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EXECUTIVE SUMMARY

This proposal includes the 4 analyses that will be pursued for the required thesis research during the spring semester. The analyses are described below in more detail:

ANALYSIS I: Prefabrication of the Curtain Wall System

This analysis is pursued as an effort to accelerate the project schedule. Prefabricating the curtain walls can have beneficial effects by saving time and money from labor reduction. The analysis will compare the prefabricated system to the existing curtain wall system to determine whether prefabrication can have a progressive effect on the project.

ANALYSIS II: Demolition Alternatives for the Building's Core

Since the demolition of the building's core was the biggest challenge on the URBN Center project, this analysis will explore the alternative possible demolition methods and compare them to the existing demolition method that was used on the project. This analysis is pursued as a constructability review of the demolition and to analyze whether the existing demolition plan was the most efficient way to pursue the demolition. This analysis also contains the structural breadth which deals with sizing steel beams as one alternative to the existing demolitions. See APPENDIX A for more details

ANALYSIS III: SIP Scheduling for the Mezzanine

This analysis keeps the focus of the research on the core of the building by implementing short interval production scheduling on the mezzanine stair and mezzanine levels that are added in the demolished area of the building's center. This analysis is pursued to study how the production could have been improved in areas such as the mezzanine with repetitive labor activities. Effects on the project schedule and the cost due to labor will also be analyzed.

ANALYSIS IV: Supply Chain Research of the Chilled Beam System

Since chilled beams are unique products utilized on this project, a research focusing on the supply chain process for the chilled beams is conducted to study the best path to order, deliver, and store the chilled beams. This analysis also compares the supply chain process to the VAV pre-existing mechanical system to see which is more effective on a project as the URBN Center. Also, a mechanical breadth comparing the energy usage of the chilled beams and the pre-existing mechanical system is conducted as part of this analysis. The breadth is described in more detail in APPENDIX A. Finally, this proposal gives a summary of how each analysis relates to the core thesis investigation areas and a time table estimation of how the spring semester will be spent to complete the thesis research.

PROJECT BACKGROUND

Figure 1: Rendering of the URBN Center *(Property of MS&R LTD)*

The URBN Center is a renovation of the famous design of Robert Venturi that is aimed to bring students of the Antoinette Westphal College of Media Arts & design in Drexel University under one roof. The four story building is re-designed to create a great working environment for students who are pursuing an education in Architecture, Arts Administration, Design & Merchandising, Digital Media, Entertainment & Arts Management, Fashion Design, Game Art & Production, Graphic Design, Interior Design, Music Industry, Product Design, and Web Development & Interaction.

The URBN Center along with the Annex, encompass a total of 145917 SF of renovation space with a total cost of $31 Million. Using a design-bid-build delivery method and a lump sum contract, Turner Construction was awarded the construction services on the project. The construction duration of the project extended from October 17, 2011 to October 12, 2012.

The renovation of the URBN Center consisted mainly of demolition of the center of the building from the roof to the first floor. The demolished area was replaced with a mezzanine structure extending along the four stories of the building and a sky light in the roof. Additional design changes include adding curtain walls along the east and north elevations of the building. The curtain walls and the sky light allow for natural lighting for the majority of the building which was a major sustainability effort implemented in this project. Other sustainable efforts implemented in the URBN Center include the use of an active chilled beam mechanical system.

Since the building is originally designed by a well pronounced architect such as Robert Venturi, there were some constraints on how much change the design team can do to the existing structure. For example, there was a full preservation of the south façade which features a mosaic design by Robert Venturi making the façade a historically significant piece of art in the city of Philadelphia.

ANALYSIS I: SCHEDULE ACCELARATION THROUGH THE PREFABRICATION OF THE CURTAIN WALLS

Problem Identification:

The rigidity of the URBN Center's construction schedule was a big challenge to the construction team. Due to the nature of the project, the completion of the construction and turn over date was not up for negotiation. The project team needed to turn over the project to the owner before the students had to start their scheduled classes in the URBN Center. Therefore, contingencies forced the project team to perform their work using over time and adding multiple labor shifts in order to maintain the project schedule. Prefabricating the curtain walls will allow for time saving due to shorter installation and possible labor cost savings.

Figure 2: East curtain wall installation. (*Photo Property of Drexel University)*

Research Goal:

The goal of this analysis is to explore the possibility of reducing the project schedule by implementing prefabrication on the curtain wall system and analyze the time and cost savings associated with the prefabrication process.

