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EXECUTIVE SUMMARY

This technical assignment will summarize the several interviews that I had with the project staff to determine some of the constructability challenges, schedule acceleration scenarios, and value engineering topics that exist for the project. Additionally, the report will address some of the opportunities for resolution which I have identified for the project and begin to address possible technical analysis for my senior thesis project.

First I summarize my interviews with the project management team. I discuss the numerous constructability challenges that the project team faced on this project. The top three constructability challenges were the column and footing reinforcement, maintaining a watertight existing and operating hospital, and the tight jobsite and traffic flow. Additionally, I discuss schedule acceleration scenarios for the project including the critical path to the project and some of the risks to the project completion date. There were numerous value engineering ideas for the project. I discuss some which were implemented on the project, including and increased metal panel size for the penthouse and the removal of work overlaps in the project phasing.

Next I discuss some of the opportunities for resolution which I observed on the project. Many of these aligned closely with those which were outlined in the project team interviews.

Finally, I developed several construction management analysis topics which will address some of the issues outlined earlier in the report. These analysis topics include the potential benefits of a design build project delivery method, the value that would be added to the project through use of a heat recovery system, the potential schedule reduction due to decreasing the necessary column reinforcement, and the potential schedule reduction from the use of a prefabricated façade system. Finally, I will research the potential of BIM as a project control tool focusing on how it could be used as a schedule communication tool to address the critical industry issue that that BIM is often not used to its full potential.

PROJECT MANAGER INTERVIEW

I conducted several interviews to complete this portion of the technical assignment. I discussed at length with the project team to gain more insight into the constructability challenges, schedule acceleration scenarios, and value engineering topics. Outlined below is the summary of the discussions that I had with my project team members.

Constructability Challenges

1. Column and Footing Reinforcement

To support the new structure many of the columns in the existing two story building had to be reinforced. There were 86 of these column reinforcements that needed to be completed, most of which had to be completed prior to the erection of new steel on top of the existing building. Some groups of 3-6 columns were able to be made; however there were several locations where only one column could be completed at a time. In turn, each of these areas of column and footing reinforcement required Infection Control Risk Assessment (ICRA) precautions to be taken.

Challenges:

- 20+ mobilizations for ICRA containment crew (just for reinforcement work – not including renovation work)
  - Each requiring double sided gypsum wall partitions floor to floor to provide contaminant containment and fire rated wall between work space and hospital as can be seen in figure 1.
  - Ventilation of interior spaces could not be tied into the hospital exhaust. Separate exhaust had to be run above the ceiling and out to provide the negative pressure necessary in each of these work areas as can bee seen in figure 2.
  - Guidelines for ICRA containment procedures were laid out in the contract documents but only some of the necessary containment was shown on the drawings.
  - Time consuming and expensive process. 1-2 Days for each of the containment setup and teardown out of a 10-15 day total duration in each area. ICRA procedures accounted for over 1% of the project cost.

Figure 1: Double Side ICRA Partition

Figure 2: Microtrap HEPA Filter for Ventilation

- Coordination with hospital
  - Temporary relocation of displaced portions of departments.
  - Little to no storage room for extra furniture, files, equipment, etc was available in the hospital.
- Footing Excavation
  - No room or access for machine excavation for these reinforcements. All excavation had to be done by hand.
  - Excavated soil gets replaced on top of newly reinforced footings but what gets done with this soil during excavation and reinforcement?
  - How does the refuse soil get removed from the basement? (Soil which was displaced by the increased footing sizes.)

Resolutions:

- Prepared ICRA Assessments and logistics plans to coordinate with the hospital
- Increased on-site supervision to focus strictly on completing the column/footing reinforcement before new steel erection.
- Sea-containers for temporary storage of furniture from displaced portions of the hospital was provided by Barton Malow in their site lot.
- Excavated soil material was stored in the basement with plywood and plastic to protect the walls from damage as can be seen in figure 3.

Figure 3: Excavation for Footing. Temporary Soil Storage with Wall Protection

2. Maintaining Watertight Operational Existing Hospital

The existing roofing had to be torn off to begin construction of the pharmacy on the third floor. The removal of the gravel from the existing roof was completed with the use of a large vacuum into a dump truck which removed the material. As will be discussed in the next section this pharmacy is on the critical path as it has to be completed earlier than the rest of the building.

