Cinema-Dining Terrace Expansion

Suburbia, USA

Thesis Proposal

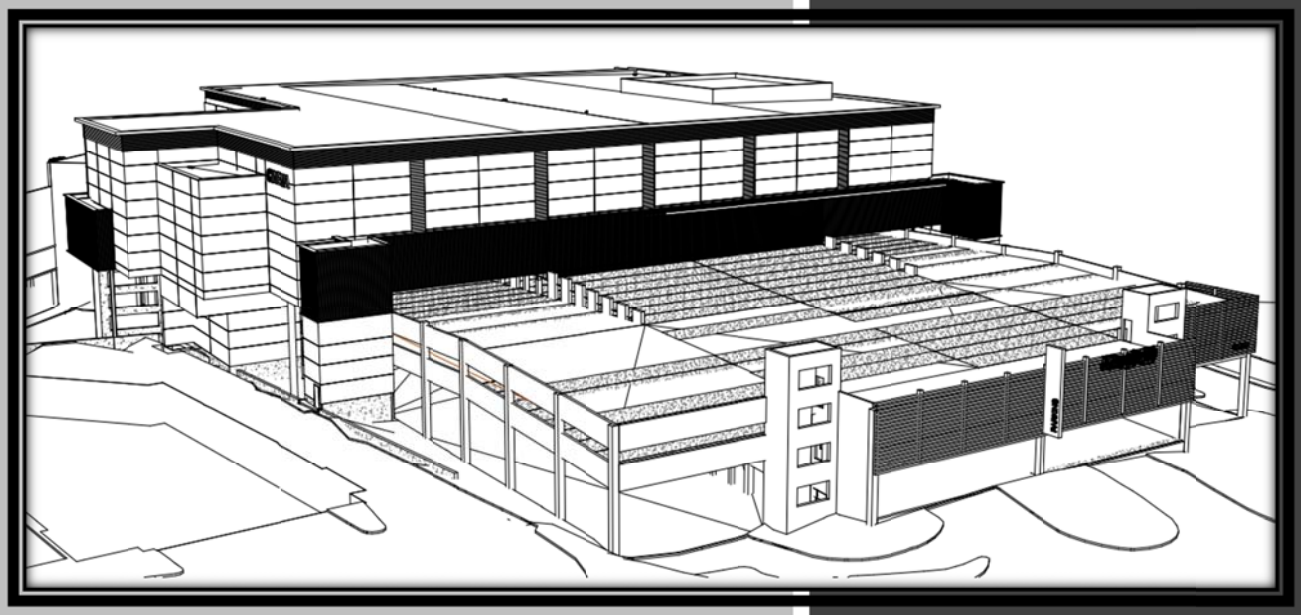

Image Courtesy of The Whiting-Turner Contracting Company

PSUAE

Cinema-Dining Terrace Expansion

Revised 1/17/2013

Executive Summary

The Cinema-Dining Terrace Expansion project is a mall renovation project that's primary concerns are focused around the schedule and cost. The opportunity to potentially improve the schedule and cost of this project will be researched and investigated by improving upon problematic areas or just seizing an opportunity. With an issue such as safety being so prominent in the industry, it will also be researched and analyzed to determine its possibly improvement on this project. Through examination into four analyses, this Thesis Proposal is striving to accelerate the schedule, decrease the overall costs, and improve the safety for this project and for future projects.

Analysis 1 focusses on modifying the site logistics plan and resequencing the early phases of the project. With a limited site and extensive demolition work required, the problem of site logistics allowed the opportunity to research into possible improvements through the use of two tower cranes instead of the original plan. The analysis will address the key impacts on the constructability, schedule, cost, and site from the implementations of equipment changes and sequencing alterations.

The second analysis evaluates the use of prefabricated curtain wall units for the façade system. Research will be done to examine possible curtain wall systems, the structural implications, and the new sequencing required. A prefabricated system will provide potential benefits to the schedule, quality, and man-power needed for this phase. Tying into the analysis 1, the cranes will be implemented for the installation of the curtain wall units. This analysis will focus on researching the constructability, cost, schedule, and sequencing required with such a system.

