Technical Assignment #3

77 K STREET

Washington, DC

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Executive Summary

Technical assignment #3 was a means of exploring potential research and analysis topics for the spring semester. This report contains a summary of the PACE Roundtable panel discussions, a research topic overview, a summary of potential analysis opportunities relating to the 77 K Street project, a description of the proposed analysis areas, and a weight matrix outlining analysis emphasis areas.

The 77 K Street project is not pursuing LEED certification though the idea was considered but not until well into the design and planning process. After conducting a LEED benchmark survey, the design team realized that the building only achieved a 4.8% energy savings, significantly shy of the 14% minimum LEED prerequisite requirement. Because the idea was first considered late in the project and significant time and cost implications would be incurred, the project team opted not to pursue certification though minor LEED items are being pursued for the sake of sustainability and efficiency. The major theme of my research efforts will be analyzing the feasibility and cost implications of making this building LEED certified. Key areas that will be explored include natural lighting and the incorporation of a green roof.

As a means of reducing the overall project schedule I am proposing developing a short interval production schedule (SIPS). Through the process of creating the critical path method (CPM) schedule in technical assignment number 2, I began to see opportunities for the implementation of a short interval production schedule (SIPS). By beginning to utilize the labor force more efficiently the project could begin to operate in a more lean and productive manner, not only saving time but saving money as well.

Ideas proposed in this technical assignment will be utilized and expanded upon in the final proposal. The final proposal report will serve as the basis for spring coursework.

Critical Industry Issues

The following three industry related topics were discussed at the PACE Roundtable event held on Wednesday, October 24, 2007, at the Nittany Lion Inn. The issues of prefabrication, building information modeling, and labor/management strategies were presented by a panel consisting of industry professionals. After opening statements by the panelists, an open forum question and comment session took place allowing students, industry members, and faculty to partake in the discussion of the issue at hand.

Prefabrication

The issue of prefabrication delves into the idea of preassembling segments of a building for transport to the construction site. The ultimate objective of prefabrication is to reduce onsite construction time and at the same time, potentially improve overall quality of the end product. Unlike in a traditional prefabrication industry, the ultimate goal is not to reduce customization in an effort to produce a lean product that flows off of an assembly line. Mass quantities of a building segment will not role out of factory assembly lines for transport to project locations across the country. Prefabrication in the construction industry is utilized on an individual project basis in an effort to decrease assembly and construction on site. Prefabricated or preassembled building elements are still highly customized and designed to meet the specifications and requirements of an individual project. Even as the concept of prefabrication continues to increase in popularity, the intention is not to reach the point of mass prefabrication but rather the point of increased individual project preassembly.

When discussing the idea of prefabrication there are two key stages of a project that one must consider, design and construction. Each will play a differing yet equally important role in the success of the prefabrication process. With any prefabrication project, the degree of success in terms of schedule and cost implications hinges on the stage in which prefabrication is decided upon. The issue is not merely one of construction but an issue that affects the design team as well. As soon as an owner decides that prefabrication should be incorporated on a large scale, the design team can begin making necessary adjustments to their overall project design. The degree to which prefabrication can be incorporated hinges on the degree to which typical, repeatable units are incorporated into the design. The more consistent a design is within the prefabricated building system or component, the more successful the prefabrication will be. Though some design professionals fear that prefabrication will hinder an architect's creativity, it is important to realize that prefabrication requires efficiency in design in order to meet an owner's schedule and cost requirements.

On the construction side of the project picture, a subcontractor must be willing to accept a prefabricated construction process from the very beginning. The entire process requires a fundamental focus on detail. The contractor will need to coordinate with multiple parties and subcontractors to ensure that the offsite construction, inspection, transportation, and onsite erection all happen smoothly. It requires that the contractor take an in depth look at the construction supply chain and analyze how failures at any level will impact other levels of the construction chain. With a focus on detail and a commitment to prefabrication, the entire project team can see enormous impacts on a project's schedule, cost, design and construction efficiency, and quality.