Approach:

- Identify vendors near Pennsylvania and inquire those vendors about prefabrication options for the curtain wall system.
    - Inquire about dimension limitations, installation requirements
- Analyze transportation methods for the prefabricated system to the project.
- Explore storage options for the prefabricated system (On Site/Off site)
- Determine the durations of prefabricated system with a comparison to the existing delivery plan utilized on the project.
    - Durations include delivery duration, unloading into storage or unloading to the site, installation duration
- Develop installation plan—crane usage, required labor…etc.
- Interview with Mr. Rockmacher (project manager) regarding labor and installation methods of the prefabricated system and the existing system.
- Comprehensive cost and schedule comparison of the prefabricated curtain wall system and the existing system.

Resources required:

The following resources will be utilized in order to conduct the analysis topics described above:

- Penn State AE Faculty
- Mr. Adam Rockmacher—URBN Center Project Manager
- Curtain wall vendors—In progress

Expected Outcome:

Prefabricating the curtain walls off site can reduce the installation time which is expected to save time on the project schedule. Also, it is expected to have cost savings associated with the labor and man power used to install the curtain walls. Although the cost of the prefabricated curtain wall system might be more expensive to purchase, a cost analysis between the prefabricated system and the existing system will yield whether the labor savings will surpass the extra cost associated purchasing the prefabricated system.

NOTE: See Appendix A for the structural breadth related to this analysis.

ANALYSIS II: DEMOLITION ALTERNATIVES FOR THE BUILDING'S CORE

Problem Identification:

As described in the project background, the center of the URBN Center's existing structure was demolished and replaced with a mezzanine stair system and a skylight in the roof. Due to structural concerns the demolition process was one of the biggest challenges for the project team. Since the demolition was a main part of the schedule's critical path, delays related to the demolition are undesirable and can result in delaying other construction activities. Therefore, the project team was faced with delays related to the demolition due to concerns from the structural engineer who was working on a new shoring plan. When the delay occurred, the project team was forced to accelerate the project schedule by working overtime, multiple shifts, and prefabricating miscellaneous metal items.

Research goal:

The goal of this analysis is to find demolition alternatives of the URBN Center's core that will result in accelerating the project schedule. Finding the most efficient alternative for demolition would be very beneficial to the project schedule because the demolition is on the critical path of the project.

Approach:

- Analyze the existing demolition plan and the structural concerns influencing the demolition process.
- Research alternative demolition methods in similar projects/case studies
- Define shoring options for the possible demolition methods
- Develop a new demolition plan
- Verify with O'Donnell & Naccarato, the structural engineering consultant on the URBN Center project.
- Compare the new sequencing of the demolition efficiency to the existing plan
- Compare the effects on the schedule and cost difference between the proposed method and the existing

Required contacts:

The following resources will be utilized in order to conduct the analysis topics described above:

- Penn State AE Faculty
- Mr. Adam Rockmacher—Project Manager, Turner Construction
- O'Donnell & Naccarato—Structural Engineer Consultant
- Demo Sub. Contractor

Expected Outcome:

The expected outcome of this analysis is to accelerate the project schedule by having a more efficient demolition sequence. Since the project schedule will change, there will be some change in the cost associated with labor as well. It is also expected to have a modified shoring plan that will fit the new demolition sequence.

ANALYSIS III: UTILIZING SIP SCHEDULING FOR THE MEZZANINE STRUCTURE

Problem Identification:

With the delays caused by the demolition in the early stages of the project, the completion date of construction remained unchanged because the building needed to be occupied by the students at the beginning of their fall semesters. Therefore, short interval scheduling can be utilized on the mezzanine portion of the building in order to effectively utilize the labor on the project. The mezzanine layout is very similar on each level of the building which makes it an ideal choice for SIP scheduling due to the similar labor activities that takes place on each level.

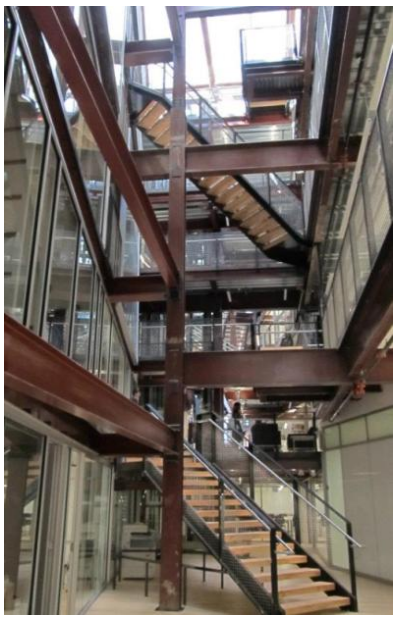

Figure 3: Finished Mezzanine at the URBN Center. (*Photo Property of Drexel University)*

Research Goal:

The goal of this analysis is to maintain the focus of the research on the core portion of the building by utilizing SIP Scheduling following the completion of the demolition. Also, the goal is to find the most effective way to utilize the labor working on the mezzanine structure due to the similarity of the construction activities for the mezzanine and to compare the time and cost savings to the existing schedule.

