Written By: Brenton Decker
Option: Construction management
Faculty Advisor: Chimay Anumba
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Thesis Technical Assignment #3

Alternative Methods Analysis

George Mason University PE Building

Renovation & Expansion

Fairfax, Virginia

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Executive Summary

During the experience of working on Technical Assignment #3 – Alternative Methods Analysis, the challenges/problems, possible schedule acceleration, and value engineering ideas were studied for George Mason's PE Building project. All construction projects run into some sort of challenges or problems, and this project is no different. Some of GMU's challenges involve delays from rain and mud, additional work being added to the scope halfway through the project, door frames, and working while school is in session. While these challenges can cause some major headaches, but the site team had to adjust accordingly to keep construction running as smooth as possible. In this case, that means working occasional weekends and adjusting work sequences to counteract some of the delays.

The possible areas for schedule acceleration on this job are limited to mainly the interior finishes. Since several of the building sectors will be opening at the same time, more manpower could be added to work on several sequences simultaneously. Working an occasional Saturday is also an option for this as well. Another maybe farfetched idea is to erect the two steel sequences simultaneously. I say farfetched because without running the numbers for the cost of an extra crane and manpower, who knows whether or not it would be feasible.

An entire list of the value engineering ideas implemented on this project is included in the Appendix of this report. The two main ones that stand out are the fact that GMU was able to keep the Cage Gym floor and racquetball courts that were going to be deleted from the lack of funding for them.

As a result of studying the problems and challenges encountered on this project, a few problems were selected for further analysis. These problems include the project delivery method, site logistics, sound isolation for the racquetball courts, and the building envelope. These areas were chosen because with further research and analysis of what was done, improvements could be made and money could have been saved. The plans to go about analyzing these areas are discussed further in the report.

Constructability Challenges

In this section, some of the constructability challenges are discussed. The reasons these are considered challenges are explained. The approaches taken to overcome these challenges are discussed as well.

Excavation

One of the challenges encountered was during the excavation of the mechanical plant area. In this area, mud caused a significant problem. The typical sequence for this phase was supposed to go in the following order:

- Mech. Room foundations
- Mech. Room walls
- Mech. Room slabs

However, the mud was so bad that it delayed pouring the slabs and other activities for the courtyard several times. To overcome this challenge, the crew had to shift their sequence. It turned out that the mechanical room slabs were not poured until after the entire second floor decking was finished. With respect to the schedule, the slabs were poured about a month later than planned.

Added Work

Another challenging aspect for this project was that work got added to the overall scope around mid project. This added work includes a new road and roundabout on the Southwest portion of the site. This addition not only affected the site and utilities work, but the exterior envelope as well. This caused them to break up their original sequence and make them up as they went. The crew ended up starting with the exposed brick before moving to the metal panels. After the brick was finished, they got their materials on the roof before the rooftop equipment blocked them access. From there, the crew followed the framer enclosing areas that had been finished. Figure 1 (below) shows the new road and roundabout under construction in the background.

Figure 1.

Hollow Metal Frames

A third challenge the crew had to manage was the hollow metal door frames. There is a large overhead door in the Linn Gym that was to be replaced. The door the subcontractor had priced was smaller than the actual door size. This was not caught right away and the door had to be reordered, which in turned delayed its installation. The main problem though as mentioned was the door frames. The subcontractor's vendor had put the fabrication of the frames on hold without really notifying the subcontractor. This hold was due to the vendor not getting paid from other subcontractors for a different job. In order to keep the delivery and installation of the frames on schedule, the subcontractor ended up paying a significant amount of money to have the frames expedited and shipped to the site on a Saturday. So that Saturday the crew had to be at work and help unload the frames. Figure 2 (below) shows the staging for the frames inside the New Venue Gym.

Figure 2.

Working Around School Time

Lastly, keeping the two gyms open has become a big challenge as well. The crew had originally had a three month window to complete the renovations of the two gyms over the summer break. Unfortunately, not all of the work was completed during that time frame. Now they have had to schedule certain times around school hours for the workers to get in and complete the work.

