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Senior Thesis Proposal

The Concordia Hotel

12/14/2012

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Executive Summary

The main purpose of the Senior Thesis Proposal is to provide readers with a project background which is followed by an identification and overview of the four research analyses areas to be performed, over the duration of the spring semester, on the Concordia Hotel project. For each analysis topic, the problem and the goal are clearly defined. For each analyses the research that will be performed, the potential solutions and the outcomes and resources that will be used to gain these outcomes is discussed. A weight matrix at the end of the report, following the technical analyses descriptions, illustrates how efforts will be distributed among the four analyses and how they meet the core requirements as the following: research; value engineering analysis; constructability review; and schedule reduction. A time table will also be developed to help show the dates of which certain analyses steps will be taken. The timetable will be followed by a description of the breadth topics along with a description of the MAE topic that will be considered. At the end of the course the proposed analyses are presented to the Architectural Engineering Faculty and attending jury members. Below are brief descriptions of the problems, the solution, and the potential benefits of the solutions application. A further description and explanation of these analyses will be presented later in the body of the document.

Analysis 1: Building Information Modeling (BIM) Application to Renovations/Rehabs

There were several key activities that caused increased costs and schedule delays. These problems could have been overcome with greater utilization of BIM to facilitate prefabrication. BIM could be used to help apply prefabrication to the extensive Mechanical/Electrical/Plumbing (MEP) systems and the drywall/framing of the interior partitions. These issues will be discussed further in the following paragraphs. This BIM consideration will allow for advantages in construction and efficiency in materials. The benefits of applying BIM to conduct prefabrication would be the potential to reduce the schedule and project costs. The analysis will consider the role which BIM can play in initiating prefabrication on the Concordia project. The goal is to improve the project's construction efficiency to improve the project schedule and costs.

Analysis 2: Implementation of MEP Prefabrication

The extensive construction and installation of the MEP systems caused extensive delays on the project. The delays resulted in employing crews for overtime work during the week and weekends. These delays and costs could have been avoided if the MEP systems were fabricated at an off-site warehouse and then transported to the construction site using prefabrication techniques. This will result in several benefits which include cost savings from reduced labor, and prevention of overtime. It will result in greater productivity, safety, quality and efficiency of materials which will potentially result in greater Leadership in Energy and Environmental Design (LEED) achievements. The analysis will discuss how to achieve the goal of putting the schedule back on track and to reduce construction costs. Since the project is about one month behind schedule, the generated 3D model used for 3D coordination and clash detection can be used to produce clash free shop drawings for MEP prefabrication.

Analysis 3: Prefabrication of Drywall/Framing Partitions

The demolition of the entire interior finishes required extensive construction of new drywall/framing partitions. The construction schedule was hindered by this construction activity and it resulted in accrued

costs. In order to meet and maintain the schedule overtime initiatives were applied, these attempts to meet the schedule resulted in exorbitant costs from the increased labor. A solution to this problem is to employ the prefabrication of the drywall/framing interior partitions. The benefits of this application will result in greater productivity, safety, quality and efficiency of materials which will potentially result in greater LEED achievements. Its application will also achieve potential schedule and cost savings. The analysis will discuss how to achieve the goal of putting the schedule back on track and result in reduced construction costs. Since the project is about one month behind schedule, the generated 3D model used for 3D coordination can also be used to produce clash free shop drawings for drywall/framing prefabrication of interior partitions.

Analysis 4: Alternate Roof Systems

The Concordia Hotel employs two different roofing systems, a green roof and a Thermoplastic Polyolefin (TPO) in different areas. Alternation of these roofing systems caused constructability issues and inefficiencies in the ordering of materials. The roofing system could have been optimized by utilizing one system over the other in order to capitalize on bulk order savings and labor efficiencies with repetitive tasks. Utilizing one system for the entire roofing area could have also optimized the potential to earn a greater amount of LEED credits. The goal of the analyses is to consider the advantages and disadvantages of applying either a cool roof, green roof, or a conventional TPO roof system to the entire roofing area. This analysis will also include a consideration of the effects on construction related to costs, schedule impacts, and constructability issues. Additionally, out of option breadths will arise during this analysis to determine how implementing a cool roof to the tenth floor roof will affect structural and mechanical systems that support the building's function.