Analysis 3 investigates the use of a water drainage recycling system to potentially improve the sustainability and lifecycle costs of the project. Researching into the current water usage, potential water recycling systems, the constructability of such a system, and the impacts on the public will drive this analysis. The already designed for drainage system will need potential redesign for the application of a water recycling system. The use of rain-water as toilet water is a key topic to this research. Overall, the investigation will focus on improving the lifecycle costs and sustainability through the use of a water drainage recycling system.

The final analysis focusses on the use of BIM for improving safety on the project and for implementing the first three analyses. The research will revolve around the uses of BIM for construction and safety. Primary focus will be on the use of a 4D model to demonstrate analyses 1 and 2 while also showing safety precautions. A 3D model will be researched into for the use to display analyses three's new water recycling system. The investigation will analyze the uses of BIM for all three of the first analyses and for the opportunity to design for safety.

The expected outcome from all the analyses is to assist in improving the schedule, safety, and cost by altering the logistics, sequencing, and designs.

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Project Background

The Cinema-Dining Terrace Expansion is the addition a new 16 screen movie theater, an expansion to the food court, and the addition of restaurant space at the concourse level. The movie theater is being built on top of an existing parking garage which made for a complicated structural construction and site logistics plan. The project is located in Suburbia, USA and the schedule lasts approximately 500 work days or around 2 years of total time. The project starts in mid-2012 and is projected to finish mid-2014.

Figure 1: New Food Court Design
Courtesy of The Whiting-Turner Contracting Company

The project consists of a new 70,000 square foot cinema at the malls level three, a 12,000 square foot expansion to the existing foot court at level 2, and 9,500 square feet of additional restaurants at the concourse level. The existing food court will be expanded into an additional level with a new ceiling/roof structure and the existing area remodeled, including new flooring, ceiling, lighting, restrooms, and a family rest room. There will be significant modifications to the existing parking and mall where the cinema connects, including demolition, new foundations, structural upgrades, and reconfigured retail.

The structure is comprised of a combination of concrete foundations and shear walls with a steel frame. Extensive work is to be done to the existing parking garage foundations using a combination of micropiles with pilecaps, sandwich footing with threadbars, and spread footings. The foundations then support the structural steel with composite beams and the massive concrete shear walls that support the entire cinema and food court additions. The façade for the entire expansion is primarily a combination of metal panels, glazing, and EIFS. This curtain wall provides an aesthetically pleasing appearance that the owner hopes will draw more customers. The MEP and fire protection systems will all be tied into the existing systems with selective demolition and necessary equipment additions.

Figure 2: North East Perspective View
Courtesy of The Whiting-Turner Contracting Company

Technical Analysis Descriptions

Analysis 1 - Site Logistics Modifications

Problem Identification

The demolition for this project required a well-coordinated and organized site logistics plan. This plan involved the use of multiple cranes that added extra complications to the project. In one area, soldier piles and lagging were added to support the excavation wall due to one of the cranes close location. Foundation work coordination had to be done around the concrete pad required for the tower crane located in the middle of the existing parking garage. This tower crane also required extensive means and methods work that caused potential safety hazards and added to the schedule. With one of the cranes needing to be located on the Ring Road that runs under the existing parking garage, the road was required to be shut down during the demolition phase. The planned site logistics plan creates complications and problems that affect the site and the project as a whole logistically and with relation to the schedule.

Background Research

The major demolition work required for the parking garage consists of the removal of half of the precast concrete for level 4. The primary equipment used for the demolition will be two hydraulic cranes on opposite sides of the building. The hydro crane on the south side of the building forced the excavation to require soldier piles and lagging with tiebacks just to support the load from the crane. The crane had to be located near the excavation due to the limited site space and to ensure it could reach the farthest required pick. A separate hydro crane had to be brought in on the north side to remove the pieces of precast concrete that the first hydro crane couldn't reach. This north side hydro crane had one location available to would allow it to reach its farthest pick, and that was located in the middle of the Ring Road that runs under the parking garage. This forced the Ring Road to close for that period of time, rerouting traffic and customers.

Also during the demolition period is the preparation for the tower crane placement. This tower crane is to be used for the steel erection primarily and is located near the middle of the existing parking garage. The means and methods for installing this tower crane requires the temporary removal of the existing precast concrete double T's located in the middle of the parking garage on the first, second, and third floor. These concrete T's weigh around 50,000 lbs each and due to their location hydraulic jacks are required for their temporary relocation. The tower crane also requires a large concrete pad to be poured on the ground floor for the crane to rest on. This pad is located near the new foundation work so coordination and planning is necessary to distribute resources properly.

