Technical Assignment 3

Alternative Methods & Research

The Wilmer Eye Institute Outpatient Surgery & Laboratory Building

Baltimore, Maryland

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Executive Summary

The purpose of this technical report is to begin to identify areas of the project that are good candidates for further research into alternative design/construction methods, as well as value engineering and schedule compression opportunities. The areas explored herein have laid a solid foundation for final proposal topics to pursue in the spring.

The first section is a brief summary of the 2007 PACE Roundtable Seminar, a small conference between students, faculty and industry professionals that happens every year here at Penn State. The topics of this year's discussion were prefabrication, workforce development, and BIM (Building Information Modeling). Each panel consisted of three industry members and one professor of Architectural Engineering, while the end of the day featured a panel consisting of six students.

The Critical Issues Research Method section identifies the issue of Infection Control Risk Assessment (ICRA) as a pressing concern in contemporary healthcare construction. An alarming number of patient deaths in hospital facilities are related to the after-effects of construction and renovation projects. Dust and other debris generated by projects can affect nearby facilities' indoor air quality, while vibration from large equipment has also been known to damper patient recovery, among other extremely legitimate concerns. This is a tremendously critical aspect of medical construction, as mistakes in this regard can easily result in patient fatalities.

Several other potentially problematic features of the project were also identified, including issues surrounding the building envelope, as well as plans for a future three-storey expansion. All of the issues identified in this report will be explored in depth through research and other data collection methods in hopes of finding realistic and feasible improvements. Another area of study will be researching any prefabrication opportunities that could potentially be utilized. This topic will likely tie-in with the infection control analysis and the study of the building envelope.

The end of the report gives further detail outlining potential methods of data collection and technical analysis for each of the topics identified. Credible sources of information and areas of research related to the building's engineered systems are noted as well, including some of the associated design and construction topics. Also included is a weight matrix to be used for grading purposes in the final assessment of the capstone project.

Essentially this report lays the foundation for the rest of the capstone project. The issues outlined here will be studied in depth in the months to come. The final thesis proposal will outline specific research steps and their expected outcomes on a semester-long timeline, whereas this report simply examines the topics, or as some prefer to call it, the "meat and potatoes".

Critical Industry Issues

The PACE Roundtable is a small conference held every year here at Penn State between construction professionals and faculty and students of the University's Architectural Engineering program. The discussion is a unique opportunity for students to network with industry members and converse over pressing issues. Attendees at this year's seminar included 50 industry professionals, 4 AE faculty members, 14 graduate students, and 43 undergraduates. The theme was "Building Collaboration" and the topics discussed were prefabrication, building information modeling (BIM), and workforce development.

Each panel discussion was led by one faculty member and three industry professionals. Each panelist gave their take on the issue and then opened the issue up to the entire room for discussion. It was interesting to observe the thoughts of all the different individuals and their specific interests, and then furthermore to learn how they relate to the critical construction industry issues at hand. At the end of the day there was a student-led panel discussion in which industry members could get feedback from the students, and also where students had the opportunity to test the wits of their classmates under the spotlight. It made for an interesting time with a few good laughs.

The first panel discussion was on prefabrication and was led by Dr. Michael Horman of Penn State, Stan Carlat of Hensel Phelps, James Haller of Southland Industries, and Charles Yetter of Tishman Speyer. It focused on the pros and cons of off-site fabrication of large components as a regular practice in everyday construction projects. It was mentioned that prefabrication is practiced more in other countries than it is the United States. Prefabrication requires more planning and coordination early on in the project which can lead to higher upfront costs, making it slightly less attractive. On the other hand, it was argued that extra time spent in preconstruction could potentially save money later on as it lowers the risk associated with accidents, damages and change orders. Other items of interest that may also be able to be applied to this thesis project are the green aspects of prefabrication. Construction waste can be minimized (example was the re-use of formwork in precast), higher quality equipment can be utilized that runs more efficiently, and items such as ductwork can be kept cleaner which essentially creates a better quality of indoor air. On the other hand, depending of the proximity of the fabrication facilities to the project site, there may be a high cost of transportation to the site. All of these concerns must be factored in when thinking of implementing prefabrication into a construction project.

