Technical Report 3

December 2, 2009

Emily Couric Clinical Cancer Center

Charlottesville, VA

Brittany Muth

Construction Management

Dr. Riley

EXECUTIVE SUMMARY

This technical report begins to look into several topics on the project that could potentially be researched in more detail. The different topics discussed about the project are the constructability challenges, schedule acceleration scenarios, and value engineering topics. Additionally, I have also identified problems and developed different technical analysis methods to in order to investigate each of the problems indentified.

The constructability challenges consist of three major issues. One of the challenges is related to the waterproofing construction and connecting it to the roofing and siding. Another issue that hinders construction is the particulars of how to connect the various façade textures on the building. If the different sections of the façade are not connected properly, major problems could arise in the building such as mold from leaks. The final issue discussed in this report is the change orders that have occurred thus far on the project. Change orders can be very time consuming and costly to the owner and the project team as a whole. The construction manager must manage these changes in order to keep the project on schedule and on budget. If these constructability challenges are managed properly, the whole team will have a successful project.

There are numerous different scenarios that would help accelerate the schedule if it became necessary to do so. In this section there is a detailed discussion on the critical path and its influence on the project acceleration. A few ideas offered such as increasing the crew size, working overtime and/or finding different techniques to complete the construction quicker. The cost of accelerating the schedule is difficult to estimate until the decision has been made to accelerate the project. Some techniques typically cost more than others. Increasing crew size and working overtime are usually not the most cost effective way to accelerate the project schedule.

Value engineering is an important part of every building project. The idea of getting more for less is crucial to understanding a building project. After conversations with the owner representative, Fred Dunn, and Project Executive, Mike Poulin, of Gilbane Building Company, I selected a few of the more impactful value engineering ideas to discuss. I discussed both ideas that were accepted and some that were declined. On this project, there were two different value engineering sessions, one at the design development stage and another at 95 percent complete documents phase.

Additionally, I identified several different problems that need more research to fully understand the process and construction of the different items. The problems are discussed in more detail in the following pages. Also, some analysis methods are mentioned to analyze a few of these problems in more detail.

TABLE OF CONTENTS

CONSTRUCTABILITY CHALLENGES

There are always unique construction challenges on every construction project. Because every project is different, they each come with their own issues. They can vary from soil contaminants to connection details of the façade connections. To assist in this, I interviewed two key contributors on the Emily Couric Clinical Cancer Center construction project, Fred Dunn, the owner representative, and Mike Poulin, the Project Executive for Gilbane Building Co. Interestingly enough they both came to the conclusion that the number one constructability challenge is the connection details between various materials on the building. This concern will be discussed in more detail below along with other issues on the project.

One of the principal challenges on the project is the details of where the siding, waterproofing, and roofing materials all come together. It is difficult to construct this connection because of the way they have to be pieced together. Typically, the waterproofing can be preformed all at one time. The same can be said about the siding and roofing. In this case, it is essential that the waterproofing cannot be exposed to ultra-violet rays for more than thirty days. This fact has complicated the process because the siding and roofing cannot be completed consistently due to the complicated connections. The solution to this issue was to piece the siding, roofing, and waterproofing together in smaller sections on the building. This is much slower process, but has been found to be the best way to keep the project on schedule because the waterproofing will be installed properly and will not have to be replaced due to too much exposure to ultra-violet rays.

Another challenge related to the construction details involves the entire façade. There are a number of different materials used to make up the façade and how some of them connect are very hard to visualize. The materials are as follows: stone, brick, three different metals: white, copper, and stainless steel, a curtain wall, storefront, and punch windows. A lot of time needs to be spent on the details for each of these connections and even then they may still not be fully understood. If the connections are not constructed correctly and become defective, there could possibly be leaks which could cause major problems for the building in the future; especially considering this is a hospital. In order to reduce chances of poorly constructed connections, the project team pushes to have the details finished ahead of time to review and see if the connections will be able to be made in the field and will prevent infiltration into the building envelope. Below are pictures of the façade provided by The University of Virginia.

