The Educational Activities Building

PSU Harrisburg Campus

Figure 1 Images courtesy of BCJ

Thesis Proposal Revised

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Option: Construction Management

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Executive Summary

The senior thesis proposal is the base that helps to develop the final thesis report in the spring semester. The four analyses that were introduced in the proposal presentation are discussed in more details in this assignment. After a meeting with Dr. Craig Dubler, it was decided to switch the Building Envelope analysis to Technology Integration for Information Management analysis. This adjustment to the thesis proposal was a result of moving the topic into an area more related to construction management discipline. Each analysis is addressing a problem or an opportunity of improvement in the Educational Activities Building. The analyses will cover one or more of the following core areas of investigation; Critical Issues Research, Value Engineering Analysis, Constructability Review and Schedule Reduction/Acceleration.

Analysis 1: Alternative Roof System (Green Roof)

This analysis was considered due to the importance of sustainability to the owner "Penn State" and an opportunity to obtain several extra LEED credits to achieve LEED Silver Certification. Different green roof systems will be analyzed and evaluated to pick the best alternative. In addition, a structural breadth will be performed due to the extra dead weight imposed by the green roof system.

Analysis 2: MEP Modularization

The MEP system modularization analysis is expected to provide a solution for job site congestion. If this solution is implemented on the project, there will be a reduction in the schedule and increased productivity and safety. Multi-trade modularization was also one of the critical industry issues that were discussed in the 22nd annual PACE Roundtable. Additionally, a constructability review will be performed on this analysis and an architectural breadth.

Analysis 3: Structural Steel Sequencing

The structural steel erection activities are on the critical path of the schedule and many other activities have a finish-to-start relationship with it. Any delays in the structural steel activities mean that the completion date of the project will be pushed. In this analysis, few sequencing plans will be created and evaluated based on a several criteria.

Analysis 4: Technology Integration for Information Management

This part addresses the issues related to communication and information handling in the Educational Activities Building project. The solution proposed consists of several parts; creating a system to share information and utilizing technology tools such as tables on the construction site. This idea was generated from one of the breakout sessions at the 22nd annual PACE Roundtable.

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Analysis 1: Alternative Roof System (Green Roof)

Problem/Opportunity Identification

There were several sustainable ideas considered for the Educational Activities Building project to obtain the minimum credits required for the LEED Basic Certification. From the Technical Reports, it was observed that there more potential credits to achieve LEED Silver Certification. However, the main focus here is to improve the building systems while staying under the budget. It would be interesting to see how this could affect the building performance in the long run.

Background Research

One of the main areas that will be researched is alternative roof systems that could potentially add value to the project. Green roof system stood out for its increasing popularity even with Penn State projects such as the Millennium Science Complex. Although, green roof systems have a higher initial cost, it will reduce the mechanical load which will decrease the utility cost in the long run. The main goal here is not only to obtain more LEED credits but to make the project more sustainable and efficient. The HUB addition project is utilizing a green roof and it will be used as a case study. Additionally, the city of Chicago developed green roof requirements, which will be looked at as a part of this analysis. A value engineering analysis will be performed on the changing the current roof system to the green roof system. Other alternative roof systems will also be considered for the project.

Potential Solutions

While using a green roof system might increase the cost, it will have the following positive impacts:

- Reduced mechanical loads
- Improved storm water management
- Increase roof life span which will decrease the cost of replacing it every several years
- Improved aesthetics
- Potential LEED credits

Methodology

To perform this analysis the following steps will be taken:

- Investigate the current roof system
- In depth research of different green roof systems available
- Evaluate the cost and schedule impact of the alternative roof system

- Redesign the roof structure in case if the green roof system was selected
- Perform value engineering analysis and constructability review
- Determined if the best roof system alternative should be implemented on the project

Expected Outcome

The implementation if the green roof system will increase the overall sustainable performance of the project. Despite the initial high cost of the green roof system, the owner could be pursued by presenting the long run benefits of the new system such as the long life cycle and reduced mechanical loads. Additionally, there will be a chance to earn more LEED credits to achieve a higher LEED Certification.

