Mount Nittany Medical Center
Perioperative Services Expansion

AE 481W | Proposal | Construction Option | Rob Liecht

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Executive Summary

The focus of this proposal is to identify key areas for critical issue research, value engineering opportunities, constructability alterations, as well as schedule acceleration activities for the Mount Nittany Medical Center Perioperative Services Renovation and Expansion. The four analysis topics suggested within this document attempt to identify and propose solutions to specific issues the project team faced during the course of construction.

Significant consideration needs to be paid to the challenges and special requirements of completing construction and facility renovations in accordance to the Department of Health regulations. In addition to these stringent guidelines, additional attention is required to minimize the impact or disruptions to medical professionals and facility personnel. This is especially prevalent when addressing areas of facility renovations.

The first proposal attempts to address these concerns by utilizing 3D laser scanning in these renovation areas to document the existing conditions digitally. This documentation can be consulted by any member of the project team in lieu of the lengthy inspection process currently in place. Additional research will be required to identify when laser surveying could be conducted. Industry professionals from SSM Group Inc. will be interviewed as well as scholastic and technical publications will be consulted to develop an ideal procedure to allow for the efficient use of 3D laser scanning.

By altering the soil retention system in the south west corner of the project over 1,000 square feet of usable space could be added to the project. Analysis two is proposed to address this concern and compare cost and schedule savings associated with altering this design. The construction manager indicated the tedious nature of constructing the existing system due to engineered fill and compaction requirements. Design calculations are to be performed as the basis of the structural breadth.

Due to the extensive and complicated phasing of the Perioperative Services Expansion and Renovation project any potential for schedule acceleration is greatly valued by the owner. Analysis three attempts to identify the potential time savings associated with the construction of the mechanical chases and pipe shafts off site during the course of steel erection.

The fourth proposal analysis attempts to address significant schedule delays due to the unique design of the new stair tower. By converting the structural steel tower enclosed by metal framing and gypsum wallboard to one constructed of precast concrete panels considerable schedule acceleration could be achieved. This would allow for the temporary scaffold stair required for personnel access to be removed opening up enclosure work in this area. The redesign of this stairwell is also intended as a architectural breadth to eliminate large beam pockets that currently obstruct the view of the occupants.
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Project Background

The Perioperative Services Expansion and Renovation Project is a four-story addition to the Mount Nittany Medical Center located in State College Pennsylvania. The 75 thousand gross square foot project designed by the Architect FreemanWhite Inc. is intended to add five state of the art operating rooms and additional support spaces to better serve the Centre County region. Also included within the scope of the project are significant mechanical upgrades to the seven existing operating rooms and the surgery recovery areas as well as the construction of new facilities intended to allow Mount Nittany to provide the best care possible to its patients.

Alexander Building Construction Company, the construction manager, on the project worked closely with Mount Nittany and FreemanWhite under a CM at risk GMP contract with a value just under 30 million dollars. With a completion date of December 4th of 2014 and a total of 120-week project duration the initial project schedule does not leave much room for schedule delays.

FreemanWhite Inc. took design inspiration for the Perioperative Services Project from many of the recently completed projects at the Mount Nittany campus. With the large curtain walls encapsulated by segmented masonry piers; the building was designed to mimic the same architectural features of the East Wing Tower directly adjacent to the Perioperative Services Project. Figure 1 shows the Perioperative Services Project, towards the right of Figure 1, adjacent to East Wing Project, which is shown toward the left side. The Perioperative Services Project is a four-story structure designed to tie directly into, and expand, both the existing sterile support spaces, as well as the existing surgical suite located directly above. Starting at the lowest of the four stories the basement level of the project is to include approximately 15,000 square feet of mechanical space with exposed air exhaust grills on the eastern façade for the four new air handling units that are to be installed. Directly above the basement, on the ground floor, is to be approximately 17,000 square feet of new sterile processing, and the associated space to store and stage all of the materials to feed the 12 operating rooms on the above floor. The 19,000 square feet of space allotted to the addition of the first floor, is to contain the main part of the surgical suite. Within this space four new operating rooms as well as one hybrid operating room are to be constructed. To support the newly expanded surgical suite, 19 new PostAnesthesia Care Units (PACU’s), 9 preparation/recovery staging areas, as well as nurse workspaces to support the increased patient volumes are to be constructed. Directly above the surgical suite is approximately 16,000 square feet of shell space that is to be left unfinished under the scope of this project.
Problem & Analysis Identification

I. Analysis 1 | 3D Laser Scanning Utilization (Critical Industry Issue)

a. Problem Identification
   The development of past technical assignments has identified several problems and complications to the successful completion of the Mount Nittany Center Perioperative Services Expansion and Renovation. As the name indicates, the project is segmented into two sections. The second of these sections, known as the facility renovation, required extensive on sight investigation to correctly and adequately identify the existing building systems within the occupied areas of the hospital. These investigations were limited to after normal operating hours, and to satisfy Department of Health regulations only permitted limited access to above ceiling mechanical spaces. This caused complications in project phasing, new system design, as well as specific sequencing of the renovation work.

