City Hospital
Pennsylvania
Phase I

Monjia Belizaire
Construction Management
Faculty Consultant: Dr. Messner
City Hospital
Southeast Pennsylvania

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Construction Management
Faculty Consultant: Dr. Messner
City Hospital
Southeast Pennsylvania

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Executive Summary

The purpose of this report is to identify areas of the project that are good candidates for research by investigating critical project areas that will illuminate a different perspective of the construction and design process of the City Hospital. These project areas will form the basis for the City Hospital thesis proposal.

On Wednesday, October 24, 2007, I attended the PACE Roundtable event, "Building Collaboration", which was organized by the Architectural Engineering department. At this event, I gathered information on several possible research topics from the panel discussion. The discussion sessions were focused on: (1) Workforce Development, (2) Prefabrication, and (3) Building Information Modeling which will be elaborated on later in this report. The PACE Roundtable event allows the building industry professionals and students to share their various perspectives on the current challenges facing the building industry; this will also be elaborated on in this report.

The Critical Issues Research Method section of this report will identify the issue of Building Information Modeling on the City Hospital project and challenges that is facing the industry in the Southeast Pennsylvania area.

The Problem Identification and Technical Analysis Method addresses several alternative methods that can be analyzed using different investigation areas such as constructability review, value engineering analysis, and schedule reduction. Most areas of interest on this project will focus on alternate methods to accelerate the schedule of the building. This is imperative because Turner Construction Company has a very limited amount of time to complete the project as well as have the building enclosed, so that the construction of Phase II can begin.

This report contains information about the critical issues facing the construction industry; these issues also face the City Hospital project. Also contained in this report are several problematic aspects of the project, an analysis that will address the problems on the project, and a weight matrix that will illustrate the analyses and core areas of investigation.

I. Critical Industry Issues

The PACE Roundtable meeting, "Building Collaboration: Big Solutions to Big Problems" consisted of about twenty five industry participants which consisted of owners, architects, engineers, and contractors and fifth year architectural engineering students. The topics discussed were; Workforce Development, Prefabrication, and Building Information Modeling.

1. Workforce Development

A major issue with workforce development is the shortage of labor management. According to the panel speakers, there are about 250,000 laborers needed per year. This lack of labor leads to an increase in cost for projects. This is partly due to the misinformed perception of people about construction work. An example that was presented at the roundtable was construction work being portrayed as a dead-end job with little or no benefits. Apprentice programs can motivate workers and teach various skills such as money management or technical skills, which they can apply to new technology and innovations to create labor saving systems. These programs could also be implemented in high school programs to inform students of the benefits of the trade. One speaker suggested creating a television shows such as "Bob the Builder", which is a children program that emphasizes conflict resolution and various learning skills for instance, renovation, repairs, and construction of projects. Studies have shown that shows like "Grey's Anatomy" has an effect on searching for a career. For example, a television program named "Engineers Are Us!" can show some insight in the work of a construction worker and be a recruitment tool. Another issue that is faced in the construction industry is the language barrier. With 23% of the US workforce currently Hispanic and 2,577,000 Hispanic workers in the construction industry, according to the 2005 Current Population Survey, there becomes an issue of communicating with the workers which allows for a demand of bilingual capable construction managers.

2. Prefabrication

Prefabrication is the practice of assembling components of a building in a factory or manufacturing site, and transporting the complete assemblies or sub-assemblies to the construction site where the structure is to be located. Another system that was discussed at the roundtable is the smart wall system. The smart wall system is constructed with lighter weight masonry units and provides energy efficiency, speedy construction, an increase in masonry production, lower maintenance cost, fire resistance, durability, and aesthetically pleasing features. A more popular form of prefabrication, in the construction industry, is used with precast concrete. Prefab supposedly reduces the project schedule time relative to typical construction projects. There are also less labor and safety issues. For example, usually skilled laborers are available to construct the assemblies on a controlled manufacturing site. This method reduces some of the congestion typically experienced on a construction site. A few disadvantages are the system requires more planning, more money,

and is limited in design and creativity. There may also be transportation issues such as high cost of transporting the assembled units and the requirement of larger cranes for handling and placing the units. The prefabricated units benefit, in most instances, far outweighs the cost. As a result of this prefabricated units materials are expect to be implemented in the future of construction.

