Final Proposal
Spring Thesis Project

50 Connell Drive Office Building
Berkeley Heights, NJ

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Executive Summary:

There will be four analysis topics that are being proposing to research for the spring thesis project. These analysis topics are as followed:

1. Method of eliminating the problems encountered installing the exterior wall panels.
2. Cost and benefits of implementing a high performance façade
3. Areas that can benefit from using prefabrication
4. Rising operating costs

The problems that were encountered installing the exterior facade can be eliminated through a design change, changing the way the work was executed in the field or a combination of the two. The current design will be reviewed to see where improvements can be made. A cost, schedule and constructability review of the proposed solution will be performed.

The current facade requires the use of perimeter baseboard heaters around the entire building. Upgrading to a high performance facade by utilizing triple pane glass and added insulation to the walls may be able to eliminate these heaters, reduce the size of the boiler, reduce the size of the mechanical equipment and reduce the operating costs for the building. Energy 10 software will be used to model the energy savings. A life cycle cost analysis will be performed and a final recommendation will be made based on those findings.

The use of materials that have been fabricated off site may reduce labor costs and reduce the schedule. Areas that will be examined include prefabricated electrical outlets, piping, vanities, pre-insulated ductwork and granite tiles that are delivered in sections on a precast frame. A cost and schedule analysis will be used to determine the feasibility of these options.

Rising energy costs has become a critical issue for the building industry. It has directly correlated to rising operating costs. This hurts both owners and tenants. A study of this topic will determine the most effective methods to decrease operating costs through the use of energy efficient design. Professionals who have experience with this type of work will be contacted to determine methods that they have used with success. Possible solutions include geo thermal wells, use of a high performance façade, low flow plumbing fixtures, waterless urinals, energy efficient equipment, photovoltaic solar panels, wind turbines, a green roof, heat recovery and the use of sun shades.

Analysis 1: Panelized Facade

Problem Statement:

The exterior stone panels that the façade is built from were pre-fabricated and delivered to the site on pre-cast trusses. The system was designed this way in an effort to reduce construction time. However there were unforeseen complications related to the installation of these stone panels. The panels were difficult to align properly. The drawings show ¼" joint between each panel. The contractor who was performing the work had trouble setting the panels within this threshold. Some of the panels had a ½" joint. To complicate issues even further the windows were set in place prior to the stone. If the joints between the panels are not exactly ¼" as designed there won't be enough space to fit the panels around the window. Turner noticed that as work proceeded on the panels both the vertical joints and horizontal joints appeared skewed as one looks down the length of the building. They determined that the problem was not solely related improper joint thickness but was also created by the window contractor who did not place the glazing correctly. About 20% of the windows had to be removed and re-aligned in order for the stone to fit properly.

Potential Solutions:

The goal of my thesis research on this topic will be finding a way to eliminate the problems that lead to the poor alignment. I plan on performing two separate analyses to reach a solution. The first analysis would be a redesign of the prefabricated sections of wall. Since there was a problem with the glass/stone interface I would examine how to eliminate this complication. One method will be designing the prefabricated sections of stone with the glass assembly already installed.

The second analysis that I plan to perform on this topic is related to how the execution in the field was performed. Two separate contractors were used for the exterior wall. One contractor installed the stone panels and another contractor installed the glazing. There is a possibility that the problems encountered in the field could have been avoided with an increased level of coordination between parties. I would also like to explore the feasibility of re-writing the contract and giving the entire responsibility of the exterior wall to a single contractor. If one contractor was responsible for the design and construction of the wall it would make coordination between the glass and the stone placement the responsibility of one party and would eliminate communication barriers. This arrangement would also provide a strong incentive to design the system efficiently and perform the work properly since the contractor wouldn't be able to place blame on another contractor.

Research Methods:

To research the feasibility of these solutions I will hold interviews with professionals within the industry who have experience working with prefabricated construction. Research would need to be conducted on similar systems. General contractors, construction managers, subcontractors, vendors, engineers who have used pre-fabricated exterior wall sections would be beneficial to contact in order to learn what works well and what does not work well for these systems. I would focus my attention on the Turner team and the subcontractors who performed the work. I plan to conduct interviews with people and compare feedback to find where the critical issues lie and how they can be overcome.

Research Steps:

1. Analyze the current wall design and contract requirements
2. Determine problematic features
3. Brainstorm alternate solutions
4. Obtain feedback and suggestions from the Turner team
5. Obtain feedback and suggestions from the subcontractors assembly the exterior wall
6. Propose alternate solutions to the Turner team
7. Perform cost, schedule and constructability analysis of potential solutions
8. Choose the best solution
9. Make final recommendation to solve the problems encountered on the project

Expected Outcome:

I expect that industry members will encourage me to make changes to the delivery and execution of the work rather than change the design. It is important to note that this can only be achieved if one contractor is willing to bid both the glass and the stone sections. There is also a concern that they may subcontract a portion of the work to another contractor to reduce risk to themselves. This would defeat the idea of awarding the façade to one contractor. It seems that re-designing any element of a building is something that should be done as a last resort. As a construction management student it will be my job to lead coordination efforts on a project and find solutions to problems with the resources that are available to me.