Figure 1: North East Façade

Figure 2: South West Facade

One of the biggest challenges of all projects, especially on a medical related project, is change orders. Change orders happen so often on medical projects because the owner always wants to have the latest and greatest technologies in the hospital. These technologies are changing constantly and constantly getting better. Every time a piece of equipment is changed on these types of projects, the MEP system and architectural drawings need to be revised and resubmitted. This is a very time consuming process and costly process. One of the most recent major change orders on the Emily Couric Clinical Cancer Center was to substitute a piece of equipment to a CAT scan room. This is a major change because not only does the MEP system change, the area that the CAT scan machine is in needs to be lined with lead panels. The floor is easier to line with lead because it is a recessed floor system and can be accessed easier than the ceiling. The ceiling, on the other hand, is much more difficult to line with lead because it involves working over your head and is not as simple because you have to us some kind of lift or ladder to reach it. Not to mention that there is a lot of different equipment in the ceiling that needs to be worked around. It takes much more time to complete the work in the ceiling. One thing that could be considered is to rough-in typical supports for the equipment that is going to be in the room. At John Hopkins they have installed typical supports that are able to support the equipment even if it changes after the supports have been installed.

One thing that could help is to substitute steel for the lead. The requirement is to have three inches of lead on the ceiling but steel can be substituted at a 2.7 ratio. This has a result of just over one inch of steel on the ceiling. Therefore, the laborers will be welding one inch steel onto the underside of the slab. This change order will end up costing the owner approximately $250,000 by the time it is over. Because this change order is going to take approximately one month to complete, the drawings need to be completed in a timely manner, if not, the project would begin to get behind on the schedule. Therefore, the construction manager decided to give the owner a deadline of when the drawings needed to be completed to stay on schedule. If the drawings were not completed by that date, they would start to lose one and a half days for every day the drawings were later. Needless to say, the drawings were completed on time and the change order is currently being completed.

Schedule Acceleration Scenarios

The Emily Couric Clinical Cancer Center started construction on April 12, 2008 and is scheduled to be substantially complete on December 29, 2010. There are many different activities that could possibly slow the construction process and delay the project. These activities can range from demolition and excavation to having a large number of change orders that delay construction process. There are many different techniques that can be implemented on this project to accelerate the schedule if the project team deems it necessary in order to finish on time. Different scenarios for schedule acceleration are discussed below.

Critical Path

The critical path for the Emily Couric Clinical Cancer Center relies mainly on demolition and steel construction. The demolition of the existing garage allowing for the new foundations to be constructed supporting the steel structure of the building. Following demolition, the steel frame was installed and topped out on May 28, 2009. Cast-in-place concrete slabs and roof construction began after the steel construction and was completed on July 1, 2009. The façade began after steel construction and is schedule to be complete on January 6, 2010. Mechanical, electrical and plumbing construction began shortly after the façade and finishes shortly after the façade. The interiors and finishes will be constructed after the MEP to finish up the building and be turned over to The University of Virginia. See Figure 1 for critical path sequence.

