Bayhealth Medical Center

Dover, Delaware

Technical Assignment three

The Pennsylvania State University

AE Faculty Advisor:Chimay Anumba

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Christopher R Barron

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I. Executive Summary

Technical assignment three is intended to highlight possible areas to do further research, to find possible cost saving, schedule compression, and alternative methods of construction. The Bayhealth Medical Center expansion is a hospital located in Dover Delaware. The expansion consists of a is 215,000 SQ feet pavilion building which will house a 225 bed patient care tower, an emergency department, oncology (both chemo and radiation), heliport, security, pharmacy, Diagnostic imaging, and shell space. A four level 370 space parking garage is already erected, and is attached to the pavilion building. A central service facility is also being built that houses all new mechanical equipment. Finally, a bridge connecting the central service building and employee parking lots to the pavilion will be erected. Construction was started on December 24 2007 and is expected to be completed on May 2012.

The first section of this report describes the three most unique constructability challenges that the project team has faced, and how they decided to overcome these issues. Next, the critical path of the project is described along with possible risks to its on time completion. Also discussed in this section, are possible ideas that could be implemented to accelerate the schedule if needed. Then, the value engineering ideas that were implemented on the project are discussed. There were three main areas of focus on value engineering by the owner and the construction team at Whiting- Turner: finishes, architecture, and structural/HVAC/ electrical systems.

The second part to technical assignment three is the identification of problematic features of the project. Through discussions with the project team and personal analysis several problems were identified. These problems were analyzed and four were chosen to be used in this technical analysis. The problems identified were the addition of green roof system, prefabrication of MEP systems, the building envelope, and implementing BIM for 3 D coordination.

II. Table of Contents

I. Executive Summary 2
III. Constructability Challenges 4
IV. Schedule acceleration Scenarios 6
V. Value engineering 8
VI. Problem Identification 10
VII. Technical analysis methods 12
VIII. Appendix A: Value Engineering charts 14

III. Constructability Challenges

Building water tight:

Because there are three very different types of exterior facade assemblies, there was a problem combining the systems together, and making the building water tight. From the beginning the construction team at Whiting-Turner was aware that there could be a potential problem combing the three systems together. So, when they received the initial set of specifications, they immediately approached the owner to try to broaden the types of wall systems that they could use. Even after having the owner agree upon several additional wall systems, the problem still wasn't solved. During construction, the project team was still having problems with making the curtain wall system moisture barrier tie into the other façade systems. Because making the building water tight was along the projects critical path, the project team had to come up with a way to make the curtain wall water tight so they could stay on schedule. So, in order to keep the project on schedule, the construction team decided to build a temporary water tight wall behind the curtain wall to keep the installation of finishes going.

Dewatering of Foundation:

After the geotechnical report was reviewed by the construction team, it was found that the site had an uncharacteristically high water table, between 4.3' to 19.1' deep. It was suggested by the geotechnical report and decided upon by the project team, that temporary dewatering of the foundation would be needed. A dewatering ssystem was installed by the excavation contractor who maintained the system while the Substructure and steel structure was completed. Because such a high water table was present, the structural design had a stipulation that the dewatering system had to be in place until the steel structure was complete, and the composite concrete slab was poured. The reason for the stipulation in the contracts was the structural design firm had concerns that the hydraulic pressure of the water would cause the building to "float" causing damage. In order to lower the water table the excavation contractor installed a multiple well point system, which was installed around the perimeter of the building, allowing for the water table to be lowered.