Overall, the session was extremely beneficial and allowed many of the students to see the potential advantages of prefabrication within the industry. Ted Border's experience with Whiting-Turner working on prefabricated projects was of particular interest. His insight played a large part in the group discussion and his follow-up presentation in AE 473 was particularly powerful. His experience with prefabrication showed just how drastically a schedule can be condensed when utilizing this process. In some cases, it is simply the only way of delivering a project on time when given an extremely aggressive project schedule. Mr. Border will be a valuable contact when information pertaining to the prefabrication process is needed.

Building Information Modeling

As the idea of building information modeling, or BIM for short, undoubtedly continues to gain popularity, the industry panelists geared this discussion session towards addressing some of the challenges that BIM must overcome before it shall become an industry standard practice. The benefits of BIM in terms of design, construction, maintenance, and operation are widely accepted from those familiar with the technology but many are struggling trying to fully integrate building information modeling into their construction projects.

Though numerous companies have begun utilizing BIM from a marketing perspective and also performing clash detection analyses, many are finding it difficult to fully incorporate their subcontractors in the BIM process. This delves into the issues of who authors the model versus who is able to use the model, who has ultimate liability if the model contains errors, and how can smaller subcontractors benefit from the use of BIM technology.

Areas of research that were brought forward during the discussion included performing statistical cost-benefit analyses, evaluating the need for delivery method adjustments, assessing contract liability, and innovatively integrating the technology to gain a competitive advantage in the industry.

Kurt Maldovan of Jacobs Engineering and Albert Zulps of Skanska USA, both of which sat on the panel for the BIM session, will prove to be valuable assets. Kurt's usage of BIM during the design phase of a project and Albert's knowledge of the legal and logistical challenges associated with the new technology offer a broad range of knowledge pertaining to the issue.

Labor / Management Shortages

As the construction market continues to grow in many regions of the country, many companies are struggling to find the labor required to meet project demands. As was brought up during the session, the industry is seeing its workforce continue to get older while struggling to recruit new, young individuals willing to enter the construction industry. Consequently, many companies have turned towards an immigrant workforce, many of which are illegal aliens.

The discussion focused around how do we as members of the industry make the construction industry more enticing. The main focus of this discussion seemed to point towards placing an emphasis on training. Reinforcing that entering the construction field can be more than a job, it can be a career, is a vital step towards labor recruitment. Individuals, many of which are only high school graduates, must be shown that there are

career paths and opportunities for advancement within the industry. They will not be field laborers for the rest of their lives if they choose to enter the construction industry.

Hearing from many of the subcontractors who are hit particularly hard by labor shortages was of particular importance. James Haller of Southland Industries, a lead mechanical subcontractor, will be a valuable contact. From the general contractor's side, I spoke with Stan Carlat of Hensel Phelps about his own struggles with labor shortages and how its affected his role as a superintendent on a project.

Critical Issues Research Method

Introduction

Leadership in Energy and Environmental Design, more commonly known as LEED, is a nationally recognized accreditation procedure and benchmark for the design, construction, and operation of green buildings. Since its founding in 1993 the U.S. Green Building Council has continued to develop and improve its rating system for the energy and environmental performance of buildings. It is now commonly accepted that green buildings certified by the LEED system have the following benefits:

- Lower Operating Costs
- Improved Occupant Health
- Enhanced Occupant Physical Comfort
- Improved Occupant Productivity
- Reduced Pollution and Landfill Waste
- Reduced Fossil Fuel Dependence
- Reduced Water Waste
- Decreased Ecological Impact

Research will focus on assessing owners' and tenants' views of green buildings and their willingness to accept higher upfront costs in order to achieve life cycle savings.

Problem Statement

As the popularity and acceptance of the green building concept continues to grow, many owners and developers of commercial office projects are struggling to come to terms with whether or not it is advantageous for them to pursue LEED certification. Will tenants be willing to pay for the increased up-front costs knowing the long term benefits? Is a building being green an important criteria for tenants when deciding on which commercial office space to rent? Industry research will attempt to assess these questions as well as quantify the cost differential between green and standard buildings.

