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Alternative Methods & Research

Executive Summary

Critical Industry Issues, Critical Issues Research Methods, Problem Identification, & Technical Analysis Methods can be found in Technical Assignment 3. Technical Assignment 3 previews my 2 research topics, 2 technical analyses, and the methods I intend to use to analyze these topics for the Teachers Education & Technology Center (TETC).

The Critical Industry Issues section summarizes sessions I attended at the PACE Roundtable Seminar where I was able to interact with industry professionals. I was able to attend sessions on design coordination & constructability of MEP systems, BIM implementation challenges, & how to build respect with design professionals.

Two topics are identified for research in the Critical Issues Research Methods sections. The first topic deals with the feasibility of obtaining a LEED (Leadership in Energy & Environmental Design) rating for the TETC project and how owners of educational buildings should approach sustainable design for their projects. My second research topic focuses on the use of technology for review of coordination & shop drawings. This research looks in depth at productivity, waste, and omissions created by the drawing review process.

The Problem Identification & Technical Analysis Methods sections pin point problem areas of the TETC project and how constructability, value engineering, & cost/schedule reduction reviews can be performed. Issues with the design of the foundation system, specifically grade beams & pile caps, and the construction methods for the grade beams & piles caps are discussed in these sections.

Critical Industry Issues

During the PACE roundtable I was able to attend sessions regarding MEP challenges, BIM implementation, and respect with design professionals. All of these sessions proved valuable although the session on MEP challenges was of the most interest to me. This session provided me with some insight on a possible thesis topic as well as reiterating things I experience during my summer internship.

The topics of most interest to me during the MEP challenges session discussed trends in construction and the modeling of these systems. One of the trends of most interest to me was the use of prefabricated materials for MEP systems. Many projects with high levels of MEP coordination have started to use prefabricated pipe assemblies, panel boards, and transformers. During the past summer I was fortunate to work on a data center project where there was extensive above and below ground MEP coordination and the use of prefabricated parts. Extra coordination was required to use these assemblies but a great amount of field labor was saved. One example of this was the prefabrication of generator flue exhaust piping and selective catalytic reduction systems. The large size of the data center required 32 emergency generators. The mechanical subcontractor coordinated the sizes and locations of openings in pre-cast concrete panels for this piping prior to fabrication. The contractor visited the pre-cast shop with the first pipe assembly to ensure a proper fit before fabricating all of the assemblies in the shop and shipping them to site. I can’t estimate exactly how much time this saved, but with 32 assemblies it was significant.

In addition to prefabrication I was also able to witness the use of BIM for the construction of an MEP system on the data center project. The PACE session discussed

the use of BIM for design, estimating, and construction MEP systems. One topic of interest that was brought up involved subcontractors not being able to understand a BIM. I disagreed with this point because I feel that it makes a MEP system easier for a subcontractor to understand. The project I worked on printed several large color drawings of the BIM to be displayed on the walls on the conference trailer on site. The MEP subcontractors were able to come to the trailer and dissect these drawings to better understand how the system should be constructed. My thesis project has a relatively large amount of lab space that will require some repetitive piping assemblies. I may look into how prefabricated materials can be used to increase productivity.

The second session I attended on the implementation of a BIM did not provide the insight I was looking for. I was hoping for some discussion on how a BIM is actually created and the steps taken to start one. This session spoke a lot about the responsibilities of the different parties in a construction and design team. Several ideas were brought up about who is the sole party responsible for developing a BIM. Different design teams and owners can have different requirements for a BIM, but it was agreed that the General Contractor/Construction Manager is responsible for the development of a BIM.

The final session I attended reiterated lessons I have learned during my internship experience on how to gain respect from the design team. The most important lesson I took away from this session dealt with communication. Communicating with the design team and forming a solid relationship with your contact is important from the beginning of the project. I learned through this session that I have been practicing the proper way to develop this relationship. All the industry members in this session pointed out that verbal communication is the best form of primary communication. Many of them noted that

young people often rely too much on email as their primary source of communication. During my internship this summer I was responsible for writing RFI's and solving discrepancies with the design team. I would call my contact, talk him through the issue, and try to suggest a solution. After this phone conversation I would follow up with a confirming RFI or email. This approach built respect with the design professional and often sped up the process of solving the problem.

Critical Issues Research Method

Problem Statement 1

The Teachers Education & Technology Center (TETC) project was initially slated for a LEED certification but the program was eliminated due to a lack of funding from the state of Maryland. Good life cycle costs and occupant productivity, that are a product of a LEED project, are important for higher education buildings.