Construction of Linear Accelerators:

Located in the basement of the bayhealth medical center expansion is two vaults that will contain the hospitals linear accelerators. A linear accelerator (LINAC) is a device most commonly used for external beam radiation treatments for patients with cancer. Because these machines give off a large amount of radiation, the project team had to take special care in the construction of the vaults. To determine the amount of material needed to block the radiation, the project team first had to look at the shielding capacity of several materials. The shielding capacity of a material is directly related to its density. Lead and steel were looked at for their shielding capabilities, but concrete was eventually chosen due to its lower cost. After it was decided upon to use concrete as the shielding medium, physicists were then hired to design the vaults with the required shielding. They choose the average unit weight of concrete to be 147 pcf to do their calculations. The problem that they didn't realize was that the dry unit weight of 147 pcf is an average of a bell curve. So in order to meet the designed assumptions, the concrete must have a minimum of 147 pcf dry unit weight. The project team then had to come up with a mix design that has an absolute dry unit weight minimum of 147 pcf. During construction the wet weight of every truck had to be measured, if any were found to be below the minimum weight required the entire truck was rejected. Because the vaults needed to be seamless, both vaults had to be poured at the same time and be one continuous pour. Since the pour couldn't be interrupted another pump truck was required to be present on the jobsite at the time of the pour in case the primary pump truck broke down.

IV. Schedule Acceleration Scenarios

Critical path

The bayhealth medical center expansion's schedule follows a typical critical path of a medical building. The major items on the projects critical path are described in the table below:

Substructure
↓
Superstructure
↓
Building Enclosure
↓
Building Water Tight
↓
MEP Rough In
↓
Finishes

Risks to project completion

At this point in time the project is on schedule to be completed by the proposed finish date. One of the risks to the project schedule that has already been discovered is the task of tying the three different façade types together and making the building water tight. Because this is so necessary to keep the project on track, the design team actually decided to build a temporary water tight wall behind the curtain wall system until it could be made water tight. Although this added wall was unanticipated and would cost the owner more money upfront, it allowed the interior finishes to still be installed which kept the project on track, saving the owner money in the long run. On possible future risk to the projects schedule is the amount of possible change orders to the MEP systems. Because no 3 D coordination or clash detection was performed on the bayhealth medical center expansion there is a potential for a large amount of coordination issues.

Areas of potential acceleration

The largest schedule acceleration potential that the project team discussed with me that wasn't taken advantage of was, that the buildings mock ups needed to be finished at an earlier date. Because the layout of a medical room is very important, the complete design couldn't be finalized until the mock ups were done. Due to poor coordination between the owner and the architect, these mock ups fell behind schedule. Not only did this slow the ordering of the materials needed for the project, but also held up the installation.

The most effective and easiest way to decrease construction duration would be to increase the manpower available on the jobsite. Because project duration isn't a large concern of the owner, this isn't a preferred option. With the amount of MEP systems being installed into the bayhealth medical center, Prefabrication would also be a great way to accelerate the schedule. The only drawback to this idea is the large lead times for the prefabricated units.

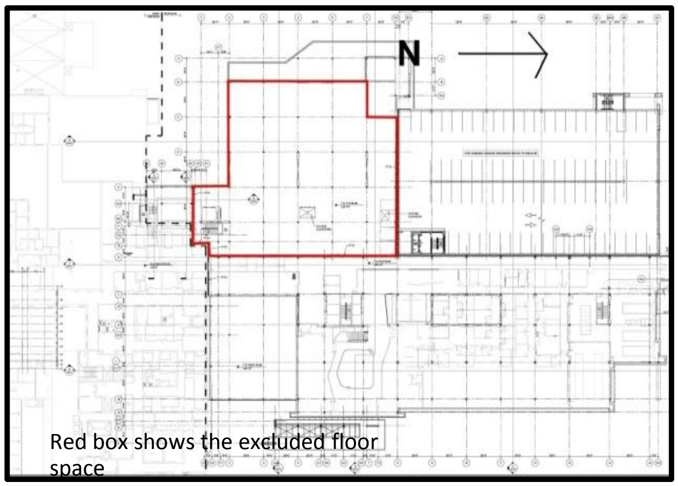
V. Value Engineering

Because cost is one of the main concerns of the owner of the bayhealth medical center expansion, there were many value engineering ideas discussed and implemented. The three main areas that were focused on were the finishes, the size of the building, and architecture. Each cost savings number includes potential savings to General Conditions, P&P Bond, and Contingencies along with labor and material.