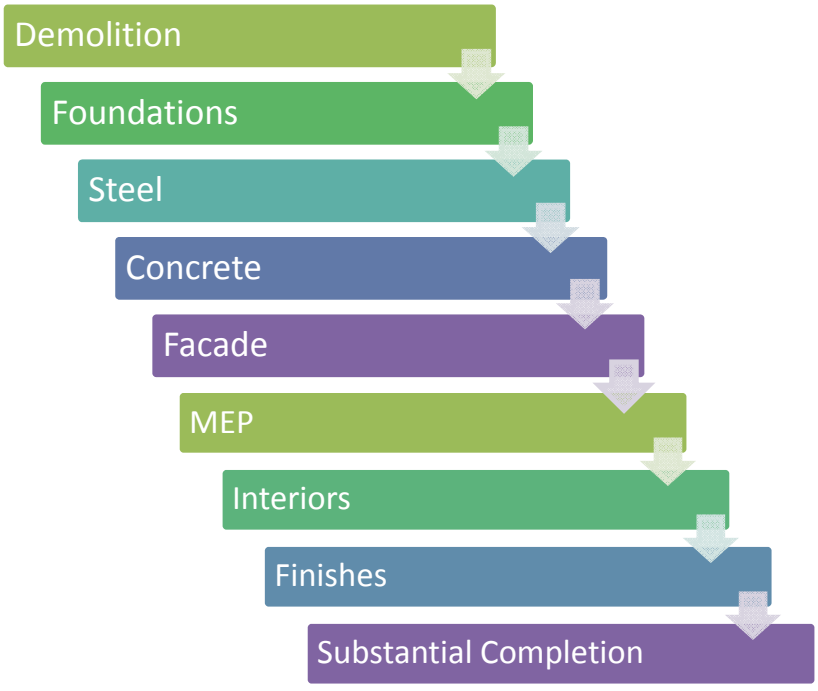

Figure 3: Critical Path Sequence

RISKS TO THE PROJECT COMPLETION DATE

There are many risks to the project completion date, some more substantial than others. One of the risks of the project was the demolition of the existing parking garage. They had to clear the site before they could begin construction on the Emily Couric Clinical Cancer Center. If they would not have finished the demolition in a timely manner the project would have been delayed right from the start. Also, when they began to excavate for the new foundations, they had to be cautious of the existing utilities that were under the garage. They needed to be sure not to rupture the utilities because they are used to serve the surrounding buildings. They also need to be aware of what they are demolishing because the project is going for a LEED Silver rating and that requires recycling of materials.

The prime risk to not completing the project on schedule is the change orders. Because it is a hospital project, technologies are always changing and improving. Since the goal of the owner is to have the most up to date technologies there tends to be a lot of change orders. The way the project team deals with change orders is to give the University of Virginia a deadline of when they need the drawings to complete the change order. If they do not have the change orders in time, they will not be able to finish the schedule. For example, after speaking to Mike Poulin the project executive with Gilbane Building Co., a change order was just proposed to change a piece of equipment to a CAT Scan machine. This requires a lot of changes including the mechanical system, architectural, and electrical systems. The change will take about a month to complete. Therefore, Mr. Poulin gave The University of Virginia a deadline of when the drawings needed to be completed or they would lose one and a half days for every day they do not have the drawings. This happened to be a great solution because they got the drawings in time and are currently working on the change order.

Another risk to not completing the project on time is the steel construction. The construction manager scheduled 17 weeks for the entire construction of the steel and decking. If the steel was not correctly ordered or delivered on time the project would have been delayed. Steel has a long lead time and needs to be organized in a manageable sequence so that it can be completed without problems. Although this could lead to a long delay in the project, it could also be a way to accelerate the project. If the project manager does not order the steel on time or correctly, the steel will fall behind and take a long time to get to the project because each piece needs to be made individually. On the other hand, if the project manager orders it on time and places it early enough, it could be accelerated if the manufacturer has the capacity to make the pieces earlier or quicker and shorten the lead time.If the construction is running smoothly, then the construction manager could push the schedule and decrease the amount of time it takes to construct the steel.

AREAS OF POTENTIAL ACCELERATION

In the unfortunate case that the project is delayed, the project team would need to investigate different areas to accelerate the schedule to prevent finishing late which could result in penalties from the owner. If the project is being delayed by demolition, the crew size could be increased to complete the demolition more quickly. If the project is delayed by steel, they could try to make up time by placing the concrete slabs more quickly by working overtime or increasing the crew size and placing more concrete in one day. Each floor has an average of 12 days to complete the slab pours and in theory this could be cut in half if the crews were doubled.

Another area that could reduce the construction duration would be to prefabricate a number of the MEP work. This would cut down on the field time for welding and other on site tasks. This could significantly reduce the number of onsite labor hours and allows that schedule to be accelerated.

