St. Joseph's Women's Hospital

Neonatal Intensive Care Unit (NICU)

3030 W. Dr. Martin Luther King, Jr. Blvd.

Tampa, FL 33607

Technical Assignment Three

November 29, 2010

BayCare Health System

Dennis Gibson

Construction Management

Dr. Robert Leicht

Executive Summary

Technical assignment three is intended to expand upon the existing design and construction program, and filter through the difficulties to see where improvements can be made. The St. Joseph's NICU Project is currently at a crucial time. The three phases, new construction, demolition, and renovation work, are soon to meet in the summer of 2011. Several constructability issues have already arisen from the dust and have required field attention. Other items are still covered, but soon to be revealed, especially with the demolition of the existing NICU tower impending this summer.

Several constructability issues from simple utility tie-in locations, to site logistics congestion and crane usage, to detailed connection misunderstandings have imposed challenges on the project team to date. Some of these items will be addressed in the technical analysis methods section at the end of this document, which is intended to outline a definitive set of criteria against which the successful rectification of these issues can be compared.

Additional analyses in this report include possible schedule acceleration scenarios that could be implemented on the project, some value engineering topics, and identification of the most prevalent issues that are currently ongoing at the St. Joseph's Project. Four main areas of focus were chosen as a starting point for the final thesis proposal research. None of these items have yet to be explored in depth and may prove to be insignificant, or be a shallow topic. A site visit to the project over the winter break will aid in the effort to refine the thesis proposal into topics that will cover both a broad knowledge of all building systems, and a deep understanding of the construction processes. Currently, the focus will be on the following:

- Reducing the schedule through resequencing of work and possible phased turnover options
- Reducing the cost of concrete by implementing a post-tensioned structural slab system
- Designing a façade to incorporate the glazing during the prefabrication stage of precast panels
- Exploring unused LEED points and the feasibility of utilizing them

The Final Proposal topics will be the next installment, and will be submitted on December 10, 2010.

Contents

Constructability Challenges

Fortunately for the St. Joseph's NICU project team, the constructability challenges thus far have not been terribly significant, and most were accounted for in preconstruction planning. Regardless there were still issues that were overseen, or created as a result of field conditions.

Mechanical Chases

One particular issue that has caused Steve Williams, General Superintendent for Barton Malow, some difficulty was the openings in the two-way flat plate slab for duct chases. These areas were oversized and required a significant amount of infill after the main slab was poured and mechanical ductwork and piping installed. The result was additional steel and metal decking, all inconsistent sizes, along with a slab-on-deck pour in a building that is already in the interior fit-out stage. This is a prime example of an item that was not seen in preconstruction planning. It is often that the mechanical engineer may provide the structural engineer with a base requirement during the schematic design phase, such as a 20' x 20' opening in each floor for mechanical chases, but the item becomes a grey area later when the structure must be detailed out. The critical path was not affected by this detail, so the impact was only a few extra dollars in steel and small sequencing setbacks; nonetheless, a problem that could have been avoided.

Utility Supply from Existing Chiller Plant

Continuing with the concept of successful pre-planning, utilities were another issue that could have been given more thought. The central chiller and power plant of the hospital is in the existing building found on the South side of the project site. The central chiller plant is intended to serve the new NICU tower once construction is complete, however, the utilities currently run along the existing NICU, which is to be demolished immediately following the turnover of the NICU tower, in the summer of 2011. Therefore, a significant amount of utility rerouting will be necessary to maintain the operations in the new NICU tower during the demolition of the old NICU. This would have been ideal to complete prior to the start of construction, but was not addressed until recently. The cost would have only been for an additional few hundred feet of pipe to be rerouted along the roof of the building and into the new NICU tower, but will now require more exploratory work and investigation along with the possibility of a shutdown of a fully operational hospital wing in the new tower. Figure 1 below depicts the current location of utility piping that was designated to feed the new NICU tower. It is clear that part of the line is located on the demolished structure. Rerouting the piping vertically out of the chiller plant and along the roof, then directly over into the 6th floor penthouse of the new NICU tower would have been ideal. This may still be done, but as the structure is already up, this task becomes more difficult. The piping must be rerouted onto the roof of the existing hospital and directly over into the 6th floor penthouse. The current location has been a nuisance during the construction of the new NICU tower structure. Other options are being explored by the project team at this time, but connections are to be made in early March.

