2009

Technical Assignment III

Marymount University 26th St Project
Arlington, VA

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Executive Summary

Technical Assignment III involves an investigation into areas of the Marymount University 26th Street Project that could be potential candidates for research, alternative methods, value engineering, and schedule compression. The report also includes a summary of an interview that was held with Mr. Erik Kaniecki, Project Manager for Marymount University. The topics of this interview include constructability challenges, schedule acceleration scenarios, and value engineering topics. Finally, the conclusion of the report includes a section of problem identification and a technical analysis of construction management activities.

In the first section of the Interview, Mr. Kaniecki was asked to describe the top three constructability challenges that were encountered on the project. The first challenge that was identified involved the location of the underground sewage ejector tank. The second issue that was described involved lowering the mat foundation, which in turn lowered the elevation of the under-slab drainage piping. This became an issue because all of the pipes are gravity fed to submersible pumps. When the elevation of the pipe was changed, the elevation of the corresponding sump pump needed to be adjusted accordingly. The third and final problem that Mr. Kaniecki described involved a conflict with a cantilever retaining wall and the sheeting and shoring system. The design of the cantilever retaining wall required a minimum clearance for the proper installation of the wall’s foundation. However, the design and installation of the support of excavation system eliminated this necessary clearance.

The second part of the interview involved identifying specific schedule acceleration scenarios. One of the major techniques that Mr. Kaniecki described was utilizing additional crews of workers. This particular technique is preferred over implementing overtime.

The last segment of the interview included a discussion regarding value engineering. This was not an area that the project team exhausted an extensive amount of time evaluating. One value engineering idea that was identified and implement involved the bentonite-geotextile waterproofing system.

After evaluating all of the constructability challenges, schedule acceleration scenarios, and value engineering topics, several problematic features were identified. The top four problems were further analyzed as potential research topics. The problems that were addressed include the MEP coordination process, the architectural precast façade, the interior finishes schedule, and a LEED analysis.

1.0 Project Manager Interview

To gather the required information for Technical Assignment III, an interview with Erik Kaniecki, Project Manager for the Marymount University 26th Street Project was required. The interview took place on Monday, November 23, 2009 at the James G. Davis Corporate Office in Rockville, MD. The contents of the interview included issues involving constructability, schedule acceleration, and value engineering that entire Marymount University Project Team encountered.

A. Constructability Challenges

As part of the interview, the Project Manager was asked to describe the top three unique and/or challenging issues relating to constructability that were encountered on the Marymount University Project. After Mr. Kaniecki identified the major problems encountered thus far, he described in detail how the project team worked to resolve the problems.

- **Challenge #1:** One of the first major issues that arose involved the location of the underground sewage ejector pit that is located on the G4 Level. *Figure 1.* displays the original location of the sewage ejector pit. This location would have been adequate; however, the size of the underground tank was altered after the support of excavation system was designed. The depth of the sewage ejector pit was changed from 10' to 14'. Though minor, the four-foot change in elevation would now place the pit below the bottom elevation of two adjacent piles and place the pit directly within the area of influence of these piles.

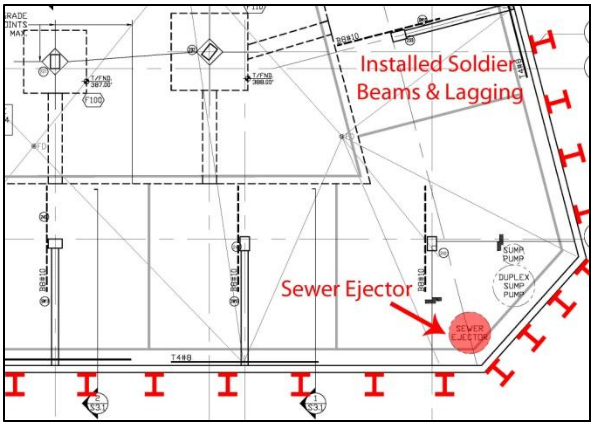

Figure 1: Original location of Sewage Ejector

- **Solution #1:** The solutions available to the project team were limited because the sheeting and shoring system was in place and the procurement process of the sewage ejector pit had previously taken place. To avoid a complete structural redesign and any major delays in the project schedule, the team determined the most logical solution would be to relocate the sewage ejector pit. The revised location is shown in *Figure 2.* This resulted in the lowering of adjacent footings and the extension of their corresponding columns.