Project Background

The Concordia Hotel is an extensive renovation project of the existing hotel located in Washington D.C. The building was originally constructed in 1965 and was in great need of a renovation to its outdated systems. The renovation project of the existing structure will cost $23 million, to the owner which wishes to remain anonymous, where The Turner Construction Company is the General Contractor on the project. The project consists of ten stories, a cellar level and a parking garage and has a size of 80,000 gross square foot and when completed will have 121 studio apartments. The construction of the project started November 2011 and had an original project completion date of December 23, 2011.

The renovation of the Concordia Hotel includes the thorough demolition of the interior and the exterior façade system, MEP systems, and several structural systems that include columns and beams throughout the structure. The construction of the structure will include the extensive installation of 78 Micro Piles in the cellar level of the structure. The construction will also include the installation of a new elevator/stair core and multiple concrete slabs throughout the structure. The structural rehabilitation will also include the implementation of Carbon Fiber Reinforcement Panels (CFRP). The construction will consist of a new façade system. The U.S. Green Building Council, an organization that promotes sustainability in how buildings are designed and constructed, created a certification for green building entitled Leadership in Energy and Environmental Design (LEED). The project is hoping to attain a LEED Gold rating via the utilization of credits associated with sustainable sites, water efficiency, energy & atmosphere, materials & resources, indoor environmental quality, innovation & design process, and regional credits.

Figure 1 Rendering of Concordia Hotel

The site for the renovation is highly restrictive and constraining due to the fact that it is located in downtown Washington D.C. The site where the renovation will take place is surrounded by several existing structures and a narrow alleyway in the rear. The site will need to remain clean in order to allow for delivery trucks and other vehicles to access the site safely. In order to create an efficient means of transporting materials and laborers to each floor a hoist will be erected.

The project experienced multiple construction issues which delayed the schedule by a month and resulted in increased costs. This delay called for the implementation of several analyses to find solutions to these problems to help put the schedule back on track.

Technical Analysis Descriptions

Analysis 1: Building Information Modeling (BIM)

The Opportunity

The successful use of BIM in the 3D coordination of the MEP system clashes helps justify its application to other aspects of the project. The application of BIM to the other aspects of the project could have benefitted the project costs and project schedule. Several BIM uses are to be suggested, analyzed, and compared in terms of costs and benefits. It would have been beneficial to have applied BIM to prefabrication initiatives on the project for several different building systems. The Pennsylvania State University BIM Execution Planning Guide will be utilized to aid in this thorough analysis.

Research Goals

The goal of this analysis is to explore and suggest other potential alternatives of BIM to help the project team complete the project. The main goal is to utilize 3D modeling software to create a model of the project that will help convey the benefits of applying prefabrication methods. Utilizing BIM will facilitate the application of prefabrication techniques to the MEP systems and the drywall/framing interior partitions. My goal is to analyze how to apply prefabrication techniques to the Concordia Hotel project.

Research Steps

- Acquire AutoCAD models from The Turner Construction Company
- Review model to consider accuracy and thoroughness of the building systems modeled
- Construct any missing systems with the utmost accuracy
- Research how BIM can be used to facilitate prefabrication techniques
- Determining how the generated 3D model will be beneficial to the alternative BIM applications
- Research the effect on construction means, methods, and logistics through the consideration of alternative BIM uses
- Gain a greater understanding of BIM's applicability to prefabrication
- Interview project manager to determine all contributing factors to project delays
- Determine areas where prefabrication can be applied to the MEP systems and framing/drywall interior partitions
    - Determine the key issues faced by the project team that can be solved via the application of BIM to the project
    - Determine the general contractors interest in the alternate BIM applications and how they might improve productivity and result in schedule and cost reductions

Resources and Tools to be used

- The Turner Construction Company project team on the Concordia Hotel
- The Pennsylvania State University AE Faculty
- Educational background from previous AE courses (such as AE 372, AE 475, AE 476, and AE 570)
- The Pennsylvania State University BIM Execution Planning Guide
- 3D Software (Revit, Navisworks)
- Applicable literature (books, websites, papers, etc...)
- Key industry members

Potential Solutions and Expected Outcomes

The possible solutions this BIM analysis will find is improvements to construction means and methods and potentially greater efficiency in construction. This research will have the effect of improving the schedule resulting in savings in overall construction costs. The solution will be that it will create a greater understanding of prefabrication of building systems. The expected outcomes of this research can potentially result in a greater efficiency in the sequence of construction.