Schedule Acceleration Scenarios

In this section, the critical path of the project is displayed. Some of the big risks of the project are discussed and how they affect the project completion date. A couple work areas that have potential for schedule acceleration are discussed along with the techniques and cost impacts. The generalized critical path for this project goes as follows:

- Mobilize
- Temp. Utilities/Egress
- Hazmat/Demolition
- Foundations & Structure
- Building Envelope
- Interior Finishes
- Close-in Inspections
- Punchlist
- Owner FF&E

Risk

Hazmat/Demolition

The Hazmat/Demolition deals with removing asbestos and other hazardous materials from the existing building that is to be renovated. This process takes a significant amount of time since every precaution and procedure to remove this stuff must be strictly followed to ensure it is disposed of properly. Demolition takes time as well since the crew is only demoing particular parts of the building. Care must be taken not to damage anything around the pieces being demoed.

Foundations & Structure

Foundations and structure are a big risk on any construction project. This is due to the fact that foundations get placed underground, so you are dealing with soil that is probably the most unknown aspect of the entire project. If even one unforeseen condition arises, the project could be delayed several weeks. Mother Nature plays a role in these phases as well. Bad weather conditions can delay the pouring of foundations. Rain and high winds can delay the erection of the structure due to unsafe conditions.

Building Envelope

Closing in the building is always of high priority as well. This needs to be done so the interior finishes can begin. On GMU's PE Building, this is a big risk factor since there are nine different façade types that will be joining together to enclose the building. With this many façade types, the risk lies in the transition from one type to another. The connections need to be well detailed to ensure proper connection. If not properly connected, the building will not pass the water tight testing. Finding leaks if this occurs is time consuming and would delay the project.

Temporary Utilities

The temporary utilities are a risk because gas and permanent power were not obtained in a timely fashion. The drywall crew has had to stop work and wait for permanent heat inside the building now that the cold season is here. Temporary heat has been set up in the gyms and around the rest of the construction site in order to be able to keep the finishes trades working.

Schedule Acceleration

Possible areas that could have potential to accelerate the schedule for this project would be:

- Structure
- Interior Finishes

The structure was assembled by having two separate sequences using one mobile crane. Assuming the schedule needed to be accelerated at this point; two cranes could have been used to erect both sequences simultaneously. This would mean the site logistics would change slightly and manpower would need to be increased. To figure out the cost implications of doing this further analysis would have to be done. The cost of the additional crane and manpower would need to be weighed against the improvement in schedule time to see if it would be an overall loss or gain.

The interior finishes are sequenced into separate areas on each of the two floors. As it goes now, the sequences follow each other. In the case that the schedule needed accelerated, manpower could be added and sequences could be done simultaneously. In fact, this is likely to happen on this job since they will have multiple areas opening at the same time. Another option is to keep the same crew and work Saturdays. Either way, the cost impact will be labor costs. Again, further analysis would need to be done to determine if doing this would result in an overall loss or gain.

Value Engineering Topics

In this section, some of the value engineering ideas implemented are discussed. There were many VE ideas implanted on this project. Most of them were implemented to reduce the cost, but quality was still maintained. A detailed list of all VE ideas implemented can be seen in Appendix B. Two of the biggest VE ideas implemented are listed and discussed below.

- Cage Gym Floor
- Racquetball Courts

The Cage Gym floor was to originally be a DD Linno floor. The university wanted to save some money, so the value engineering decision was made to go with an alternate floor that was half the price. After this decision was made, the athletic department came up with the money for the DD Linno floor that they originally wanted. They came up with it in time and the DD Linno floor was the floor that got placed in the gym.

The original design had racquetball courts to be built above the mechanical plant. However, GMU figured out they did not have the money to build the courts they wanted. Gilbane was able to make a great deal with the court company and get a contract for the cost of submittals and an alternate court system. If the athletic department wanted these alternate courts they had until December to come up with the money. They were able to come up with the money and notified Gilbane in time for the courts to be accepted and installed. GMU was able to get two major items that were going to be deleted by compiling funds from other budgets that they could not afford with the building budget.