- **Challenge #2:** The second major issue was determined to be a clash between the under-slab drainage piping with the 54" mat foundation. The lowering of the mat foundation was necessary to make space for additional parking that was necessary by local code requirements. However, when the elevation of the mat foundation was lowered to accommodate the additional parking spaces, the foundation conflicted with the under-slab piping. This particular piping system provides waterproofing and serves to keep the building watertight. All of the drainage pipes are fed by means of gravity to submersible sump pumps, which in turn, pump water away from the building. The elevations of the inlet pipes to the pumps have been established based off the design of the mat foundation and if lowered, the elevation of the pumps will need to be altered accordingly.

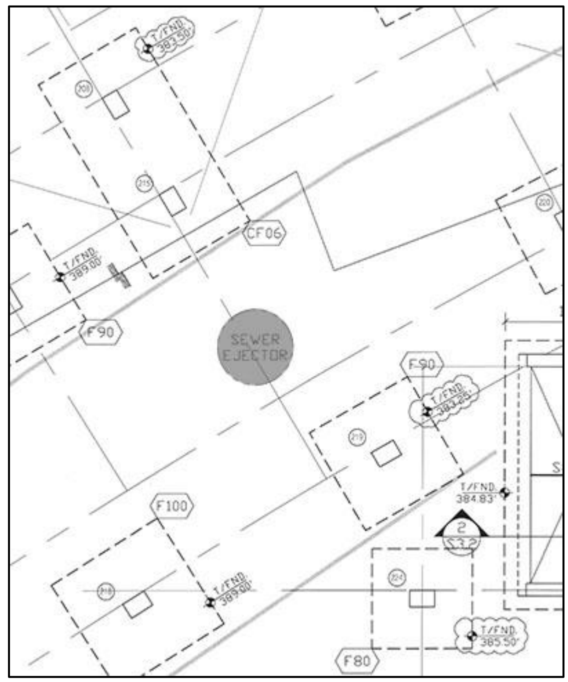

Figure 2: Revised location of Sewage Ejector

- **Solution #2:** To keep the building code compliant, the project team was required to lower the foundation, thus lowering both the under-slab drainage and the submersible sump pumps. The redesign required the pit for the sump pump to be lowered 4'. The lowering resulted in additional excavation, concrete, and reinforcing steel that needed to be put into place before any other work with the foundation of the building could proceed. To ensure the safety of the contractors, a large steel tube was brought in to protect the workers who were setting the rebar for the foundation of the pit. A detail of the original design is displayed in *Figure 3.*, while the redesigned pit can be seen in *Figure 4*.