Additionally other items could be prefabricated to accelerate the schedule such as the brick façade. The prefabricated brick façade also, known as precast panelized brick, usually looks better than typical brick masonry and definitely can shorten the schedule by finishing the façade early. The drawback of prefabrication, however, is that it has long lead times. Therefore it will have to be planned out in advance and can only be implemented if the delay were to occur long before the prefabrication takes place.

Since there is about twenty months to complete this project, it should not need to be accelerated but if the need to accelerate it would arise, another option would to have a prefabricated interior wall system. There are typical systems that can be included in the wall are the electrical and controls conduit. These are typical metal studs with drywall covering and could be another option. Again planning would have to take place in advance; however the use prefabrication would allow not only the trades that use the prefabrication to accelerate but all the trades on the project. This can happen because the entire site would be less clutter allowing for better efficiency of all trades.

COSTS AND TECHNIQUES

The cost of the delays and solutions is difficult to calculate until they needed to be implemented. It would depend on how delayed the project is and what type of solution the project team decides to use. The longer the delays are the more the cost will be to fix it and vice a versa. Prefabricating can save a lot of time and money in some cases. It allows the work to be simply put together like a puzzle instead of cutting, welding and building it on site.

Overtime can add a lot of labor cost to a project and could result in reduced productivity if overused. On the same note, adding additional crews can become less productivity because it can create confusion and spatial conflicts on site by having too many people in one area. The people will be running into each other and it will hurt their productivity. If there would be a delay, the cost and techniques would be analyzed to see which technique is the most effective way to get the project back on schedule.

VALUE ENGINEERING TOPICS

There were many different value engineering ideas proposed for this project. Some of these ideas were accepted and others were not. These ideas ranged from saving on engineering costs by creating similar walls to substituting different mechanical equipment. Since the main goal of value engineering is to lower costs over the lifecycle of the building, each of the value engineering ideas were considered carefully and either approved or not approved by The University of Virginia. This project incorporated value engineering during two different stages of the project, one at the design development stage and the other at 95 percent complete construction documents. At each stage there were many ideas brought up and these ideas will be discussed below.

DESIGN DEVELOPMENT VALUE ENGINEERING:

First, I will discuss a few of the value engineering ideas that were accepted during the design development stage. They recognized early on the project that they could save money by doing rough grading after the demolition of the garage. Another idea that was approved was to simplify the façade and curtain wall system. For the electrical system, relocating the primary switch, transformer, secondary and emergency to the mezzanine was estimated to save $223,000. Simplifying the lighting and controls and fire alarm system also saved money on the project. An interesting idea that was approved was to delete the PA system and incorporate a PA system with the fire alarm speakers since they already have speakers in the fire alarms.

There were also a few partially approved ideas that include the following, one of the larger value engineering ideas that were discussed and partially approved was to reduce the building area to the conceptual design to save $848,000 but the project team did not see the full amount being approved. Another option was to replace the wood panel ceiling with architectural acoustic ceilings but it was only partially approved. The original set of drawings

Figure 4: Steam tunnel entering south side of building.
Picture provided by The University of Virginia.

showed the steam tunnel, coming from the hospital on the south side of the cancer center, crossing the street and going around the building and entering the cancer center on the north side of the building. The project team recognized that this would be a very costly task and decided to accept the idea of entering the cancer center on the south side and running the steam through the building which would save a lot of excavation and construction of a tunnel which is very costly. Figure four is a picture of what was actually done.

A few ideas that were declined include the following: to eliminate the curvature of the passageway to the garage would save money but it did not fit into the Lee Street plan. Another idea that was discussed was to replace the penthouse design with a brick box/flat roof penthouse. It was also suggested to decrease the size of the emergency generator to a much smaller generator of 250K was not approved because it would not meet the air handling unit requirements.