Problem Identification

In this section, several problematic feature of the GMU PE Building project are discussed. These features are problems worth further analysis into the building systems and construction methods in an attempt to improve what was actually done.

Project Delivery Method

The delivery method chosen (CM at Risk) may not have been the best choice. This approach may not have been the best choice given that the George Mason staff as well as the Gilbane staff were not used to using this method. As mentioned in technical assignment 1, George Mason is used to working with general contractors not construction management firms. The CM at Risk approach was used as a hybrid between the two methods, which in turn created an “interesting relationship” between the two parties. Further research into what delivery methods work best for university projects would be beneficial to improving relationships between the owner and construction firm.

Site Logistics

The PE Building's site is quite congested and practically all materials were planned for just in time delivery due to lack of staging space. The addition of the road and roundabout mid project greatly affected this as well. In doing further analysis of the site logistics, a more efficient layout may not be obtained. However, analyzing the site logistics using two cranes instead of one for the steel erection to accelerate the schedule as previously mentioned would be an option.

Racquetball Courts

The racquetball courts are located directly above the mechanical room. This could potentially be a problem with respect to vibration and noise issues since mechanical equipment tends to be loud. So further analysis into what type of insulation and acoustical precautions went into the mechanical room's roof design would be necessary. Researching better materials and the cost impacts would be beneficial to maybe finding what could have been a better solution.

Building Envelope

The exterior envelope is another problematic feature that could be worth further analysis. The problem with the exterior envelope is that there are too many varying façade types. There are nine different façade types including four different types of metal panels. The metal panels in particular were what the problem with the building envelope became. The crew had multiple coordination meetings regarding these panels. In these meetings, the subcontractors argued over who was supposed to complete various tasks that go along with these panels. There were constructability issues with the metal panels as well. The crews had problems connecting these panels to the structure and other façade types. Further analysis into using a different façade type instead of several different types of metal panels might be beneficial in regards to ease of construction and possible cost savings.

Technical Analysis Methods

In this section, construction management analysis activities for the problems/challenges identified above are discussed. These activities include any research that will be required, types of redesign, and construction analysis.

University Projects Delivery Methods

Project efficiency can be affected by the type of project and delivery method chosen. With this being the case on the George Mason project, I plan on researching what delivery methods work best for university projects like this one. The steps that will be taken are outlined below.

Research Goal

To learn more about the way that a contractor must operate when the owner is a university like George Mason and eventually reach a conclusion as to what project methods may work best for this kind of job.

Research Steps

- Conduct my own independent research by reading various articles about current and past construction projects at George Mason University and The Pennsylvania State University
- Personally interview one or two industry members that have experience working for jobs on which the Owner is a university.
- Handout a brief survey to several construction industry parties that are able to take the time to answer a few questions about their experiences and opinions.

Required Sources

A number of sources will be required to successfully research this topic. The first and most accessible are articles from various construction magazines. I intend to find a couple articles that I can compare to my research and collect information about the overall project schedule / delivery methods. The other sources that this research will require is a few people from the construction industry that have enough experience that they will be able to contribute valuable feedback. I plan to speak to one or two members from the Gilbane project team working on the PE Building at George Mason University. I will also use a couple contacts at The Pennsylvania State University to interview / survey people regarding recent projects on campus. Some example survey questions can be seen in Appendix A.

Alternative Site Logistics & Schedule Acceleration

The site for George Mason's PE Building is quite small and very congested. This causes material storage to be limited and leaving subs relying on delivery trucks for mostly just in time deliveries. While the crammed site may not be able to be remedied, it is possible the schedule could be accelerated by using two cranes and erecting both steel sequences simultaneously. In doing this, it would require slight rearranging of the sight logistics. The steps that will be taken to analyze this option are outlined below.