Analysis 2: Cost and benefits of implementing a high performance facade

Includes Breadths 1 and 2: Structural and mechanical

Problem Statement:

The building currently has perimeter baseboard heaters around the entire building. It also has a boiler with a capacity of 1739 MBU. There is an opportunity to eliminate the perimeter heaters and reduce the size of the boiler if the building was designed with a high performance facade. Elimination of the heaters will result in less site congestion. This will also result in reduced operating costs through the life cycle of the building. The goal of my research is to determine how changes can be made to improve the current design, what will the upfront cost be to implement the improved system and how long it will take for the system to pay for itself.

Potential Solutions:

The insulating properties of the facade could be improved by implementing high performance glazing. This could be in the form of triple pane glass. There may also be opportunities to increase the amount of insulation behind the exterior stone panels.

Research Methods:

To analyze this topic I would research the high performance facades that are on the market today. Rising energy costs have increased the demand for this type of system and contractors are beginning to see more owners choose these systems on their projects. I plan on contacting the contractors who have performed this type of work to learn what the critical constructability challenges are and how much of a premium this type of system costs over the standard facade. I will also contact engineers and mechanical contractors to determine how high of an R Value the wall will need and how that will effect the size of the boiler and overall energy consumption of the building. Energy 10 is a piece of software that I plan to use to model the energy efficiency of a building. The software will also be able to help me develop an idea of how long it takes this system to pay for itself. I would also contact local, state and federal agencies to determine if they offer any incentives to the owner for using an energy efficient design. Faculty members within the AE department also have expertise in this area and they could provide valuable advice and insight into the design of such a system. Listed below are various research steps and tools that that I will use to conduct my study.

Research Steps:

1. Research benefits of high performance building envelopes
2. Determine how the current façade can be improved
3. Contact professionals for an expert opinion

4. Determine estimated cost of potential solutions
5. Evaluate constructability of all potential solutions
6. Determine performance of each solution
7. Choose best solution
8. Perform Energy 10 simulation
9. Calculate energy savings of switching to a high performance building envelope
10. Make recommendation on feasibility of the proposed system

Tools:

1. Southland Industry
2. AE faculty consultants
3. Energy 10 software
4. Turner Construction
5. The Whiting-Turner Contracting Company

Expected Outcome:

I expect that a highly efficient façade will be a substantial investment for the owner. The upfront costs may be 50% more or higher than the cost of a traditional facade. I expect that this upfront investment will pay for itself over the life cycle of the building. The potential aid from state and federal incentives will make this option more attractive to the owner. The combination of energy costs that are expected to rise in the future and an upcoming administration that is proposing further incentives to energy efficient design will be a motivating factor for the owner to switch to a more energy efficient system.

Analysis 3: Prefabrication

Problem Statement:

Prefabrication is becoming more commonplace in the industry. The only part of this building that utilized prefabrication was the panel wall system. I would like to analyze whether there are any other building components that can benefit from prefabrication. Benefits of standardization of parts would be measured by the schedule and cost savings impact that it has on the project.

Potential Solutions:

There are numerous building components that have the potential to benefit from off site assembly. They include prefabricated electrical outlets, preassembled plumbing pipes that make use of mechanical fasteners, vanity units and pre-insulated ductwork. It would be interesting to investigate whether the granite floor in the lobby could be delivered on a precast frame and set into place in large sections rather than piece by piece. The project team learned that installing this granite was a time consuming process and threatened the completion date of the project.

Research Methods:

Contacting suppliers would allow me to obtain a unit cost for standardized items. I will also consult with the Turner team who is running the project to see if they can help identify areas that could implement prefabrication. Researching other projects that have taken advantage of prefabricated elements will also provide a good idea for potential implementation on this project. Surveys will be distributed to general contractors to see what kind of preassembled products have been used on their projects and whether their use resulted in measurable cost or schedule savings. Listed below are the steps and resources that I will use as tools for conducting my research.

Research Steps:

1. Research where prefabricated elements have been used on past projects
2. Determine which of those elements can be used on this project
3. Research the advantages and disadvantages of prefabricated construction through literary review and interviews with experts
4. Contact the Turner team and ask them to identify areas on the project that can benefit from off site assembly

5. Contact suppliers and manufactures to inquire if they can custom build prefabricated elements
6. Create preliminary list of prefabricated items that could be implemented on the project
7. Compare prices of prefab units vs. traditional stick built units
8. Determine if standardized production can improve schedule
9. Identify constructability challenges
10. Make final recommendation

Tools:

1. ASCE Journal of Architectural Engineering
2. Turner Construction
3. The Whiting-Turner Contracting Company
4. PACE supporters
5. Journal of Construction Engineering and Management

Expected Outcome:

I expect that there can be measurable schedule and cost savings from utilizing standardization of parts on this project. I expect that a core and shell office building does not have as much potential to benefit from prefabricated electrical outlets or vanities as a large apartment building with many units but even small scale use of these elements will make a difference. Pre-insulted ductwork should save time and labor in the field. More research will be needed to determine if the lobby granite could be delivered as a panelized system. If this can be achieved I expect it would be a major improvement over the actual design that will save time and money.