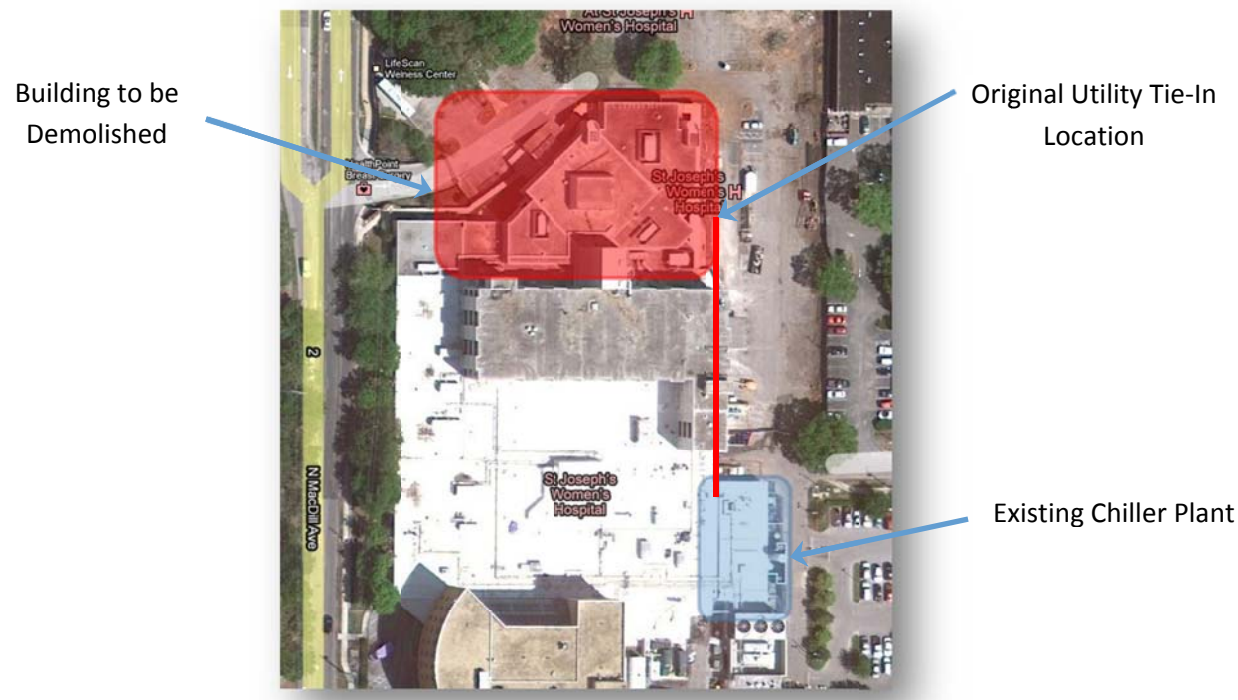

Figure 1. Location of CHWS&R from Existing hospital into new NICU. Courtesy Google Earth.

Window Connections

The window system experienced a setback later into the process due to a chain reaction from local aviation restriction. As aforementioned in Technical Assignment One, there was a height restriction on the cranes that could be used for the construction. Due to this, not one, but two cranes were used to be able to reach all areas of the building. Due to crane location, and the inability to use a tower crane, it became difficult to reach the East façade of the building to set the precast panels. To rectify the situation, the precast manufacturer was able to construct the panels out of lightweight concrete instead of normal weight concrete. Solving one problem created another in the fact that the window system was designed to tie directly into the normal weight concrete panel. The new lightweight concrete panel required angles and haunches to be installed in the panel for the windows to be anchored to. This detail was not accounted for in the original window shop drawings. Therefore, the windows would not have been properly anchored to the panels as designed. A new connection system had to be engineered for the windows to work, but there would be no Notice of Acceptance number (NOA), which is required for quality assurance purposes. Florida is a hurricane hotspot, and this number certifies that the system in question had been tested to a particular criterion for primarily wind and rain resistance, although other factors such as fire resistance do come into play. In order to achieve the NOA rating, the new connection types developed had to be reviewed and tested accordingly.

