THE CLARK

The Sterling & Francine Clark Art Institute

Williamstown, MA.

Revised Senior Thesis Proposal

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January 13, 2012

Executive Summary

The Senior Thesis Proposal purpose is to overview the four analyses to be performed on the Sterling and Francine Clark Art Institute in the final senior thesis report in the spring semester. For each analysis, the reason for choosing the analysis will be discussed as well as how the research will be performed, solutions and expectations, and resources. The analyses are to suggest areas of improvements in the process of both building construction and operation.
The weight matrix at the end of the report illustrates how the effort was distributed among the four analyses and how they meet the core requirements as the following:
research; value engineering analysis; constructability review; schedule reduction.

Analysis 1: Implementation of MEP Prefabrication
The Mechanical/Electrical/Plumbing (MEP) system that is embedded in the 2 ½' thick mat slab is the main construction issue. Many conflicts were spotted before construction which called the need to make a 3D model to better coordinate the embedded system. Since the project is about one month behind schedule, the generated 3D model is beneficial in creating clash free shop drawings for MEP prefabrication. The analysis will discuss how to achieve the goal which is to put the schedule back on track and reduce construction costs.

Analysis 2: Building Information Modeling
The successful use of building information modeling (BIM) in 3D Coordination on the project is a proof of how BIM is beneficial to construction projects. The project team at the Sterling and Francine Clark Art Institute has efficiently utilized only 3D coordination BIM use. The goal of this analysis is to explore and suggest more applicable BIM uses as they are project specific. Three BIM uses are to be suggested, analyzed, and compared in terms of costs and benefits. The Penn State BIM Execution Planning Guide will be utilized to aid in the research process.

Analysis 3: Precast Floor Units
With the irregularity in the shape of the Sterling and Francine Clark Art Institute, pouring concrete in corners can be tedious and challenging. The precast units can ease the construction process by having the ultimate unite size with exception of corner units to reduce joints and onsite resizing. The goal of using the precast units is to increase productivity and constructability of the building. The analysis will show a contrast of current vs. suggest systems in terms of cost and schedule. Applying analysis 1 and 3 can speed up construction significantly.

Analysis 4: Solar Photovoltaic (PV) Panels
Being a green building is not implicitly means obtaining LEED certifications or having lower carbon footprint. It can also mean more energy cost savings with reasonable payback and less generator use. The PV panels are to assist in electricity generation to power the high energy consumption of the art institute. Brief structural and electrical analyses will be developed.

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Project Background

The sterling and Francine Clark Art Institute new addition consists of high end art galleries and research labs located in Williamstown, MA. The growing number of students and the fact that the museum became well known in the world of art were the reasons of the need to build a new addition the existing building. The addition of this new facility costs $28 million where Turner Construction is the General Contractor on the project. The state of the art new addition is design by the famous Japanese Architect Tadao Ando. It is made up of one floor and a basement and has a size of 68,000 SQF. The construction of the project started on January 2011 and scheduled to complete on September 2013 with a design bid build delivery (DBB) method and a guaranteed maximum price (GMP) contract.

Figure 1: Rendering of the new addition

The site for the new addition is relatively not constraint where it is next to an existing building called the Manton and the main parking lot. In figure 2, mark 1 shows a rendering of the new addition, 2 shows the Manton, and 3 for the parking lot.

Figure 2: New addition location in respect with surroundings

The project faced some construction issues which delayed schedule by one month. That called the need to implement new solutions to put the schedule back on track with several solutions that will be discussed in this proposal.

Figures 1 & 2 courtesy of Turner Construction

Technical Analysis 1: Implementation of MEP Prefabrication

The Problem

The complex MEP system that is embedded in the 2 ½' thick mat slab is the main construction issue. The issue required the construction team to better coordinate the MEP layout in the slab. The team took the extra effort, time, and cost to generate a 3D model to avoid future field conflicts which would be challenging and expensive to solve. That made more critical to better coordinate what is in the mat slab. Also, since the project is delayed by almost a month, there were options considered by the team to make up time such as doubling shifts or working on Saturdays and Sundays. Another option, was not considered by the team, that can significantly accelerate the schedule is installing MEP prefabricated units.

The Goal

The goal of implementing the MEP prefabrication is to catch up with the schedule. It is also to determine the cost and benefits of this implementation.

The Method

- Gathering the required information about the required performance of the MEP system.
- 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 and not limited to distance or cost.
- Calculating time and cost of transportation.
- Effect on logistics and equipment.
- Determining a typical area to research the cost and time differences and benefits between the new and the current systems.

