TECHNICAL ASSIGNMENT #3
ALTERNATIVE METHODS AND RESEARCH

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A. EXECUTIVE SUMMARY

This technical assignment explores the areas of *Medlar Field at Lubrano Park* that are good candidates for research, alternative methods, value engineering, and schedule compression which will be used in my final proposal. By attending the critical industry issues seminars at the PACE Roundtable (10/13/05) and investigating value engineering, schedule compression areas, and constructability review items, many ideas have been developed for use in my final senior thesis proposal due in April 2006.

On Thursday, October 13, 2005, I had the privilege of attending *PACE Roundtable* conference at the Penn Stater Hotel and Conference Center. Before attending the *Roundtable,* I had an idea that I wanted to research the area of building information modeling (BIM) relating to the construction industry. By attending two morning sessions relating to technology within the industry, ***Frontiers for Innovation I: Promoting Innovation*** and ***Frontiers for Innovation II: Developing Innovative Capacity***, I immediately realized that BIM is an important discussion for industry members. The following discussion will:

- Summarize key topics discussed in each session I attended.
- List the current industry members that have shown an interest in the attended sessions.
- Evaluate the initial method and goals of applying BIM to my thesis project, Medlar Field at Lubrano Park.

At the time my research concludes, I hope to further educate the industry on BIM and answer as many questions as I can that were proposed during the *Roundtable* sessions.

The problem identification section identifies several areas for future analysis as part of my senior thesis project. These areas include value engineering analysis, constructability review, and schedule reduction / acceleration. Many of the value engineering items relate to the choice and/or use building materials. The items associated with the constructability review relate mostly to the problems associated with the building enclosure being constructed during the winter months in State College, PA. Because *Medlar Field at Lubrano Park* is a sport facility and the construction schedule for these types of projects are often very short, my schedule reduction focuses on the problems occurred during MEP system design and release of MEP drawings for bid. Lastly, I have briefly outlined the methods that will be used to help analyze each technical area.

B. CRITICAL INDUSTRY ISSUES

PACE ROUNDTABLE: SESSION I

Frontiers for Innovation I: Promoting Innovation

The discussion began with the topic of building information modeling (BIM) and its use in the industry. Essentially a building information model is a materialized 3D model meaning that everything in the building is drawn with its true properties. An example of this is with an exterior masonry wall. A typical 3D model would just draw the dimensions of the wall, whereas a BIM details the wall with its brick façade, air barrier, sheathing, studs, etc. for the wall properties. Many questions were asked in regards to this topic:

- What is it?
- How will it help?
- What projects is it useful for?
- How can it be implemented?
- How much does it cost?
- How do you train people to understand this type of modeling?
- How do you integrate these models with a renovation project?
- Can BIM modeling help with a safety analysis on a project?
- Can these models be integrated during the close-out document phase and also as a way of tracking systems within the building?
- How can this type of model contribute to the life cycle data for the project?
- How do you sell owners on BIM and get them to use it?
- Is there an information flow chart for the implementation of BIM modeling?

The overall feeling with BIM modeling is that it is not currently a knowledgeable subject and more explanation about it is needed. There was an adamant feeling in the room that of the typical project team members, it is the owners/developers responsibility to make the implementation possible because they are the ones ultimately paying for its use. The owner must set ground rules up front and enforce them for the project to be successfully modeled. The implementation of this model also reflects the delivery type for the project; a design-build or CM agency project would allow for a model to be constructed easier or more effective. The value of an accurate BIM during the operation of the building could be endless. Trammel Crow Company recently developed a BIM model of a project in Shirlington, VA and used it to help coordinate exterior construction methods. The implementation of this model allowed them to recover 3 weeks on their construction schedule.

Furthermore BIM can be used for estimating and scheduling procedures. Many programs currently used to develop a BIM include quantity take-off calculations

B. CRITICAL INDUSTRY ISSUES

as a model is being generated. Using the model for assistance during the bid phase could allow for more accurate bid results and proper verification of bids.