The project team was able to keep this issue from affecting the critical path, even though dry-in is clearly a critical milestone. They attribute the successful correction of the issue to their procurement schedule which was developed during preconstruction. The team could instantly see the impact of window

manufacturing durations and were able to have a new system designed, tested, approved, and manufactured with no schedule impact.

Site Logistics

The challenge of site logistics has always plagued the St. Joseph's project. The aviation restriction that forced the team to use two cranes has only compounded the issue. The need for an access road that can run continuously through the site has yet to be solved, and may be an area of future exploration. The tight staging areas also consume a great deal of superintendents' time as they deal with the coordination of deliveries. Their focus should be on completing the work at hand, which is where the superintendents' value is, not necessarily in coordinating material staging for a portion of each day. Pre-stocking floors with materials as soon as they are constructed will assist the situation, but does not provide a full-proof solution to the nagging problem of site logistics.

Schedule Acceleration Scenarios

Project team experience has allowed for the St. Joseph's NICU project to be constructed under an aggressive schedule, which spent a lot of time in review during preconstruction. Currently the critical path has been maintained, but there are still some areas where the aggressive schedule may cause a bind. The demolition of the existing NICU tower is probably the biggest area of concern. The ambiguity of demolition work and the tight twenty day duration will press the schedule harder than any activity up to that point. Exploratory work and intense logistics planning is in place to aid that effort, but it is still necessary to look at what other areas of the project could be accelerated to meet the baseline milestones, especially with the demolition becoming an area of uncertainty.

Superstructure

The easiest way to accelerate a project is in the earlier activities. The superstructure was entirely concrete, and is the first area that could be accelerated, particularly with increased manpower and efficient processes. The repetitive nature of the work allows for the process to be refined, and the Doka table formwork system helped with productivity. The Doka system which can be seen in Figure 2 below, was a crucial part of the superstructure's schedule success. After about a two-week learning curve, the system proved its worth as the tables were flown from floor to floor faster with each slab pour. The largest advantage was not just in the speed with which the system could be used, but the safety that was integrated into the design. The Dokamatic Table system comes with railings that quickly attach to the slab edge, providing a safer working environment than lumber framed rails would provide, and in less time. All-in-all the construction of the superstructure was completed about three weeks ahead of schedule, so further acceleration for this phase is probably not a good place to focus.

Figure 2. Dokamatic Formwork System. Courtesy Doka Website.

Facade

The façade installation and effort to become watertight consumes the next portion of the critical path. While precast panels are generally the fastest façade types to install, there may be room for improvement. The issue with window connections mentioned above is another reason that the façade could use more focus. Prefabrication of both concrete panels and windows together would save a lot of time on site for dry-in. If the windows were installed in the precast panels offsite, two things would have been addressed: the first being the connection detail mentioned above, and the second would be that the time spent installing windows onsite would be entirely eliminated, approximately two months of work for the glazing contractor. This allows the gap between precast installation and the water tight milestone to be separated only by the joint sealant installation between precast panels. Changing this process will likely require the layout of the panels and connections to be redesigned, but will offer a significant schedule savings and provide a better opportunity for quality control in the manufacturing environment.

MEP

Moving on to the interior tasks, MEP coordination is always difficult in a hospital. The geometry of the new NICU tower does allow for pretty consistent branches of piping. Similarly to the façade acceleration, there may be some room for prefabrication of common piping runs. Figure 4 shows the repetitive nature of the hydronic piping system in the fourth floor of the NICU tower. The main runs in the hallways could be installed onsite, but the CAV Reheat boxes and branch piping could be a single prefabricated unit, that only requires two connection points in the copper piping. This would save a considerable amount of labor costs and time needed for plumbers to sweat the multiple connections and fittings, and again carries with it the inherent ability to increase quality control in the manufacturing environment.