After an initial cost of the finishes was showed to the owner, it was decided that the costs of finishes should be reduced by 5% overall. This 5% reduction of cost was attained by selecting cheaper finish materials that still met specifications. Also, it was decided that several initial items such as fireplaces and won doors would be completely omitted from the project. The total savings to the owner from the 5% reduced cost of finishes totaled 745,000 dollars.

The largest area of savings came from the architectural changes made to the expansion. It was decided by the owner and the design team that the overall square footage of the building should be reduced by 82,750 sq ft. This was accomplished by shrinking the foot print of the building, reducing the size of the second and third floor, excluding a third floor mechanical room, and excluding a 4th floor patient floor shell.

The largest architectural cost savings came from a decision to simplify and stream line the façade by switching form a plankton curtain wall system to a cheaper curtain wall system. Other key ideas included lowering the floor to floor height by one foot, and raising the SOG 1'-7" higher due to a high water table on site. The total savings to the owner from the architectural changes totaled 19,219,500 dollars.



Red box shows the excluded floor space

The last major area that was studied for value engineering ideas was the Structural, HVAC, and electrical systems. One of the largest changes in this area was to the structural steel. Because initially a floor design load of 100 PSF was used, it was decided to lower the floor design load to the code minimum of 80 PSF. Most of the changes in this area were to exclude items completely or to defer them to another phase of construction. The total savings to the owner from the Structural, HVAC, and electrical systems totaled 1,319,750 dollars

The table below summarizes the total savings to the owner from implemented value engineering ideas. Located in appendix A is a further breakdown of each value engineering idea implemented on the project.

Summary of value engineering savings

Finishes	$770,000.00
Architectural	$19,409,250.00
Structural/HVAC/Electrical	$1,319,750.00
total	$21,499,000.00

VI. Problem Identification

Building envelope

The largest problem that arose from the buildings envelope was getting the facade watertight. Because making the building watertight is along the projects schedule's critical path, it was something that Whiting-Turner focused on. It was even decided early on in the project that an envelope consultant, R.A. Kennedy & Sons, Inc., should be brought in to make sure things would go as planned. Because three different façade types were used and each required a different manufacture controlled waterproofing technique, the issue of combining each system arose. Not only did this cause coordination issues, but also delays to the schedule.

Sustainability

Because the owner's main concerns for the bayhealth medical center expansion was cost and quality, few sustainability ideas were implemented into the project. Because of the size and type of building, and also that it will be operating 24/7, It will consume a lot of energy. Because building energy consumption is a large topic in the construction industry today, a look into energy saving systems that could be effectively implemented into the bayhealth medical center expansion would be a great research topic.

Prefabrication

Hospitals require the installation of an extensive amount of building systems. Along with an average buildings MEP systems, the bayhealth medical center expansion also includes medical gas systems, pneumatic tubes, and an extensive low voltage system. If prefabrication were applied to these systems not only could a higher quality product that potentially could cost less be produced, but there is a potential to save time in the schedule.

Dewatering of the foundation

Since the water table is extremely high in the location of the jobsite, an extensive dewatering system had to be installed into the foundation. This not only cost the owner more money for the system, but added time to the schedule. Also, because of the high water table a temporary dewatering system had to be installed during excavation, and remain in use until after the structural system was in place.

MEP Coordination using BIM

Because of an extensive amount of MEP work on the bayhealth medical center, coordination between each of the trades is of utmost importance. Each system must be installed in coordination horizontally and also vertically in harmony with each of the other systems. There was no 3 D coordination between the subcontractors on the bayhealth medical center expansion, which could have saved money and time.

VII. Technical analysis methods

Topic 1: Addition of green roof

Because of the already oversized structural system, the addition of a green roof system can be a viable option for the bayhealth medical center expansion. A green roof is not only a great way to control levels of storm water runoff, but also has the added benefit of reducing the buildings overall heat island effect, and will reduce overall building energy costs.