If a BIM is made for projects within similar markets, this model can be used for future planning of similar projects. The use of this modeling technique will also allow and require a commitment to the project design. If the design is in 3D initially and changes are not made to the design during construction, the shop/coordination drawing phase could be expedited.

Summary of Session

- Where do we go from here with building modeling in the industry?
- Are there other industries we can use to help the construction industry with the transition of technological models?
- Are there certain projects that these virtual models are useful?
- How best to structure projects to succeed?
    - What are the impediments/SOP/delivery types?

Industry Attendees:

Mark Bodenschatz	PSU OPP
Jack Brown	Skansa USA
Kenneth Catlow	Pentagon Renovation Group
Marilyn Juban	Gilbane Building Company
Charles Yetter	Trammell Crow Company

B. CRITICAL INDUSTRY ISSUES

PACE ROUNDTABLE: SESSION II

Frontiers for Innovation II: Developing Innovative Capacity

The goal of the session was to discuss how do we get around impediments and take advantage of new relationships of doing business. Current impediments associated with BIM are:

- People not wanting to change
- Capitalization
- Short term focus
- Liability/vulnerability concerns
- Knowledge of technology
- Practical use of technology
- Convincing others
- Proof of Profitability
- Understanding limitations
- Owner acceptance
- Interdependence

An intriguing item that was discussed during the session was that currently Holder Construction is constructing many data center projects and they are using BIM on these projects. Holder feels that to successfully build an intensive MEP project like a data center requires much pre-planning and they have used a BIM as part of their pre-planning coordination. The interesting fact with these projects is that two (2) full time on-site CAD operators have been employed for these projects. These CAD operators assist with any coordination or design errors that are discovered daily on the project and they are able to update the BIM immediately to avoid further confusions. Because Holder has had success using this modeling with the data center projects, there might be an opportunity to incorporate BIM with other projects in the industry. It is important that the model is useful to each player for project. An architect, construction manager, engineer, superintendent, foreman, etc. must all understand the model and the value associated with the model. Within this session, there were also several questions that were asked and are worth noting:

- Can technology reduce contingency?
- Will the BIM method follow the initial hardships presented with LEED projects? (initially difficult and eventually second nature)
- Should construction manager monitor the technological model?
- How does the architect/engineer help with the model process?
- Who makes the model?
- Who manages the model?
    - Possibly another entity?

B. CRITICAL INDUSTRY ISSUES

- Does BIM help with design coordination?

By making a BIM and incorporating model review meetings and on-site implementation, it is apparent that a project could be more successful. Furthermore, we currently develop schedules off of two-dimensional (2D) drawings, whereas with a BIM, a schedule could be developed off of a three-dimensional (3D) model and viewed for all parties to understand in the fourth-dimension (4D). A more thorough 4D model can be generated from a BIM and can allow for a constructability review that the owner, architect, contractor, maintenance staff, etc. can all understand. One of the most important items to effectively implement a model is to find the proper means of communication to all parties involved, mostly subcontractors. The underlying belief is that the value of a BIM in terms on productivity and coordination could be endless to the construction team and building management team during the lifetime of the building.

Until the rest of the industry realizes the value of a BIM, the companies that have already implemented a BIM successfully will continue to use it as a competitive advantage when trying to be awarded a project. A BIM will provide an initial cost that may not be factored into the project budget; however, the cost savings

that could result from its implementation could offset the initial cost (note that this is a question proposed during the session). Many of the questions proposed in this session are relevant and could be addressed as part of a research project.

Industry Attendees:

John Bechtel	Turner Construction Company
Jack Brown	Skansa USA
Benjamin Gerald	Holder Construction Company
Katie Lynahan	Barton Malow Company
Priya Varadan	Gilbane Building Company
Richard Willie	Alexander Building Construction
Charles Yetter	Trammell Crow Company

C. CRITICAL INDUSTRY ISSUES RESEARCH PLAN

PACE ROUNDATABLE: WHAT'S NEXT?