Resources and Tools

The following resources will be used to help with this analysis:

- The project structural engineer
- The Architectural Engineering Department at Penn State
- Office of the Physical Plant at Penn State
- Green roof systems manufacturers
- Online journals on green roof systems
- Project schedule and documents

*** See (Appendix A) for Structural Breadth ***

Analysis 2: MEP Modularization

Problem/Opportunity Identification

Through analyzing the Educational Activities Building project schedule from the Technical Report 2, it has been observed that the MEP System activities overlap each other as shown in Table 1. This causes congestion on the construction site due to having multiple crews working at the same time. As a result, the potential for accidents and reduction in productivity is increased. Additionally, having a crew for each component of the MEP systems increases the labor cost. In the 22nd annual PACE Roundtable, one of the critical industry issues Multi-trade Modularization was the main topic discussed in the breakout sessions. If this could be implemented on the project, it will eliminate the problems from the MEP systems such as cost and site congestion.

Table 1 the MEP system construction schedule

Task	Start Date	Finish Date
Mechanical Rough-In	7/17/2013	11/21/2013
Electrical Rough-In	9/4/2013	12/9/2013
Plumbing Rough-In	9/4/2013	11/28/2013
Mechanical Distribution	8/14/2013	12/13/2013
Electrical Distribution	9/27/2013	12/18/2013
Plumbing Distribution	9/4/2013	1/1/2014
Mechanical Finishes	9/13/2013	12/26/2013
Electrical Finishes	9/27/2013	12/24/2013
Plumbing Finishes	10/11/2013	1/9/2014

Background Research

Multi-trade modularization is a growing trend and being employed in many projects. In order for multi-trade modularization of the MEP System (Figure 2) to be applied on the Educational Activities Building project several things will be considered. An analysis of the building different zones will be performed to decide what sections of the building can utilize it the best. Additionally, an evaluation of the multi-trade modularization of the MEP System impact on the cost and schedule will be done. In depth research of the region modularization shops will be done to find the cost,

Figure 2 A sample of MEP Modularization. Image courtesy of http://www.modulusmep.com

time and quality of their products. Finally, other building systems will be considered to see the feasibility of utilizing modularization. The main goal is to improve the constructability and accelerate the overall project schedule.

Potential Solutions

Implementing the multi-trade modularization of the MEP System will have several positive impacts on the project:

- Improve the quality of the final product by manufacturing it in a control environment (Figure 3).
- Accelerate the project schedule by decreasing the MEP System activities to the minimum such as installation and inspections (Figure 4).
- Lower the cost by eliminating the need for multiple crews for each trade.
- Safety onsite is improved by lowering the site congestion.

Methodology

To perform this analysis the following steps will be taken:

- Research the uses of multi-trade modularization in the construction industry.
- Analyze if this solution is best implemented for the MEP System of the entire project or just a specific section of the building.
- Review pervious projects that have utilized this solution.
- Research modularization shops in the region
- Determine constructability issues and the impact on the schedule
- Estimate the cost of implementing this solution
- Determined if this solution should be implemented on the project

Figure 4 The installation process of the MEP system modular. Image courtesy of http://www.globaloff-site.com

Figure 3 A modularization shop where the components are built in a control environment. Image courtesy of http://www.mepsolutions.com

Expected Outcome

This analysis will compile a lot of information regarding the utilization of multi-trade modularization on construction projects. Upon the completion of this research, a deeper understanding of issues related to modularization will be obtained. The evaluation of the cost, schedule and quality will prove the benefits of implementing this solution on the Educational Activities Building.