Challenges:

- Once the new columns were erected on top of the existing building – the building below was opened up to water leaking in at these locations. This can be seen in figure 4.
- Tools, material, and debris from above opens the possibility of puncturing this existing roof which creates potential leaks before the enclosure is completed.
- Hospital below had to remain operational while the construction above was completed.

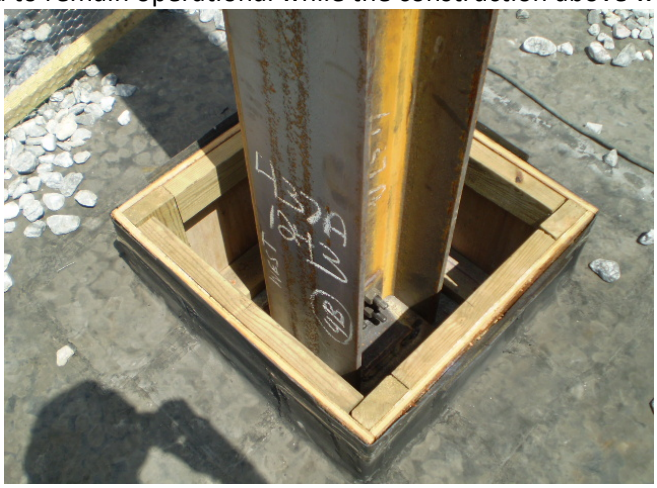

Figure 4: New Column Connecting to Existing Structure through the Existing Roof

Resolutions:

- EPDM membrane used to seal up against the columns until the building was fully enclosed.
- Gravel on existing roofing was removed, membrane pealed back and insulation removed. EPDM membrane was then place back down directly to the concrete to provide some water protection while construction progressed.

3.Tight Jobsite and Traffic Flow

This site is very confined because of its urban setting. The efficient use of the available space is critical to the success of the project.

Challenges:

- Little laydown space for shakeout and material storage as can be seen in figure 5. (Additional site layout plans which show the confined site can be found in Appendix D of Technical Assignment 1)
- The crane had to leave out some steel at courtyard (D8) to be able to reach all the other steel on the project which meant that the entire elevated slab at each floor could not be poured until the project was topped out.
- Flow of materials and people through the building needs to be minimized the impact on hospital operations and to reduce the risk of contamination.
- Material hoist would consume to much valuable site space and would hinder the completion of the façade which is on the critical path of the project.
- Two flagmen were required for each delivery.

Figure 5: Site Layout During Steel Erection

Resolutions:

- Material flow to the upper floors was provided through the use of cranes and boom lift trucks.
- Laborer flow up ladders and through building until the completion of the north stairwell.

Schedule Acceleration Scenarios

Critical Path Project Schedule

1. Column/Footing Reinforcing
2. Room Reconfigurations
3. Steel
4. Penthouse
5. Enclosure
6. Pharmacy
7. Fit-out remaining floors

Risks to Project Completion Date

- Masonry - Weather projection may be needed some of the interior work can begin as the masons work their way up the building.
- Pharmacy – On time turnover is critical to the on time completion of the entire project. The start of the 4th floor where the existing pharmacy space will be converted to pre-operative rooms is contingent on the completion of this new pharmacy on the third floor.
- MEP coordination – Completing the coordination for the 4th floor so that construction on the floor can commence.

Schedule Acceleration Scenarios

- Multiple phases of renovation at once.
    - The contract drawings broke the room renovations down into small individual phases. These mini-phases were stacked so that areas on different floors were done concurrently to expedite the renovation process.
- Larger Metal Panel Sections which were utilized on the penthouse were larger… this resulted in 2 weeks of savings on the schedule – actually implemented
- Steel erection – Extended hours
    - Only person that can be working on a project at a given time so steel erectors gain a day, the project gains a day.
    - Cost of overtime is just for the steel erectors not for the entire job.
- Prefabricated masonry panels to expedite the turnover of the pharmacy and completion of the rest of the project.

