I chose to pursue. These topics will enhance my knowledge in those areas I have previously studied as well as expand my understanding of unfamiliar areas which are still useful in my professional development. A weight matrix diagram is provided to illustrate how effort will be distributed among the different analyses proposed.

II. Analysis Descriptions:

Analysis I – Redesign of AHU's

Problem Statement

The Integrated Science Center is a state-of-the-art facility which contains over 40 fume hoods. All of the ambient air in the building must be exchanged with external air several times per day. Recirculation of air is not permitted, as the fume hoods are integral to the building exhaust system. Unfortunately, the design engineer who specified the air handler units did not take into consideration the massive amount of condensation that forms when operating the system at 100% external air exchange during the humid summer months, and as result, moisture began to overflow the small drain pans and flood the penthouse floor.

Potential Solution

After consulting with the design engineer, fume hood manufacturer, and mechanical contractor, it was decided to operate the system at less than maximum airflow, add moisture eliminators, and install larger drain pans to resolve the issue. I plan to calculate the building's peak demands during Williamsburg's humid summers and determine if the number, size, and location of the AHU's would affected by the new numbers. The estimated new AHU cost could then be compared to the current system plus the added expenses for the overflow fixes (larger drain pans and moisture eliminators). The AHU's are part of the critical path so the impacts on the project schedule will also be evaluated.

Research Steps

- Become more familiar with the originally designed AHU system (get product data sheets).
- Contact a mechanical professional, preferably from Facility Dynamics who was the mechanical engineer for the ISC project, regarding assistance in designing an air handler unit.
- Research alternative AHU manufacturers and products.
- Redesign the AHU system to accommodate the new demand loads.
- Estimate the cost of the newly proposed AHU.
- Obtain the actual costs for the current AHU and the required repairs of this system from the project manager.
- Compare overall benefit/cost of the two systems.
- Determine the impacts on project schedule.

Expected Results

Although I anticipate the newly designed AHU to have a higher initial cost than the current air handler unit, I expect that measures implemented to resolve the moisture problem with the original AHU's will exceed the difference in cost. Therefore, I believe the cost of the redesigned air handler unit will less than the overall cost of the current AHU. I predict that the installation duration of the AHU would not vary much from the actual time but that the commissioning time would be noticeably shorter.

Analysis II – Existing Windows Versus Replacing Windows for Phase II

Problem Statement

Phase II of the Integrated Science Center project consists primarily of the complete interior demolition and renovation of approximately 25,000 SF of lab space. The original contract documents required the existing window and curtainwall systems to remain protected and in place. Blinds would eventually be installed for glare control. However, blinds hinder the use of daylighting in spaces. Replacing the existing windows with a different system could provide an alternative measure of glare control without compromising the penetration of daylight. Daylighting can significantly reduce artificial lighting requirements and energy costs. Studies of schools have also shown that daylighting can improve student performance and occupant comfort. The new window system would also improve energy efficiency, aesthetics, and quality.

Research Goal

I would like to propose installing tinted windows to replace the existing system. Tinted windows would provide glare control without negatively impacting daylight infiltration as much as blinds. This analysis would require calculating the amount of light that would be able to penetrate both window systems. With this information I would compute the decrease in artificial lighting required for the tinted window system and the savings in electrical demand. The installation of a new window system will add to the project construction time and would need to be integrated into the project schedule.

Research Steps

- Obtain product data information for the existing windows from the project team.
- Research tinted window manufactures and compare possible options.
- Calculate daylight infiltration for both systems.
- Compare the difference in daylighting penetration, the artificial lighting requirements and the electrical demand.
- Determine the additional material and construction costs of replacing windows.
- Adjust current project schedule with the affects of installing a new window system.

Expected Results

Through this analysis, I expect to find that the newly proposed tinted windows will provide more daylighting to interior spaces than the existing windows with blinds as well as supply a sufficient amount of glare control. The additional daylighting will decrease the amount of artificial lighting required and reduce the electrical energy required for spaces. Purchasing and installing the replacement windows will initially cost more than keeping the existing windows in place and lengthen the project schedule.

Analysis III (Critical Issues Research) – Implementation of 3D Design Coordination

Problem Statement

The use of 3D design coordination programs has been of growing interest in the construction industry. Implementing this on a project however remains a huge challenge. This topic is of interest to me because MEP coordination is crucial for a high-end laboratory, such as the Integrated Science Center at William & Mary. There were a few major clashes between the mechanical duct and the structure as well as the piping and the duct that went unseen until discovered in the field. These unexpected situations added time and costs to the project. The implementation of a 3D model might have helped this project significantly due to the complexity of the facility.

