THESIS PROPOSAL

MEDLAR FIELD at LUBRANO PARK

(PENN STATE BASEBALL STADIUM)

TABLE OF CONTENTS

A. EXECUTIVE SUMMARY

Medlar Field at Lubrano Park is located in State College, PA and will be the new home for The Pennsylvania State University baseball team as well as a the State College Spikes, a minor league Single A short season affiliate. This project is unique in the fact that it is the first project in the country to have joint ownership group between a university and a minor league baseball team. Construction of the new facility began in June 2005 and will be complete in time for the minor league baseball season in June 2006. The following discussion describes the three main areas that my thesis report will focus on. The two breadth areas which will be analyzed are the structural columns that support the field lighting fixtures on the first and third base line, and an electrical distribution analysis of the retail store/ticket building. Furthermore, my construction research topic will analyze streamlining the superstructure design & construction through computer modeling.

In analyzing the structural columns that support the field lighting fixtures, I hope to successfully find an alternative way to design the field lighting fixture structural supports while still achieving the same aesthetic look. This will ultimately allow for cost savings in the structural steel package, and might allow for a quicker erection time in this area due to lighter and less steel members. I will be able to use the knowledge I have learned from performing this analysis when value engineering ideas might be needed on future projects and the project team might need suggestions in how to achieve the same look with lighter steel members.

The second breadth area analysis will focus on re-designing the electrical distribution for the retail store and ticket building. Upon completion of this analysis, I will propose an alternative electrical feed to the retail store and ticket building along with upsizing the main electrical switchboard in the building. This analysis will provide me an approximate magnitude of upsizing a switchboard and understanding how to alter an electrical design.

By evaluating the efforts to streamlining the superstructure design & construction through computer modeling, I will be able to address better techniques in going from steel design to fabrication stage of a project. Because the steel phase of a project is often on the critical path, any time that might be able to be saved could result in a quicker delivery of the entire project. This research will benefit structural designers, construction managers, and steel fabricators as well as leave ideas for continued research in streamlining the design to construction of the structural sequence. Furthermore, I will be able to address better coordination techniques between steel suppliers.

B. BREADTH TOPIC #1

ANALYZE THE STRUCTURAL COLUMNS WHICH SUPPORT THE FIELD LIGHTING FIXUTRES

Medlar Field at Lubrano Park follows the same construction duration that has come to be accepted for sports facilities. Excavation of the 22 acre site began in June 2005 and the construction will end in May 2006 with the first game to be played in June 2006 for the minor league franchise. This means that approximately $25 million will be put in place in a twelve month time period. Furthermore, any delays in design or construction could have an immediate impact in finishing the project by May 2005.

The structural system package was released for bid in late May 2005 and bids were received by the middle of June 2005. The structural system package included 600 tons of structural steel with the interesting figure that 150 tons of that estimate was allocated to the structural columns which support the light fixtures as depicted below.

Ballpark rendering with the area highlighted which will be analyzed.

The area highlighted on the first base side is typical for the third base light fixtures as well. The design includes three (3) W21x132 columns with cross-bracing members connecting the structural bays. The overall height of the W21x132 members varies between the first and third base side because there is a sixteen (16) foot elevation difference; this is due to the fact that there is a basement level on the first base side but not on the third base side. Although the rendering appears to have the same structural support for the scoreboard in left field, this is not true. The structural supports for the scoreboard are being designed by the scoreboard manufacturer, Daktronics Inc.

Barton Malow Company, the construction manager for the project, has developed a strong niche in the sports construction market including minor league baseball facilities. Because this project is not a design-build project with the construction manager having control of the architect, Barton Malow can only advise design changes. During the bid review period and post-bid meetings, Barton Malow suggested that these columns could be altered to support the same structural loading as well as achieve the same aesthetic look for the architect. One of the concerns proposed by Barton Malow and stated earlier was the fact that this area of the project accounted for 25% of the entire structural steel package. Furthermore, from past projects of similar size, Barton Malow has learned that the columns which support the main light fixtures of the stadium can be designed under 100 lbs/ft.