   Construction activities in the existing areas were held up several times because the existing conditions were not known and therefore could not be planned for ahead of time. To remedy the circumstances that caused these delays extensive on site investigations and redesigns were often required. These investigation sessions had to be scheduled around the extremely busy surgical depart schedule, and often times had to be delayed for several months. While these delays were expected preventive measures to eliminate these delays could greatly accelerate the project schedule.

b. Critical Industry Issue
   Thorough investigation is to be done on how 3D laser scanning works and what benefits it can provide a construction project. Due to the new unknown nature these benefits each benefit will be coupled with potential opportunities to use this technology and what negative impacts this could have on the project if not done correctly.

c. Research Goals
   The goal of this analysis topic is to provide extensive insight on how 3D laser scanning practices can be utilized on the Mount Nittany Medical Center Expansion and Renovation project to facilitate better understanding of the existing building conditions. Detailed analysis will also be conducted on what extents 3D laser scanning can be used for. These uses will be evaluated in addition to how they can be implemented into the existing project schedule. Following technical literature research, a site-specific plan will be developed for the implementation of laser scanning on the Perioperative Services project. Any cost and schedule impacts will be analyzed and recorded.

d. Methodology
   The following steps will be taken to ensure successful analysis of this topic:
   • Conduct research on uses and implementation of 3D laser scanning on modern construction projects.
• Conduct interviews with laser scanning professionals on how they utilize this technology as well as what they require for the successful implementation of laser scanning.
• Additional interviews will be conducted with the project and design teams to gauge what exposure they have with 3D laser scanning technology as well as their goals for successful implementation.
• Compile the information gained from research and the interviews to formulate an implementation plan.
• Analyze schedule and cost impacts.

e. Expected Outcome
   It is expected that the successful implementation of 3D laser scanning early in the project duration will provide valuable information to system designers as well as the construction manager when developing the complicated phasing sequence required on medical renovation projects. It is expected that laser scanning some areas may not be possible or of great value due to inaccessibility due to gypsum wallboard ceilings required in sterile portions of the facility. It is expected that the congested nature of the above ceiling space in these areas will make laser scanning from access panels ineffective. Further investigation will be required to determine if the laser scanning plan and procedure is within the special Infection Control and Risk Assessment (ICRA) guidelines.

II. Analysis 2 | Alteration of Large Soil Retention Structure to Provide Additional Usable Space (Structural Breadth)

a. Problem Identification
   During the course of construction Alexander Building noted a great deal of planning to install the cast in place concrete retention structure located on the basement level of the facility. This three-sided retention structure required extensive steel reinforcing to support the loads exerted by the elevated slab on grade. Steel reinforcing was stretched triangularly between the three sides of the structure in attempt to brace against outward wall deflection. In addition to extensive reinforcing efforts, extensive work was required to back fill this structure once constructed. Special attention was required to ensure proper soil compaction, as this soil would be the foundation under the elevated slab on grade that capped this structure.

   By altering the design to provide the retention system on the south and what is now the currently open side of this structure 1,049 square feet could be added to basement mechanical space.

b. Research Goals
   By excavating this area down to basement elevation and installing a traditional foundation system along the south wall and a retention wall structure along the west, over 1,000 square feet of usable space can be added to the basement level. The goal of this analysis topic is to design and analyze schedule and cost impacts of this new system.
c. **Structural Breadth Consideration**

Structural calculations resulting in the appropriate design for the soil retention wall will be performed for the redesigned west elevation. Additional calculations will be performed to establish the additional loading exerted on the column by converting the elevated slab on grade to an elevated slab typical of this floor.

d. **Methodology**

The following steps will be taken to ensure successful analysis of this topic:

- Interviews of the structural engineer and the Architect of record will be conducted to determine why the structure was designed as it was.
- Calculations and designs will be performed as taught in CE 397a and AE 404.
- Analysis of the duration of work required to install the original soil retention system and elevated slab on grade and comparison of that to the new system.
- Cost differences between these two systems will be considered.

e. **Expected Outcome**

It is the impression of the Alexander Building and Construction that the soil retention system was designed as it was due to sloping site conditions. This slop was cut and benched back as part of the site utility and foundation work to allow better access to these scopes of work. The removal of this soil therefore required much more engineering fill than what was expected by the structural engineer.

By analyzing and comparing the two structural retention systems it is expected that the existing system, which requires soil retention systems to be installed on three sides and engineered backfill will cost much more than the proposed system. Additionally the redesigned system is expected to take less time for instillation resulting in significant schedule acceleration.