Resources and Tools

The following resources will be used to help with this analysis:

- The project manager Mr. Adam Dent
- The 22nd Pace Roundtable discussion sessions
- Office of the Physical Plant at Penn State
- Modularization shops in the region
- Online journals on multi-trade modularization
- Project schedule and documents

*** See Appendix A for Architecture Breadth ***

Analysis 3: Structural Steel Sequencing

Problem/Opportunity Identification

The structural steel sequencing plan on the Educational Activities Building project (Figure 5) is good but there is more room for improvement. From the Technical Report 3, it was established that the structural steel activities is on the critical path which means there are huge risks that connected to it. Most construction activities post the structural steel erection can't start till the final completion of it. So any delays in the structural steel activities will lead to delay the overall project schedule.

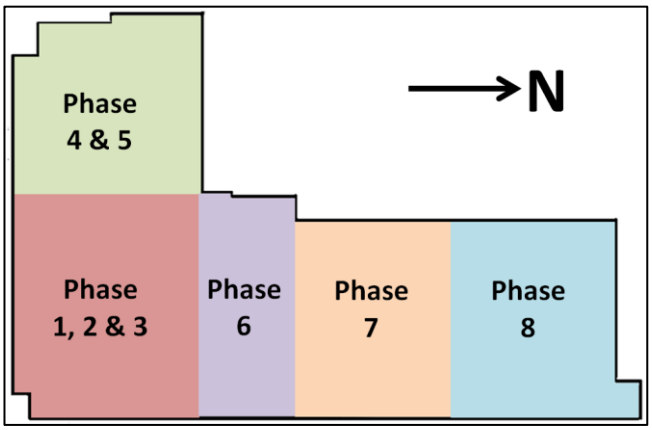


Figure 5 The current structural steel sequence used on the EAB project

Background Research

A thorough research on methods to improve the structural steel sequence will be performed. The construction site will be studied to find the optimal locations for storage areas, cranes and other items. Multiple structural steel sequencing plans will be created and evaluated to select the best alternative for the current sequence plan. Additionally, any activities dependent on the completion of the structural steel erection will be studied to create solutions for any potential delays. As a result, it will be possible to start some of these activities before the completion of the steel frame. The main goal is to ease constructability and sequencing the steel frame erection to avoid any delays. There is a great opportunity to perform value engineering analysis in this area.

Potential Solutions

The potential solutions are either to re-sequence the structural steel erection activities or find alternative ways to start some of the activities that have finish –to-start relationship with it. This will allow other trades to start working earlier and avoid any delays and added cost to the project.

Methodology

To perform this analysis the following steps will be taken:

- Analyze the current structural steel sequence and the site plan

- Investigate projects that employed an efficient sequencing plans
- Develop alternative sequencing plans
- Create a rating system to compare and evaluate the alternative sequencing plans
- Choose the optimal alternative sequencing plan
- Perform a cost estimate and schedule reduction
- Determined if the best alternative should be implemented on the project

Expected Outcome

The expected outcome of this analysis is to find the ideal structural steel sequencing for the Educational Activities Building project. If an improved sequencing plan to be chosen, it will result in schedule reduction and better constructability by using a more efficient erection process.

Resources and Tools

The following resources will be used to help with this analysis:

- The project team: the steel fabricator and Mr. Adam Dent
- The Architectural Engineering Department at Penn State
- Office of the Physical Plant at Penn State
- Structural steel subcontractor
- Online journals on structural steel sequencing
- Project schedule and documents

Analysis 4: Technology Integration for Information Management

Problem/Opportunity Identification

Information management for the work force was one of the main topics discussed during the breakout session at the 22nd annual PACE Roundtable. As mentioned in the technical report 3, there is a cultural shift toward the use of technology in the construction industry. Using the old fashioned way of handling documents and communication is not sufficient enough to meet the industry needs nowadays. Project teams spend a good amount of their time going through printed documents and communicating with each other. If the technology tools available in the industry can be implemented on this project, it can increase the efficiency of the project team and the workforce.

Background Research

From the technical report 3 section on the PACE Roundtable, it has been noticed that an increasing percentage of the industry is utilizing technology tools on their projects. Technology can save much of the time wasted on finding or sharing information between the project participants. There is a good chance for integrating more technology into the project due to the heavy use of BIM. For instance, tablets (Figure 6) could be used on the construction site as a tool for easy access to the project documents.