95 PERCENT COMPLETED CONSTRUCTION DOCUMENT VALUE ENGINEERING:

The 95 percent completed document value engineering review also had ideas that were reviewed and either accepted or declined. Examples of both of these will be provided below.

A few of the ideas that were approved will be discussed first. A redesign of the steam tie-in location, depth, and manhole configuration was approved to save $100,000. A smaller savings, but still an improvement, was to revise the curtain wall system to make the fabrication details simpler. A mechanical redesign was approved to replace the CRAC (computer room air conditioning) units with FCU's (fan coil unit). Reducing the emergency heating capacity also saves money.

Ideas that were not approved include the following. Reconsidering the quantity and quality of casework required. A redesign of the north wing curtain wall to windows in metal panels was also declined. Deleting one elevator car but not the shaft requirements would save money but it was also declined.

These value engineering ideas correlate to the goals of the owner because they want to provide their patients with the best quality and highest technologies available. They have not reduced the quality of their project by approving these value engineering ideas but they have reduced the cost of the building and reduced the lifecycle cost of the building by implementing the new designs over the older less energy efficient designs.

MY OBSERVATIONS:

PROBLEM IDENTIFICATION

There are many different items or tasks that could be seen as problems or were a problem during construction. Some of them have been discussed in the previous sections of this report. The degree in which these are viewed as problems varies. Each topic would require a significant amount of research to comprehend the effects and arrive at an alternate solution.

FOUNDATION SYSTEM:

The foundation of the Emily Couric Clinical Cancer Center could result in a project delay because they are drilling piers and placing concrete which could be time consuming. Alternate foundation systems should be explored for both time and cost savings. Because there are a lot of caissons, one alternative could be to use Geopiers instead of caissons.

Figure 5: Caissons being placed.
Picture provided by The University of Virginia.

INTERIOR WALL SYSTEM:

Interior walls can be very time consuming and could delay the schedule if they are not being constructed in a timely manner. One option to avoid this would be to prefabricate the walls. It is possible to fabricate typical wall systems with metal studs and drywall to cut down on man power and shorten the schedule. These walls can also include prefabricated conduit for the electrical and controls systems.

REPLACING WOOD PANEL CEILING WITH ARCHITECTURAL ACOUSTIC CEILINGS:

One of the value engineering ideas that were partially approved was to replace the wood panel ceiling with architectural acoustic ceilings. It could be investigated to see why it was only

partially approved and if there is an alternative that could be used to replace the entire wood panel ceiling and save money and time. It could also be looked at the acoustical effects of switching the panels and if it is still acceptable to switch completely too architectural acoustic ceilings.

CHANGING THE DUCT INSULATION:

One thing the University of Virginia considers a value engineering idea that I consider cost cutting is to reduce the duct insulation requirements. The suggestion was to reduce the insulation requirements on the ductwork. I would like to look into finding a compatible material that is cheaper but still meets the original requirements.

GARAGE DEMOLITION:

One of the major tasks in this construction project is the demolition of the existing parking garage. It takes about two months to complete this task and great care needs to be taken not to disturb the surrounding buildings because they are all in use throughout the duration of the project. The existing utilities are also located under the garage and need to be maintained to service the other buildings surrounding the garage. After the garage is demolished, the site then needs to be excavated to start constructing the new building. Another problem with the demolition of this building is that the nearby buildings are medical buildings and hospitals that cannot be disrupted by large vibrations. Debris needs to be contained to the site and prevented from flying into pedestrian and vehicular traffic.

Figure 6: Garage demolition.
Picture provided by The University of Virginia.

SURROUNDING BUILDINGS:

The surrounding buildings and roads need to stay in service throughout the duration of the project because it is a campus and will be active during the entire duration. This is a problem because they need to be aware of the safety of the public and people in the buildings next to the site. There needs to be more safety precautions taken to protect the people walking and driving near the site. Additionally site security will have to be considered. Also the campus utilities will need to be maintained during construction. This will be challenging because some of the utilities run through the site.

