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Executive Summary

This final technical assignment consists of critical industry issues, critical issues research method, problem identification, and technical analysis methods, relating to the background for my research in the spring of 2008 of the Harrisburg University of Science and Technology's Academic Center.

Some of the main features that have been analyzed and researched on the Harrisburg University of Science and Technology's Academic Center are critical industry issues relating but not limited to those discussed at the 2007 PACE Roundtable meeting, "Building Collaboration". These issues are prefabrication, building information modeling (BIM), and work force development.

In this report is an extensive look at the topic areas for my thesis. They are divided into the main area of research and study and breadth analysises. The main area will be looking at the U.S. Green Building Council's LEED® rating system and green building design as it pertains to the knowledge of owners and developers. The breadth analysises are divided into sections of value engineering analysis, constructibility review, and schedule reduction/acceleration involving the relocation of the mechanical system servicing the building as well as a pre-cast concrete vs. steel structural system for the Academic Center. At the end of the report, there is a weight matrix for how my final efforts among the different analyses proposed will be evaluated.

A. Critical Industry Issues

"Building Collaboration" PACE Roundtable 2007

There were many attendees at the roundtable meeting this fall from all over the state of Pennsylvania and even other states. There were many familiar faces as noted industry professionals have entered classrooms for discussions and presentations in previous class lectures. However, there were strong opinions expressed by few and women that were present representing their companies and specific trades were not heard as loudly. Contacts that I have made that would be able to advise me in my research are Steve Wilt and Chris Magent from Alexander Building Construction, Seth Glinski from Forrester, and Jeff Merritt, Todd Buzard, and Walter Tack from Reynolds Construction Management. I will be using most of my contacts for advice on green building design with some questions relating to the topics discussed at the meeting. The following are the topics discussed at the PACE roundtable that may be applied to my research and notes taken during discussion.

Prefabrication
This can exist both on and off-site. It can be as detailed as sheet metal ductwork for HVAC systems and smart walls where there are already raceways and cabinetry assembled. There is a difference between residential and commercial prefabrication. In houses there are specific state codes to be followed so manufacturing can be difficult; little prefabrication exists in office structures and a possible route for implementing this would be the standardation of components. Change orders bring problems to prefabrication; there needs to be a window of opportunity of change so there may be constraints necessary. There were open questions for debate, the greatest being how does one optimize prefabrication in general.

Building Information Modeling (BIM)
BIM pushes decision making to the front and has great potential to facilitate the change order process. This modeling system educates the owner or developer but can require more necessary skills from the contractors. It can be a great marketing tool, analyze costs and benefits, and improve communications. BIM can enable paperless design in the future and one could better analyze designs and the construction process for a certain building project. Mechanical systems have the most to lose or gain from the building modeling because the surrounding structure already exists.

Work Force Development
Workforce shortages have increased greatly in recent years. This could be the effect of the need of a higher standard of working conditions and also the ignorance of the construction industry in general relating to full careers. To reduce this problem, a career path could be shown to laborers. Recruitment is necessary at junior or technical colleges. Hiring immigrant laborers as bilingual human resource and project managers is another potential idea. Reduction in labor equipment as related to prefabrication could also remedy the need for more field laborers. There have been a positive effect of such shows as "Engineering Marvels" and "Bob the Builder" on some younger generations and viewing the industry.

B. Critical Issues Research Method

Problem Defined
With the number of LEED® Accredited Professionals on the rise, there still is a need for awareness with owners and developers to implement the U. S. Geen Building Council's rating system for green building design. The importance of green building projects needs to be displayed in a different light so that those interested in constructing projects can see the immediate and long term benefits of such building designs, etc. It will show environmental effects and cost analysis.

Research Goal
The goal for the research will be to understand why more projects are not becoming LEED® Certified through the USGBC's rating system or even referred to as "green buildings". Architectural and engineering magazines and other publications have produced various articles for either displaying green projects, advertising for products currently and potentially on the market to save energy, and works by professionals showing work with research relating to findings of environmentally-friendly solutions to solve a particular building projects needs. However, many of these articles are for an educated audience and do not explain on a general level the benefits of such design ideas and methodologies.

