Senior Thesis Proposal

CHEMISTRY BUILDING

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Construction Management

Dr. Riley

EXECUTIVE SUMMARY

Senior Thesis Final Proposal is anticipated to present the four areas of research and analysis that will be completed on the Chemistry Building. These four areas came forth through the series of technical reports completed and meeting with Dr. Riley. These practical areas were chosen, based upon the idea that they could be modified based upon critical industry issues, value engineering, constructability, and schedule reduction/acceleration.

Analysis #1: Critical Industry Issue

After working on the Chemistry Building for two summers and being a part of the PACE roundtable discussion, it was clear that this project is a prime example of "bringing BIM into the field." The purpose of this analysis is to investigate additional ways BIM could have been used on the Chemistry Building besides MEP coordination.

Analysis #2: Curtain Wall System

The Chemistry Building is designed to have a forty million dollar curtain wall system that is manufactured in Italy and contracted with Permasteelisa. The goal of this analysis is to determine two things. The first is to determine if breaking the contract up between multiple players can shorten lead-time and reduce the schedule. The second is to investigate other high-efficiency glazing systems to determine if a US manufacturer can produce a similar system. Glazing with PV capability will also be explored to see if it will be realistic to incorporate on the Chemistry Building.

Analysis #3: Electrical Breadth

Analysis #3 will be incorporated with analysis #2. Because the curtain wall is extremely expensive, a financial analysis will be conducted to determine if a PV capable glazing systems can be substituted. The goal is to find a system that can help with the energy consumption of the building with a short payback period.

Analysis #4: Mechanical Breadth

During the balancing and commissioning process of the lab penthouse AHU's of the Chemistry Building, it was realized these five AHU's were performing inefficiently. It was determined the cause was poor layout of duct work. The goal of this analysis is to use the BIM model to layout the duct work differently to eliminate the additional two inches of static pressure between the AHU and exhaust duct.

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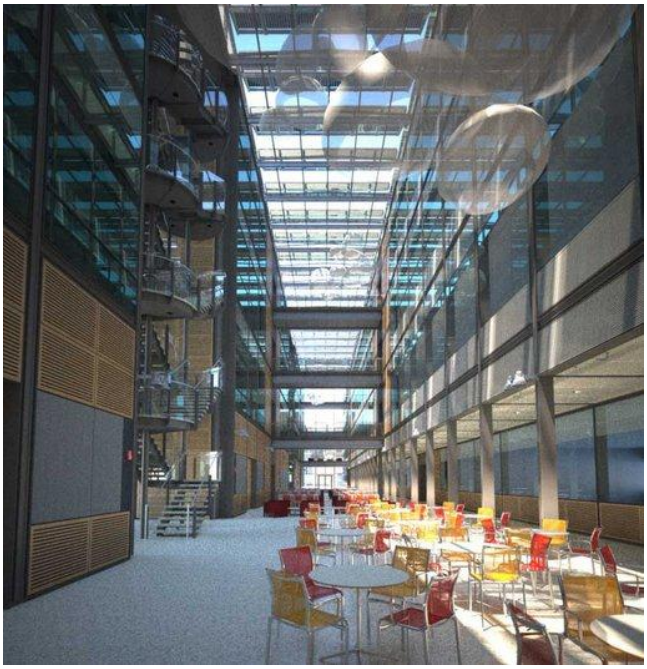
Project Background

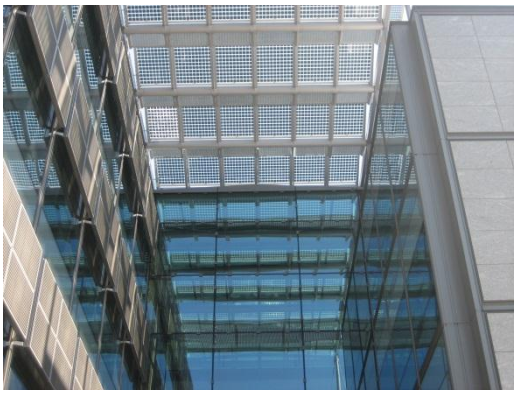


The Chemistry Building is designed to separate the building into separate spaces. The East side of the building is four stories of research and teaching labs. The West side of the building is four stories of offices. These two spaces are then connected by a large 4 story glass atrium with 3 bridges spanning across the large open space for access from one building to the other. The picture on the right is taken from inside the atrium looking north.