Value Engineering Topics

Implemented

- Metal Panel Sizes Increased
  - Increased from 12" to 36" Panels
    - Saved $50,000
    - Saved 2 Weeks on the schedule
- Phase 1 &2 Overlapping Scope Elimination
  - Contracts written so that the team could eliminate elements that are demolished in phase 2 once phase 2 was approved, without any cost implications.
  - Subtract metal cladding of beams and columns in the courtyard
    - Saved $140,000
  - Elevator Elevated Pit
    - Just start in phase 2 no elevator pit for phase 1
  - Framing and gypsum board @ Courtyard
  - Basement Excavation
    - Plans called for concrete encased columns for the basement level columns for phase 1 which would have to be demolished in phase 2.
    - Oversized caisson cans were used to hold back the soil which currently occupied the basement so that the basement did not have to be dug out for phase 1.
    - Stone was used in these cans to make the site safe until the phase 2 basement dig out commenced.

Suggested but NOT Implemented

- Hospital Grade MC Cable
  - Specs call for all hard piped
  - Electrical subcontractor proposed MC Cable from junction boxes to devices
  - Proposed $70,000 credit
  - Labor and time savings

OBSERVATIONS

Opportunities for Resolution

- Difficulty communicating and motivating to subcontractors to be in the proper areas for the renovation and retrofit work.
  - Resulted in congested work areas as some subcontractors stayed on schedule while others fell behind.
  - Longer durations than expected in these work areas.
- Lack of subcontractor cooperation to properly implement and maintain all ICRA precautions.
- No Cooling Tower Access after the completion of courtyard steel. New building on west side and light rail system on the east side prevent crane access to the cooling tower.
  - How do you replace the cooling tower in the future?
- Many instances where ductwork and piping run through existing congested above ceiling space when there were less congested alternatives through the
- Installation of MRI chilled water piping occurred three times because of mis-coordination, and ambiguity on piping specifications.
- There are few sustainable features incorporated into the project.

TECHNICAL ANALYSIS METHODS

Below I have outlined the technical analysis that I plan on performing for my senior thesis project in the spring semester. The content of these analyses and steps that I will take to complete each will be further developed and finalized in my thesis proposal. In this report I have called out coursework that I believe has developed my competency to perform each of the analyses. Additionally, as I am part of the integrated BAE/MAE program I have called out how I will tie my graduate coursework into my project to meet the program requirements.

Constructability

DELIVERY METHOD

Motivation/Hypothesis

A constructability suggestion for Maryland General Hospital Central Care Expansion will be the use of a design build or design assist delivery method for the project in place of the traditional design-bid-build method utilized on this project. In specific this construction management analysis will focus on the mechanical contractor for this type of delivery method. I believe that such a delivery method would have avoided several problematic features of the project saving time and money.

Research

To complete this analysis I will first research of several precedence cases. Specifically, I will look the characteristics of the projects that made them a good fit for this project delivery method, and the benefits that they boast. Additionally, I will research the time and costs for the design and coordination phases of the project.

Analysis

Based on the research I will develop a basic rubric for projects which are good candidates for this type of delivery method. I will use this rubric to evaluate how successful implementation of such a delivery method would be on the Central Care Expansion project. To quantitatively evaluate the successfulness of this delivery method I will compare case study data to time and cost data that I collect the Maryland General Hospital project with respect to the design through coordination phase of the mechanical systems, and rework cost and duration.

Coursework Reference

AE 372: Introduction to Building Industry
AE 472: Building Construction Planning and Management
AE 572: Project Development and Delivery Planning**
**Integrated BAE/MAE Requirements

Value Engineering
ENERGY RECOVERY SYSTEM
Motivation/Hypothesis
Sustainability is a growing trend which should have been a larger concern for hospital project such as this. Hospitals are large energy consumers partially because of their large outdoor air requirements which requires more air to be conditioned. On this project there was no heat recovery system which could dramatically impact the energy consumption of the building. A value engineering suggestion for the project would be the use of an energy recovery system as part of the HVAC system.

Research
I will research the various options for heat recovery that are currently available on the market. I will evaluate each based on the design criteria for the project and efficiency keeping in mind that indoor air quality is a top concern.

Breadth Study
Utilizing this research I will select the best system for the project and incorporate it into the mechanical design. I will then perform an energy analysis utilizing this new system to determine the amount of energy saved through the use of such a system. Additionally, I will investigate if any subsequent upsizing of fans and downsizing of equipment which could result from this change in the system.