Figure 6 Using tablets to view BIM files. Image courtesy of http://obamapacman.com

Potential Solutions

The solution consists of different components that will help to solve the presented issues. The first task is to create a system for managing and sharing information between the different project teams. Then technology tools such as tablets will be integrated into the construction site so the workforce can view what activities needed to be performed on each day. Additionally these tablets can be used to provide the workers with the right amount of information they need to know instead of confusing them with too much information. The main goal is to increase the efficiency of the construction process of the Educational Activities Building.

Methodology

To perform this analysis the following steps will be taken:

- Research the technology tools uses in the construction industry
- Interview the project manager (See Appendix B)
- Review pervious projects that have utilized this solution
- Determine the feasibility of implementing this solution
- Estimate the cost of implementing this solution
- Determined if this solution should be implemented on the project

Expected Outcome

The expected outcome of this analysis is a document covering the use of technology in the construction industry and the qualitative impact on this specific project. If the advantages of applying this solution on the Educational Activities Building project outweigh the disadvantages, it will be recommended to the owner. It is believed that using technology tools can enhance information management of the project.

Resources and Tools

The following resources will be used to help with this analysis:

- The project manager Mr. Adam Dent
- The Architectural Engineering Department at Penn State: Professor Robert Leicht
- Office of the Physical Plant at Penn State: Mr. Eric Nulton
- Industry members: Mascaro Constriction
- Online journals on technology used in the construction industry
- Project documents

Analysis Weight Matrix

In order to suggest a fair weighting breakdown of the spring semester grade, an analysis weight matrix was created as illustrated in Table 2. The grading was divided between the four analyses based on the amount of work and time will be spent on each area. Additionally, breadths were taken into account when the grades were divided between the four analyses.

Table 2 Analysis Weight Matrix

Analysis Description	Critical Issues Research	Value Engineering Analysis	Constructability Review	Schedule Reduction/ Acceleration	Total
Alternative Roof System (Green Roof)	-	10	10	-	20
MEP Modularization	15		5	10	30
Structural Steel Sequencing	-	15	10	5	30
Technology Integration for Information Management	20	-	-	-	20
Total	35	25	25	15	100

Grade Breakdown

Based on Table 1, the suggested grade breakdown is the following:

Analysis 1 Alternative Roof System (Green Roof) : 20%

Analysis 2 MEP Modularization : 30%

Analysis 3 Structural Steel Sequencing : 30%

Analysis 4 Technology Integration for Information Management : 20%

Conclusion

In conclusion the four analyses in this thesis proposal will serve as the base of the thesis investigation that will be conducted in the spring semester. Each analysis took advantage of an opportunity of improvement or solved a problem that was encountered at the Educational Activities Building project. Owner goals, quality, safety, cost and schedule were all considered when this proposal was prepared. There were two breadths identified, a mechanical breadth for analysis 2 and a structural breadth for analysis 4.

Appendix A

Breadth Topics

Breadth 1 Mechanical

The proposed MEP system modularization is a great potential solution for the site congestion problem. For this analysis to be successfully completed an architectural breadth analysis will be needed. Although, this is mainly a mechanical analysis but it directly affects the architectural design of the building. This breadth analysis will focus on the constructability review of the MEP modularization. Changes such as modifying the ceiling height will be investigated to enable the constructability of this solution. Any changes in the system will be documented to ensure the feasibility of implementing the MEP system modularization without negatively affecting the schedule, cost and quality.

Breadth 2 Structural

To take advantage of potential extra LEED credits, improve the building sustainable performance and reduce the mechanical load, a green roof system will be analyzed as a possible solution. In order to do implement this alternative, a breadth analysis will be performed on the roof structure. As mentioned in the building statistics 2 assignment, the current roof structure is made of a composite metal deck covered with a 3.25" layer of light weight concrete (figure 7). The green roof system will impose additional dead weight on the roof structure which might be redesigned to adapt the extra weight.