III. **Analysis 3 | Prefabrication of Multiple Mechanical Chases to Accelerate Project Schedule**

a. **Problem Identification**

Due the complex phasing of the project, the mechanical chases and pipe shafts were one of the first areas of focus of both the construction manager and mechanical subcontractor. These areas had to be completed, inspected, and enclosed early in the duration of the project as some of these chases were located within a sub-phase that had to be turned over much earlier than the remainder of the building addition. Due to the extremely complex nature of the building systems these chases are the only places where these building systems can access the upper floors of the facility.

b. **Research Goals**

Establish which pipe chases would benefit most from prefabrication. Evaluation would be required of what systems could be incorporated into these prefabricated racks. The dimensions and constraints of the racks themselves would need to be considered. Additional consideration would also be required for establishing a fabrication facility in
close proximity to the project. Schedule, cost, as well as logistics would need to be analyzed to determine the feasibility of successful implementation of prefabrication.

c. Methodology
The following steps will be taken to ensure successful analysis of this topic:
- Shop drawings and model reviews will be conducted to determine what systems can be incorporated into the rack assembly.
- Detailed research of existing buildings that utilized prefabrication will be conducted.
- Rack layout will be developed.
- Establish an assembly facility

d. Expected Outcome
The innovative nature of this type of scope delivery may introduce a significant challenge to the traditional nature of central Pennsylvania building construction. The basis for most of the required inspections and code jurisdiction will be based off of major metropolitan areas where mechanical prefabrication is much more common.

IV. Analysis 4 | Utilization of Concrete Precast Stairwell Enclosure Panels In Lieu of Metal Framed System (Architectural Breadth)

a. Problem Identification
Efficient material and personnel access are crucial to the success of a construction project. During the course of the Perioperative Services Expansion Alexander Building utilized a temporary scaffold stair to provide access to the four different stories of construction. The duration of this temporary stair was greatly extended due to design complications with the permanent stair tower. Fire separation for this stair tower was achieved by utilizing a complicated system of gypsum wallboard and metal framing. In addition the structural support for the stair structure itself had to be cantilevered from the existing steel structural system requiring extensive calculations due to this eccentric loading condition. The architect would not accept stair connection details that did not cantilever the support from the structural steel, as they did not want to have these supports inside the stair tower.

b. Architectural Breadth.
Using a precast stairwell enclosure system will allow for four large beam pockets to be removed from intruding into the stair landings. Figure 2 shows a section through this stairwell as currently designed. A great deal of money was spent to incorporate large 50-foot tall curtain wall into the stairwell construction. It is of great disappointment to the owner and the surveyed user groups that their vision out this curtain wall is all but completely blocked by these large beam
pockets. As part of the architectural breadth sight lines from various perspectives will be considered and analyzed for both the existing and redesigned system.

c. Value Engineering Consideration
   Tremendous cost savings is available by eliminating temporary conditions earlier in the course of the project. To facilitate personnel and material logistics a temporary scaffold stair tower as well as the omission of a curtain wall panel were utilized by Alexander Building. Several complications to the stair tower design as well as delays to the shop drawing approval caused these temporary provisions to be required much longer than originally intended. This cost much more than anticipated as well as prevented work both on the interior and exterior of the project from being completed as expected.

d. Research Goals
   The goal of this analysis would be to determine the feasibility of utilizing a precast concrete stair tower system to both lower cost as well as accelerate the installation schedule. Determination and study of when and how the precast system should be constructed and any potential schedule impacts that this may cause on what was the expected project sequence (prior to the delay of the original stair design) will be analyzed as part of this analysis topic.

e. Methodology
   The following steps will be taken to ensure successful analysis of this topic:
   • Detailed review of returned stair shop drawings to identify structural concerns with the original stair design and how this may be avoided with a more traditional design.
   • Interviews will be conducted with members of the design team with past experience with precast stair tower systems.
   • A detailed model of existing and new design will be developed.
   • Cost and schedule analysis between the as designed system, concrete masonry units, and precast systems.

f. Expected Outcome
   The precast system upfront cost may be marginally higher than that of the original design but early installation of the system will allow for better personnel and material logistics. This increase in productivity due to the removal of the temporary stair and material access will allow for significant project acceleration, warranting the additional cost.

Thesis Investigation Objectives
I. Analysis Weight Matrix
   Table 1 shows a breakdown of the four key areas of focus and the weight in which each one will be studied for each analysis. The four key areas include critical industry research, value engineering, constructability review, schedule reduction and acceleration. The primary focus of each analysis will be constructability review of the proposed solution presented in each analysis. Due to the complicated nature of the Perioperative Services
Expansion and Renovation project, a unique approach is required to complete the project under the stringent guidelines associated with renovating an operating medical facility. The second highest weighted category, schedule reduction and acceleration, is also very important to the success of the project. While a unique approach is important, the project would not be a success if these approaches delayed the project as the medical staff has already begun scheduling surgeries in the new operating rooms the week after the project is set to be completed.