Research Steps
1. I will continue to educate myself of the U. S. Geen Building Council's rating system for green building design, LEED® and green building in general. Throughout the summer during my internship with Reynolds Construction Management, I had the opportunity to attend study sessions for those interested in becoming LEED® Accredited. Through this experience, I obtained study materials that break down the ideas and methodologies of the rating system and go about describing in detail what LEED® is.
2. Interview successful owners and developers to find out what their interests, concerns, and ideas about using LEED® for their projects are/were. I will also interview potential owners and developers to see why or why not the rating system was implemented. From this, I will conduct further research by asking other questions relating to their knowledge of green buildings. See sample survey.
3. I will gather the results from the earlier mentioned discussions and compile this as the basis for my specific research. Two examples are (if they are aware of green buildings) if they knew green building concepts prior to their construction project or if the owner's representive directed them into considering an environmentally-friendly approach.
4. I will speak with individuals who have developed similar projects to those that have been questioned about LEED® and green building and ask why the system was not implemented. Potential reasons could be finances or benefits to the environment seemed to small or insignificant to them.
5. Assemble the information from the surveys and develop a goals sheet for what I plan to research further.
6. Develop from the data taken a way to show owners and developers the benefits from using the LEED® rating system and what green building design can do for the

environment. I will also keep in mind initial and life-cycle costs and break down what benefits their building specifically will do for the environment or the area in which it is located. (The benefits of the environment, etc. will be from results gathered in the owners and developers who are not using the rating system. I will tailor it to suit the questions they might still have and show them potential changes and solutions.)

7. I will return to my chosen thesis building project, the Harrisburg University of Science and Technology, and show them future potential changes they can consider when expanding the university's campus.

Sample Survey

*Given to owner, developer, owner's representative to survey particular project about knowledge of green building design, awareness of LEED® system

*Building statistics for each project referenced will be considered for use, size, cost, location, and year design and constructed

For contacts with LEED® certified or green building project

• How was the idea of green building design for the project first introduced?

• Were you aware of it prior to the idea of this building project?

• Can you tell me when you were first introduced to the idea and concept of green building and a rating system for it from the USGBC? How long have you been aware of this?

• Can you rate or describe your knowledge of green building design?

• In order to construct more green and LEED® certified buildings, do you think it is necessary to teach owners and developers of the idea prior to the design or during this phase of the construction of a project?

For contacts without LEED® certified or green building project

• Are aware of green building design?

• Are you aware of LEED®?

<u>If so,</u>

For how long and where did you first hear of it?

Were you aware of it prior to the idea of this building project?

Can you tell me when you were first introduced to the idea and concept of green building and a rating system for it from the USGBC? How long have you been aware of this?

Can you rate or describe your knowledge of green building design?

In order to construct more green and LEED® certified buildings, do you think it is necessary to teach owners and developers of the idea prior to the design or during this phase of the construction of a project?

<u>If not,</u>

Would you be interested in learning more about green building design and the USGBC's LEED® rating system?

Would it be benefitial to see the breakdown of costs saved and added to specific areas of the project?

Out of the following, can you tell me the most influential factor in the decision to not go green with [specific project]?

*Not in budget
*Not aware of LEED®/green building design
*Could not see benefits clearly in green design
*Design professionals were not educated/not a choice in design

C. Problem Identification

Listed below are some of the issues that arose during the pre-construction and construction of the Harrisburg University Academic Center. Through discussion with the pre-construction department and the field superintendent and Reynolds Construction Management, these items have been noted as the most considerable and challenging aspects of the building project and systems. From the following topics, proposal research ideas will be chosen.

1. Building Information Modeling: During the preconstruction and at the beginning of the construction phase of the building project, there were excessive addendas, bulletins, and requests for information. Had there been an implementation of BIM or 4D CAD, there might have been a relief for such questioning and clarifications.

2. LEED®/Green Building Design: There is a growing need and understanding to consider ways of saving energy and non-renewable resources. Further analysis of why a green building design approach was not implemented could be examined. Who was the uninformed party or who chose not to consider/implement the LEED® rating system?

3. The mechanical systems located on the top floor have very large ducts and have to service the entire building which is 16 stories. The floors have an average height of twelve feet (floor-floor height). Could there have been two mechanical floors in the building or one located mid-height? Is the best system in use for energy efficiecy? Is this a possible design issue and can it be considered for LEED®/green design?

4. The curtain wall system was chosen so that the structure could use expansive floor plans, use a smaller foot print for a larger amount of square footage (high-rise construction), and have the possibility to change the specific floor arrangements as the University felt necessary.

    a.) Is the steel structure the best for the spanning between support columns for spacial issues? Could a pre-cast concrete structure have been used? Would this have been a cost savings issue with the current price of steel? Would this have worked with the site conditions in the down-town Harrisburg area (staging)? Would lead time for the pre-cast concrete affect the current schedule? Would the erection of the pre-cast change in relation to the erection of the steel?

    b.) Was the glazing system chosen the best for efficiency?