This 265,000 SF University Building was constructed as a result of their outdated and confined current facilities. The funding for this project came from a percentage of profit from a cancer drug discovered at this university.

There are six concrete cores for vertical transportation which break each building into sections. The lab building has three of the concrete cores which separate this part of the building into 4 main lab spaces. On the office side the cores are within each main pod which separates the office into only 3 main spaces on each floor. Besides the concrete cores where the elevators are located the architect used the rest of the vertical transportation as an aesthetic feature. On the lab building there are three stair towers enclosed in glass on the exterior of the building. They are a major part of the exterior design of the building and can be seen in the picture on the left. On the inside in the atrium there are also two large staircases which are and architectural feature. They can be seen in the picture above on the left side and help give the building an open feel. Going along with the open feel the end walls of the atrium are comprised of all glass and the entire

roof on the atrium is a glass skylight. Also the sides of the office building and lab building that face the atrium are all glass. Above the skylight has PV trays which are custom made for this building. They are not a traditional looking panel and are almost all clear glass allowing sunlight to make it through them and still naturally light the atrium. This can be seen in the picture on the right in the top center.



The Building façade is a curtain wall system. All the glass was produced in Italy. There are shading devices for each floor that also add to the aesthetics as well as function of the building. All the glass for the end walls on the atrium, skylight, office building, and lab building are tinted glass. The egress stair towers have a different type of glass. The end walls on the office and lab buildings are a granite stone. On the office side every room has a sliding door the height of the room with a screen for when the door opens. Because of safety and code requirements there is also a railing on the exterior covering the opening so no one falls out. All the penthouses have louvers that were produced in Mexico. These were chosen for their overall look as long with being function with the mechanical systems.

The university that owns this building has its own sustainable requirements for all the buildings on campus. Because of this, a lot of green aspects are incorporated in this building. The major one that can be seen when looking at the building is the PV trays on the roof. However these were done as more of an aesthetic feature and really do not produce too much energy. There is also a grey-water system that collects water and uses it to flush the toilets. All the lights and rooms have occupancy sensors which help reduce energy consumption. Because the building has a lot of glass it allows for a lot of natural lighting. The bad part about all of the glass though is it affects the mechanical system, which is why the windows were tinted and shading devices were incorporated on the façade. To also help with the mechanical system the AHU have a heat recovery system and VAV boxes.

Analysis #1: Critical Industry Issue

Problem Identification

The Chemistry Building produced a BIM which was used for 3D MEP coordination. After attending the "Bringing BIM into the Field" breakout session of the PACE roundtable conference, it was clear the Chemistry Building was a prime example of this topic. Some of the main topics discussed were tablets, barcode scanning, paperless jobs, tracking progress, and improving efficiency. Through my experience working on this project for two summers, I have noted ways the BIM model can be used more efficiently. The costs to use tablets, barcode scanning, etc. are minimal compared to the large upfront cost of building the model. These minimal costs could save time on the project, organize information, and help track it. Loading the model with manufacture information and warranty information could also be beneficial for the owner throughout the lifecycle of the building and its maintenance.

Research Goal

The goal of this analysis is to show the benefits of BIM and how it can be better utilized on a project. The goal of this is also to tie all my analysis's together and be an underlying theme for my senior thesis project.

Methodology

- Research projects that have used BIM to its fullest potential
- Explore case studies associated with BIM
- Interview select industry members regarding BIM
- Compare research gathered to my experience and project team's experience on the Chemistry Building
- Draw conclusions based upon comparison
- Develop summary of findings and associate cost and project impacts to them

Resources and Tools to be used

- Industry Professionals
- Turner team from Chemistry Building
- Applicable literature
- BIM case Studies
- Information from PACE roundtable conference
- AE Faculty – Craig Dubler and Dr. Messner

Expected Outcome

Using this mainly as a qualitative analysis, the expected outcome is to show the additional potential benefits BIM could provide for the Chemistry Building. The research and information gathered should show BIM was underused for the large upfront cost associated with it. The interviews of select industry members should also show there is a desire to expand upon the current uses of BIM.

Analysis #2: Curtain Wall System

Problem Identification

The Chemistry Building Currently has a forty million dollar curtain wall system that is manufactured in Italy. As a result, there were many problems associated with lead time and tracking pieces needed for construction. Because the scope of this work was so large, there were not many bidders due to the fact that a company could use the same amount of resources to bid four projects. Another problem associated with the curtain wall was engineering showed the three exterior glass stair towers only needed to be heat strengthened on the exterior pane. During construction a large percentage of the glass was broken.