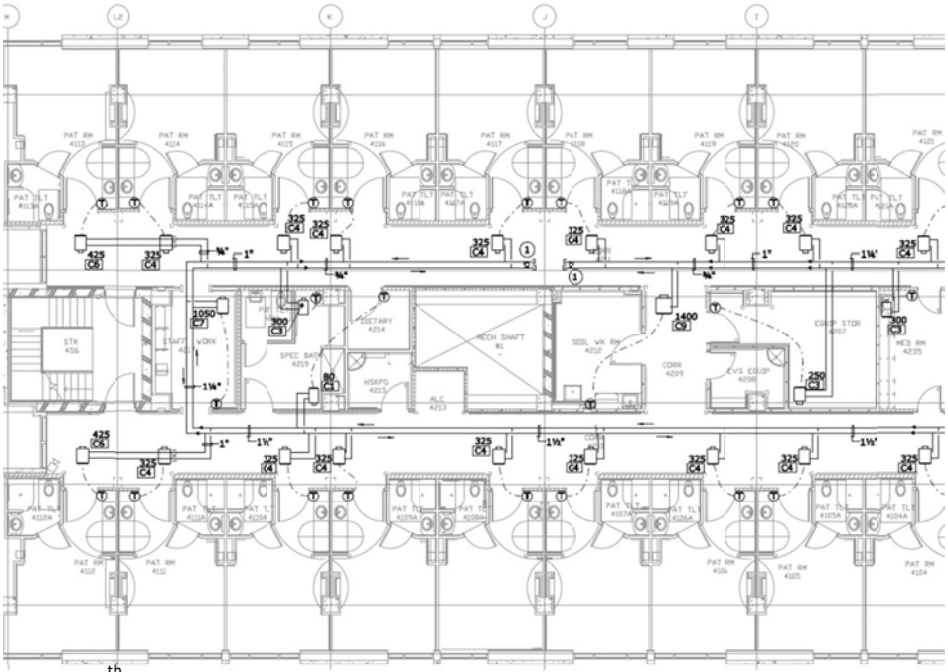

Figure 3. 4th Floor Hydronic Piping Plan. 100% Construction Documents, Courtesy HKS, Inc.

Owner Furnished Equipment

Owner furnished equipment has been identified as an area of disparity between drawings and procurement. The owner's procurement team may not be as familiar with procurement of materials as the project team may be. In the event that this happens, it may be beneficial for the owner to simply shift the responsibility to the CM through the contract. While this increases costs due to CM markup, it can often be a wash in the end as additional time savings are likely to be the result. Regardless of who purchases the equipment, there needs to be a review of the cut sheets by the construction team. This is where the coordination issues uncover themselves and if overlooked for too long, will result in a slippage in procurement time if an order needs to be changed. Providing the owner with a proposed procurement schedule for their portion of the equipment can assist the owner is making timely purchases of equipment as well as graphically showing them the schedule impacts if the proper procedures are not followed.

Once the procurement of equipment is successfully completed, there is another opportunity to accelerate the schedule during installation. It is not uncommon to see 24/7 operations begin with the installation of equipment. This is often done in hotels, cruise ships, and other repetitive projects where liquidated damages are involved. As long as all materials are onsite, pre-stocking each floor and perhaps the use of a short interval project schedule can save up to 2/3 of the original time allotted for equipment installation, assuming productivity is the same as a single eight hour operation.

Value Engineering Topics

St. Joseph's NICU is attempting to achieve LEED Certification, therefore value engineering efforts must not just be focused on reducing costs, but also maintaining the points necessary for certification. Sometimes the two different items have conflicting interests; for example a more energy efficient window system tends to cost more, and likewise with air handlers and energy recovery units. The following items were VE items that were deleted so as to provide a cost saving, but at the expense of the LEED points: LEED wood requirements from all casework, Marlite Panels, and wood door materials; a valued savings of $87,000. These VE deletions were all approved.

The project and design team both were able to utilize a "cool roof". This item provides a 78% minimum reflective surface to reduce the cooling load that the building will be experiencing as a result of the climate along Florida's Gulf Coast. The return period has not been calculated yet, but is expected to be relatively short in comparison with other energy saving devices, especially when compared to active systems.