- Outcomes
    - Cost analysis that will discuss the cost savings associated with schedule and labor savings. Reducing the schedule via this application of BIM can prevent extra general conditions costs
    - It is likely that BIM will facilitate the prefabrication of key building systems

Analysis 2: Implementation of MEP Prefabrication

The Opportunity

The extensive construction and installation of the Mechanical/Electrical/Plumbing (MEP) systems caused extensive delays on the project. Duct banks, electrical bus ways, conduit, telecommunications, and various other components were constructed using a stick-built method that failed to achieve schedule and cost savings potential. The project team has expressed fears that they might go over schedule approximately a month and potentially more. In order to stay on schedule, The Turner Construction Company has considered bringing in more tradesmen and employing extra crews during the week and on Saturdays. These overtime crews would include mechanical piping installers and plumbing trim-out crews which would result in a cost of close to $40,000. These delays and costs could have been avoided if the MEP systems were fabricated at an off-site warehouse and then transported to the construction site rather than applying the typical stick-built method. These components can be manufactured offsite with the proper lengths, sizes and with all the required bends. After each designated component is prefabricated offsite, they can be delivered, placed, combined and then installed together in order to simplify the installation process. This will result in several benefits which include cost savings from reduced labor and prevention of overtime. It will result in greater productivity, safety, quality and efficiency of materials which will potentially result in greater LEED achievements. The analysis will discuss how to achieve the goal of putting the schedule back on track and to reduce construction costs. Since the project is about one month behind schedule, the generated 3D model used for 3D coordination can be used to produce clash free shop drawings for MEP prefabrication.

Research Goals

The main goal of applying the MEP prefabrication is to prevent the project from going over schedule and to reduce costs associated with labor increases and general conditions costs.

Research Steps

- Research the type of labor used on project (Union or Non-Union Shop)
- Determine which components can be fabricates to fit together as an assembly
- Determine who is responsible for installing such systems
- Assess the time required to fabricate and then install assemblies
- Evaluate the constructability issues, and potential time and cost savings
- Gathering the required information concerning the desired performance characteristics and sizing of MEP systems
- Gathering the required information on the MEP system to determine what will best serve the prefabrication implementation
- Determining how the generated 3D model will be beneficial to the MEP prefabrication
- Locating and choosing the best prefabrication facility in terms of value not limited to distance and cost
- Effect on construction means, methods, logistics and equipment

Potential Solutions and Expected Outcomes

MEP prefabrication can result in savings in cost, schedule, labor, materials, and it has the potential to improve quality and safety. The project team can utilize the 3D model in creating clash free shop drawings that can facilitate the application of prefabrication techniques. The outcomes that will likely come from this application are the ones previously mentioned. This technique will also improve the attainability of certain LEED credits concerning the material use credits. This may result in potential increases in LEED certifications.

- Outcomes
    - The outcome will likely be that this will be beneficial to the project and result in schedule and costs savings
    - Cost analysis that will discuss the added costs such as delivery costs and the total savings from this method's application
    - Schedule analysis which will show how much time the prefabricated units will save. To give an idea of how detailed the schedule will be, it will show how much time each unit will take to arrive to the site, time to shake them out, and the time to install

Resources

- The Pennsylvania State University AE faculty
- Owner representatives and construction team
- Educational background from previous AE courses
- Prefabrication facilities
- Key industry members

Analysis 3: Prefabrication of Drywall/Framing Partitions

The Problem

The extensive construction and installation of the interior finishes, specifically the installation of the interior partitions, resulted in extensive delays to the project. The drywall/framing partitions were constructed using a stick-built method failing to achieve schedule and cost savings potential. The project team has expressed fears that they might go over schedule approximately a month. In order to stay on schedule The Turner Construction Company has considered bringing in more tradesmen and employing extra crews during the week and on Saturdays. These overtime crews would include twenty one tradesmen employed two hours a day for ten days resulting in a total cost of just under $9,000. These delays and costs could have been avoided if the framing/drywall was fabricated at an off-site warehouse and then transported to the construction site rather than applying the typical stick-built method. These components can be manufactured offsite with the proper lengths, sizes and with all the required finishes. After each designated component is prefabricated offsite they can be delivered and then installed together in order to simplify the installation process. This will result in several benefits which include cost savings from reduced labor, and prevention of overtime. It will result in greater productivity, safety, quality and efficiency of materials which will potentially result in greater LEED achievements. The analysis will discuss how to achieve the goal of putting the schedule back on track and to reduce construction costs. Since the project is about one month behind schedule and at risk of being extended more. The generated

3D model used for 3D coordination can be used to produce shop drawings for drywall/framing prefabrication.