Approach:

- Analyze the mezzanine structure
- Identify key equipment used to construct the mezzanine
- Identify Construction activities required to construct the mezzanine
- Conduct an interview with Mr. Rockmocher regarding available labor and work durations to construct the mezzanine.
- Use the results of the interview to develop a SIP plan
- Develop a 4D model of the proposed SIP construction sequence using Revit, Synchro, and Microsoft project.
- Compare the effects on the project schedule caused by using SIP on the mezzanine
- Analyze the productivity improvement and cost changes caused by SIP

Required contacts:

The following resources will be utilized in order to conduct the analysis topics described above:

- Penn State AE Faculty
- Mr. Adam Rockmacher—Project Manager, Turner Construction
- O'Donnell & Naccarato—Structural Engineer Consultant

Expected Outcome:

The expected outcome of this analysis is improved productivity of the construction labor. SIP scheduling takes an assembly line approach to the construction process which allows for a learning curve since the construction activities are repetitive which leads to the improved productivity of labor. The improved productivity will in turn lead to cost savings from labor and to schedule acceleration as well.

ANALYSIS IV: SUPPLY CHAIN RESEARCH FOR CHILLED BEAM SYSTEM

Problem Identification:

Using an active chilled beam system was a major value engineering decision for the owner. With over 100 buildings under the owner's operation, the URBN Center was the first building to use a chilled beam system. Therefore, the owner was hesitant to use this type of system because of the unfamiliarity with how the chilled beam operates and what the cost of operation will be like in the long run. Also, supply chain is one of the main critical industry issue that was discussed during the PACE Roundtable. Therefore, this research is pursued to gain a better understanding of supply chain and how it would be best utilized on a unique product such as chilled beams.

Figure 4: Chilled Beam at the URBN Center *(Photo Property of Drexel University)*

Research Goal:

The goal of this analysis is to conduct a research about the supply chain of the chilled beam system. Also, the goal is to analyze the supply chain of the pre-existing mechanical system and perform a comparison of both systems to decide whether the chilled beams system is the more efficient of the two.

Approach:

- Conduct an interview with Mr. Rockmacher (Project Manager), Mr. Lawson (MEP Consultant) regarding the supply chain process of the chilled beams
- Develop a Supply Chain map for the chilled beam system
- Develop a Supply Chain map for the pre-existing VAV mechanical system
- The steps to develop a supply chain map include the following[1]:
    - Identifying the key players involved (vendor/supplier, distributer, customer, warehousing)
    - Linking each element from the supplier to the customer to discover the time period that will take the product to reach the customer (elements include delivery, logistics, storage…etc.)
- Analyze the following supply chain elements of the Chilled beam system and compare them to the pre-existing VAV mechanical system:
    - Delivery
    - Logistics
    - Storage availability
    - Local materials

- Replacements (Duration(
- Resilience

Required Contacts:

The following resources will be utilized in order to conduct the analysis topics described above:

- Penn State AE Faculty
- Mr. Adam Rockmacher—Project Manager, Turner Construction
- Mr. Scott Lawson—PHY Engineers Inc., (MEP Consultant)
- TROX World Wide—Chilled Beam vendor for the URBN Center

Expected Outcome:

The expected outcome of this analysis is a better understanding of supply chain methods and how chilled beams can be utilized on a renovation project. Also, this analysis gives more knowledge on the benefits of a chilled beam system which is becoming a more common sustainable system choice.

NOTE: See appendix A for the mechanical breadth related to this analysis.

[1]http://onlinelibrary.wiley.com/doi/10.1002/j.2158-1592.2003.tb00045.x/pdf

ANALYSIS WEIGHT MATRIX

The table below shows the estimated time that will be spent on each analysis during the spring semester. The table also shows how each analysis is divided between the core thesis investigation areas.