D. Technical Analysis Methods

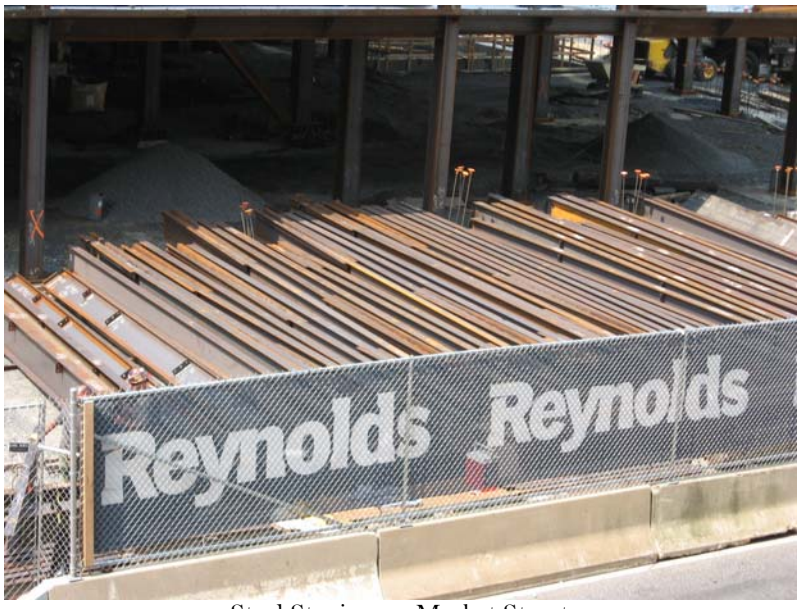
The Problem Identification (and Opportunity), Section C. showed potential design and construction methodologies that could have been implemented or could be used in related projects or future construction for the Harrisburg University of Science and Technology. The following are core thesis investigation areas for further analysis and study. Below are the technical analysis methods that will be used to research two additional topics relating to the Harrisburg University of Science and Technology's Academic Center, relocating the mechanical system servicing the building as well as a pre-cast concrete vs. steel structural system for the project.

Value Engineering Analysis

The mechanical systems located on the top floor have very large ducts and have to service the entire building which is 16 stories. As far as value engineering, there might have been cost savings and energy efficiency added to the system in the Academic Center. The relocation of the system to the center of the building could reduce the duct sizes needed to service the other fifteen floors. Having two partial floors dedicated to housing of the mechanical systems could also be analyzed. The glazing of the two facades of the building may have also been considered for value analysis for their thermal efficiency. If the architecture of the building is considered, there could have been repetition of design throughout the stucture where large atrium spaces are located. Studying the effects of air flow and indoor air quality in spaces is also an option for value engineering and further green building designs.

Constructability Review

The Harrisburg University Academic Center is a high-rise building in the city of Harrisburg. The current structural system consists of steel girders, beams, and columns; precast concrete wall panels; and composite slab on metal deck. An analysis to further determine if this system integrated with the curtain wall system is the best choice for the area, site, project, and cost could be done. Considerations of a pre-cast concrete structure would include staging for the pre-cast concrete, lead time for the pre-cast concrete, integration with mechanical, electrical, and plumbing systems. Continuing, studying the costs of each system, plenum heights allowed, spanning distances, and green building design will be analyzed. The following image is of the steel staging area on the south façade of the construction side, located on Market Street.



Steel Staging on Market Street

Schedule Reduction/Acceleration Proposal

During the beginning of the erection of the steel structure for the Academic Center, there were a number of schedule delays including the need to reposition the tower crane on site. As discussed above, the structural system currently in place has a long lead time for the fabrication of the steel members. With the integration of the existing pre-cast concrete wall panels, there could be a reduction or acceleration of the schedule if a structural pre-cast system was in place. However, in order to implement such a change in design, considerations for this modification to the structure would have to have occured during the design phase of the project. An analysis of whether a pre-cast concrete structure would have led to possible fast-tracking or acceleration of the schedule will be conducted.

E. Weight Matrix

The following is the weight matrix associated with the evaluation of my thesis research for the spring 2008 semester. At least 15% of every core thesis investigation will go toward my final grade. The descriptions for the 2 breadth studies and main thesis research area are listed as well. Due to the fact that analyzing and researching LEED®/green design is highly extensive and will put me as a candidate for becoming a LEED Accredited Professional, more weight is added to this research area.

Description	Research	Value Eng.	Const. Rev.	Sched. Red.	Total
LEED	25%	10%	5%		40%
PPC vs. Steel	5%		20%	10%	35%
Mech System	5%	10%	5%	5%	25%
Total	35%	20%	30%	15%	100%