Research Goals

The main goal of applying the drywall/framing partitions prefabrication is to prevent the project from going over schedule and to reduce costs associated with labor increases and general conditions costs.

Research Steps

- Research the type of labor used on project (Union or Non-Union Shop)
- Determine which interior partitions can be easily fabricated, transported, and installed on-site
- Locating and choosing the best prefabrication company in terms of value not limited to distance and cost
- Assess the time required to fabricate, transport and then install interior partitions
- Evaluate the constructability issues potential time and cost savings
- Gathering the required information concerning the desired performance characteristics and sizing of MEP systems
- Gathering the required information on the Drywall/Framing Partitions to determine what will best serve the installation of this system
- Determining how the generated 3D model will be beneficial to the Drywall/Framing Partitions prefabrication
- Effect on construction means, methods, logistics and equipment

Potential Solutions and Expected Outcomes

Drywall/framing partitions prefabrication can result in savings in cost, schedule, labor, materials, and it has the potential to improve quality and safety. The 3D model will be utilized when creating clash free shop drawings that can facilitate the application of prefabrication techniques. The outcomes that will likely come from this application are the ones previously mentioned. This technique will also improve the attainability of certain LEED credits concerning the material use credits. This may result in potential increases in LEED certifications.

- Outcomes
    - I believe that the outcome will be that this will be beneficial to the project and result in schedule and costs savings
    - Cost analysis that will discuss the added costs such as delivery costs and the total savings from this method's application
    - Schedule analysis which will show how much time the prefabricated units will save. To give an idea of how detailed the schedule will be, it will show how much time each unit will take to arrive to the site, time to shake them out, and the time to install

Resources

- The Pennsylvania State University AE faculty
- Owner representatives and construction team

- Educational background from previous AE courses
- Prefabrication facilities
- Key industry members

Analyses 4: Alternate Roof System

The Problem

The Concordia Hotel employs two different roofing systems, a green roof and a Thermoplastic Polyolefin (TPO) in different areas. This difference in roofing systems caused constructability issues and inefficiencies in ordering of materials. The roofing system could have been optimized by utilizing one system over the other in order to capitalize on bulk order savings and labor efficiencies with repetitive tasks. Utilizing one system for the entire roofing area could have also optimized the potential to earn a greater amount of LEED credits.

Research Goals

The goal of this analysis is to perform an in-depth study related to implementing a sustainable cool roof, or a green roof system or a typical TPO roofing system for all the roofs rather than just a fraction of them. The ultimate goal is to determine the benefits to the owner and occupants of the facility, as well as the effect on cost, the project schedule, and the issues of constructability. Additionally, out of option breadths will arise with this analysis of the applicability of a sustainable cool roof, or a green roof system or a typical TPO roofing system. These other breadths will include; structural and mechanical analyses that will influence the performance and overall functionality of the structure.

Research Steps

- Research various sustainable roofing system technologies and compare the advantages and disadvantages of each of the systems
- Analyze current designs and the energy efficiency associated with each type of roofing system
- Analyze how each different roof type will influence mechanical and structural systems.
- Determine constructability issues, schedule impacts, and perform an in-depth life cycle cost analysis

Potential Solutions and Expected Outcomes

It is believed that applying a single roof system throughout the entire roofing surface will result in greater efficiencies in cost, schedule and construction. The application of a green roof system will cost more and require greater structural reinforcement; however, it will allow the building to qualify for greater LEED credits through reduction of the Heat Island Effect and the reduction of storm water runoff. The system will also have increased savings due to its thermal efficiency. Installing the cool roof system to all of the roof's surfaces will likely result in greater LEED qualifications and cost savings due to reduced structural needs. Unfortunately, the cool roof system will not be as thermally efficient as the cool roof system.

- Outcomes

- Detailed analyses will likely show that each system will have its own advantages associated with cost, mechanical and structural impacts and LEED certifications.
- Analyses will also likely show that the systems will have constructability advantages and disadvantages that could make them more beneficial alternatives.

Resources

- AE Faculty, Key Industry Members
- Owner Representatives and the Construction Team
- Product manuals and Reviews
- Project Drawings and Specifications
- Educational Background from Previous AE Courses, Internship with Dr. Riley
- Knowledge from undergraduate courses (AE 308 and E 404)
- Applicable Literature

Weight Matrix

The four technical analyses that are described in this proposal involve studies based on four core thesis investigation areas including; Critical Issues Research, Value Engineering Analysis, Constructability Review, and lastly, Schedule Reduction/Acceleration proposal. The weight matrix depicted in Table 1 shows the percentages in which the technical analysis areas incorporate these core investigation areas.