Research Goal

The goal of this analysis to show the advantages of using 3D design coordination, and present a way of implementing it during construction. It is necessary to educate the owner, contractor, and subcontractors on this technology so that everyone can participate and benefit from using the software. A 3D model can identify many of the mechanical, electrical, and plumbing clashes before they occur in the field. To provide an example relevant to my project, I will model a portion of my building and present clashes that went undetected in the 2D drawings. These 3D programs can provide a better visual concept and get everyone involved on the same page. The initial time and costs to develop the model would be minimal compared to the time and money saved by using this technology.

Research Steps

- Review literature on the use of 3D design coordination.
- Research what is involved and needed to produce a 3D clash detection.
- Interview the Gilbane project team about their experiences with 3D design and whether or not they would have preferred its use on the ISC project.
- Question subcontractors on their experiences with 3D design and if it would have been beneficial to them on the ISC project.
- Research similar projects that used 3D clash detection programs.
- Design a model for a portion of the ISC building and provide a clash example.
- Analyze the advantages and disadvantages of implementing it in the construction industry.
- Suggest possible ways of encouraging its use on a project.
- Summarize results with sufficient information.

Possible Interview Questions

1. Have you ever used 3D coordination software on a project?
2. What are some of the challenges faced using this technology?
3. Would 3D coordination been useful on the Integrated Science Center?
4. How and who would be trained for the use of 3D modeling if it were used?
5. What would have been the benefits of using this technology on the project?
6. What necessary steps are needed to implement 3D coordination on a project?
7. What parties would be involved?
8. How does Gilbane initiate 3D coordination to their clients?

Expected Results
Through this analysis I hope to better understand all that is involved 3D design coordination, demonstrate the advantages of this technology, and provide suggestions for the challenging issues that arise with its use. I would like to illustrate the functionality of using clash detection for the mechanical, electrical, and plumbing systems and encourages its use in the construction industry.

III. Conclusion:

Through the analysis described in the previous section, I hope to provide a thorough construction management study on the Integrated Science Center project at the College of William and Mary. This proposal summarizes the topics I will research for my thesis during the Spring 2009 semester. This project is an opportunity to apply everything I have learned over the last five years as well as expand my knowledge in areas that will be useful in the construction industry.

IV. Weight Matrix:

The weight matrix below shows the different analyses that will be areas of investigation addressed in the thesis proposal. The proposed topics will be analyzed in areas such as value engineering, constructability review, and schedule reduction.

The redesign of the AHU would have an effect on the constructability. An evaluation of location and position of mechanical floors could be taken into consideration. Ultimately, construction time would be saved because remedies for moisture carry-over would no longer be required.

Replacing the existing window system with a new window system is a possible option to provide value to the building. The increase in daylighting would decrease the artificial lighting required and the electrical energy demand. The new window system would also improve energy efficiency, aesthetics, and quality.

The research for the 3D coordination will mostly consist of literature review and interviews. A 3D model can identify many mechanical, electrical, and plumbing clashes before they occurred in the field thus reducing schedule time and construction costs.

Description	Research	Value Eng.	Const. Rev.	Sched. Red.	Total
AHU Redesign	-	-	15%	20%	35%
Window Systems	-	25%	10%	-	35%
3D Coordination	20%	-	5%	5%	30%
Total	20%	25%	30%	25%	100%

Figure 4.1 – Weight Matrix Diagram

APPENDIX

Appendix A – Breadth Studies

Breadth Studies

While completing the construction management analyses for the Integrated Science Center, I plan to investigate other area specialties of the Architectural Engineering program. The breadth studies I have selected are briefly explained below.

Mechanical Breadth

The Integrated Science Center is a state-of-the-art laboratory facility and it requires an elaborate mechanical system. During the humid summer months caused an excessive amount of condensation formed when the system was operating the system at 100% external air exchange. As a result moisture began to overflow the drain pans and flooded the penthouse floor. I plan to calculate the building's peak demands during Williamsburg's humid summers and determine if the number and size of the AHU's would affected by the new figures.

Lighting/Electrical Breadth

Phase II of the Integrated Science Center project consists primarily of the complete interior demolition and renovation of approximately 25,000 SF of lab space. The original contract documents required the existing window and curtainwall systems to remain protected and in place. Blinds would eventually be installed for glare control. However, blinds hinder the use of daylighting in spaces. I propose replacing the existing windows with a tinted window system which would provide an alternative measure of glare control without compromising the penetration of daylight. The increase in daylighting would significantly reduce artificial lighting requirements and electrical energy demands compared to the existing windows and blinds. The new window system would also improve energy efficiency, aesthetics, and quality.