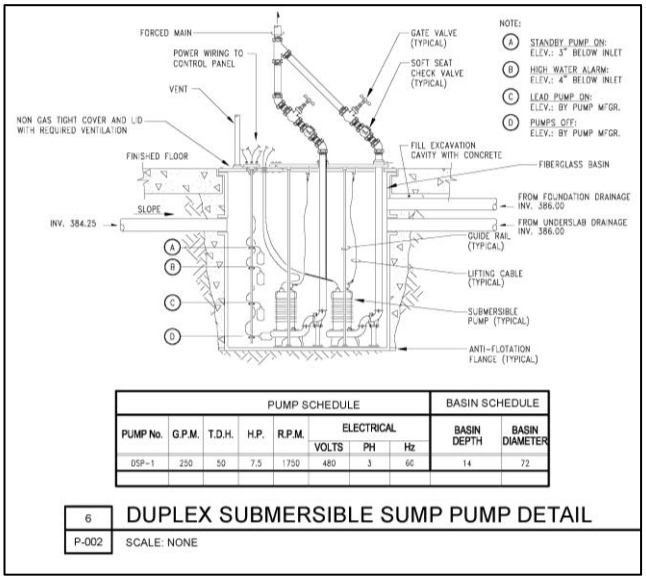

Figure 3: Revised Sump Pump Detail

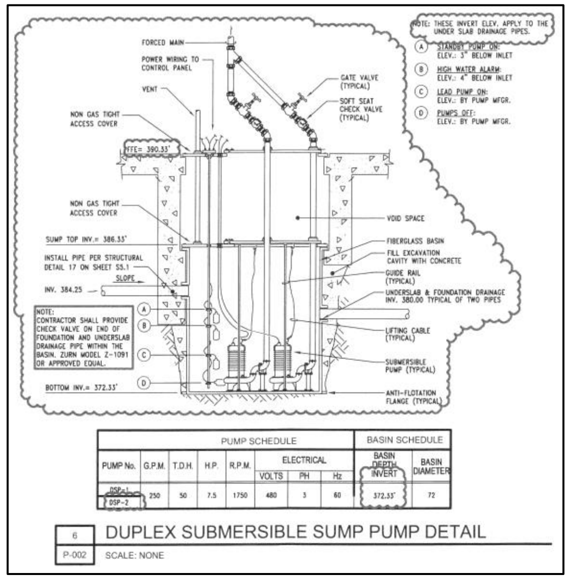

Figure 4: Original Sump Pump Detail

- **Challenge #3:** The third notable issue that the Project Team at Marymount University faced involved a conflict with a retaining wall and the support of excavation system. The design of the sheeting and shoring system, which was currently in place, did not allow for the proper installation of the heel of the cantilever retaining wall. The sheeting and shoring system was mistakenly designed and installed flush with the retaining wall running along column line R-1. A plan view is displayed in *Figure5.*, while *Figure 6.* Shows a section cut through the retaining wall.

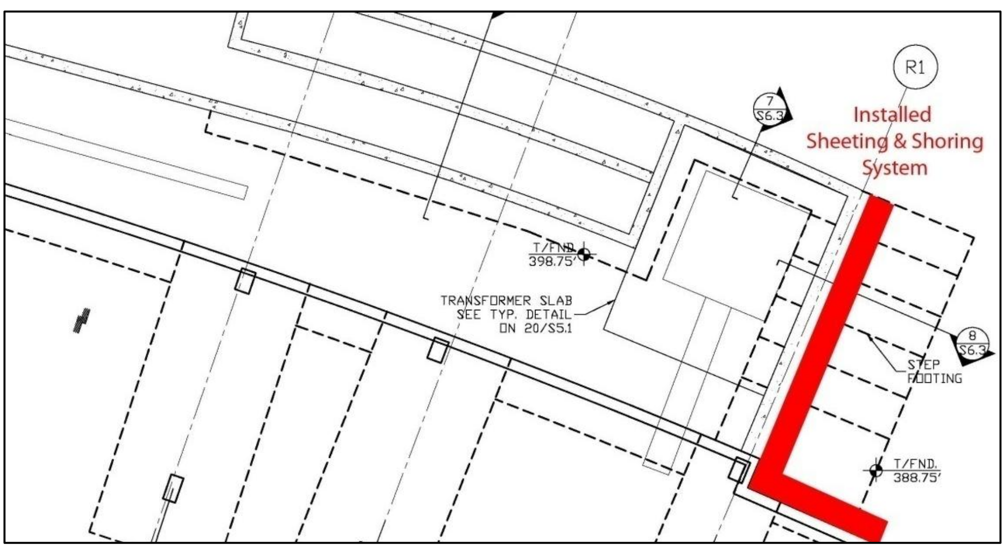

Figure 5: Retaining Wall Plan

- **Solution #3**: Short of relocating the sheeting and shoring system, or providing an additional row of sheeting and shoring in the proper location, the retaining wall along column line R-1 and its corresponding foundation required a complete redesign. The redesign involved moving the entire foundation of the retaining wall within the building. *Figure 7.* Shows a revised section cut through the retaining wall. This new foundation design introduced additional loads that needed to be dealt with. Part of the solution involved installing a massive steel angle that had dimensions of 12" x 8" x 18' and a thickness of 1". An angle of this size created some issues relating to the procurement process. This is because there is a limited number of fabrication shops across the country have the capability to bend steel at this thickness. After further inspection by the design team, thickness of the steel angle was reevaluated and thus reduced to 5/8", a thickness that is much more manageable.