Because the structural steel package is on the critical path of the project and costs saving measures are often needed, I will analyze the structural columns which support the field lighting fixtures in terms of:

1. Value engineering methods to determine if a smaller W-shape member can be used to lessen the steel tonnage and decrease the cost while supporting the same loading.
2. Value engineering methods to determine if an alternative structural member (ex. HSS) can be used to lessen the steel tonnage and decrease the cost while supporting the same loading.
3. Constructability methods to determine if the columns can be altered, but still achieve the aesthetic smooth appeal required by the architect.

In order to be able to accomplish the three (3) items listed above, I will need to first understand the design process of a structural engineer and how her design relates to the architects design intent. In order to accomplish this, I will discuss the design steps taken by a structural engineer with the professors in the structural option within the architectural engineering department at Penn State University as well as discuss the design intentions with the structural designer from DLR Group. This will allow me to fully understand the design requirements and intent before I begin to technically critique the field lighting structural supports on the first and third base line.

Next, I will contact Barton Malow Company and ask for information about the field lighting structural supports on past minor league baseball projects. I will need to ask for the following information when talking to them:

1. Size of the structural members in the described area.
2. Shape of the structural members in the described area.
3. Field lighting fixture manufacturer to analyze their requirements.
4. Overall tonnage of the steel package to see if the described area is typically 25% of the structural steel tonnage.

Once I receive this information, I can begin determining possible alternatives to the field lighting structural supports. Using my knowledge of AE 401 (basic steel design), I will determine the size and shapes of the steel members needed to support the field lighting fixtures for *Medlar Field at Lubrano Park*. In order to determine if the aesthetic look is affected with the alternative design, I will model the envelope of the facility including the structural columns being analyzed in Autodesk REVIT 8.0. The functions in REVIT will allow me to easily adjust between structural members and shapes to visually see if the desired look has been altered.

Once my technical analysis has been completed and modeled in REVIT, I hope to have successfully found an alternative way to design the field lighting fixture structural supports. This will ultimately allow for cost savings in the structural steel package, but might allow for a quicker erection time in this area due to lighter and less steel members. Furthermore, I will be able to use the knowledge I have learned from performing this analysis when value engineering ideas might be needed on future projects and the project team might need suggestions in how to achieve the same look with lighter steel members.

C. BREADTH TOPIC #2

ELECTRICAL DISTRIBUTION ANALYSIS FOR THE RETAIL STORE AND TICKET BUILDING

The electrical system design for Medlar Field at Lubrano Park was documented rather quickly and sent out for bid without complete design documents. When the electrical package was awarded to the responsible low bidder, a new set of electrical construction documents was released. Not only did this require the electrical contractor to submit appropriate pricing for the changes, but the construction manager also had to make the necessary planning changes for the revised electrical work. Because the electrical package was assembled quickly, there are two items that I have found to give the owner, The Pennsylvania State University, a more worthwhile facility.

The first electrical item I will analyze is the retail store and ticket building located near the intersection of Porter Road and Curtin Road. As depicted below, this building is separate from the rest of the structure and will be used during non-operating game times.

Ballpark rendering with the area highlighted which will be analyzed.

Within the 2000 square foot structure, there is a ticket booth area, a retail store, an office, a small mechanical room, and a storage area. The spaces contain standard electrical equipment devices; for example, there are standard light fixtures, wall receptacles, and data outlets. All of the electrical wiring for this area is designed to be run overhead through the canopy structure and into the building. Because there is no underground raceway conduits designed for this area, there is an added labor cost for running all wires through the canopy along with extra material cost for running the wires to the required panel board. Furthermore, by not designed an electrical panel within the building, electrical maintenance could become an issue. If an electrical problem arises, the maintenance crew must use an electrical panel that is not near the retail store and ticket building.