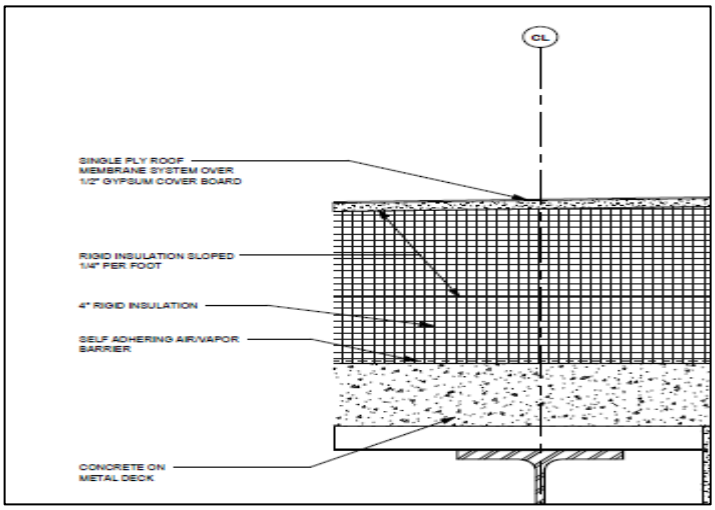


Figure 7 Sectional view of the roof structural. Image courtesy of BCJ

Appendix B

Analysis 1 Project Manager Interview

Project Manager Interview on Technology Integration for Information Management

1. **What issues have you or other members of the project team encountered when communicating with each other?**

2. **How is technology utilized in the Educational Activities Building project?**

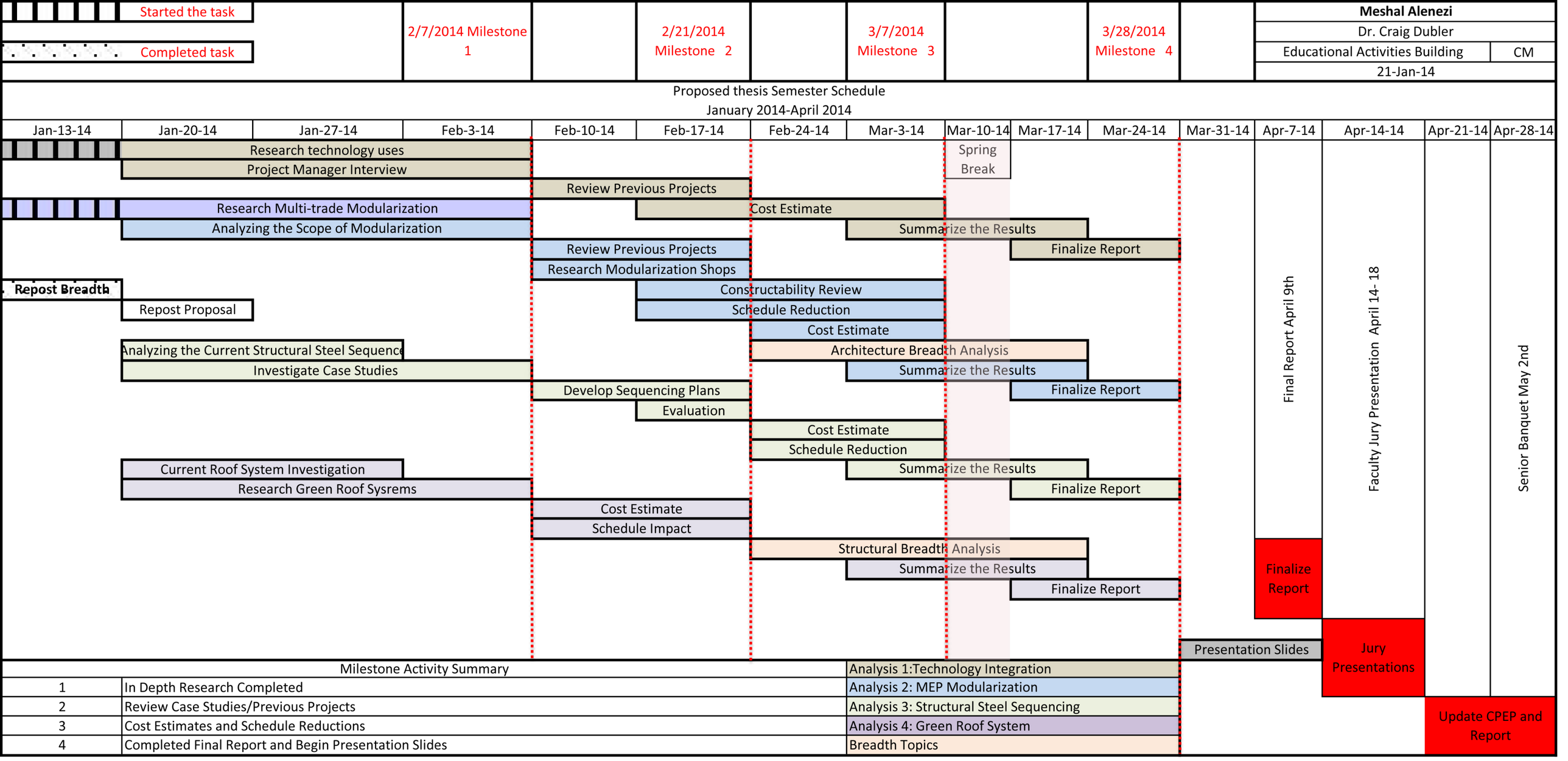
3. **Have you used any technology tools such as tablets in previous projects? And how comfortable are you with technology?**