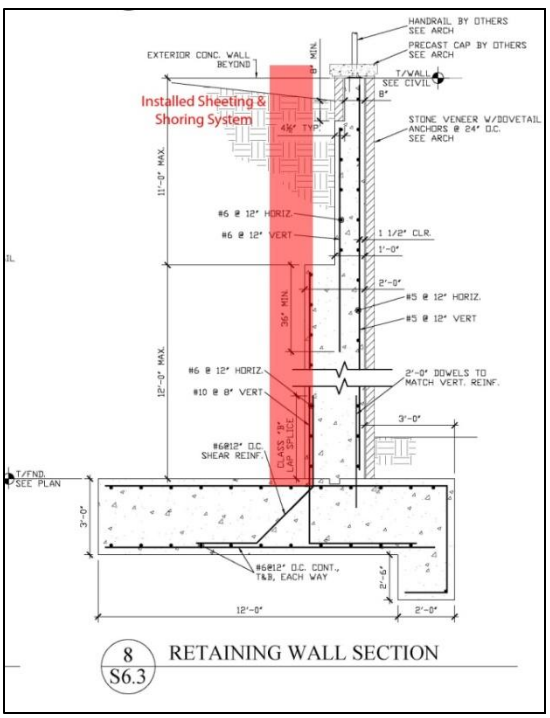

Figure 6: Retaining Wall Section

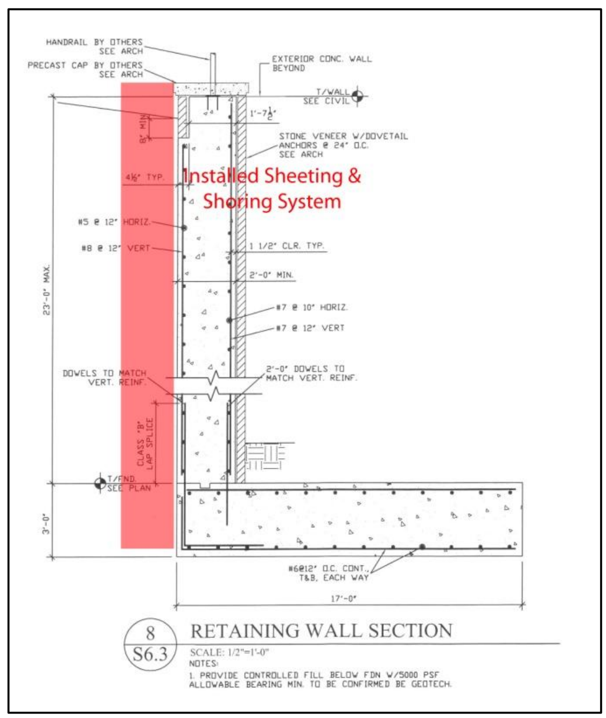

Figure 7: Revised Retaining Wall Section

B. Schedule Acceleration Scenarios

Throughout this segment of the interview, the Project Manger was asked a variety of questions in regards to the project schedule. The questions were developed to determine the critical path of the project, potential risks associated with the project schedule, and possible techniques to accelerate the schedule.

When asked to describe the critical path of the project, Mr. Kaniecki felt that the four major phases of construction establish the critical path of the schedule. These phases include excavation, concrete structure, building enclosure, and interior finishes. The Marymount University 26th Street Project is phased in such a way that each of the given phases must be entirely complete before the subsequent phase can begin. Once excavation to sub-grade is complete, the structure can begin. As soon as concrete structure tops out, the building enclosure can commence. Following the enclosure of the entire building and achieving a watertight status, all of the interior finishes can begin. It can be seen that in order to follow the critical path and turn the project over on time, each phase needs to be completed on time so each succeeding phase can begin. Even though this is a common scheduling technique throughout the construction industry, it does not exclude the potential risk factors.