Research Goal

The goal of this analysis is to show that breaking the curtain wall system contract up could improve the construction and management of constructing the curtain wall system. An additional goal is to find alternative systems that will work for the Chemistry Building and have potential to reduce schedule or cost. With the idea of value engineering in mind, a glazing system with PV capabilities will also be investigated. The hope is that system will have a similar upfront cost or a short payback period.

Methodology

- Contact manufactures for alternative glazing systems
- Find examples of similar projects where contract was split up
- Develop cost comparison between alternative systems and current system
- Develop schedule comparison between alternative systems and current system
- Draw conclusions and determine if alternate systems make sense
- Draw conclusions on how breaking up contract would improve project
- Electrical Breadth based upon PV glass system (explained in analysis #3)

Resources and Tools to be used

- Glazing system manufactures
- AE Faculty – Dr. Riley
- Applicable literature
- Turner Chemistry Building Project team

Expected Outcome

Keeping the BIM theme in mind, the outcome is to show using barcode scanning would solve the problems associated with Turner tracking pieces of glass. An additional expected outcome is more competitive bidding will increase quality or reduce cost based on smaller bid packages. Breaking the contract up will also allow more US manufactures to be used resulting in shorter lead time and less schedule impacts. Lastly, it is expected that value engineering will show a PV capable glass can be used with a short payback period.

Analysis #3: Electrical Breadth

Problem Identification

As discussed above, there were many problems associated with the curtain wall system. While exploring other curtain wall systems, it seems practical to explore a glass with PV capabilities. Besides the large cost of the curtain wall, about two million dollars' worth of custom PV trays cover the glass atrium skylight. This is an impractical cost considering they are used mainly for an architectural feature and produce minimal energy.

Research Goal

The goal of this analysis is to find a PV capable glazing system that can be implemented on the Chemistry Building

Methodology

- Contact manufacturers that produce glazing systems with PV capabilities
- Determine the total cost of this system
- Determine energy usage of the building and its cost
- Determine how much energy it produces and electrical equipment required to utilize the energy produced by this system
- Perform feasibility analysis based on cost of current system and payback period

Resources and Tools to be used

- Manufacturers
- AE Faculty – Dr. Riley
- Applicable literature
- AE Faculty – Electrical

Expected Outcome

Similar to what is stated above in the curtain wall analysis, the expected outcome is to find a photovoltaic glazing system for the Chemistry Building. The financial cost analysis completed comparing cost difference in the curtain wall systems and the energy savings from the PV glass should show this system is practical.

Analysis #4: Mechanical Breadth

Problem Identification

During the balancing and commissioning process of the lab penthouse AHU's of the Chemistry Building, it was realized these five AHU's were performing inefficiently. It was determined the cause was poor layout of ductwork. Two inches of static pressure were being lost between the AHU and the exhaust duct. As a result, the fans needed to run at a higher rpm in order to achieve the required CFM of air flow. Therefore, the fans were using a lot more energy, thus making the system inefficient.

Research Goal

The goal of this analysis is to use BIM to layout the ductwork differently in order to reduce the static pressure drop. This will reduce the fan speed and save energy.

Methodology

- Use current fan speed and CFM to calculate out energy consumption
- Use the BIM model to layout ductwork differently
- Calculate out the CFM and fan speed based on new ductwork layout
- Calculate energy savings based on new fan speed from changed ductwork

Resources and Tools

- Chemistry Building BIM Model
- Turner MEP superintendent and engineer
- Chemistry Building Balancer and Commissioning Agent
- AE Faculty – Mechanical
- AE Faculty – BIM - Dr. Messner

Expected Outcome

Keeping the underlying theme of BIM, this software will be used to redesign the ductwork. The driving factor of the modifications and redesign will be the calculations that show the new ductwork will reduce the fan speed while keeping CFM constant. This will result in the expected outcome of a ductwork layout that will reduce the energy consumption of the AHU's while meeting CFM requirements.

Analysis Weight Matrix

The weight, which is below, is used to breakdown the four analyses that will be conducted. This matrix breaks these analyses down based upon how much time and effort will be associated with each one.