The topic of the second panel discussion was building information modeling (BIM) and was led by Dr. John Messner, Kurt Maldovan of Jacobs Engineering, Todd Vochinsky of the Barton Malow Company, and Albert Zupps, AIA, of Skanska USA. One of the first things discussed was the meaning of BIM, and it was addressed that many people have a different view of what BIM actually is. BIM seems to generally be the term used for a computer program used to manage construction documents and communication between different parties on a project, and sometimes also refers to 3D/4D modeling used to coordinate trades. BIM tends to create a clearer picture of the building and the construction process that will be used, while also creating a solid historical reference of documents and correspondences. However, not all owners are requiring the use of such a program. There are issues surrounding the learning curve and marketing of these somewhat technical tools. Initial implementation will require

research (cost-benefit analysis, etc.) and may steer away some owners. As with Johns Hopkins Hospital, an institution this large is always managing multiple projects at once and it is beneficial for them to have a common ground to organize them. The BIM program used on the Wilmer Eye Hospital building is Constructware© by Autodesk.

The last discussion was on workforce development and was led by Dr. David Riley, Michael Miller of Southland Industries, Steven Smithgall of Balfour Beatty Construction, and Ray Sowers of ONCORE Construction, LLC. This panel basically addressed issues surrounding the dynamics of having a diverse crew of construction workers. Many Americans graduating from high school are choosing to avoid the construction labor industry, essentially creating a gap in the labor force that is being filled by immigrant workers. This is posing potential problems to construction managers, especially those who cannot speak the primary language of their workers. One of the panelists was even explaining that some of his workers were illiterate in their own languages, and that they were forced to hire tutors for them to be able to communicate effectively. A measure that could be used to bridge this gap would be to somehow or another train the management in the language of their workers, which tends to be Spanish in areas where this is an issue. This could be done either by having a foreign language requirement associated with construction degrees such as Penn State Architectural Engineering, or by contractors requiring their managers to take lessons in the language at hand.

All in all, the roundtable discussion was positive event that resulted in a general expansion of knowledge and an excellent networking opportunity for all. The key contacts made relating to the Wilmer Eye Hospital thesis project are Mr. Andreas Phelps and Ms. Elena Enache-Pommer, both of whom are graduate students in Architectural Engineering and are researching green design and construction practices as they relate to medical facilities. Their knowledge will be a solid resource when investigating infection control measures.

For more information about PACE and the roundtable discussion, visit www.engr.psu.edu/PACE.

Critical Issues Research Method

One of the biggest issues in healthcare facilities construction these days is infection control. Renovation and expansion projects are one of the leading causes of patient deaths in hospital buildings. Even new construction can pose a threat from noise and vibration, as well as dust and other elements that may affect nearby or adjacent facilities. Taking special measures to suppress these hazards could potentially save lives.

The AIA outlines an Infection Control Risk Assessment (ICRA) program that focuses on the reducing the risk of infection throughout the phases of facility planning, design, construction, renovation, and even facility maintenance. This document could prove to be an extremely useful tool for the hospital in assessing the current construction practices, as it coordinates and weighs knowledge about infection, infectious agents, and care environment, allowing the institution to anticipate potential impacts their practices may have on patient health.

Another related area of research could be the effect of prefabrication in mitigating these health risks, as well as assessing the associated constructability and cost issues. It may be beneficial to both the contractor and the owner in this case to have items, such as curtain wall panels, constructed at a different location and then delivered to site only to be lifted into place. This could alleviate noise and debris that could potentially be harmful to patients in nearby facilities, and might also prove to be easier and less costly to construct.

Steps towards researching these alternatives will surely include a number of interviews of people working on the project, including, but not limited to, the general contractor's project managers and executives, as well as Johns Hopkins Hospital's project managers and designers assigned to the job. Finding the right people to interview will be a big part of the process, and the sole purpose of some of the phone calls may merely be to find out who exactly is in the decision-making shoes on the issues at hand. In regards to prefabrication, it would be also be helpful to get the perspective of the company that will be doing the installation, as well as the design team assigned to that aspect.