Research Goal 1

The goal of this research is form a plan to deliver higher education buildings with a LEED rating. This research will look specifically at how a LEED rating should be specified based on the types of spaces in the TETC and the owners interests. I hope to conclude if a LEED rating is necessary for a building meant for the college of education or if there are certain LEED areas that should be concentrated on more in depth. Additionally I hope to determine the costs to LEED rate the building.

Research Methods 1

1. Develop a survey to be distributed to UMAEC*, Holder Construction, the design team, & teams from other outside education projects.

* University of Maryland Architecture, Engineering, & Construction

2. Determine which LEED point areas are most important to owners of educational buildings.

3. Perform any Value Engineering or Re-design work necessary for these points.

4. Calculate the costs associated with obtaining those LEED point goals.

5. Conclude what the total cost to LEED rate the TETC would be. Compare to the cost of meeting just the LEED point goals that are of most importance to owners.

Problem Statement 2

The construction industry has very high costs and extreme waste of paper through the drawings used to communicated the design. LEED projects and others recycle materials but printing and shipping costs of drawings is extremely high. Drawings also become outdated extremely quickly. Time is often wasted with transferring marks from one set of "red line" drawings to the next for distribution.

Research Goal 2

The goal of this analysis is to determine the feasibility and cost to streamline a typical project a digital drawing review system. The industry is using more digital media and the introduction of "smart boards" allows large scale digital coordination drawing reviews. This can also be performed for shop drawings. Drawings can be reviewed, comments can be made, and the marked up drawings can be saved. Digital copies could be distributed to subcontractors and engineers so they could switch from marked up drawings to a CAD drawing on screen without having to reference a paper drawing. I believe this would eliminate continued errors & omissions. I would like to look at the productivity improvements of producing "red line" drawings digitally for distribution than by hand.

Another area of interest would be to look at how a “red line” drawing could be over-layed on the correct drawing to pick up any omissions.

Research Method 2

- Survey construction team, design team, and subcontractors to :
    - Determine resistance to transition
    - Determine what technology and the amount needed
- Obtain an estimate of printing and shipping costs for projects from Holder Construction Company
- Research cost of technology needed
- Conduct a productivity study of digital versus non-digital reviews

Problem Identification

The following items are problems that can be analyzed for cost/schedule reduction and constructability improvement.

- Foundation design features grade beams that rest on pile caps at different elevations
    - Top of pile elevation is approximately 7 feet below grade
    - Top of pile cap elevation is approximate 3 feet below grade
    - Piles are poured higher than intended and chipped to correct elevation to minimize cave in
    - Allowance required for chipping costs. Increased need for formwork
    - This analysis will conclude if it is feasible to re-design the foundations so that top of grade beam and top of pile cap elevations coincide
- Grade Beam & Piles Cap Formwork
    - Placement of grade beams on pile caps and deep excavation in sandy soils required pile caps and grade beams to be formed instead of pouring directly into hole
    - This analysis will show the schedule & cost reduction of eliminating formwork
- Both shingled and metal roofing systems are being considered for the project. The following items could be investigated:
        - Schedule time required for each system
        - Initial cost of both systems
        - Life expectancy of shingles vs. metal
        - Anticipated R-Values

- Addition of a “green” roof on flat roof portions that are not visible
  - Reduction of rain leaders
  - Reduce Heat Island Effect
  - Reduce Cooling Load
  - Life expectancy of shingles vs. metal
  - Anticipated R- Values

Technical Analysis Methods

The following section highlights the problems identified in the previous section and describes how I intend to address the design and construction issues.

Foundation Design

Integrate bottom of grade beam & bottom of pile cap elevations

This area of research will require structural analysis to be completed for the foundation system to determine if the sizes of grade beams need to be altered. Dowel/Rebar details will need to be checked to check if this is feasible from a constructability stand point.

Grade Beam & Pile Cap Formwork

Pour concrete directly into trenches & pits

This analysis will conclude if concrete can be poured directly into excavated trenches and what are the labor and schedule saving involved. The grade beam details have required formwork to be used because of a combination of sandy soils and deep excavation. I will investigate if formwork still needs to be used with a foundation redesign.

Weight Matrix

Table 1 below is intended to show how I will distribute my efforts for the analyses described above.

Description	**Research**	Value Engr.	Const. Rev.	Sched. Red.	**Total**
Foundation Re-Design		5%	10%	10%	25%
Formwork Analysis			5%	20%	25%
Digital Drawing Review	25%				25%
LEED Certification	10%	15%			25%
Total	35%	20%	15%	30%	100%

Table 1 – Weight Matrix