Table 1 – Analysis Weight Matrix

<table>
<thead>
<tr>
<th>Description</th>
<th>Critical Industry Research</th>
<th>Value Engineering Analysis</th>
<th>Constructability Review</th>
<th>Schedule Redudcement Acceleration</th>
<th>Total</th>
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<tr>
<td>3D Laser Scanning Utilization</td>
<td>10%</td>
<td>12%</td>
<td>5%</td>
<td>27%</td>
<td></td>
</tr>
<tr>
<td>Alteration of Large Soil Retention Structure</td>
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<td>10%</td>
<td>7%</td>
<td>27%</td>
<td></td>
</tr>
<tr>
<td>Prefabrication of Mechanical Chases</td>
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<td>2%</td>
<td>5%</td>
<td>5%</td>
<td>20%</td>
</tr>
<tr>
<td>Concrete Precast Stairwell Enclosure System</td>
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<td>5%</td>
<td>8%</td>
<td>10%</td>
<td>26%</td>
</tr>
<tr>
<td><strong>Total</strong></td>
<td><strong>21%</strong></td>
<td><strong>17%</strong></td>
<td><strong>35%</strong></td>
<td><strong>27%</strong></td>
<td><strong>100%</strong></td>
</tr>
</tbody>
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II. Projected Timetable – Spring 2014

The proposed semester schedule shown in Appendix 2 designates the activities identified in the methodology sections of each analysis topic to a certain timeframe in the upcoming spring semester. This timetable breaks the semester down week-by-week and associates each activity with an allotted amount of time. Milestones are tentatively set at the beginning of each month with the exception of milestone #3 which is intended to mark the completion of all research and analysis in preparation of preparing the final report and presentation.

Conclusion

The main goal for the analysis topics presented in this document is to investigate and identify areas of improvement for the Mount Nittany Medical Center Perioperative Services Expansion and Renovation project. The topics of these analyses were specifically selected to address several constructability issues that the project team faced during the course of construction. By studying these areas and identifying potential solutions and the impact these solutions may have on project budget and schedule further understanding about these topics can be gained implementation on future projects.
## Appendices

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Appendix 1: Breadth Topics

Structural Breadth
Analysis 2 | Alteration of Large Soil Retention Structure to Provide Additional Usable Space

By redesigning the large soil retention structure located in the basement of the project over 1,000 square feet can be added as usable space to the basement of the project. What little additional excavation this would require would eliminate the need for engineering fill and align this area to that of the rest of the basement level. Structural calculations would be performed to design an appropriate soil retention structure that would be required to support the existing soils along the west elevation. Additional calculations would be required to determine if additional provisions would be required to support the additional load due to the conversion of an elevated slab on grade to an elevated slab similar to what is found on the remainder of this level.

Architectural Breadth
Analysis 4 | Utilization of Concrete Precast Stairwell Enclosure Panels In Lieu of Metal Framed System

Having a full height curtain wall inside a stairwell is new to the Mount Nittany campus. As currently designed four large beam pockets that fall at eye level block the vision of the staff inside this stairwell. This breadth would be closely associated with analysis 4 and the conversion of the structural steel stairwell to a more traditional masonry or precast system. A detailed model will be developed of the new system. Special attention is to be placed on where the structural supports are located. In depth analysis of sight light and day lighting will be studied as part of this breadth.
Appendix 3: Interview Questions

Laser Scanning Professional

(1) How many hospital or medical center projects have you been a part of?
(2) What specific requirements and challenges do these medical projects have over other type projects?
(3) When in the course of the project do you normally complete the surveying work?
(4) What type/format of the model do you normally hand over and how are they normally used?

Design Team

(1) Have you any past experience with 3D laser scanning to document existing conditions?
(2) In what capacity were the models developed by the laser scanning agency used on the project?
(3) Do you see real value in having these models and the associated information available at the start of design?

Structural Engineer of Record

(1) What specific reasons caused you to design the basement soil retention structure as you did?
(2) What challenges or complications do you see with altering this design?
(3) What reasons caused Stair N to be designed as it was?
(4) What complications do you see with changing the steel structure of this stair tower to a more traditional masonry or precast system?
(5) Was any consideration given to shifting the horizontal beams of the stair tower spanning the curtain wall to allow better sight lines?

Architect of record

(1) What specific reasons governed the basement soil retention structure design?
(2) Was any consideration given to reversing this structure to provide more floor area to the basement mechanical space?
(3) What specific reasons caused Stair N to be designed as structural steel instead of a more traditional masonry unit?