1. Critical Issue Research
2. Value Engineering Analysis (VE)
3. Constructability Review
4. Schedule Reduction/Acceleration

Weight Matrix					
Description	Research	VE	Constructability review	Sched. Reduction	Total
MEP Prefabrication	5%	-	10%	20%	35%
BIM Uses	-	20%	-	10%	30%
Prefabricated Interior Partitions	-	-	5%	10%	15%
Alternate Roof System	10%	10%	-	-	20%
Total	15%	30%	15%	40%	100%

Table 1 Weight Matrix

Time Table

To ensure the ability to stay on task and to meet the senior thesis goals, a timetable for the spring 2013 semester has been developed. The table will be utilized to track and assess progress. It will also be used to properly sequence and consider each analysis.

It is essential to use this table as a guideline to schedule items to be completed and the major milestones that should be achieved in order to efficiently complete four technical analyses and two out of option breadths. Maintaining this schedule will assist in remaining on task and organized throughout the spring 2013 semester.

Critical Issues Research Methods

A critical industry issue that applies to the Concordia Hotel project is lean construction. The analyses will apply techniques used to attain a lean construction practice by employing prefabrication techniques to the project utilizing BIM as a valuable asset to this analysis. The analyses will pursue research in this critical industry issue because of the experiences, interests, and experiences at the PACE Roundtable meeting that support its relevance. Throughout the curriculum of the Architectural Engineering Program, experience is provided with lean construction initiatives and sustainable/green design. Throughout the program has been a push to apply more prefabrication and modularization methods because of their ability to improve construction efficiency. The PACE Roundtable event helped justify the application of prefabrication to the project.

Problem Statement

The challenge that faces the industry when it comes to prefabrication is the ability to apply this method to construction. Prefabrication and modularization are becoming more and more prevalent in the construction industry; however, the feasibility of this method still requires some justification. Unfortunately, this method is not always feasible because of the fact that there are not enough facilities that are located nearby a construction site. It is often impractical to apply prefabrication, because the cost of transportation often outweighs the potential schedule and project cost savings.

Goal of Research

The goal of my research is to better understand what prefabrication can truly benefit in concern to the construction industry. My hopes are that I will better understand the need for its application, the benefits that will occur and the areas in which it can be applied. In order to apply this method to my analyses one and three I will need to have a great understanding of how to design for prefabrication, how to plan for offsite fabrication, the design of logistics and lastly production planning.

When researching the design for prefabrication, the analysis will consider the ideas of standardization, design schedule requirements & constraints, and unique considerations. Conducting research on the planning of offsite fabrication I plan to look into the labor and production tradeoff optimization. My research will also analyze transport, transport design and constraints, and erection/placement methods when considering the design of logistics. A thorough analysis will finally be conducted on the sequencing and scheduling for modularization and install coordination requirements related to production planning.

These research areas will be compiled in order to comprise a report essentially that can be used for different audiences who may benefit.

I imagine that my guide can be utilized by any industry members hoping to apply prefabrication techniques to construction activities and key systems on their construction project. The guide can be used by students, faculty and professionals in order to better prepare individuals tackling the somewhat daunting task of applying this method to their project.

Conclusion

Upon completion of the four technical analyses described in this proposal, alternative methods for delivering this project based on a central theme of efficient design and construction will be determined. The goal of these analyses is to suggest areas of improvements in the process of both building construction and operation that can be performed on the Concordia Hotel. The analyses will be performed involving four core investigation areas including Critical Issues Research, Value Engineering Analysis, Constructability Reviews, and Schedule Reduction/Acceleration Proposal. The first analysis, BIM, is to increase efficiency of the construction means and methods, decrease cost, add value to the building and to reduce the schedule. The second analysis, MEP Prefabrication, is to help with schedule and cost savings. The third analysis, Prefabrication of Drywall/Framing of Interior Partitions is also an initiative to help with schedule and cost savings. The fourth analysis, Alternate Roofing Systems, will be applied to the project in order to improve the efficiency of the project. Additionally, out of option breadths will arise during this analysis to determine how replacing the currently proposed green roof system combined with a typical TPO roof system with other roofing alternatives. These analyses will be conducted over the duration of the spring semester and then compiled into a final thesis report and finally the findings will be presented to the AE Faculty and Jury Members.