Analysis 4: Rising Operating Costs

Critical Industry Research Topic

Problem Statement:

Rising operating costs have become an issue of concern to building owners. The discussion at the fall 2008 PACE Roundtable made it clear that high energy costs are a reality that many owners are becoming all too familiar with. The goal of my research is to determine what the highest value mechanical upgrades can be made to this type of project. Energy efficient products and green building technology are becoming mainstream within the industry. My research would aim at determining the best methods to reduce life cycle costs for a building. Owners will clearly benefit from this technology. Not only will their building have lower operating costs but an energy efficient building is more valuable on the open market. Owners will be in a position to charge a premium to their tenants because their building consumes less energy. Society as a whole will also benefit from green building technology. Less energy consumption correlates to less pollution and a healthier environment. If our society is successful in implementing energy efficient design in the future there is even a chance that a decrease in demand for energy will correlate to lower energy costs.

Potential Solutions:

There are many options when it comes to reducing operating costs. Potential solutions to reducing operating costs may include implementation of geo thermal wells, use of a high performance façade, low flow plumbing fixtures, waterless urinals, energy efficient equipment, photovoltaic solar panels, wind turbines, a green roof, heat recovery and the use of sun shades.

Research Methods:

To gain a better understanding of which options provide the greatest benefit research will be performed in the form of literature review and interviews with experts. These experts include specialty mechanical contractors, vendors, owners and general contractors. Survey questions similar to those below will also be distributed:

Survey Questions:

1. Do you have experience working with green building technology?
2. Do you have experience performing an energy retrofit of an existing building? Please explain the nature of the work.
3. Are there specific measure you have taken on projects to reduce energy consumption and if so what are they?

4. Which methods have proven to provide the greatest reduction in energy consumption?
5. Can you quantify these energy savings?
6. As an expert in this field what advice would you give to building owners who want to implement new technology to reduce operating costs for projects that they are planning?
7. What are the most valuable lessons learned from retrofitting?
8. What are the most common methods of implementing energy efficient design and what is the measurable benefit over a traditional design?
9. Is there any area where you see a great potential for improvement?
10. Are you aware of any state or federal incentives for investing in energy efficient design?

Expected Outcome:

I expect that experts within the industry are seeing an increase in the number of projects that are taking steps to reduce life cycle operating costs. Common areas of improvement are likely upgrading to a more efficient electrical and mechanical design. I also believe that many owners are reluctant to invest large sums of money in new technology that has not yet proven to be effective in the long run. Any type of state or federal incentive for switching to a more efficient system will help suede owners to invest their money in new technology.

Weight Matrix:

The matrix in Figure 1 shows how my effort will be distributed among each analysis topic. There are four main categories that I will be focusing on. They include research, value engineering, constructability review and schedule reduction. The chart demonstrates how heavily each analysis topic focuses among each of the categories.

Description	Research	Value Engineering	Constructability Review	Schedule Reduction	Total
Panelized Facade	0%	0%	15%	10%	25%
High Performance Façade	5%	15%	5%	0%	25%
Prefabrication	5%	5%	5%	15%	30%
Rising Operating Costs	15%	5%	0%	0%	20%
Total	30%	25%	20%	25%	100%

Figure 1 – Weight Matrix

Conclusions:

There are many opportunities for areas of study related to this building. Each of my four analysis topics will require research, expert opinion and creative solutions. These innovative solutions will reveal the constructability concerns, value engineering opportunities and potential schedule reduction for this project.

Appendix A – Breadth Studies

My spring thesis project will demonstrate breadth in Architectural Engineering. The breadth studies will be imbedded into my analysis topics and will not become a separate study of their own. The breadth that I will be studying within the curriculum of Architectural Engineering will be structural and mechanical.

One of my analysis topics that I am proposing is to identify elements that can benefit from prefabrication. I plan to propose the use of a modular central plant to replace the current mechanical system. A modular plant is a very heavy load for the building's structural system to support. I will perform a STAAD analysis on the supporting beams to determine if they can support this load.

I will be proposing the use of high performance glazing on the façade to improve energy efficiency. A high performance façade will impact the building's mechanical system. The intent of the improved façade is to reduce the heating and cooling loads within the space. Successful implementation of a high performance building envelope will result in smaller less energy consuming air handling units and boiler unit. There is also a possibility that smaller ductwork can be used to deliver the conditioned air into the space. The new facade will reduce the load on the building's mechanical system. Energy modeling software will be used to estimate the energy savings.