Potential Solutions

Alternate site logistics plans will be explored to identify possible benefits with relation to the schedule, cost, constructability, and site coordination. A potential solution can be changing to a two tower crane plan. This analysis will focus on incorporating two tower cranes instead of the two hydraulic cranes and one tower crane previously planned for. The two tower cranes could use foundations that are being placed for new stair towers, as their foundation. The use of these new stair tower foundations as the tower crane pad would require a structural analysis to redesign the stair tower foundations to allow for the loads of a tower crane in addition to the stair tower. These two new tower cranes would now be located outside the foot print of the existing parking garage so that would also eliminate the mean's and methods of relocating the existing precast concrete double T's that required relocation with the original tower crane location. The two tower cranes could then be used for demolition, steel erection, and other tasks such has placing roof equipment. This potential solution will affect the schedule, cost, construction sequence, and the site coordination so analyses into all these areas will be necessary.

Analysis Procedure

- Constructability Analysis
  - Analyze the tower cranes reach and capacity
  - Analyze sequencing to see if the foundations can be poured early
  - Analysis into whether the foundation work for the whole building will be complete in time to begin steel erection once demolition is complete
  - Analyze worker production rates
- Structural Analysis
  - Analyze the current foundation design
  - Determine loads from the stair tower
  - Determine loads from the tower crane
  - Calculate required foundation design of the footing
  - Analyze excavation to determine if soldier piles and lagging are still required
- Site Analysis
  - Car and pedestrian traffic flow
  - Laydown areas
  - Truck access
  - Tower arm swing restrictions
  - Height restrictions
- Schedule Analysis
  - Collect durations of the existing schedule
    - Soldier piles and lagging
    - Foundations excavations and installation
    - 4th floor demolition
    - Relocation of precast for original tower crane
    - Ring Road closure time periods

        - Steel erection
    - Collect potential durations for proposed plans
        - Foundation excavation and installation
        - Tower crane assembly, erection, and tear down
        - Demolition phase
        - Steel erection phase
- Cost Analysis
    - Cost of two tower cranes
    - Cost of the new stair tower and tower crane pads
    - Cost of less mean's and methods
    - Estimated daily revenue of the mall with the project complete
- Owner impact
    - Up front cost
    - Site traffic plans
    - Schedule
    - Quality control
    - Develop the best way to display the proposal to the owner

Resources

- Industry Professionals
- AE Faculty Members
- Project Documents
- Cinema-Dining Terrace Expansion Project Team
- The Whiting-Turner Contracting Company resources
- RS Means
- Project Subcontractors
- AE Classmates
- Applicable Books, Papers & Websites

Expected Outcome

The site logistics plan incorporating two tower cranes is anticipated to help with all the problems mentioned early though it is expected to cost more up front. It is expected that the stair tower foundations with proper upgrades will be sufficient for the two tower cranes to be set on. Besides the problems possibly being eliminated, there is expected to be substantial schedule acceleration involved around the demolition and steel erection phases. These schedule accelerations are also expected to help cover the initial costs by opening the mall sooner allowing more money to be made earlier. It is also expected that the new site plan will allow for easier traffic flow and improve the construction sequence.

*See Appendix A for Structural Breadth Details

Analysis 2 – Curtain Wall Prefabrication and Unitization

Opportunity Identification

With the schedule being so important to the owner any opportunity to improve it is worth analyzing. Early in the project, the work is focused on the foundations and steel erections since they are keys to along the critical path. These two activities take up much of the early schedule time which allows the perfect opportunity for the possibility of prefabricating future parts to the project. Prefabrication would be done at an offsite facility and trucked in ready for installation allowing for the potential to have much less on site work. The prefabrication work could be done while the foundation and steel erection work is occurring allowing for the possibility of accelerating the schedule substantially for the activities following the steel erection.