Table 1: Weight Matrix for Time Distribution between Each Analysis

Analysis	Research	Value Eng.	Const. Rev.	Sched. Accel.	Total (%)
Prefab	5	5	5	10	25
Demo	5	-	10	10	25
SIPS	5	-	5	10	20
Chilled Beams	10	20	-	-	30
Total (%)	25	25	20	30	**100**

TIME TABLE

APPENDIX B includes a detailed time table of the spring semester. The table shows how the student's time is going to be spent in order to perform the proposed analyses. This time table is intended as a time management tool for the student in order to complete the thesis research on schedule. However, this time table is to be updated by the student in case of future contingencies

CONCLUSION

After discussing the challenges faced on the URBN Center with the project team and faculty advisors, the analyses described in this proposal are intended to explore alternative possibilities that could have improved the construction process. The prefabrication of the curtain wall system is intended as an effort to schedule acceleration. The demolition alternatives and the SIP scheduling of the mezzanine both focus on the core of the building which was a main challenge on the project. The supply chain analysis of the chilled beam system is performed because the chilled beam is a unique product utilized in the URBN Center which raised delivery concerns to the project team.

Overall, it is hoped that the analyses in this thesis research are to be concluded as positive alternatives and a progressive learning experience for the student.

NOTE: this proposal will be updated by the student upon after receiving feedback from the faculty advisor.

APPENDIX A

BREADTH TOPICS

BREADTH TOPICS

The following breadth topics are subcategories of the analyses described previously focusing on other disciplines with in Architectural Engineering. The breadth topics are intended to study certain concerns that relate to the construction analysis.

Structural Breadth—Analysis I

As described previously, analysis II focuses on demolition alternatives for the building's center. One alternative that is being studied is placing temporary or permanent beams to brace the columns in the mezzanine's perimeter. Therefore, the breadth would be to calculate the appropriate size of the steel beams that would brace the columns.

Mechanical breadth—Analysis IV

In addition to the supply chain analysis for the Chilled beam system, an overall performance comparison between the chilled beam system and the pre-existing VAV mechanical system will be utilized as a mechanical breadth. This mechanical breadth will include mechanical calculations to determine the energy usage of the chilled beam system in order for it to perform efficiently. Similar calculation will be conducted on the pre-existing VAV system. The energy usage of both systems will be used to analyze the cost of performance for the owner.

This mechanical breadth along with the construction depth regarding the supply chain will conclude whether the chilled beam system was a positive choice for the owner and how the owner will benefit from this system in the future.

APPENDIX B

SPRING SEMESTER TIME TABLE

PROPOSED THESIS SEMESTER SCHEDULE: JANUARY 2013– APRIL 2013

Jan-7-13	Jan-14-13	Jan-21-13	Jan-28-13	Feb-4-13	Feb-11-13	Feb-18-13	Feb-25-13	Mar-4-13	Mar-11-13	Mar-18-13	Mar-25-13	Apr-1-13	Apr-8-13	Apr-15	Apr-22
Rev. Prop.								Spring Break (Mar 3-9)				Final Report (Apr 4)	Presentation (Apr 8-12)		Senior Banquet (Apr 26)
Research Prefab. Shops and Conduct interview s															
	Analyze Delivery and Storage Methods														
			Develop Installation Plan												
Analyze Exis. Demo Plan					Schedule and Cost Comparison										
	Research Alternative Demo/Case Studies								Breadth I & Summaries						
			Develop and verify New Demo Plan												
					Schedule and Cost Comparison										
Analyze the Mezzanine									Summaries & Conclusions						
	Identify Key Equip/ Re-sources for const.														
		Conduct interviews &Develop SIP Plan													
			Develop 4D Model												
Conduct Interviews					Compare Schedule/Productivity										
	Develop C. Beam Chain Supply Map								Summaries & Conclusion						
			Study chain Supply of alt. System (VAV)												
				C. Beam vs. VAV Supply Chain Comparison											
					Breadth II: Energy Usage Comparison										
									Summaries & Conclusion			Finalize The Report	Present to Jury		Update CPEP
									Develop Report/Presentation					ABET Assessment	
			Milestone 1 (1/28/13)		Milestone 2 (2/11/13)		Milestone 3 (3/1/13)				Milestone 4 (3/25/13)				

Milestone	
1	Complete background research and begin Analysis
2	Complete the first half of the Analysis & Go/no Go Check
3	Complete the Second Half of the Analysis
4	Summarized Conclusions and Report/Presentation in Progress

Legend

Analysis I: Prefabrication of the Curtain Wall System

Analysis II: Demolition Alternatives for the Building's Core

Analysis III: SIP Scheduling for the Mezzanine

Analysis IV: Supply Chain Research of the Chilled Beam System

BY: GHAITH YACOUB

CONSTRUCTION MANAGEMENT OPTION

FACULTY ADVISOR: DR. ROBERT LEICHT