Appendix A

Breadth Topics and MAE Requirements

Breadth Topics

In order to demonstrate a breadth of understanding in Architectural Engineering, two breadth studies will be performed to display competency in other disciplines. The following breadths are related to the impacts on the structural and mechanical systems due to the review of a more efficient roofing system.

Structural Breadth

The current designed roof of the tenth floor consists of a green roof system and typical TPO type roofing. With the construction of a new roofing system to the tenth floor, the current design of the structural system may be affected due to the weight of the proposed alternate systems.

This analysis will satisfy a structural breadth requirement by illustrating skills to perform a structural analysis and redesign of the tenth floor roofing system. The structural analysis will consist of determining if the existing system is sufficient and if redesigning the system is necessary due to the increased or decreased dead loads. If changes to the design must occur, the impact on project schedules and costs will also be determined. Each different roofing type will have different weights and support requirements causing redesigns of the structural systems. These may cause a reduced or an increased requirement of structural capacity depending on the system applied. Through the utilization of STAAD and the knowledge acquired in my structural analysis classes AE 308 and AE 404 I will conduct an analysis of the structural loading requirements. Each roofing system will have its advantages and disadvantages associated with LEED credits, construction costs and schedule impacts.

Mechanical Breadth

The current designed roof of the tenth floor consists of a green roof system and TPO type roofing. With the construction of a new roofing system to the tenth floor, the current design of the mechanical system may be affected due to the thermal properties of the alternate systems.

This analysis will satisfy a mechanical breadth requirement by illustrating skills to perform a mechanical analysis of the alternate roof systems. The impact of the system will be analyzed in terms of thermal resistance between the alternate roof systems and their impact on the mechanical systems for the project. Through the utilization of energy model programs like eQUEST and TraneTrace I will analyze the energy savings potentials through the application of roof systems with greater thermal capabilities. After determining any changes to the heating or cooling loads, mechanical system resizing and load reduction calculations will occur. A cost analysis for the savings involved in the reduction of the mechanical load will be calculated and used as evidence to support the application of the alternate systems.

MAE Requirement: Material Staging and Just-In-Time Delivery Methods for Prefabricated Systems

The site logistics of this project served as a challenge for the project team due to the complex phasing of the schedule and the fact that the facility will remain active during the entire duration of construction. The goal of this analysis is to perform an in-depth analysis to explore options for a “lean” construction approach to material delivery and material storage for the project. Another goal for this analysis is to explore the idea of implementing prefabricated MEP and drywall/framing of interior partition systems to the job and understand its impact on constructability of the systems.

Appendix B

Spring Semester Preliminary Timetable

			1/28/2013 Milestone 1		2/11/2013 Milestone 2		3/1/2013 Milestone 3				3/25/2013 Milestone 4	**Ian Bower** Mr. Sowers						
Proposed Thesis Semester Schedule January 2013 - April 2013																			
Jan-7-13	Jan-14-13	Jan-21-13	Jan-28-12	Feb-04-13	Feb-11-13	Feb-18-13	Feb-25-13	Mar-04-13	Mar-11-13	Mar-18-13	Mar-25-13	Apr-01-13	Apr-08-13	Apr-15-13	Apr-22-13				
Receive the BIM Model From Turner & Update Model								Spring Break				Final Report April 3	Faculty Jury Presentation April 8-12		Senior Banquet April 26				
	Design Shop Drawings of MEP for local Prefabrication																		
		Locate and Choose MEP Prefab Facilities based on Value Added																	
			Design Shop Drawings of Framing/Drywall Interior Partitions for Local Prefabrication																
				Locate and Choose Framing/Drywall Interior Partitions Prefab Facilities based on Value Added															
					Analyze Cost and Schedule Savings Potentials With Prefabrication														
					Research Alternate Roofing Systems														
						Structural Breadth Analysis of Roof Systems													
							Mechanical Analysis		Breadth Roofing										
									Analysis of Savings in Project Costs & Schedule, & LEED credits		Tie-Up Loose Ends								
												Finalize Report							
Milestone					Begin Write-Up				Begin PowerPoint										
1	Depth 1 Complete Building Information Modeling (BIM)							Spring Break					Jury Presentation						
2	Depth 2 Complete Implementation of MEP Prefabrication							Submission											
3	Depth 3 Complete Prefabrication of Drywall/Framing Partitions							Miscellaneous						ABET Assessment					
4	Depth 4 Complete Alternate Roof System							Finished Work						Update CPEP and Report					