Potential Solutions and Expected Outcomes

MEP Prefabrication can assist in schedule acceleration, waste reduction, and may have cost reduction. The team can utilize the 3D model in creating clash free shop drawings that can serve the prefabrication process greatly by having problem free units installation. Prefabrication allows having the units' quality under control that will increase the quality of the final product; which eliminates waste and scraps and that will result in cost reduction and accomplishing more LEED credits as well. Add in, safety levels will be enhanced since laborers will not be exposed to MEP modifications.

- Outcomes:
    - Cost analysis that will discuss the added costs such as delivery costs and the total savings from this method.
    - 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 the site, time to shake them out, and the time to install.

Resources

- AE faculty.
- Owner representative and construction team.
- Educational background from previous AE courses.
- Prefabrication facilities.

Technical Analysis 2: Building Information Modeling

The Problem

For the Sterling and Francine Clark Art Institute, Building Information Modeling (BIM) was only utilized as a clash detection tool and was implemented after document completion. They decided to use it as a clash detection tool since it helped coordinating the MEP system in the mat slab. The owner and project team could have benefitted more from different BIM uses to either add more value to the building or increase the construction efficiency. From AE 473, buildings which are sustainability evaluated, which is one BIM use, has a better value, their rent increased, occupancy rate increased, etc.

The Goal

The goal of implementing more relative BIM uses, as they are project specific, is to increase efficiency and add value to the building.

The Method

- Determining how Construction System Design (Virtual Mockup) is an effective BIM use that will serve the project at best. The uses were selected per to the following criteria:
    - The nature of the building and its assets and the value added to the owner
    - The construction issues faced by the team
    - Future modification to the building spaces
    - General Contractor interest and how they will increase productivity
- Research the mentioned BIM uses more in depth.
- Contacting Turner Construction to find out how beneficial BIM was to either past or current projects.
- This BIM use can better show how effective it is to implement the first analysis, the MEP prefabrication, to the building utilizing the virtual mock up.
- Cost vs. benefits will be analyzed to determine whether this BIM use worth the effort.

Potential Solutions and Expected Outcomes

The owner is the one who decides which BIM use can be implemented in the project. To do so, the owner will be evaluating the costs and benefits from the suggested uses. If the owner finds the uses can add value to the project, then the owner may elect to go with the valuable ones more if any. Demonstrating how asset management helps the owner in operating the building, how virtual mockup increases productivity, and how space management and tracking aids both of the owner and the project team in insuring the optimum use of spaces and planning future space needs may encourage the owner to implement the suggested BIM uses.

Resources

- AE faculty and graduates.
- Owner representative and construction team.
- Educational background from previous AE courses.
- U.S. Green Building Council.
- 3D software.
- Penn State BIM Execution Planning Guide

Technical Analysis 3: Precast Floor Units

The Problem

The Sterling and Francine Clark Art Institute new addition has an irregular shaped geometry due to the complexity of the architectural design. So, pouring concrete in tight areas, especially corners where there are many, can increase constructability issues. As a result, labor costs will increase as well as time. The precast units will cover the elevated slab area over the basement only as illustrated in the shaded area on figure 3.

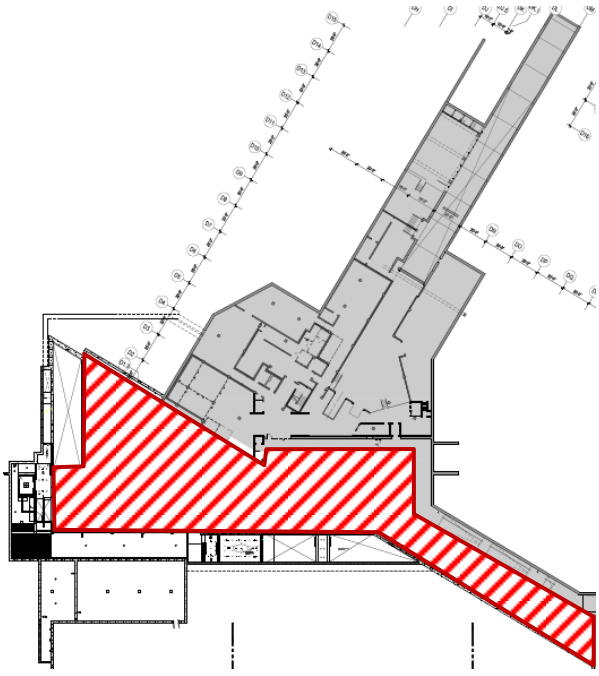


Figure 3: Proposed Covered Area by Precast Units

The Goal

The goal of using precast floor is to increase productivity and constructability of the complex building geometry and to put the schedule back on track.