An additional energy focus was analyzed for the mechanical systems. Since typical hospitals are 100% outdoor air systems, there would be a significant amount of wasted energy at St. Joseph's if this system was implemented. At the same time, recirculating air is not usually an option due to airborne contaminants that can spread infection. To rectify this issue, ULPA (ultra low particulate air) filters were installed in the mechanical systems and will treat the return air before sending it back into the air handler. These filters are designed to remove particulates as small as 120 nm in size, which accounts for most bacteria, dust, and mold spores. While outside air will still be needed, and DOAS systems are still required in operating rooms, there will be a significant energy savings by allowing the recirculation of return air in other spaces.

Problem Identification

From the issues mentioned above in the constructability challenges section, an area that deserves more exploration is certainly the façade. The crane situation has really thrown a kink in the construction of the superstructure and façade, but there was not enough time for a total redesign of these systems to accommodate this issue. While a total redesign may be superfluous, it may be worth looking into. The prefabrication suggestion of integrating the windows into the precast panel is especially something that should be explored deeper, since a relatively small investment up front will likely yield a large time savings in the field.

Another detail that should be analyzed is the two-way flat plate slab. The slab is 12" thick, which seems extremely excessive. Another floor system such as post-tensioned concrete would certainly reduce the concrete costs by eliminating some of the slab thickness. I have personally been on jobs where structural slab and beam parking garages were only about 6" thick, so it is safe to say that there are alternatives to the current design that are worth looking into.

Successful phasing will be difficult to accurately project on this project. There are many phases of work in which things can go wrong. Keeping the schedule impacts within a phase is critical. The turnover

dates must hold, so interphase scheduling must go unchanged. The renovation phase in particular is one task that appears to have some flexibility in it. The renovation phase may be pushed up in the schedule, but there are many details and requirements that the hospital needs that may affect this. It may be a reasonable goal to run renovation activities concurrent to other work, so this deserves a closer look. Overall sequencing is an area that may allow for outside the box thinking to accelerate the schedule with little energy input.

The mechanical system is based on a constant air volume reheat system. This is the most inefficient system that you can implement in a building due to the fact that the fan is always run at a constant rpm and energy is spent cooling the air to below the desired space temperature, then reheated to the desired temperature. There is significant energy loss is this process, and when LEED points for energy efficiency are trying to be achieved, there should be a focus on an alternative system. It is understood that there is a DOAS and CAV reheat is easier to use in this situation, but for the entire hospital it is not practical.

Site logistics planning will be a constant battle as mentioned before. Constant attention from the superintendents is burned up on trivial site logistics issues, and the single access point for deliveries hinders the situation even more. Furthermore, emergency egress provisions have to be maintained through the middle of the site. While these exits are not used on a regular basis, they must still be maintained for emergencies, and they do bisect parts of the site. Placing a labor foreman on the job as head of site logistics may be the answer, but a cost analysis should be conducted to see if it's financially acceptable.

The current utility feeds into the new NICU tower should have been rerouted to accommodate an easier tie-in point, and to not affect the demolition of the existing NICU tower.

Demolition of the NICU tower is on a very compressed schedule. Severing two buildings apart from each other may uncover several field issues that cannot be accounted for at this time. Schedule slippage due to this activity is a definite possibility. Additionally, the noise from demolition may affect the premature babies that are very sensitive to loud noises. More temporary sound attenuation must be accounted for at their new location during demolition.

LEED Certification appears to be based mainly on sustainable sites, and the St. Joseph's Hospital proximity to downtown Tampa and transportation links. There is not much of an engineering focus on the LEED points available. There may be financial or time constraints that have persuaded the owners' interests to void these options, but more attention could be given to other LEED credits with an engineering basis of design. Often these are the credits that yield an operations return on initial investment, such as energy recovery, and water usage reduction.

Technical Analysis Methods

Analysis Method #1: Sequencing to Assist Schedule Acceleration

The complexity of phased turnover to maintain full operational status of the hospital will be taxing on the schedule. Any critical path slippage will carry through to every phase of the project as the sequencing is currently laid out. As planned, the new NICU tower will be completed, then the patients will be moved into it across the parking lot. Then the existing tower will be demolished to begin the Phase II connector work, finally followed by the renovation work of Phase III.