The sessions I attended should reflect that I am interested in the innovation of technology within the construction industry and how the new technology can be implemented. The discussions proved that the emerging technologies are a concern / "hot topic" with any companies in the industry. As expected the industry does not fully understand BIM and the usefulness of such a model.

Essentially a building information model is a materialized 3D model meaning that everything in the building is drawn with its true properties. An example of this is with an exterior masonry wall. A typical 3D model would just draw the dimensions of the wall, whereas a BIM details the wall with its brick façade, air barrier, sheathing, studs, etc. for the wall properties. A BIM can be used to design any of the systems for a building (ex. MEP, FP, steel, etc.)

The goal I have with the *Medlar Field at Lubrano Park* project is to be able to develop a BIM of the project and analyzes various subjects relating to a BIM. The subjects include:

- Owner/architect awareness/understanding of designed spaces.
- Compare quantity take-offs results performed by subcontractors to the design quantity take-offs.
- Develop a 4D model of the project which will be used to describe the project to the subcontractors and obtain their understanding of the construction schedule.
- Compare the usefulness of the architects "block" 3D model created in AutoCAD versus the value generated by a BIM created in Autodesk REVIT.
- Evaluate the accuracy of design coordination with a BIM over 2D drawings.
- Compare MEP shop & coordination drawings to the BIM design of these systems.
- Inform an educated owner, Penn State University, on the value and possibilities associated with this type of building modeling.
- If possible, determine a way that this type of model could be incorporated into the close-out phase of a project.
- Document projects that have been successful using BIM and develop a flow chart for successful designing and implementing a BIM.

Please note that these are all initial ideas and will be more focused by the end of fall semester.

Over the next few months, I will generate a BIM for *Medlar Field at Lubrano Park* and use this model as a case study to answer the questions listed above and incorporate any other issues I find as I continue my research.

D. PROBLEM IDENTIFICATION

Please note that valuable design investigations are **bolded**.

Value Engineering

- **EFIS vs. Brick Façade – the construction of an EFIS wall often can present leakage problems which can ultimately lead to mold formation; this might change the building life expectancy and lead to an unsatisfied owner.**
- Playing field system (proprietary system vs. typical field system) – the specified field system provides a drainage system which is overkill for this site.
- Process rock for fill material – over 100,000 CY of rock are within the site which could be used for re-use on site instead of removal from site.
- Steel Procurement Act (U.S. vs. competitive rest of world) – part of the requirements with the steel package was that all steel had to be made in the U.S. whereas other projects steel could be procured from any country.
- Metal Railings vs. Plastic Railings
- Alternate construction material for brick pavers in the landscaping area.
- **SF allowance for finishes vs. design intent**
- **Tapered light & scoreboard columns – the design steel light towers are 200+ lbs/ft, but on past projects the steel light towers were less than 100 lbs/ft.**
- Landscaping Quantity – minimize the landscaping quantity while still meeting township & university requirements; caliber of trees removed vs. caliber replanted.
- **Field lighting system – 2 column versus 3 column along with lighting system.**
- **Raise/Lower building – raise 1’ or 2’ to minimize rock excavation, trenching, processing, etc.**

Constructability Review

- EFIS façade construction occurring during winter months presents many construction means and methods problems.
- **Time of year for major building construction occurs in winter and requires proper pre-planning and coordination to be successful.**
- Building placement could be moved to better balance the site (cut/fill).
    - Raise Building 1’-0”
- Adhered roof construction in winter
- **Structural system – load bearing masonry wall construction versus structural steel; cost of steel package versus cost of time to construct load bearing wall.**
- Structural system design review – tube (HSS) versus structural shapes (W); structural tubes might make a more cost efficient design and provide more efficient construction techniques.
- Remove or reduce camber design of members – steel camber affects many of the construction trades.

D. PROBLEM IDENTIFICATION

- Probing of foundation system versus geotechnical exploration with actual design.
- Adequate geotechnical report in lieu of only boring log provided as part of bidding documents.
- Evaluate preconstruction personnel strengths/weaknesses and how decisions made during that phase have affected the construction team.