Background Research

Looking into the design of the building, modularization of areas doesn't appear to be the best choice for prefabrication since there aren't many repeated spaces. The physical screen theaters are too large to modularize even if they were repeating. The primary material that is repeatedly used on the project is the curtain wall façade around the movie theater. This curtain wall is a combination of exterior glazing, metal panels, and EIFS. This façade is located on the north, south, and east sides of the cinema and accounts for the majority of the curtain wall on the project. The façade adds the aesthetic appearance that the owner desires but takes approximately 120 days to install using a stick-built installation method.

Potential Solutions

A potential solution to using prefabrication to accelerate the schedule is to unitize the curtain wall. Prefabricating the curtain wall in easily installable units can be a great way to keep the appearance the owner desires while also accelerating the schedule. The analysis will focus on the potential schedule reduction that could come from prefabricating the curtain wall. Prefabrication can significantly reduce the on-site labor and the materials used since the units would be made in an off-site factory. Testing and quality control are also far easier to perform and ensure when the units are assembled in the controlled environment. Far fewer materials would need to be stored on site if the project prefabricates the curtain wall. With the use of prefabricated curtain wall units, different steel connections would need to be redesigned to accommodate easy installation of the units. The cranes from **Analysis 1** can be used for the installation of these prefabricated units. Analyzing the schedule, cost, and constructability of this solution will be the keys to determining if this prefabrication is a valid substitution to the stick-built curtain wall.

Analysis Procedure

- Constructability Analysis
  - Determine whether the curtain wall is easily unitized
  - Define if there is a close location to perform the prefabrication

  - Evaluate delivery of these prefabricated panels
  - Evaluate the man-power requirements
  - Assess the qualifications of the installation subcontractor
  - Develop an installation procedure
  - Analyze site requirements for prefabricated panel installations
  - Analyze worker production rates
- Structural Analysis
  - Evaluate Current structure
  - Develop required structure for prefabricated curtain wall units
  - Define new structural changes
- Schedule Analysis
  - Determine Factory time to prefabricate the curtain wall units
  - Define the installation time
  - Determine the time difference for designing the prefabricated panels
- Cost Analysis
  - Define cost of stick-built materials and installation
  - Determine cost of prefabricating and installing the unitized curtain wall panels
  - Determine cost savings from the potentially accelerated schedule
  - Determine the costs of altering the structural system to accommodate the prefabricated panels

Resources

- Industry Professionals
- AE Faculty Members
- Project Documents
- Cinema-Dining Terrace Expansion Project Team
- The Whiting-Turner Contracting Company resources
- RS Means
- Project subcontractors
- AE Classmates
- Applicable Books, Papers & Websites

Expected Outcome

Prefabricating the curtain wall is expected to accelerate the schedule but decreasing installation time substantially. It is also probable that the up-front costs for materials and factory prefabrication will increase but the costs of the accelerated schedule and reduced man-power for installation should assist in countering those costs. It is projected that the structure will require minor changes such as easy attachment locations for the panels.

*See Appendix A for Structural Breadth Details

Analysis 3 – Water Drainage Recycling

Opportunity Identification

This project didn't strive for any LEED certification nor did they strive for any significant sustainability aspects. This creates the opportunity to incorporate some sustainable features without the need for major changes or the costs of LEED certification. Sustainable features primarily affect the lifecycle costs and lifecycle environmental impacts. The opportunity to possibly help the environment and also save the owner money through the lifecycle costs are the major considerations for this analysis.

Background Research

The flat roof design requires dozens of water drains for rain and snow. These drains have a piping system that leads to the general water drainage for the building. Water is an essential for buildings to function comfortably so savings with relation to water is an easy way to improve sustainability and improve the lifecycle costs.

Potential Solution

Through the use of a water drainage recycling system, rain and snow water could be recycled and used as toilet water throughout the Cinema-Dining Terrace Expansion. The already planned for drains located on the roof can be used to pipe the rain and snow water into a new piping design that would allow the water to be used as toilet water. This has the potential to save water usage over time decreasing the environmental impact and lifecycle costs. Since the building is public, people won't notice or care about this sort of system so its public affect will be negligible. People won't be hesitant to go to a mall or movie theater that recycles water for its toilets or uses a grey water system since they probably won't even realize. The analysis will primarily focus on the constructability of the new water recycling system, its effect on the schedule, and the cost impacts.