The Method

- Gathering the required information about the required performance structurally.
- Finding the ultimate unite size to minimize joints.
- Locating and choosing the best precast facility in terms of value and not limited to distance or cost.
- Calculating time and cost of transportation.
- Effect on logistics and equipment.
- Determining the entire floor system of the elevated slab area to research the cost and time differences and benefits between the new and the current systems. A ll units will have a typical size with the exception of the corner units to minimize joints and onsite resizing.
    - It is challenging to find a typical size for the precast units with given irregular shaped building and the intention to create a good surface with a minimum number of joints to eliminate errors and uneven surface.

Potential Solutions and Expected Outcomes

Precast floor units are expected to cut down costs of labor and increase efficiency as well as increasing safety levels onsite.

- Outcomes:
  - Schedule analysis that will show the time differences between the proposed and the old system.
  - Cost analysis for both systems as well.

Resources

- AE faculty.
- Owner representative and construction team.
- Educational background from previous AE courses.
- Precast facilities.

Technical Analysis 4: Solar Photovoltaic Panels

The Problem

The Sterling and Francine Clark Art Institute new addition is a state of the art facility with high end art galleries and research labs. The building has high energy consumption rates. That is due to the nature of the building as it has different complex HVAC system to better control the air quality. In addition, the lighting system is considered to be one of this building's systems that has high energy consumption rates to properly light artifacts in galleries not to mention the energy consumed in labs. This new project may not be able to achieve the aimed Silver LEED rating according to the latest version LEED score card. Employing the benefits of the solar PV panels will not only contribute to better LEED rating, better yet, it will reduce the dependency on relying on power grid, decrease the use of generators, and decrease energy costs.

The Goal

The goal is to determine the reduction in energy costs in the long term by determining the payback period and the how effective energy produced by the PV panels.

The Method

- Studying the solar intake of the building.
- Determining the most effective solar angle that will produce the highest energy rates.
- Defining the most applicable and effective panels to the location and energy performance needed of the building.
- Studying the existing structure capability to carry the new dead load.
- Calculating how much of energy can the panels produce with the given location, solar intake, and type of the selected panel. Then, determining the panels cost, energy savings, and payback period.
- Construction analysis in terms of:
    - Schedule and critical path impacts.
    - Detailed cost estimate for a typical area that can give a relatively accurate estimate.
    - Means and methods for installation and other building systems impacts such as mechanical and electrical systems with negligible structural impact.

Potential Solutions and Expected Outcomes

PV panels are expected to reduce energy consumption costs but not to depend on them in carrying building electric loads. Moreover, PV panels are expected to have a reasonable payback period. Last but not least, they will help the owner in achieving their LEED rating goal.

See Appendix A for the structural and electrical breadths.

Resources

- AE faculty.
- PV panels facilities.
- Educational background from previous AE courses.
- Previous similar projects with similar solar intake that have used PV panels.

Weight Matrix

Table 1 below illustrates how the effort and time were spent and distributed for each of the four analyses associated with each core area. There are four core areas for each analysis, and they include:

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

Description	Research	VE	Const. Review	Sched. Reduction	Total
MEP Prefab.	10%	5%	5%	15%	35%
BIM Uses	15%	-	10%	-	25%
Precast Units	-	5%	5%	10%	20%
PV Panels	5%	10%	5%	-	20%
Total	30%	20%	25%	25%	100%

Table 1: Weight Matrix for Distribution in Investigation Areas

Time Table

To ensure the ability on staying on task and meeting senior thesis goals, a timetable for the Spring 2012 semester has been developed. The table is to track the progress of each analysis as well. See Appendix B for the timetable.

Conclusion

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 Sterling and Francine Clark Art Institute. The first analysis, MEP prefabrication, is to help in catching up with schedule. The second analysis is, BIM, is to increase efficiency, decrease cost, and add value to the building. The third analysis, precast floor units, is to increase productivity and constructability of the complex building geometry and to put the schedule back on track. Finally, the last analysis, PV panels, is to reduce costs in the long term and the use of generators. The application of all analyses combined will reflect extraordinary benefits.

Appendix A
Breadth Topics

Breadth Topics

As part of the Construction Management Senior Thesis Design, two more analyses breadths have to be performed in an area other than the main option. The proposed breadths for the Sterling and Francine Clark Art institute project are in the electrical and structural disciplines.

Electrical Breadth

The purpose of this electrical breadth of installing photovoltaic panels is to be able to reduce project's electric consumption from the grid.