Schedule Reduction

- MEP system design did not reflect dates proposed by the construction manager.
  - Design team did not release an underground package and a above ground package.
- Type of Contract (DB versus GMP versus Hard Bid)
- Bidding/Purchasing
- Execution into construction

Construction Research Topic

Please see section B and C of Technical Assignment #3.

Please note that these are all initial ideas and will be more focused by the end of fall semester.

E. TECHNICAL ANALYSIS

Value Engineering

EFIS vs. BRICK DESIGN

A value engineering suggestion for *Medlar Field at Lubrano Park* will be the use of masonry brick in lieu of the exterior finish insulation system (EFIS). This will require a detailed take-off of brick, mortar and horizontal reinforcement as additional material cost. A detailed estimate of the cost of the designed EFIS system will have to be calculated as well as a cost comparison so the alternate can be analyzed to the designed system. There are additional factors such as scaffolding cost, constructability of an EFIS system under certain temperatures, associated labor costs, etc. which will have to be researched as my analysis progresses.

FIELD LIGHTING SYSTEM

The field lighting system for the baseball stadium is based on a performance based specification. The University and the design team chose the preferred lighting system based on lamp efficiency, energy savings, and maintenance warranty. A value engineering solution for this system would be a different sports lighting system provider. By researching the typical sports lighting system providers and evaluating each company based on lamp type, size, quantity, efficiency, energy savings, and maintenance warranty another lighting system would be proposed. An additional factor to the alternate lighting system would be the redesign of the light columns that support the light fixture. In order to redesign the light poles, the load of the lighting fixture "cluster" must be determined along with any other steel members that might tie into the poles.

Constructability Review

BUILDING ENVELOPE CONSTRUCTION

Due to the facility needing to be occupied by June 2006 for the minor league baseball season, the construction schedule shows the majority of the building enclosure construction occurring during November 2005 through February 2006. To perform this analysis, I will study the construction schedule and evaluate each system which is being installed during the above months. The analysis will need to include the availability of labor and materials, the ability to construct the design, and the added costs incurred because of the construction occurring during those months (ex. winter weather protection, admixtures in concrete, etc.).

Schedule Reduction

EXPEDITE MEP DESIGN

Medlar Field at Lubrano Park is a fast-tracked design project which began in January 2005 with the design packages divided into six (6) different phases. These design phases include:

Design Package #1: Utilities, Sitework, and Paving
Design Package #2: Structural Steel
Design Package #3: Building Enclosure
Design Package #4: Interior Fit-Out
Design Package #5: Stadium Specialties
Design Package #6: Signage and Graphics

The first three design packages were released in a timely manner and not hinder the construction schedule. However, the design coordination associated with design package #4 which included the general trades, plumbing, mechanical, electrical, and fire protection drawings which has caused many problems for the construction team. The underground plumbing and electrical drawings were included in design package #4 and were not bid out separately which is uncommon for stadium construction. This caused the construction to hire subcontractors based on time and material pricing to install underground items before the bid package was awarded. In evaluating the schedule reduction on this project, I will look at expediting the release date of design package #4 and the efforts needed for better design coordination. The analysis will look at proper design coordination methods early in the design process to help facilitate a more timely release date of design package #4.

F. WEIGHT MATRIX

The following weight matrix shows how I plan to distribute my thesis analysis and research during the spring semester. Most of my time will be placed on my research topic relating to BIM while less time will be spent on the technical analysis topics.

WEIGHT MATRIX
Medlar Field at Lubrano Park

Description	Research	Value Engineering	Constructability Review	Schedule Reduction	TOTAL
EFIS vs. BRICK DESIGN	5%	75%	10%	10%	100%
BUILDING ENVELOPE CONST.	5%	10%	85%		100%
EXPEDITE MEP DESIGN	10%	15%		75%	100%
BIM CASE STUDY	80%		20%		100%
TOTAL	**100%**	**100%**	**115%**	**85%**	