There will also need to be a strong element of personal research into the principles of ICRA and its associated construction methods. Obtaining a copy and becoming familiar with the above mentioned AIA document will be integral before approaching anyone for an interview on the subject. Another beneficial measure would be reviewing past healthcare projects that have taken ICRA measures and possibly interviewing the experts who made decisions concerning infection control.

Some possible interview questions could be:

- What are the current infection control measures on the project?
- Are these measures hindering the ease of construction of the building? If so, how?
- Are you familiar with the current version of the AIA's infection control guidelines?
- Do you think prefabrication could be beneficial to patient health? Or to ease of construction?
- What are the measures taken to protect the indoor air quality of adjacent hospital facilities?

Problem Identification

With every construction project comes a large slew of decisions that must be made, usually creating a number of issues and a margin for improvement. The purpose of this section is to identify a few areas of the Wilmer Eye Institute project that may be problematic or could potentially be improved upon.

The above mentioned infection control issue is a big one on the list. This is an extremely critical issue to all healthcare construction projects. Poor decisions in this regard could lead to patient fatalities and other major problems for the hospital. An institution as large and well-known as Johns Hopkins definitely cannot afford such an error.

Another major area of concern is the future plan for a three-storey expansion. Essentially, all of the engineered systems have initially been sized to be able to accommodate the load associated with three extra occupied floors. This may not necessarily be the best option in some cases as it is all contingent on an amendment to a building height restriction from a local zoning code (PUD—see Building Statistics for more details on the code). Depending on how long it will be before the expansion is actually constructed, this may not be the most cost-effective plan. Further technical analysis and constructability review could possibly yield a better option.

A third area that will be pursued is the design and construction of the building envelope. The architectural wall sections seem to have a somewhat vague description of the envelope and its associated dampproofing measures. This creates a grey area between the drawings and the specifications, which tend to have a much more detailed description of the types of products to be used. Ensuring that the building envelope is designed and constructed to specification is crucial to preventing water penetration and mold growth, and is especially important in an application like this where indoor air quality is an infection control issue. This also ties in with the prefabrication analysis, as parts of the curtain wall may be simpler to install in large pieces, rather than stick-building.

Technical Analysis Methods

ICRA

As mentioned earlier, a major part of the infection control analysis will be research-oriented. Familiarization with the AIA infection control guidelines for healthcare construction will be crucial. Other outside research including sources such as the world-wide web and other hospitals that have undergone similar projects could also be pursued. After a solid understanding is achieved, an analysis of the hospital's current ICRA measure can be conducted. First step in this process would be to find out who is in charge of mitigating health risks caused by construction at Johns Hopkins Hospital, as well as if the general contractor or any other parties have a person in such a position. After the hospital's current infection control methods have been researched and analyzed, alternate methods and/or additional measures may be proposed. Any proposed measures will require an analysis of the associated constructability and project schedule issues, as well as any other aspects of the project they may affect.

Prefabrication

The first step in this analysis will be to identify any parts of the building that have the potential to be prefabricated. The next step would be to preliminarily determine for each item if off-site fabrication is something that is feasibly and realistically obtainable in the downtown Baltimore area. This will likely require various phone calls to manufacturers and material providers in the area, as well as possibly the designers and those responsible for installation/construction of the items in question. Each item will also require constructability, schedule and cost effects, and possible value engineering analyses. After all information has been collected and studied, a final conclusion can be drawn as to whether or not prefabrication is a viable and beneficial alternative for any of the building's components.