Research Goal

To implement the use of two cranes to erect the structure sequences simultaneously and see the effects of the changed site logistics as well as hopefully determine the schedule acceleration would result in an overall cost savings for the project.

Research Steps

- Obtain costs of the crane and manpower used to erect the steel
- Analyze site plan and rearrange to accommodate the two cranes
- Calculate the schedule acceleration and determine if this was a good or bad idea

Required Sources

The sources required to perform an in depth analysis of this will be a couple people from the Gilbane staff and possibly RS Means. The Gilbane staff should be able to provide me with the site plans they made for the steel sequencing. If not, I will use the ones made from technical assignment two. They should also be able to provide me with the crane and manpower costs or a contact to get this information. If not, I will use RS Means to obtain the closest comparison possible to the crane size that was used.

Sound Isolation for Racquetball Courts

The racquetball and squash courts are located directly above the mechanical plant and beside the cooling towers. Since mechanical equipment has a tendency to be noisy and vibrate, I plan on researching materials that could be used to combat the noise issues that are likely to occur.

Research Goal

To find out if acoustics were taken into consideration during the design of these courts since this was part of a VE decision and find alternative materials to improve the acoustics if necessary.

Research Steps

- Determine if acoustics was taken into account already
- Determine what acoustical materials are being used if any
- Find out desirable noise levels for this application
- Find acoustical materials that provide optimum sound isolation

Required Sources

The required sources needed to perform this analysis include the Gilbane project staff, my acoustics textbook and professor, and the internet. The Gilbane staff will be able to help determine whether or not acoustics has already been taken into account as well as provide material information if it has. My textbook and professor will be able to give me the desired noise levels for this application. I would use the internet to find alternative acoustical materials.

Building Envelope

The building envelope consists of too many façade types. There is no need for four types of metal paneling. While it may enhance the architectural look of the building, it hinders the construction process therefore causing delays. I plan on researching an alternative façade type to replace the metal paneling that is more cost efficient without losing the architectural appeal.

Research Goal

To find a more cost efficient façade type to replace the metal paneling that promotes ease of construction while maintaining the architectural appeal.

Research Steps

- Obtain costs of metal paneling being used
- Find alternative façade type and compare price and aesthetics
- Check connection details to ensure alternative will mesh with others

Required Sources

The required sources to perform this analysis include the Gilbane staff, the internet, and possibly a structural engineer. The Gilbane staff would be able to give me the costs for the metal paneling. I would use the internet to research an alternative façade type that would promote ease of construction and be more cost efficient. I may need a structural engineer's input on connection details depending whether or not details are given with whatever material would be chosen.

Appendix A

Appendix A

- What are some of the university project(s) that you have had experience working on?
- What kinds of project delivery methods (i.e. CM at Risk, Multiple Prime, etc.) were chosen for each of these projects? If these methods were chosen beforehand for a reason, please list the reasons.
- In your opinion, what was the best thing about this kind of project delivery method?
- What was the worst thing about this kind of project delivery method?
- How much of a role did the Owner (the university) play in the project?
- If they played a large role, did you feel that they had too much control over the project?
- Lastly, do you think the project delivery method (especially looking at the relationships with the owner and other contractors) plays an important role in the success / efficiency of the project?