3. Building Information Modeling (BIM)

BIM is a documentation process that consists of information about a building project in design and construction with the use of technology and collaboration. The benefits of using BIM are for design, construction, and operational visualization; and data modeling efficiency and effectiveness. Construction applications such as estimating, scheduling, and design coordination can be implemented with BIM. In order for BIM to be effective on a project, it has to be used in the early stages of the project by the designers which include the project team: owners, construction manager, and contractors as the project progresses. Grace Wang from Jacobs Facilities Inc., who was also at the roundtable, was one of the pioneers of BIM during her graduate studies at Penn State. Her research was titled, *Using 4D Modeling to Advance Construction Visualization in Engineering Education*. One of the many advantages of BIM is the visual coordination of the various systems of a building such as the MEP systems; the model shows the possible collisions and problems between construction and management of trades. With these conflicts detected and resolved in the design phase of a project this saves the owner money in change orders during construction. With its capabilities, BIM is making a positive impact on the construction industry today. A barrier that is keeping BIM from flourishing in the industry today is the fact that owners do not require BIM. In a paper, published in 2004 from The National Institute of Standards and Technology (NIST), wrote, "The cost of inadequate interoperability in the U.S. capital facilities industry to be $15.8 billion per year. The intended audiences are owners and operators of capital facilities; design, construction, operation and maintenance, and other providers of professional services in the capital facilities industry". The assumptions made with BIM are that it is not currently a knowledgeable subject and more explanation about it is needed. Like every new technology employees also often come across difficulty while trying to understand how the technology is used and determining the benefits of its use. Some may find that it is too risky to invest in and may not realize how it will affect the construction process. In the future, BIM will become a standard practice and will be the new requirements for design and construction. Clients such as the General Services Administration and the Department of Defense are already defining their requirements for BIM.

II. Critical Issues Research Method

Critical Issue:

After further thought and discussion at the Roundtable, the topic that I was most interested in and felt would be most applicable for my thesis project is the use of 4D models (BIM) on the City Hospital project. Building Information Modeling is very exciting because it potentially solves a lot of conflict issues by helping the design team to determine possible conflicts in the design of a project before construction begins. This potential is the reason why I decided to research why BIM was not used on Phase I of City Hospital project, especially because this project requires a great amount of communication and coordination.

Goals:

The goal of the proposed research would be to investigate how the use of BIM during the design phase would have potentially eliminated most of the conflicts between trades during the construction phase which would reduce the cost and schedule of the project, evaluate how innovative technology such as 4D CAD modeling is an effective tool for evaluating the construction process, research who and how would personnel be trained to use BIM, and also create awareness of the advantages of using BIM.

Research Methods:

There are some advantages to designing phase I of the city hospital without using BIM, and I believe these advantages are the reasons BIM wasn't implemented in this phase of the project. Weighing and comparing the advantages and disadvantages between using BIM and not using BIM will form the foundation of this research. It will be crucial to speak to the Mike Ellis, MEP coordinator of Phase I and Paul White, MEP coordinator of Phase II (which uses BIM), at Turner Construction. I can also tap the wealth of knowledge possessed by my advisor, Dr. Messner, who is very knowledgeable in this area of study, and the architectural engineering graduate students who are currently researching BIM.

Below are a few questions that I would ask in my preliminary investigation:

Interview/Survey Questions:
1. Why BIM was not used in Phase I?
2. How and who would be trained for the use of BIM if it were to be used on this project?
3. Do you think there would have been benefits to using this technology on Phase I? Explain.