In order to decide if the addition of a green roof is a viable option several things must be taken into consideration. Can the current structure carry the added weight of a green roof system? Because there are plans for additional floors to be added in the future, can a green roof system be placed and then moved? The cost advantages and disadvantages will also need to be determined. It will also have to be determined what effects if any the addition of a green roof would have on the schedule.

An analysis into an addition of a green roof will satisfy constructability and breadth requirements of my final report.

Topic 2: prefabrication

Because of the extensive systems that are being installed into the bayhealth medical center expansion, prefabrication would be an ideal way to save money and time on the schedule. If prefabrication was implemented on this project the number of change orders could be greatly reduced. Also since one of the largest concerns of the owner is quality, this could be an easier way for the owner to monitor the level of quality.

In order to complete this analysis, I will have to research the feasibility of implementing prefabrication on my project. The cost of installation on the field vs. prefabrication costs will need to be determined.

An analysis into prefabrication will satisfy constructability, value engineering, and schedule acceleration requirements of my final report.

Topic 3: simplify building envelope

Because the project team is having such a difficult time making the building water tight, a look into improving the buildings envelope, would have the potential of saving the owner money and keeping the project on schedule

In order to perform this analysis, I will need to determine what exactly is the cause or causes to this problem, and what can be done to solve this. I working system will have to be produced, and an estimate of the new system compared to the existing system will need to be produced.

An analysis of the building system will satisfy constructability and schedule acceleration requirements of my final report.

Topic 4: implement 3 D coordination for clash detection

Although no major coordination issues have been encountered, the construction schedule may have benefited from the use of 3 D coordination. This could not only prevent coordination issues from occurring, but can make the installation of these systems more efficient. Through the use of 3 D coordination the subcontractors could have a definitive idea of exactly what they are supposed to get done and where before the day began. The potential savings in time and money to the owner could be substantial.

In order to analyze the possible effect of implementing 3 D coordination, I will have to study the possible reduction in the amount of time of system installation. The cost and feasibility of implementing 3 D coordination must also be studied. This would not only reduce the amount of possible overtime, but perhaps shorten the schedule.

An analysis of implementing 3 D coordination for clash detection will satisfy constructability and schedule acceleration of my final report.

VIII. Appendix A: Value Engineering charts

Finishes

replace terrazo flooring with tile	$150,000.00
exclude fireplaces	$60,000.00
downgrade of elevator cab finishes	$100,000.00
dex-o-tex to epoxy paint	$75,000.00
exclude won doors	$15,000.00
exclude ceiling in main basement corridor	$25,000.00
change toilet partions from ceiling hung to floor mounted	$40,000.00
resinous to dex-o-tek flooring	$175,000.00
downgrade of light fixtures	$45,000.00
misc. downgrade of finishes by 5%	$85,000.00
total	**$770,000.00**

Architectural

exclude skylight over waiting area/reduce size of front lobby skylight	$189,750.00
reduce footprint and floor size by 82,750 sg ft	$14,500,500.00
exclude 3rd floor mechanical room	included in footprint reduction
reduce number of beds in the emergency department ftom 46 to 41	included in footprint reduction
exclude exterior covered walkway	included in footprint reduction
defer construction of 3rd linear accelerator vault to future phase	$181,000.00
lower total floor to floor height by 1'	$75,500.00
raise SOG by 1'-7" to eliminate waterproofing membrane	$750,000.00
simplify/streamline façade	$3,712,500.00
total	**$19,409,250.00**

Structural/HVAC/Electrical

reduce structural floor load from 100 PSF tp 80 PSF	$100,000.00
exclude water heater replacement of existing building	$60,000.00
exclude stairwell pressurization fans	$24,750.00
exclude spare 15 KV load interrupter switch/fuse unit	$115,500.00
use fire rated fire alarm MC cable instead of conduit and wire	$49,500.00
exclude an emergency generator	$907,500.00
exclude a 10,000 gal fuel oil tank	$62,500.00
total	**$1,319,750.00**