Analysis Description	Research	Value Engineering	Constructability Review	Schedule Reduction	Total
Current Industry Issues (BIM)	15%			5%	20%
Curtain Wall System	15%	10%	10%	5%	40%
Electrical Breadth	5%	10%			15%
Mechanical Breadth		5%	10%		15%
Total	**35%**	**25%**	**20%**	**10%**	**100%**

Timetable

In order to complete all of these analyses by the set deadline, a timetable for the spring semester was comprised and can be viewed in **Appendix B**. This timetable includes four milestones of when certain tasks are expected to be completed by.

Conclusions

Based on the technical reports completed throughout this semester and a meeting with Dr. Riley, four analysis topics were clearly defined. In order to complete these analyses explained out above, extensive research and in-depth investigation will be required. The research and all four analyses are based on value engineering, current industry issues, constructability, and schedule reduction /acceleration.

The senior thesis project will be tied together based on the current industry issue of BIM and bringing it into the field. This will then lead into the curtain wall system and how the construction of it could have benefited from using BIM. Besides using BIM, other changes could have been made to improve the curtain wall system based on value engineering, constructability, and schedule reduction/acceleration. One of the value engineering portion of the curtain wall leads into analysis #3 and an electrical breadth. This is an investigation into a photovoltaic glazing systems. Lastly, BIM also leads into analysis #4 and a mechanical breadth by utilizing this software to modify a MEP system.

Appendix A – Breadth Studies

Breadth Topics

In conjunction with Construction Management ideas, some of the analyses that will be conducted require additional analysis in other disciplines within Architectural Engineering.

Electrical Breadth

As explained in Analysis #3, the electrical discipline will be used in order to complete an analysis on a photovoltaic glazing system. This analysis will require the calculation of the total energy produced by this system. The next step will be determining and sizing the equipment and/or connections necessary for the Chemistry Building to utilize this energy.

Mechanical Breadth

As explained in Analysis #4, the Mechanical discipline will be used to improve the efficiency of five of the Chemistry Building's AHU's. Based on calculations and information learned in AE 310, the ductwork will be redesigned. The new layout will decrease the fan speed of the AHU while maintaining the required CFM for the serviced spaces. The end result is to save energy and make these AHU's run efficiently/how they were originally designed to. With the help from the mechanical AE faculty and equations learned in the mechanical discipline, calculations will prove the new ductwork layout improves this system's efficiency.

Appendix B – Timetable

MileStone #1 1/28/11 | MileStone #2 2/18/11 | MileStone #3 3/4/11 | MileStone #4 3/25/11

Proposed Spring Semester Thesis Schedule

10-Jan-11 | 17-Jan-11 | 24-Jan-11 | 31-Jan-11 | 7-Feb-11 | 14-Feb-11 | 21-Feb-11 | 28-Feb-11 | 7-Mar-11 | 14-Mar-11 | 21-Mar-11 | 28-Mar-11 | 4-Apr-11 | 11-Apr-11 | 18-Apr-11 | 25-Apr-11

- Go over BIM Uses with Turner
- Research on Bringing BIM into the Field
- Compare Research to Project
- Anylsis on how different BIM uses impact cost and schedule
- Research on Alternative Curtain Wall Systems
- Research on changing contract breakup for curtain wall system and Feasibility Analysis
- Feasibility Analysis for alternative systems
- Cost and Schedule Impacts
- Research and Analyze Energy Consumption for the Hospital
- Electrical equipment required to utalize energy from PV in curtain wall glass
- Finacial Feasibility Analysis
- Energy Consumption of Lab Penthouse AHU
- Lab Penthouse AHU duct redesign based on BIM
- Energy impacts based on redesign

Spring Break 2011 | **Final Reports Due** | **Faculty Jury Presentations** | **Senior Banquet**

Milestones	
1	Alternative Curtain Wall Systems Chosen, Analysis of Information gathered for analysis 1 &4 complete, 3 ongoing
2	Research for Analysis 1 & 2 complete, Analysis 3 electrical analysis ongoing, AHU duct redesign complete
3	All Analyses in Evaluation/Completion Stage
4	All Analyses Complete

	Analysis 1	Bim Usage Analysis
	Analysis 2	Curtain Wall System Analysis
	Analysis 3	Electrical Breadth - PV curtain wall system option
	Analysis 4	Mechanical Breadth - BIM usage to redesign AHU Duct