Future 3-Storey Expansion

As mentioned in problem identification, all of the major equipment in the engineered systems (i.e. pumps, AHU's, etc.) has been initially sized to accommodate the load of the future three floors. This means that this equipment will be running at less-than-full capacity and will require more energy than is needed for the period of time until the expansion is added and occupied. Another option would be to size the equipment for the initial seven floors and add in additional equipment when the expansion is added. This would save energy and money as smaller equipment costs less and would be operating at 100% capacity for the time until the expansion is added. Both options have a number of factors associated with their feasibility. Sizing the equipment for the expansion will initially cost more to operate, but may save time and money during the addition construction. On the other hand, sizing the equipment smaller will save money on initial operating costs, but the need to purchase additional equipment and lift it into place may cost more down the line. However with this option there may be less of a need to shut down systems during the addition (if the top three floors are dedicated to the

equipment added in with the addition), which could save time or money as the building will be occupied and any mechanical/electrical shutdowns could delay laboratory research and/or patient services.

Technical building systems analyses associated with weighing the pros and cons of each option will include, but is not limited to:

- Calculating the costs of operating larger equipment until the expansion is added
- Calculating the savings of downsizing the initial equipment, as well as the savings in running smaller equipment at full capacity until the expansion is added
- Calculating the cost of purchasing additional equipment
- Investigating constructability issues and costs associated with adding more equipment during the expansion
- Assessing the issues surrounding building occupancy and system shut-downs during the addition
- Assessing the structural issues with placing more equipment on the roof, or
- Determining if dedicated expansion equipment could be placed in the basement, and whether or not it would be best to install it during the initial building construction

In determining which systems to analyze, an initial survey of the designers and the builders for each specific system would be beneficial to get an idea of why they designed each system the way they did. Building systems that could potentially be analyzed include:

- Mechanical
    - Air Handling
    - Steam
    - Water
    - Vacuum
    - Natural gas
    - Oxygen
    - Reverse osmosis (RO) water
- Plumbing
    - Chilled water
    - Domestic water
- Electrical
    - Normal & emergency power
- Structural (with rooftop equipment, etc.)

The first step in the process will be to pick to the minds of the project staff at Hopkins and find out the hospital's plans and the most recent advancements with the expansion—basically get up to speed with as much of their knowledge as possible. This should lead to other individuals on the project dealing with the expansion, all of which will likely be interviewed.

The local PUD (Planned Unit Development) zoning height restriction will also need to be investigated, as the expansion is entirely contingent on an amendment to this code. A talk with the local zoning

organization would be helpful in learning the specifics of code and the process of amending it. However, a discussion with the code consultant on the project (Schirmer Engineering) may prove to be just as helpful.

Essentially, the overall goal of all these communications would be to establish a timeframe addressing how long it could possibly take to amend the height restriction, and furthermore as to how long before the hospital will actually construct and occupy/use the expansion. This information will most likely be the determining factor as to which option is the best.

After this piece of the puzzle is obtained, it will simply be up to running all the numbers and weighing all the other factors (constructability, etc.) to determine which option is the best.

Building Envelope

The first course of action in examining the building envelope would be to learn as much possible from the drawings and specifications. After doing this, it should be fairly clear where the grey area is and any discrepancies should be well defined. As with the other analyses, telephone calls will follow. The main purpose of the communication here would be to (1) find out exactly which parties are responsible for the design and the construction of the cladding system, (2) how they are communicating, and (3) exactly how the system is designed to operate and (4) how it will be constructed.

After all of this information is collected and a general understanding is achieved, the currently designed system can be critiqued, and research into alternate designs/methods can commence. The system will primarily be analyzed in the aspects of dampproofing, insulating value, and constructability. Conversations with professionals in the field of building cladding systems should help to get a better idea of the options available and the pros and cons of each according to project specific criteria (material availability, climate, etc.). The final step will be to make an educated recommendation based on all of the research and discussion that will hold water under the eye of a professional.

Weight Matrix

Analysis Description	Research	Value Engineering	Constructability Review	Schedule Reduction	Total
ICRA	8	5	5	2	**20%**
Prefabrication	2	2	4	7	**15%**
3-Storey Expansion	10	10	10	5	**35%**
Building Envelope	10	5	10	5	**30%**
Total	**30%**	**22%**	**29%**	**19%**	**100%**