Because of the issues named above, I have decided to design an electrical panel located within the building. The current panel which is not located within the building is 300A, 3 phase, 4 wire panel at 208V/120V for panel while the lighting is on a 225A, 3 phase, 4 wire panel at 480V/277V. In order to design a new panel, I will determine all of the connected loads with the appropriate electrical design factors for lighting, receptacles, and mechanical equipment. I will also provide underground raceways to the help minimize the wires that travel through the canopy area. Lastly, I understand before beginning the electrical calculations that two electrical panels will be required and a step-down transformer will be needed for the electrical receptacles and track lighting in the area. Furthermore, I will provide a cost-benefit analysis between the designed system and the proposed re-design to help determine the value of using an alternative system.

To keep with the theme of providing the owner with an easier to maintain space, I will also propose to increase the size of the main switchgear in the facility. Currently, the main switchboard size is 2000A, 480V/277V with 3 phase power. With recent Barton Malow sports facility construction of similar size, the main switchboard has been larger than 2000A to accommodate future growth within the stadium including the scoreboard power and other added electrical items that could occur.

Upon completion of this analysis, I will propose an alternative electrical feed to the retail store and ticket building along with upsizing the main electrical switchboard in the building. This analysis will provide me an approximate magnitude of upsizing a switchboard and understanding how to alter an electrical design.

D. CONSTRUCTION RESEARCH

STREAMLINING THE SUPERSTRUCTURE DESIGN & CONSTRUCTION THROUGH COMPUTER MODELING

1. Chapter 1: Introduction

a. In July 2005, the General Services Administration (GSA) announced that all new projects require their funding will be required to include a building information model (BIM) as part of the project proposal.
   i. The term BIM is a relatively new term in the industry, but in the past as been noted as a project model and multi-dimensional (MD) modeling.
   ii. 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.
   iii. The GSA's requirement with a BIM needed for all of their future projects is a new approach to project design and delivery. In the past, many projects have been designed in three dimensions, but have not included the object properties which would make it a BIM.
   iv. Computer aided project development has been in the industry for quite some time, however implementing it has been a hardship. Many owners, architects, and construction managers have not seen the value that these models can bring to a project mostly due to initial costs and time to develop the models.

b. Ongoing Construction Industry Problems:
   i. Duplication during the steel sequence continues to be a problem in the industry. The structural engineer designs the steel structure for the building and then the structural steel contractor, upon award, redesigns the building through steel shop drawings. Because of the need to produce these shop drawings, steel cannot begin fabrication until six to eight weeks after an award is made to the steel contractor.

ii. Coordination between various fabricators involved with the structural package is many times a problem. There is often improper coordination between metal deck, metal joists, and structural steel which leads to fabrication and construction delays.

c. This research proposal will focus on a BIM model of the superstructure for *Medlar Field at Lubrano Park*. The goals and objectives of this research are to answer the following questions:

i. Can the construction industry reduce the waste in the steel shop drawing process through implementing building information modeling?

ii. Can BIM help with fabrication coordination (supply-chain management) between structural steel, decking, and joist suppliers?

(1) Decrease material delivery time.

(2) Better coordination methods allowing for less re-work and added cost.

d. By analyzing existing practices (shop drawings and coordination) during the steel phase of a project, I will propose a more streamline process for the steel phase of a project.

2. Chapter 2: Background/Literature Review

a. Currently, there has been a lot of research devoted to computer aided design/construction research. Most of this research is based on project case studies and not how to effectively implement computer aided models on a construction project.

b. Most projects are documented with a 3D model which is made during the preconstruction phase of a project. These models are used to develop a rendering of the project which is mainly used for marketing purposes. Unfortunately, these models are 3D models and not building information models. Furthermore, these models are very rarely taken from the design phase of a project and implemented in the construction phase.

c. During the summer of 2005, I began my initial study of building information modeling. My research paper was tilted, “Integrating Building Models In the

Construction Workplace," and documented some of the current practices with computer modeling within the industry.

i. The most valuable information received during the research timeline were the responses to a series of survey's I sent to architects/engineers, owner representatives, and construction managers. The survey's asked a series of questions relating to implementing a 3D and 4D model on the project and the value that each can bring to a project.

d. Many industry members are interested in implementing new technology on a project, but either do not know how or cannot afford the cost and time associated with developing a model. Some trades in the industry already implement 3D models to assist with pre-fabrication of systems with the steel trade being at the top of the list in terms of implementing technology.