BRICK FACADE:

The brick façade could be a problem during construction because there is so much area that it covers and it is a very time consuming process. Masonry work is very messy and it consumes a large amount of the site. There is a lot of time and money put into the scaffolding that is necessary for this task. There could be a better process or technique to speed up the process and make it a less time demanding procedure.

MY OBSERVATIONS:
TECHNICAL ANALYSIS METHODS

After reviewing the topics that could be issues during the construction of the project, I chose four topics to analyze and find a solution to the problem.

TOPIC 1: ALTERNATE FOUNDATION SYSTEM

One of the most expensive and most important tasks on the critical path schedule is the foundation system. The system installed was a concrete caisson system that included a large number of caissons. This system is time consuming and expensive. First the holes need to be drilled to place the concrete for the piers. Then the concrete has to be placed and cured. Concrete is expensive along with the machinery to drill the holes for the caissons. Research needs to be done to be sure that another system would be suitable for the project site conditions and building.

One system that I would consider would be Geopiers. Geopiers could be cheaper because the drilling and piers are being installed together which would reduce the time needed to complete the foundation. I initially learned about Geopiers this past October on the S:PACE trip and found it to be an interesting process. I would need to research it more to fully understand the process of both the chosen foundation and the Geopiers foundation system. I have already built a relationship with a representative of the Geopier Foundation Company and she is very willing to help me with my educational projects. Once the information is obtained I could do both a structural analysis and a cost analysis to determine if it would be feasible to change the system. Additionally other systems should be considered making sure that the system chosen is the one best suited for the project.

TOPIC 2: ARCHITECTURAL ACOUSTICAL CEILING SUBSTITUTION

Another topic to be investigated is the value engineering idea of changing the wood panel ceiling with an architectural acoustical ceiling. This could be a problem with the acoustics of the room. Both materials would need to be researched to understand the properties of each and also the look of each material. A substitution not only needs to perform the same it needs to look the same too, to please the architect and make it a true value engineering idea.

After the topics are researched, calculations would need to be performed to make sure that they both perform the same. A model of the space may need to be produced to fully understand how the acoustics of the room will be. An acoustical study and a cost analysis will be performed to fully show the impact of the alternate material. A virtual mockup of the space can also be created in order to ensure that the architectural intent is maintained.

TOPIC 3: INTERIOR WALL PREFABRICATION

The interior wall system can take a very long time to construct and could delay the project. One way to prevent that would be to prefabricate the walls to shorten the duration of the task to speed

up the schedule. The walls are typically metal studs with drywall and some conduit for the electrical and controls systems. Because the walls are similar throughout the entire building it would be easy to prefabricate due to the repetitiveness and simplicity of the walls.

The process of the prefabrication would need to be studied and analyzed for the prefabrication and installation on site as well as the process for onsite construction. Once the processes have been studied a list of pros and cons would need to be developed. The cost would need to be analyzed and compared to the original costs. One thing to keep in mind with prefabricating the walls would be shipping the pieces to the site and how to move them once they are in the building. Will they be light enough to move by manpower or will machinery be required to move them. Additional planning will also be required to ensure that the prefabrication is successful.

TOPIC 4: SIMPLIFYING THE FAÇADE

The façade is currently a combination of many different materials including brick, stone, a curtain wall, three different metals: white, copper, and stainless steel, storefront, and punch windows. The details for all of these connections are very time consuming and difficult to comprehends. Simplifying the materials to more consistent materials would allow for less details and more consistency allowing the construction to run more smoothly.

The materials would need to be researched to see if there are alternatives that have easier connections. The materials also need to have similar properties to perform the same. I would need to contact manufacturers to understand the properties and connections of the different materials. After that is understood, I would analyze the pros and cons along with the cost of each and make a decision as to whether it would be a viable option. It would also be possible to use BIM technology to assist in a number of ways including the visual aspects using a virtual mockup, the cost of the changes using quantity takeoff and the schedule implications using 4D modeling.