Figure 8: Critical Path

One of the major risk factors that is associated with Marymount University 26th Street Project is the compressed façade schedule. The sequencing of the façade is an area that the project team felt could be utilized to make up valuable time. The building enclosure was chosen over the other three phases because they all have pre-determined sequences that are commonly practiced across the industry. This compressed schedule has the potential to be an extremely effective way to condense the schedule, however, it also carries a high risk. To help negate these risks, the project team has been meeting regularly to coordinate the design, construction and the installation sequence of the precast façade.

In the scenario that the compressed façade schedule is executed unsuccessfully, the project team has identified potential techniques to accelerate the project schedule to ensure the project is completed on time. One potential technique includes implementing shift work. Shift work involves bringing in a new crew of workers to help increase productivity and shorten the duration of specific activities.

The additional crew will allow work associated with the interior finishes to take place in both the residential building and the academic building simultaneously.

Additional schedule acceleration techniques include implementing overtime for the same crew of workers. The project team does not prefer this particular technique because they feel that overtime will result in fatigued workers that will be even less productive. Both of these techniques have high costs associated with them, but the project team has determined that it will be more cost effective to pay for shift work. Paying for shift work for a set duration has been calculated to be significantly less than paying for the liquidated damages for the same duration.

C. Value Engineering

The final topic of the interview with Mr. Kaniecki involved a discussion regarding value-engineering ideas. One specific example of a value engineering that was utilized on the Marymount University 26th Street Project involved the bentonite-geotextile waterproofing system. Both the drawings and specifications noted that a contaminant resistant bentonite-geotextile was required due to the current ground water conditions. However, after an in depth analysis of the ground water tests, the water was determined to be free of harmful contaminants. This allowed a generic bentonite system to be utilized on the foundation walls. The project team suggested replacing the Voltex-CR waterproofing system that was specified, with a common Voltex water proofing system. This provided the building with the same waterproofing capabilities, while saving the university over $3,000. In addition, Marymount University gave no resistance because it resulted in the same value at a lower overall cost.

Figure 9: Voltex Logo (www.cetco.com)

According to Mr. Kaniecki, this project design was extremely driven by the budget. The university set a budget that they were not willing to exceed and the architect designed accordingly. It was felt by the project management team that the drawings and specifications provided by the design team to the university presented the best possible value. This being stated, it was determined that any ideas generated to potentially reduce the overall project cost would be highly likely to simultaneously reduce the value.

As a direct result of the project management team looking to avoid this “cost cutting” approach, to date, there has yet to be any specific ideas for value engineering that were considered for the project but never implemented.

2.0 Problem Identification

The complexity of the academic facility, location of the facility, and the congestion of the site at Marymount University provide areas for problematic features to occur. Each of the issues listed below could be further evaluated through a detailed analysis of technical building systems and construction methods.

A. Construction Traffic

The campus of Marymount University is adjacent to numerous areas that are zoned for residential use. This has the potential to create some major issues when dealing with the issues of the noise and disruptions related to construction traffic. This traffic includes trucks hauling soils off-site and deliveries of materials/equipment to the site. In addition, specific restrictions have been placed on the hours available for working. The working hours are restricted to 7:00 AM to 7:00 PM, Monday through Friday, and 10:00 AM to 7:00 PM on Saturday. These times not only limit work associated with construction, but also limit deliveries and any traffic associated with construction. To help negate any problems, a detailed Maintenance of Traffic Plan (MOT) was developed and approved by Arlington County. A further evaluation of the MOT Plan and additional sequencing could be analyzed to ensure these processes go as fluently as possible. Additionally, any revisions to the MOT Plan need to account for the safety of all pedestrians that are traveling around the project site. This provides an area that could be very problematic as Marymount University has the potential to have over 3,000 students and personnel on campus at any given time.

B. MEP Coordination

The MEP systems at Marymount University are fairly complex due to the requirements of the high-tech laboratories. All of the equipment and components require extensive amounts of coordination, both vertically and horizontally, to avoid any clashes in the field. The MEP coordination was done traditionally by incorporating each of the individual trades into one drawing. Weekly meetings were held to resolve any conflicts between trades that were discovered. Often these meetings required the input from the designers and solutions could not go forward until the design team provided consent. In order to make the MEP coordination process as efficient as possible, 3D modeling and clashed detection could be used as an area of study. This would help to make the most efficient use of time, as well as help to provide contingency to the project schedule.