Analysis
A detailed takeoff of the existing and new mechanical equipment including heating coils, cooling coils, air handling components, fans, chillers, cooling towers, and subsequent piping would need to be performed. This takeoff may be done with the assistance of 3D coordination model which was created for the project. Quotes from subcontractors might be obtained to gain a true market rate estimate for the system. Additionally, I will investigate how this change in the system will impact the completion of the penthouse.

Coursework Reference
AE 310: Introduction to HVAC
AE 597D: Sustainable Building Methods**
**Integrated BAE/MAE Requirements

Schedule Reduction

STRUCTURAL REINFORCEMENT REDUCTION

Motivation/Hypothesis

As was described earlier, the structural reinforcement of the columns and footings for this project consumed a significant amount of time and money both for the reinforcement and precautions that need to be taken for each work area. I will investigate how the structural steel system could be altered to decrease the number of column reinforcements which needed to occur to support the building. This should reduce the schedule time for the reinforcement but may increase the erection time for steel above.

Research

Aside from brushing up on structural analysis techniques and researching any analysis procedures that I have not been exposed to I do not expect much research in for this analysis topic.

Breadth Study

I will perform calculations on the existing structure utilizing the structural analysis program, RAM structural system. This will be completed by exporting my model from Autodesk Revit Structure to the analysis program (this process was researched and documented as part of a team project for my virtual facilities prototyping class). I will perform hand calculations to confirm that the program is properly functioning. Once this is complete I will redesign a portion of the system in an attempt to reduce the number of columns necessary to support the new structure. I will utilize the analysis program to quickly check and size different options.

Analysis

I will evaluate any alternatives that I generate for constructability. A detailed structural analysis takeoff will be completed. This will include footings, caissons, structural steel beams and columns, column reinforcements, connections. Additionally, the schedule will be analyzed for reductions due to decreased column reinforcements as well as any schedule increases for the new structure which may result. Did decreasing the number of columns that need to be reinforced decrease the overall construction duration?

Coursework Reference

AE 308: Introduction to Structural Analysis
AE 404: Steel and Concrete Structural Analysis
CE 397A: Foundations
AE 597F: Virtual Facility Prototyping**

PREFABRICATED FAÇADE SYSTEM

Motivation/Hypothesis

Because the column reinforcement process took up a large chunk of the schedule to complete, the masonry was pressed to be completed before the winter months of the project and in time for interior fit-out to be completed for the 3rd floor pharmacy which was originally scheduled to be turned over in late January. The use of a prefabricated façade system could have made up some of this time in the schedule, keeping it in line with the original turnover date.

Research

I will research various prefabricated options and manufacturers. I will also research the connection types that will be associated with each

Analysis

I will analyze the system for constructability with the existing structural system. I will work through any connection details that will be necessary to support the system. Once this is complete I will analyze how this will impact the site logistics. I will compare the production of the typical masonry system with that of the prefabricated system. I will use this to adjust the schedule accordingly. For this system an assemblies estimate will be completed for both the masonry and precast system and compared. This data will be compiled from masonry subcontractor and potential manufacturer/installer or the precast system.

Coursework Reference

Critical Industry Issue

BIM AS A PROJECT CONTROL TOOL

Motivation/Hypothesis

At the 2008 PACE Roundtable event the fact that building information models are often not used to their full potential was brought up as an industry issue. The question of what opportunities there are to use BIM throughout the lifecycle of the project was raised. I would like to address this issue on two fronts:

First, a broad overview of the use of BIM as a project control mechanism which would be strictly case study review and analysis.

Second, in a more specific use on the Maryland General Hospital Project as a potential resolution to some of the constructability challenges which were present. Specifically, I would like to look at how a BIM could have been used as a schedule communication tool for the project.

Research

1. I will research several case studies of how BIM was utilized as a project control on a project. Potentially, I would survey industry to determine potential good uses for such a tool and perceptions that exist with respect to BIM.

2. I will develop a full BIM of the project and will utilized it to develop a 4D model of the project. I will survey subcontractors on the traditional method of schedule communication which was utilized on the project. I will present the 4D model to the project management team, subcontractors, and the owner to gain feedback on the usefulness of the tool on the project.

Coursework Reference

AE 473: Building Construction Management and Control
AE 570: Production Management
AE 597F: Virtual Facility Prototyping**