4. **How are project documents and drawings being used? Are electronic versions being used more that printed versions?**

5. **How do you predict the future of the construction industry in regard to using technology?**

Appendix C

Preliminary Spring Semester Schedule


Started the task
Completed task
2/7/2014 Milestone 1
2/21/2014 Milestone 2
3/7/2014 Milestone 3
3/28/2014 Milestone 4
Meshal Alenezi
Dr. Craig Dubler
Educational Activities Building
CM
21-Jan-14
Proposed thesis Semester Schedule
January 2014-April 2014
Jan-13-14
Jan-20-14
Jan-27-14
Feb-3-14
Feb-10-14
Feb-17-14
Feb-24-14
Mar-3-14
Mar-10-14
Mar-17-14
Mar-24-14
Mar-31-14
Apr-7-14
Apr-14-14
Apr-21-14
Apr-28-14
Research technology uses
Project Manager Interview
Spring Break
Review Previous Projects
Research Multi-trade Modularization
Cost Estimate
Analyzing the Scope of Modularization
Summarize the Results
Finalize Report
Review Previous Projects
Research Modularization Shops
Repost Breadth
Constructability Review
Repost Proposal
Schedule Reduction
Cost Estimate
Analyzing the Current Structural Steel Sequence
Architecture Breadth Analysis
Investigate Case Studies
Summarize the Results
Finalize Report
Develop Sequencing Plans
Evaluation
Cost Estimate
Schedule Reduction
Current Roof System Investigation
Summarize the Results
Research Green Roof Sysrems
Finalize Report
Cost Estimate
Schedule Impact
Structural Breadth Analysis
Summarize the Results
Finalize Report
Final Report April 9th
Faculty Jury Presentation April 14- 18
Senior Banquet May 2nd
Finalize Report
Presentation Slides
Jury Presentations
Update CPEP and Report
Milestone Activity Summary
1 In Depth Research Completed
2 Review Case Studies/Previous Projects
3 Cost Estimates and Schedule Reductions
4 Completed Final Report and Begin Presentation Slides
Analysis 1:Technology Integration
Analysis 2: MEP Modularization
Analysis 3: Structural Steel Sequencing
Analysis 4: Green Roof System
Breadth Topics