Appendix B – Thesis Research Time Line

Thesis Research Time Line

Analysis I – AHU Redesign

Task 1. Research Designed AHU System

(a) Become more familiar with the originally designed AHU system (get product data sheets).

(b) Contact a mechanical professional from Facility Dynamics, who was the mechanical engineer for the ISC project, regarding any questions about the currently installed air handler unit.

(c) Obtain the actual costs for the current AHU and the required repairs of this system from the project manager.

Task 2. AHU Redesign

(a) Calculate new demand loads accounting for humid summer months.

(b) Research alternative AHU manufacturers and products.

(c) Contact a mechanical professional, preferably from Facility Dynamics who was the mechanical engineer for the ISC project, regarding assistance in designing an air handler unit.

(d) Redesign the AHU system to accommodate the new demand loads.

(e) Estimate the cost of the newly proposed AHU.

Task 3. Construction Management Analysis

(a) Compare overall benefit/cost of the two systems.

(b) Determine the impacts on project schedule.

Analysis II – Existing Windows Versus Replacing Windows for Phase II

Task 4. Investigate Current Window System

(a) Obtain product data information for the existing windows from the project team.

(b) Calculate daylight infiltration.

Task 5. Propose Tinted Window System

(a) Research tinted window manufactures and compare possible options.

(b) Calculate daylight infiltration for both

Task 6. Comparison of Existing and Proposed Window Systems

(a) Compare the difference in daylighting penetration

(b) Calculate the difference in artificial lighting requirements and the electrical demand.

Task 7. Construction Management Analysis

(a) Determine the additional material and construction costs of replacing windows.

(b) Adjust current project schedule with the affects of installing a new window system.

Analysis III – Implementation of 3D Design Coordination

Task 8. Research Topic and Conduct Interviews

(a) Review literature on the use of 3D design coordination.
(b) Research what is involved and needed to produce a 3D clash detection.
(c) Interview the Gilbane project team about their experiences with 3D design and whether or not they would have preferred its use on the ISC project.
(a) Question subcontractors on their experiences with 3D design and if it would have been beneficial to them on the ISC project.
(b) Research similar projects that used 3D clash detection programs.

Task 9. Implementation of 3D Model

(a) Design a model for a portion of the ISC building and provide clash examples.

Task 10. Summary and Results

(a) Analyze the advantages and disadvantages of implementing it in the construction industry.
(b) Suggest possible ways of encouraging its use on a project.
(c) Summarize results with sufficient information.

	January 26	February 9	February 23	March 16
Task 1. Research Designed AHU System	In Progress	Complete	Complete	Complete
Task 2. AHU Redesign		In Progress	Complete	Complete
Task 3. CM Analysis for AHUs				In Progress
Task 4. Investigate Current Windows	Complete	Complete	Complete	Complete
Task 5. Propose Tinted Windows	In Progress	Complete	Complete	Complete
Task 6. Compare Window Systems		In Progress	Complete	Complete
Task 7. CM Analysis for Windows			In Progress	Complete
Task 8. Research 3D Modeling	In Progress	In Progress	Complete	Complete
Task 9. Implementation of 3D Model		In Progress	In Progress	Complete
Task 10. Summary and Results				In Progress

Figure B.1 – Research Time Line Chart

SCHEDULE																
1/12-1/16	1/17-1/25	1/26	1/27-2/1	2/2-2/8	2/9	2/10-2/15	2/16-2/22	2/23	2/24-3/1	3/2-3/6	3/7-3/15	3/16	3/17-3/23	3/24-4/5	4/6-4/12	4/13
Proposal Re-submission		P			P			P				P				
	4. Windows	R			R			R			S	R				P
	1. Designed	O	AHU Study		O			O			P	O				R
	5. Tinted	G	Windows		G			G			R	G				E
	8. Research	R	3D Modeling		R			R			I	R				S
		E		6.Window	E	Comparison		E			N	E				E
		S		2. AHU	S	Redesign		S			G	S				N
		S		9. 3-D	S	Model Implementation		S				S				T
							7. CM		Analysis for Windows		B					A
		C			C			C	3. CM Analysis for		R	C				T
		H			H			H		10.Results	E	H	& Summary			I
		E			E			E			A	E	Revisions for All			O
		C			C			C			K	C	Presentation Preparation			N
		K			K			K				K				

Figure B.2 – Research Time Line Graph