C. Architectural Precast Façade

Architectural precast panels make up a majority of the façade on the Marymount University 26th Street Project. These panels serve to be atheistically pleasing, fit into architectural theme of campus, and most importantly, enclose the building. This particular building element is critical to the project schedule, as they are required to achieve a watertight status and a prerequisite to beginning interior finishes. The precast panels will take extensive planning and coordination to ensure a smooth installation. In addition, the entire procurement process is extremely lengthy and needs considerable planning. An additional investigation could involve creating a detailed façade sequence. This has the potential to be extremely beneficial to the project team as the façade was an area of concern within the overall project schedule.

D. Site Layout

Roadways border all three sides of the site for the Marymount University 26th Street Project. The enclosed, triangular site is extremely congested and there is minimal space available. The only storage space that is available for use is found along Yorktown Boulevard and 26 Street. To make the most efficient use of the site, a 4D site logistics plan could be developed to help visually display the exact locations of materials/equipment at any given time in the project.

Figure 10: Aerial View (www.marymount.edu)

E. Interior Finishes Schedule

One of the additions to the campus to of Marymount University is a Residential Facility. The new facility will provide suite-style housing for 239 students. There are 62 units, situated in four and five person configurations. The interior finishes that are involved with the completion of the Residential Facility are extremely repetitive from unit to unit and from floor to floor. This is an ideal situation to implement a Short Interval Production Schedule (SIPS).

SIPS is a scheduling technique that assigns a planned quantity of work to be completed in a specific amount of time. SIPS techniques have been traditionally used to construct buildings that involve a great deal of repetitive activities. Also, Short Interval Production Scheduling attempts to maximize productivity by bringing an assembly line approach to the construction industry. Specific projects that benefit the most from SIPS include high-rise office buildings, hotels, apartments, and prisons.

F. LEED Analysis

The Marymount University 26th Street Project has opted to incorporate sustainable feature into the design and construction of the newest addition to their campus. The project is striving to achieve a LEED Certified rating and was designed according to LEED NCv2.2. The university is extremely committed to sustainability and they are trying to establish a baseline for any construction that they will undertake in the future. That being said, this is their first attempt with LEED and the entire project team is working to make it as successful as possible. The university has also made it very clear that the budget for the project is not to be exceeded and they are unwilling to "buy" a green building. An investigation into potential benefits, drawbacks, and life-cycle cost implications of certain sustainable practices looks to be an excellent area of research for this project.

3.0 Technical Analysis Methods

After identifying the major problematic features of the Marymount University 26th Street Project, four construction management activities have been chosen to be analyzed more thoroughly.

Analysis 1: MEP Coordination Process

As with most with most projects, the coordination of the mechanical, electrical, and plumbing systems are extremely problematic. This is a process that must begin months ahead of the actual construction in order to leave time to resolve issues that arise. The mentality across the industry seems to be, catch the clash/conflict with enough time to resolve the issues before it has time to affect the overall project schedule. However, not all issues are resolved in a timely manner and they have the potential to carry significant cost and schedule implications.

To help eliminate overlooking major conflicts within the MEP coordination process, the industry has begun to adopt the practice of MEP coordination through 3D modeling. This process allows all of the systems and their individual components to be modeled in three-dimensional space. Once each component is modeled, computer software such as Audodesk Navisworks, can be utilized to detect any clashes that are present. This practice will help to increase productivity in the field and help to ensure that the project remains on schedule.

In order to begin my analysis, I must first obtain the MEP coordination shop drawings that were utilized on the project. I had the experience of participating in an internship with the General Contractor, James G. Davis Construction Corporation in the summer of 2009. As part of my internship, I took part in the MEP coordination process at Marymount University and should have no problem obtaining the required documents. Also, I have had exposure to 3D MEP coordination in relevant coursework, specifically AE 473, Building Construction Management & Control.