Analysis Procedure

- Constructability Analysis
  - Determine the components of a water recycling system
  - Analyze the current drainage pipe system
  - Determine the current designs water usage
  - Calculate water savings with new system
- Cost Analysis
  - Define the cost of the current drainage system
  - Determine the cost of the new drainage recycling system
  - Evaluate the lifecycle costs of water savings
- Schedule Analysis
  - Define the duration for the current systems installation

- Determine the durations for the new designs and for the new installations for a water recycling system

Resources

- Industry Professionals
- AE Faculty Members
- Project Documents
- Cinema-Dining Terrace Expansion Project Team
- The Whiting-Turner Contracting Company resources
- RS Means
- Project subcontractors
- AE Classmates
- Applicable Books, Papers & Websites

Expected Outcome

It is expected that this analysis will show reasonable constructability with relation to the additions of a new drainage recycling system and to the water usage. It is also predicted that the initial costs will be minuscule when compared to the lifecycle savings from the reduced water usage. The schedule is anticipated to be impacted very little by this water drainage recycling system.

*See Appendix A for Mechanical Breadth Details

Analysis 4 – BIM Utilization

Problem Identification

Though the schedule is the primary concern for the owner, the project's cost is still a top priority. The owner's concern about the cost has the potential to create hazards when attempting to add aspects that could theoretically improve the project. This cost awareness could create resistance to pay what seem to be unnecessary up-front costs if the owner can't see the benefits. Costs such as change orders could also be over-looked by the owner if they don't see the potential for them.

Background Research

The three analyses stated before this all have up-front costs that could be potentially more than the original plan but the lifecycle costs are where the possible savings can be seen. For the site logistics modifications, the use of two tower cranes could potentially be more expensive than the originally planned cranes but the savings from the schedule accelerations may cover the added costs. Prefabricating the curtain wall will possibly cost more than the original stick-built plan but the probable savings in the accelerated schedule could allow the project to open earlier creating the ability to start making money back sooner. Implementing a rain-water recycling system could add extra design, mechanical equipment, and installation costs but the environmental impact and the savings on water usage can be benefits that outweigh the initial costs over the building lifecycle.

With the project being the addition of a movie theater and dining terrace connecting to an existing food court renovation, coordination between trades is a problem. Connecting new MEP systems to the existing systems can add complications that require an excess of RFI's and change orders. These coordination complications for particularly the HVAC systems could cause potential delays in the schedule.

Potential Solution

A possible solution to displaying potential project savings and to coordination complications could be the use of BIM. It can be used for the site logistics modifications to display the changes to the owner, while also presenting the benefits and negatives of the new site logistics and the new sequencing needed. A 4D model could be used to show the new site logistics and how the new demolition and steel erection phases will be sequenced. 4D modeling could also be used to display to the owner and the project team the delivery and installation of the prefabricated curtain wall units. The use of a 4D model is useful to help demonstrate the procedure to the owner but also even more important to accurately display it to the team and subcontractors. A 4D model could assist in improving the safety and quality of nearly all the phases of the project. A constructability analysis, cost analysis, and schedule analysis will all be performed to explore the utilizations of BIM to assist with the other three analyses.

A 3D model could be used for coordination between the trades particularly the MEP systems. This coordination could assist in preventing future change orders and potentially accelerate the schedule. The 3D model could also be used to display to the owner and team how the new rain-water recycling system would fit into the planned system.

BIM also has the potential to be used for Facility Management but this analysis will not cover that.

Analysis Procedure

- Constructability Analysis
  - Evaluate a 4D model for the use of Analysis 1 and 2
  - Determine the uses of a 3D model for coordination and Analysis 3
  - Define why the owner didn't request BIM initially
  - Investigate the safety impacts BIM can have
  - Evaluate possible safety that can be shown using BIM
  - Analyze production rates of the workers for analyses 1, 2, and 3
- Cost Analysis
  - Determine costs of a 4D model
  - Evaluate the costs of a 3D model
  - Investigate the estimated costs of MEP coordination change orders
  - Gather and analyze potential cost savings with the uses of analyses 1, 2, and 3
- Schedule Analysis
  - Evaluate the duration to creating a 3D and 4D model
  - Determine schedule savings from the uses of analyses 1, 2, and 3