Research Objective Statement

Do tenants of commercial office buildings view a building being green as an important criteria when making rental decisions? Additionally, are tenants willing to accept higher rental costs knowing the long term benefits they will achieve in terms of occupant productivity, health, and happiness?"

Research Overview

Through industry surveys of both owners/developers and tenants I hope to assess both the owner's and tenant's perception of green buildings. Do they believe the benefits outweigh the initial costs? Are they willing to spend more upfront in order to save in the long run? The owners and tenants will be the primary audience. These parties, as well as the design team will benefit from the results obtained from the surveys. Results will help identify whether office building projects should pursue LEED certification.

In order to obtain contact information for various developers I will utilize contacts I have made with general contractors and construction management companies that perform work in the commercial office building sector. These contacts will be sent a survey to assess

their views of the topic at hand. I will also use these contacts to help identify contacts within their tenant companies. The tenants will be sent a similar survey that will assess their views.

Sample Owner Survey Questions:

- Has your company constructed a LEED certified building in the past?
  - If so,
    - What level of certification did those projects achieve (Certified, Silver, Gold, Platinum)?
    - Were tenant rental rates more expensive than to be expected if the project was not a green building? If so, percentagewise, approximately how much more expensive were the rental agreements?
    - What benefits have you seen?
    - Are you pleased with your decision to pursue LEED certification? Why or why not?
    - Is your company interested in pursuing more LEED certified projects in the future?
  - If not,
    - Are you familiar with the U.S. Green Building Council's LEED program?
    - Would you be interested in pursuing LEED projects in the future even if upfront building costs are more expensive than a traditional building of the same type?
    - What factors have prevented you from pursuing a LEED building in the past or will prevent you from pursuing a LEED building in the future?
- Do you believe most tenants are willing to pay higher rental rates to work in a green building? Why or why not?

Sample Tenant Survey Questions:

- Has your company occupied a LEED certified building in the past?
  - If so,
    - What level of certification did those buildings achieve (Certified, Silver, Gold, Platinum)?
    - Do you believe the tenant rental rates are more expensive than to be expected if the project was not a green building? If so, percentagewise, approximately how much more expensive were the rental agreements?
    - What benefits have you seen from occupying a green building?
    - Are you pleased with your decision to rent a LEED certified space? Why or why not?
    - When seeking additional rental space in the future, would you be willing to occupy another green space?
  - If not,
    - Are you familiar with the U.S. Green Building Council's LEED program?
    - Would you be interested in renting a LEED certified space in the future even if rental costs are more expensive than a traditional building of the same type?
    - What factors have prevented you from renting a LEED certified space in the past or will prevent you from renting a LEED certified space in the future?
- Is LEED certification a criterion when determining a location for your office rental?
- Are you willing to pay higher rental rates to work in a green building? Why or why not?

Problem and Opportunity Identification

Building Information Modeling: Trade Conflict Identification

Through the use of a 3D model in combination with the current project schedule I hope to show the potential uses for BIM to reduce crew conflicts. By allocating work zones in the building and identifying those zones graphically with simple 3D geometric shapes in the model, the schedule can then be linked to the model to illustrate the location of various trades. Elements of the building will not be linked to illustrate the construction of the building but rather the 3D geometries will be linked to their associated schedule activities in the finished model to illustrate the flow of trades throughout the building and identify problematic conflicts before they occur in the field.

Chilled Beam System

Though popular in Europe for the last decade, chilled beam systems have been slow to make their way to the United States. The system drastically reduces the need for reheating and generally results in the size reduction of outside air handlers and ductwork by as much as 40%. With metal prices on the rise, reductions in ductwork equate to cost savings for the owner. The system also reduces the amount of air changes in a space leading to up to 50% energy efficiency. Though the cost of the equipment is more expensive, downsized ductwork and equipment leads to overall cost savings of generally 5-15%. A change from the VAV system currently in place to the chilled beam system would provide for an interesting construction management and mechanical analysis.

Green Roof Design

By incorporating a green roof into the project, the owner can reduce energy demands by reducing cooling loads thus leading to a reduction in equipment sizes. It will also enable the owner to obtain points towards LEED certification. By analyzing the structural, schedule, and cost implications of this decision, I hope to compare this roofing decision to the current roof design. This would incorporate a structural breadth study.