One the coordination drawings are obtained, they will be utilized to construct a 3D model that will be run through a program that is capable of clash detection. This particular analysis would most likely alter both the design and construction of the MEP systems. Through this analysis, I hope to provide the project team with a more efficient solution to MEP coordination. I anticipate the final product will allow for a more efficient workforce, while providing the owner with higher quality results.

Analysis 2: Architectural Precast Facade

The façade at Marymount University is comprised of architectural precast panels and aluminum framed windows. These two building components are critical to the project schedule, as their completion is necessary to achieve a watertight status. This puts the entire process of procurement, to installation, of the precast panels on the critical path. The process will require extensive coordination and planning in order to go as fluidly as possible.

Figure 11: View of Plaza Level (www.marymount.edu)

The architectural precast panels have been chosen by the university to be atheistically pleasing and to fit into the overall theme of the campus. After a review of the project budget, roughly $3,100,000 has been allocated for the precast façade. The costs associated with this system falls just short of the total cost of the concrete structure and the MEP systems.

It can be seen that the precast architectural façade provides an area of analysis that has the potential to reduce both the project schedule and the project costs. Factors that will be considered throughout the analysis include the delivery/storage methods, installation methods, and the installation sequence.

In order to begin my research on this topic, I will have to obtain the precast shop drawings from the General Contractor. Secondly, I will need to contact a representative of Arban and Carosi, the precast subcontractor. Optimistically thinking, this contact will be able to provide me with the traditional methods of installation and sequencing that are commonly used throughout the Washington, D.C. metropolitan area. Finally, in the spring of 2010, I am scheduled to be taking AE 542, Building Enclosure Science and Design. Hopefully, this course will further my knowledge on the topic of building enclosures and serve to provide a relevant application to Marymount University.

Analysis 3: Interior Finishes Schedule

As discovered in the interview with Mr. Erik Kaniecki, Project Manager, the interior finishes is the last component on critical path of the schedule. This set of activities is highly important to both Marymount University and the entire project team. Also, this particular phase of the project is challenging to accelerate without sacrificing quality. The project team needs to maintain efficiencies, while avoiding "trade stacking" and over-staffing. However, a schedule acceleration strategy could be developed to ensure the project completion date is met.

For this part of my analysis, I hope to develop a way to increase the productivity of the workforce and optimize activity durations, while maintaining the highest quality of work. It was determined that the repetitive nature of the work that is involved with the interior finishes in the residential facility provides an ideal location to implement Short Interval Production Scheduling (SIPS). This particular scheduling technique has traditionally been used in areas that are repetitive in nature.

To initiate my analysis of SIPS, I will need to utilize my previous experience with SIPS that was supplied through my coursework at Penn State, specifically AE 473, Building Construction Management & Control. Secondly, I will need to contact the Project Superintendant to determine activity durations and basic crew sizes. From these durations, I will develop a project specific SIPS for Marymount University that will account for an increase in productivity as the crews follow the detailed sequence of activities. I will then compare the SIPS schedule to the schedule developed by the project team to determine if this is a viable option for schedule acceleration.

Analysis 4: LEED Analysis

Marymount University is proving their commitment to sustainability by striving to achieve a LEED Certified rating. By building sustainable, they university is setting a precedence for future endeavors in construction and are looking to have a successful first attempt with utilizing LEED. Every member of the project team, from design to construction, is looking to ensure that this occurs.

As part of my studies, I will be attempting to discover alternate systems/equipment that have successfully been implement on similar projects. The factors that will be investigated include performance, initial costs, and life-cycle costs. These are all important factors to the university as they plan to be inhabiting their new facilities for a minimum of fifty years.

Additionally, it was suggested at the 18th annual PACE Roundtable Meeting to incorporate an energy education plan for both the student residents, as well as the building engineers. By developing this building specific plan, the occupants the Marymount University facilities can be educated to help potentially decrease the building's energy demands.

The research for this particular analysis will include an in depth investigation into other universities whom have developed similar education plans for their occupants. Other research will involve potentially utilizing the contacts I obtained at the 18th Annual PACE Roundtable Meeting. Additionally, relevant course work AE 597D, Sustainable Building Construction, and AE 572, Project Development and Delivery Planning.