Resources

- Industry Professionals
- AE Faculty Members
- Project Documents
- Cinema-Dining Terrace Expansion Project Team
- The Whiting-Turner Contracting Company resources
- Project subcontractors
- AE Classmates
- Applicable Books, Papers & Websites
- PACE Roundtable Breakout Session
- AE 473 course materials

Expected Outcome

The use of a 4D model for Analyses 1 and 2 is expected to be extremely useful in displaying the procedure and benefits. A 3D model used for MEP coordination and Analysis 3 is predicted to help substantially preventing change orders and displaying the new rain-water recycling system. It is also expected the through the use of BIM, production rates will improve for activities associated with analyses 1 and 2. The use of BIM is projected to be very influential on the job site safety, improving it for the workers and pedestrians. Overall, it is expected that the use of BIM will assist displaying the advantages of analyses 1, 2, and 3 while also improving the job sites safety.

Critical Industry Issue Analysis

At the PACE Roundtable, many topics that are critical to today's construction industry were discussed. Safety in construction through design was one of the key discussion topics for one of the breakout sessions. Designing for safety is one of the best ways to ensure accidents are being prevented. Not every safety aspect can be designed for ahead of time, but if done right, many unsafe scenarios can be prevented or properly dealt with in the field. The use of BIM to display these safety designs was a main subtopic throughout the breakout sessions. BIM can not only design for actually safety equipment and precautions, but also properly designing for easy installations can be an effective way to keep the workers safe. The use of BIM to display the site logistics, deliveries, and installations can also be extremely beneficial to the workers by accurately defining the procedures for everyone to see. By simply getting everyone on the same page, activities can run much smoother and avoid accidents.

With BIM being implemented for analyses 1, 2, and 3, investigating into how safety can be included in and displayed from the models is a focus of the research. The goal of this research is to investigate how BIM can be used to design for safety in terms of site logistics and installations for the benefit of the workers, the project team, and the owner.

Interviewing current industry members is one research tactic to investigate how design and BIM have been used to improve safety on a job site. A questionnaire that will be used for the interviews can be seen in Appendix C.

Thesis Investigation Objectives

Analysis Weight Matrix

Table 1 below displays the weight matrix that has been created to visually exhibit the time allocation process for the analyses. The four core areas of investigation for the analyses are (1) Critical Industry Research, (2) Value Engineering Analysis, (3) Constructability Review, and (4) Schedule Reduction/Acceleration. As seen, the primary focus will be on the site logistics modifications which will be focusing on the schedule reduction and value engineering in the attempt to save the owner time by improving the site logistics. The primary focus of nearly all the analyses is to accelerate the schedule and value engineer the activities to in the end save the owner time and money. Overall, the time is distributed pretty evenly with the water drainage recycling analysis getting the least amount of focus.

Table 1 – Weight Matrix

Description	Critical Industry Research	Value Engineering Analysis	Constructability Review	Schedule Reduction/ Acceleration	Total
Site Logistics Modifications	5%	10%	5%	15%	**35%**
Curtain Wall Prefabrication	5%	5%	5%	10%	**25%**
Water Drainage Recycling		10%	5%		**15%**
BIM Utilization	5%	5%	10%	5%	**25%**
Total	**15%**	**30%**	**25%**	**30%**	**100%**

Projected Spring Semester Timetable

A week by week timetable has been created to outline the schedule for the spring semesters work on these analysis. The timetable displays summary activities that will be completed throughout the semester for the analysis and also includes milestones to show the relative completion dates for tasks.

Conclusions

These four analyses are being performed to investigate the core research areas in the attempt to improve the schedule, cost, and safety on the project. The analyses are expected to show methods and designs that could be implemented to assist in accomplishing the owner's goals of a fast and cheap quality project. Through proper research in the core areas of investigation, it is probably that realistic options for the project will be developed. With the conclusion of the analyses,

possible improvements to the schedule and cost could be utilized for this project or future projects.

Appendix A – Breadth Topics

Breadth Topics

Structural Breadth

The opportunity to implement research outside of construction management can be seen in Analyses 1 and 2. Analysis 1 will be analyzing the site logistics modifications that will include the placement of two tower cranes on foundations intended for just stair towers. This analysis will require load calculations for both the stair tower, the tower crane, and what the original foundation was designed to support. A new foundation will most definitely be required that will include size, strength, and reinforcing designs. Investigating into the type of foundation required, the size, the required reinforcing, and the necessary excavation will be the primary focusses into the structural aspect of this analysis.