Short Interval Production Schedule (SIPS) Development

In technical assignment number 2 you will find that the critical path method schedule was broken down into an activity grid. The grid helps easily illustrate when each activity is occurring and also on which level of the building. Most importantly, the grid helps identify gaps in work sequence. If the trades are able to optimize their efficiency by creating a “parade of trades” that flows throughout the building with no gaps in production, quality will increase and the overall project schedule will be shortened. From this activity grid it is apparent that the development of a SIPS schedule with consistent activity durations and a systematic workflow will help to reduce overall schedule.

Window and Shadow Box Alterations

The windows on the current building were not designed to achieve LEED benchmarks for daylight and heat loss. An opportunity exists to adjust the window design to maximize day lighting and views of the exterior glazing to earn LEED credits in the Daylight & Views category. Additionally, sun shades could be designed to reduce heat gain in the summer and optimize daylight in the winter.

Technical Analysis Methods

LEED Accreditation Analysis

The owner of the 77 K Street project was extremely interested in pursuing LEED accreditation but unfortunately, the idea wasn't presented until well into the project's design phase. Consequently, the idea was abandoned. The overarching theme of my spring thesis research and analysis will be assessing how the project could have changed its design elements and building systems to earn LEED points and achieve accreditation by the U.S. Green Building Council.

Industry research will focus around assessing an owner's and a tenant's willingness to pay for additional upfront costs associated with a green building. Industry surveys as outlined in the Critical Issues Research section of this technical report will address this issue.

Additionally, an in-depth analysis of *LEED for Core & Shell Version 2.0* will performed to assess what credits the project would currently obtain and how many additional credits would be needed to achieve each level of accreditation. The following additional analyses will provide means for redesigning building components in order to achieve additional LEED credits.

Window and Solar Shade Design Analysis

Continuing with the LEED theme, an analysis could be performed on the existing windows to determine the current heat loss and gain. Based on this information, solar shades could be developed that would be installed on the exterior of the building to reduce solar heat gain in the summer months and allow direct sun light during the winter months when the sun is lower in the sky. This would reduce the loads on the building and allow a reduction in equipment size. Also, the sizes of the windows could be adjusted to meet LEED requirements for credit 8.1 for daylight reaching 75% of all occupied spaces. This would incorporate a solar analysis breadth study.

Green Roof Design

Green roofs can potentially be a substantial component of sustainable design. They conserve energy my moderating temperature on the roof, reduce storm water runoff, restore ecological aesthetic, and extend the conventional roofing systems lifespan. Based on their performance, green roofs can contribute from as little as 2 to as many as 10 points towards LEED certification. I intend to look at a green roofing system known as the GreenGrid System. I will study the cost and LEED impacts that the system will have on 77 K Street. Additionally, I intend to incorporate a structural breadth into this study to assess whether the structure of the roof needs to be upgraded.

Short Interval Production Schedule (SIPS) Development

Based on studies of the current critical path method schedule performed in technical assignment number 2, I intend to create a short interval production schedule to decrease the overall schedule of the core building interior activities. In order to do this, zones within the building core will be defined. Then a standard work duration will be established that each activity will need to be completed in. Based on the current activity breakdown,

activities will be combined into activity groups that can be completed with the established work duration. Based on these activity groups a resource analysis will be performed in order to assess which activities may need additional labor resources in order to be completed in the specified time frame. In order to determine the productivity rates, contractors will be contacted. After all activities have been established and resource leveling has occurred, the SIPS will be assembled. Finally, an analysis will be performed to determine how much schedule reduction has occurred and the cost impacts associated with changes in labor resource usage.

Weight Matrix

Description	Research	Value Engineering	Constructability Review	Schedule Reduction	Total
LEED Accreditation	20%	10%			30%
Window and Shade Design	5%	15%	5%		25%
Green Roof Design	5%	5%	10%		20%
SIPS				25%	25%
Total	30%	30%	15%	25%	100%