Figure 3.1 Survey

III. Problem Identification

Analysis #1: *LEED® Rating*

Green buildings and sustainable methods of construction are emerging topics and will only continue to grow. City Hospital is seeking LEED® Silver Certification for New Construction. To achieve a silver LEED® certification the project must earn between 33- 38 points. Some of the credits the hospital are applying for are construction activity pollution control, fundamental refrigerant management, the use of a commissioning authority, complying to minimum energy performance standard as set forth by ASHRAE90.1-2004, storage and collection of recyclables on site, the omission of CFC use in the building, the minimization of occupants to environmental tobacco smoke, and complying with minimum indoor air quality. The basis of my research is to investigate how the City Hospital project can go for a higher LEED® rating.

Analysis #2: *Conduit vs. Busduct*

A question arose during the construction phase of the City Hospital project on whether it would be cheaper and more efficient to use bus ducts in place of the conduits which are currently being installed in the building. Busduct consist of a rigid piece of copper or aluminum, usually in flat bars and conduits are a raceway of circular pipes; both containing conductors which carry current to distribute power throughout the building. An issue on the construction site was the installation of conduit was an extensive process that reduced the productivity of other trades in onsite. The basis of my research is to investigate which wiring method would be economical.

IV. Technical Analysis Method

Research Analysis #1: *LEED®*

The goal of the proposed research would be to identify four to five LEED® points that would explore different design and construction methods that would encourage a Gold LEED® rating. For example, the goal of using rapidly renewable building materials and products on the project can best be aligned with the LEED® credit *MR 6 Rapidly Renewable Materials* or providing individual comfort controls for the building would comply with credit *EQ 6.2 Controllability of Systems Thermal Comfort.*

The second analysis I will perform is a more detailed research of one to two LEED® credits from the credits established initially for LEED® Gold rating. I will first need to determine which credits the project is currently pursuing. This analysis will require a large amount of research that will impact the schedule and the cost. The credits I will pursue will implement schedule reduction and value engineering.

In order to assure that the credits chosen are reasonably achieved on the City Hospital Project, I will review my findings with the LEED® consultant, Gabriella Edwards on this project and faculty advisor, Dr. Riley. I will also discuss my ideas with Elena Enache-Pommer, a graduate student in the architectural engineering department, who is currently researching green building deliveries. After further discussions with these key individuals, I will decide which credits I would suggest that the City Hospital pursue and how to achieve them. The U.S. Green Building Council's (USBGC) website will provide me with additional resources related to the credits that will help further my research.

Research Analysis #2: *Electrical Wiring Method*

My analysis of the wiring system would begin by first determining the use and power need of the circuit and the environment in which the wiring must operate. After researching the cost information the comparison of the two methods will be expected to differ in cost, the impact installation will have on the schedule, and the space required on the site for installation. Finally, I would research the operating and maintenance cost of using both wiring methods.

To obtain information about the disadvantages and advantages of using either system, I would contact Tom Bedesem; MEP superintendent on Phase I and previously an Electrical subcontractor. Dr. Horman is also very knowledgeable with electrical systems and may be a great reference for my research. After further research and discussions, I will be able to compare both methods and determine which electrical wiring would be cost-effective.

V. Thesis Proposal

The weight matrix below illustrates the different analyses as presented in the Technical Analysis Methods section of this report that will be areas of investigation addressed in the City Hospital thesis proposal. There will be two breadth studies that will be proposed from the analysis areas which are the following:

1. *Proposed LEED® credits*
2. **Electrical:** *Conduit vs. Busduct*

Weight Matrix					
Description	Research	Value Engineering	Cost. Review	Schedule Reduction	Total
Analysis 1: BIM	10%	10%	5%	10%	35%
Analysis 2: LEED® Rating	15%	10%	10%	–	35%
Analysis 3: Electrical Wiring	5%	10%	10%	5%	30%
TOTAL	30%	30%	25%	15%	100%

Figure 3.2 Weight Matrix Diagram

VI. Works Cited

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