Analysis 2 will also incorporate a structural breadth with the research into redesigning the curtain wall system. The use of prefabricated panels will provide the opportunity to investigate into not only the structure of these panels, but also the connection to the steel structure of the building. The constructability of these steel connections will heavily rely on the choice of design and panel integration. Investigation into the current steel structure and the structure needed for prefabricated panels will drive this analysis.

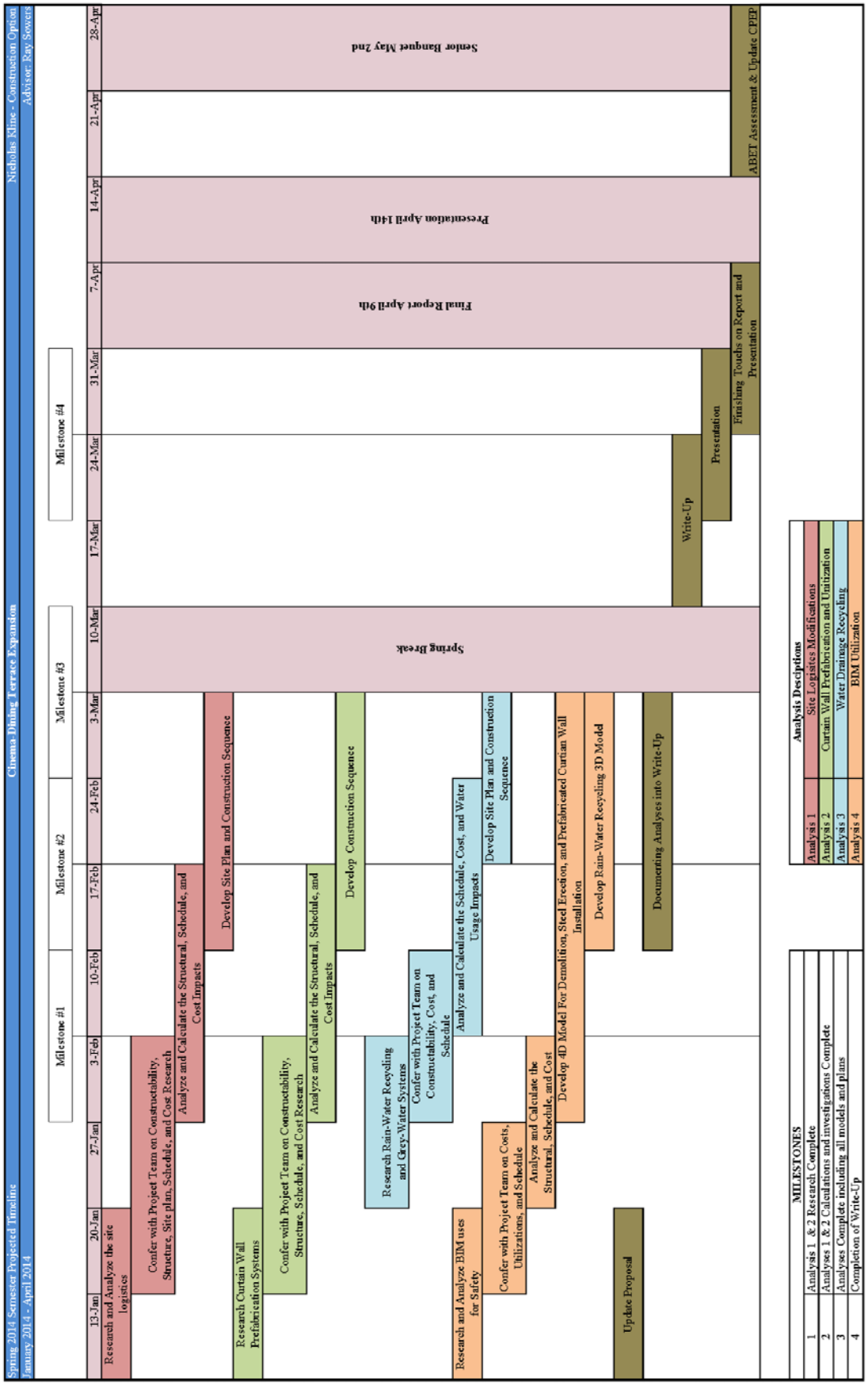
Both these structural breadths will assist in their individual analyses that are overall being investigated into as to improve the schedule and cost of the project.