Appendix B

Appendix B

02A Abatement & Demo	Deduct for not removing ductwork within the gym.
02B Sitework	Add 6" of #57 stone in mechanical service lot and replace concrete in mechanical service lot
03A Concrete	Fibermesh in lieu of welded wire mesh in 5" slab on grade
03A Concrete	Four inch (4") thick in lieu of five inch (5") thick slab on grade
04A Masonry	Deleted rigid insulation at stud walls with brick veneer. Stud walls already insulated.
04A Masonry	Use Hyload in lieu of stainless steel flashing
06A Rough Carpentry	Eliminate 4 HM windows at Linn Gym and associated steel and shoring
06B Cabinets & Millwork	Substitute the cabinet pulls with a 96mm solid brass wire pulls for specified Hafele edge-mounted pulls
06B Cabinets & Millwork	Substitute plastic Titus clips for recessed KV 255 standards & KV 256 for adjustable shelving in cabinets
06B Cabinets & Millwork	Substitute color choice for 'Select Series' of Corian colors for specified 'Verano White'
06B Cabinets & Millwork	Delete coved/integral backsplashes at typical restrooms and provide "loose" or field applied backsplashes
06B Cabinets & Millwork	Substitute a 'standard' plastic laminate for the Wilsonart #6313 'Bronze Stria' at Fitness and Juice Bar casework
06B Cabinets & Millwork	Substitute standard open base cabinets for the custom 3" thick, p-lam covered sidewalls at the Fitness Desk
06B Cabinets & Millwork	Delete closet shelving specified under Division 06200, page 10, Item E - 'Shelving'
07B Roofing	Provide EPDM roofing system in lieu of 3-ply
07C Fireproofing	Delete spray fireproofing on tube steel in New Gymnasium
00A Glass & Glazing	Provide a curtainwall system with a 6" vertical mullion in lieu of 10.5", and one row of 5x3 horizontal tube steel and intermittent 5x3 tube columns to provide support.
08A Glass & Glazing	Use standard Kawneer Kynar paint in lieu of custom color

08A Glass & Glazing	Use standard Kawneer Kynar paint in lieu of custom color (if 6" verticals are provided)
08A Glass & Glazing	Use standard medium stile doors in lieu of Tuffline
08A Glass & Glazing	Rework composite panel joint reconfiguration based on shop drawings
08A Glass & Glazing	Use standard Kynar paint for Type 1 panels in lieu of custom colors
08A Glass & Glazing	Delete field testing of curtain wall in Section 08400 Item 2.05 B
08A Glass & Glazing	Use standard color Kynar for exterior louvers (coordinate with CW)
09A Drywall & ACT	Change 1'x4' Optima Plank to 2'x2' Optima and change 2'x4' Optima to 2'x2' Fine Fissured
09B Ceramic Tile	Use Laticrate 2500 grout instead of epoxy grout on ceramic floor tile.
09B Ceramic Tile	Use Dal Tile 4"x4" Bone color instead of US Tile as specified
09B Ceramic Tile	Substitute floor tile T1 with a 13"x20" as floor tile (instead of 16"x32" as specified), substitute the wall tile with a 6 1/2"x20" as wall tile (instead of 4"x24"as specified)
09D Carpet & VCT	Use standard 12"x12"x1/8" VCT in lieu of Altro Quartz tile
13A Squash/ Racquetball Courts	Eliminate WSF certification requirement for all courts
15A Mechanical	Provide EMT conduit on lieu of IMC/rigid for mechanical work
15A Mechanical	Use Trane T-series AHUs in lieu of scheduled custom type AHUs.
15A Mechanical	Delete insulation of the exterior ductwork and line the duct with 1.5" thick liner.
15A Mechanical	Delete insulation on the domestic water piping within pipe chases.
15A Mechanical	Use 1.5" thick duct wrap on horizontal storm piping in lieu of .5" pipe covering specified.
15A Mechanical	Delete Uninterruptible Power Supply requirement (specified in Sect. 15900 2.03k)
15A Mechanical	Change Chillers from Centrifugal to water cooled scroll w/o VFD Trane Series R™.

16A Electrical	Light Fixture "Equal" VE package
16A Electrical	MC cable for branch lighting homeruns at panel board in lieu of conduit and wire
16A Electrical	MC cable for branch power homeruns at panel board in lieu of conduit and wire
16A Electrical	Fire Alarm MC for fire alarm branch circuitry in lieu of conduit and wire
16A Electrical	Delete lightning protection/ground loop. If allowed by code and approved my engineer.
General Conditions	Eliminate Gilbane Payment and Performance Bond
General Conditions	Eliminate keeping Cage and Linn Gyms open
General	Delete squash and racquetball floor level complete