3. Chapter 3: Objectives and Methods

a. Problem Statement

i. Duplication of structural design delays fabrication of structural members and coordination of structural systems between fabricators (ex. decking, joist, etc.), is a problem that effects each project in the construction industry.

b. Specific Measurable Objectives

i. Review literature and understand current practice.

ii. Develop a solution through a model and delivery flow chart.

iii. Test and validate proposed solution.

iv. Leave ideas for future research.

c. Methods

i. First, I will read articles documenting projects that have implemented building information modeling and understand how the research was performed.

ii. Next, I will find any articles relating to the shop drawing sequence of a project in order to see if there is already documented waste in this process.

iii. Then I will find any articles relating to the steel fabrication of a project and any known documented problems that may exist.

iv. Through building information modeling during the design phase, the time invested during the shop drawing phase can be decreased and coordination between steel material fabricators can be more easily achieved.

   (1) I will make a building information model of the superstructure sequence of the project using Autodesk REVIT 8.0. This program has all of the structural members and shapes that are in the current steel manual including joists and decking which will allow me to produce an accurate model.

v. I will then obtain a copy of the SIST 2 modeling standards which describe the information that must be on all steel shop drawings.

vi. Once the computer model is made, I will contact three (3) steel contractors and discuss with them the items that are needed to go from design to fabrication. I will also with these steel contractors the current means and methods of coordinating between various steel suppliers (decking, joists, structural, etc.).

vii. I can then document the difference between the items documented on a building information model and those needed per SIST 2 standards. By documenting the differences between a SIST 2 and BIM model and discussing what is needed from a contractor's perspective to go from design to construction, I can propose an alternative means and methods to the structural design and approval phase of a project.

viii. In order to better streamline the coordination process between various fabricators, I will use the BIM to determine if each entity can use the model and implement to fit their need.

ix. Most likely, the model will need to be altered to fit the different fabricators and I can outline those needed steps.

x. Lastly, I will describe the overall affect of implementing a BIM for the structural sequence of a project and document the value of such a model for fabrication and coordination.

d. Expected results / outcome / benefits

   i. In developing a BIM of the superstructure for *Medlar Field at Lubrano Park*, I will be able to address better techniques in going from steel design to fabrication stage of a project. Furthermore, I will be able to address better coordination techniques between steel suppliers.

   ii. This research project will help me identify current problems and time constraints associated with the steel/structure phase of a project and allow me to suggest alternative methods to beginning the construction of a steel structure.

   iii. Because the steel phase of a project is often on the critical path, any time that might be able to be saved could result in a quicker delivery of the entire project. This research will benefit structural designers, construction managers, and steel fabricators as well as leave ideas for continued research in streamlining the design to construction of the structural sequence.

e. Timeline

   i. January 2006
      (1) Read articles about current BIM projects, studies performed with the steel sequence, and any articles with current fabrication practices.
      (2) Develop a BIM of *Medlar Field at Lubrano Park's* superstructure.

   ii. February 2006
      (1) Contact steel contractors and discuss questions proposed above.
      (2) Analyze the results of the study.
      (3) Find any missing areas that more research can be applied to.

   iii. March 2006
      (1) Summarize and document results of study.

   iv. April 2006
      (1) Present results of study to construction industry members.

E. WEIGHT MATRIX

The following weight matrix depicts how I will allocate my time in order to achieve a successful construction thesis during the spring of 2006.

WEIGHT MATRIX

Medlar Field at Lubrano Park

Description	Research	Value Engineering	Constructability Review	Schedule Reduction	TOTAL
STEEL COLUMN VE	**5%**	**25%**	--	--	**30%**
ELECTRICAL DIST. VE	**5%**	**10%**	**5%**	**5%**	**25%**
STREAMLING STEEL / BIM	**40%**	--	**5%**	--	**45%**
TOTAL	**50%**	**35%**	**10%**	**5%**	**100%**