Mechanical Breadth

With little sustainability aspects specifically designed for on this project, the opportunity arose to implement a simple system that can still potentially help the cost and environmental impact. Investigating into the use of a water drainage recycling system is the primary focus of Analysis 3. The research will revolve around finding a simple system to implement and install in order to prevent unnecessary costs, while also improving the sustainability and potentially the lifecycle costs to the owner. Evaluations into the use of rain-water as toilet water and possibly a grey-water system are some key areas of investigation. The system being researched will primarily consist of extra piping with a large storage tank. This tank will be the storage area for the collected rain water so analyzing the rain quantities for that area will be essential when picking the size of the tank. The collected water will be recycled into the toilets but if the tank is too low, there will still be a connection to the domestic water for the building. Comparing the current designs water usage to the new designs savings will be an emphasis in analyzing the sustainable and cost impacts. Using a chart, comparisons of the cost, schedule, water usage, and constructability will be shown to display the new recycling system against the original design. Also analyzing the impact this will have on the owner and on the customers will be key in determining if the system will be beneficial in the end.

Overall, the mechanical breadth will analyze the constructability of a water drainage recycling system and investigate that systems impact on the buildings sustainability, the owner, and on the customers.

Appendix B – Spring Semester Projected Timetable


Spring 2014 Semester Projected Timeline
Cinema-Dining Terrace Expansion
Nicholas Kline - Construction Option
January 2014 - April 2014
Advisor: Ray Sowers
Milestone #1
Milestone #2
Milestone #3
Milestone #4
13-Jan
20-Jan
27-Jan
3-Feb
10-Feb
17-Feb
24-Feb
3-Mar
10-Mar
17-Mar
24-Mar
31-Mar
7-Apr
14-Apr
21-Apr
28-Apr
Research and Analyze the site logistics
Confer with Project Team on Constructability, Structure, Site plan, Schedule, and Cost Research
Analyze and Calculate the Structural, Schedule, and Cost Impacts
Develop Site Plan and Construction Sequence
Research Curtain Wall Prefabrication Systems
Confer with Project Team on Constructability, Structure, Schedule, and Cost Research
Analyze and Calculate the Structural, Schedule, and Cost Impacts
Develop Construction Sequence
Research Rain-Water Recycling and Grey-Water Systems
Confer with Project Team on Constructability, Cost, and Schedule
Analyze and Calculate the Schedule, Cost, and Water Usage Impacts
Develop Site Plan and Construction Sequence
Research and Analyze BIM uses for Safety
Confer with Project Team on Costs, Utilizations, and Schedule
Analyze and Calculate the Structural, Schedule, and Cost
Develop 4D Model For Demolition, Steel Erection, and Prefabricated Curtain Wall Installation
Develop Rain-Water Recycling 3D Model
Update Proposal
Documenting Analyses into Write-Up
Spring Break
Write-Up
Presentation
Finishing Touches on Report and Presentation
Final Report April 9th
Presentation April 14th
Senior Banquet May 2nd
ABET Assessment & Update CPEP
MILESTONES
1 Analysis 1 & 2 Research Complete
2 Analyses 1 & 2 Calculations and investigations Complete
3 Analyses Complete including all models and plans
4 Completion of Write-Up
Analysis Deciptions
Analysis 1 Site Logistics Modifications
Analysis 2 Curtain Wall Prefabrication and Utilization
Analysis 3 Water Drainage Recycling
Analysis 4 BIM Utilization

Appendix C – Interview Questionnaire

Interview Questionnaire

1) *Have you been on projects where safety was specifically designed for? If so, how was it designed for and was it beneficial?*

2) *Have you ever used BIM to design for safety? If so, how was it used and was it beneficial?*

3) *What are the safety hazards that are most important to design for early in a project?*

4) *What type of BIM would you recommend implementing safety designs into?*

5) *How else would you attempt to design for safety without the use of BIM?*

6) *What benefits do you see from designing for safety at the beginning of a project?*