The amount of energy generated from the PV panels, which will be strategically placed on the museum in order to get the maximum amount of electricity, will be used as a measure of how much money could be saved on average per a specific amount of time. In addition, the measure of the payback period would be calculated. This will show how effective the PV panels are.

The method would be by figuring out the best PV panels on the market that are available for this project; after which solar angle studies would be performed to figure out the best way to place the PV panels on the building. The surface area of the PV panels and the amount of electricity generated per panel would provide a measure of the total energy generated and amount of money saved. This will depict the practicality of incorporating PV panels.

Structural Breadth

As a result of the precast floor unit analysis on the elevated slabs shown on figure 3 earlier (page 9); there will be weight changes on the beams and columns. The precast floor units that would be placed would have less dead load on the beams and columns since they have a reduced dead load over cast in place (CIP) slabs which may not affect the structure of the building. If the new dead load generated by the precast floor units would cause structural instability; then the structural system may have to be modified in order to maintain stability and safety of the structure.

This structural analysis would calculate the change of load that occurs on the beams and columns that support the mentioned area of this building as a result of placing the units. A structural analysis will be conducted to study the structural support for the change as well as the load path for the new system on the beams and columns supporting it and their ability to sustain the new loads without a problem. If the dead load requires a change in structure, then the next step in this analysis would be to figure out the new structural members' details/sizing.

Appendix B

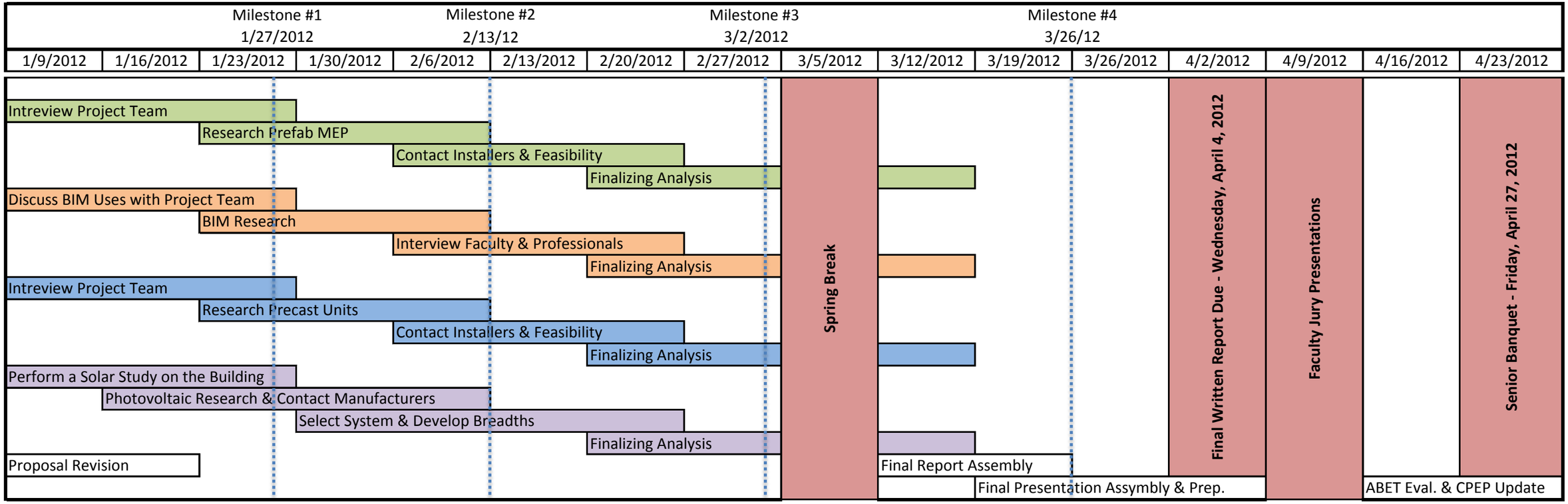
Spring 2012 Semester Preliminary Timetable

The Sterling & Francine Clark Art Institute - Williamstown, MA
Mohamed S. Alali - Construction Management Option

Final Proposal for Spring Senior Thesis Project
Faculty Advisor: Dr. Robert Leicht

Proposed Spring 2012 Senior Thesis Schedule

January 2012 - April 2012



Milestones	
1	Preliminary Information is obtained
2	Analyses Research Complete
3	Analyses Evaluation
4	Analyses Complete

Key

- Analysis 1: MEP Prefabrication
- Analysis 2: BIM Usage Analysis
- Analysis 3: Precast Floor Units
- Analysis 4: Solar Photovoltaic Panels