This analysis method will require inquiring the exact needs of the hospital in hopes of initiating a phased occupancy of the new NICU tower. Since there are to be twice as many beds in the new NICU tower as the current, there will only be a need to have half of the beds in the new tower available for turnover. Having three of the five floors ready for turnover should be sufficient for the transition, and will allow more float for the demolition of the existing NICU.

Restructuring the sequencing will require producing a new schedule for the phased occupancy, and possibly revisiting the HVAC start up and testing and balancing to be earlier in the process. Additionally, temporary facilities will need to be in place such as ICRA barriers and clear means of egress. That being said, there may be a financial analysis in order as well to compare the general conditions costs incurred to the monetary value of the schedule savings.

Points of research with this analysis would include a detailed breakout of general conditions needed for phased turnover in the new NICU tower. This would consist of an interview with a project team member. Furthermore, a talk with the owner's representative, Bill Shevlin of BayCare Health Systems will be necessary to even deem if the phased turnover is possible from an operations perspective. If in the end the costs offset each other, the phased turnover would still be successful by allowing additional time to surgically demolish the existing NICU; time that is likely to be needed.

Analysis Method #2: Redesign of the Façade

The constructability issue involving the precast panels and the window connections threw the flag for a possible redesign situation. It is clear that there is a better way to address this issue, and should the project team been aware of this situation before hand, they would have had the time to address it on paper instead of in the field.

Redesigning the façade will require not only a redesign of the connection between window frames and precast panels, but a redesign of the entire façade layout. Additionally, including the window frames in the precast panels prior to delivery will increase productivity of onsite labor and eliminate the two months allotted for the glazing contractor to perform their work. Research needed for this analysis will include a call to the precast manufacturer and window manufacturers to inquire their opinions on feasibility. Furthermore, a layout redesign will have to be compared with the crane lifting capacities so as to not exceed the size limits for the panels, and of course a cost analysis to summarize what savings, if any are available. Some items that should be kept in mind during the analysis would be: increased lead time for the panels, additional transportation measures if the panels need to go to the glass shop

for prefabrication of glazing, additional transportation measure to ensure that the glazing is not harmed during delivery to the jobsite, and irregular details that may require field installation of glazing. The effort will be deemed successful if the panels are able to be sized small enough to accommodate the cranes' shortcomings, and if the cost of prefabrication can offset the time savings reflected upon the critical path.

Analysis Method #3: Redesign of the Structural Floor System

The current structural slab design requires top and bottom reinforcing mats of #5 through #7 rebar at about 8" to 12" on center. The resultant slab thickness is 12" of f'c=5,000psi concrete. This is extremely expensive as the job calls for just under 4,500 CY of structural slab concrete. A structural floor system to reduce the thickness of the slab and thus the quantity of concrete used would be the alternative analyzed; likely a post-tensioned slab system.

Research for this analysis will include consultations with a structural engineer for general feasibility, and more interviews with concrete subcontractors to determine how post-tensioning will affect the schedule. The tendons must be stressed at several intervals during the curing process, so the pace of concrete pours may be hindered by the change. This would be a successful VE option if the cost of implementing post-tension tendons into the concrete is offset by the savings in concrete quantity, and if the schedule is unaffected. If schedule is affected, it is not likely to be feasible regardless of cost savings, although when combined with other schedule saving analysis methods mentioned above, it may be. An additional bonus would be the increased above ceiling space which will help the MEP coordination effort, however, this is not likely to play a large part in the feasibility study, but could sway an opinion if the other criteria leaves the decision on the fence.

Analysis Method #4: Available LEED Points

There appears to be an opportunity to include more LEED points than what is currently being pursued. The design is not so much geared towards LEED, but the logistics. A recycling program is implemented, the site is already in a city, and recycled materials will be used. But there are extensive amounts of LEED points that have been left on the table. In particular, the Energy & Atmosphere credits can be engineered into the design. Increased energy reduction and renewably energy sources were barely touched. Enhanced commissioning was utilized, but on a traditional mechanical system. There is no construction IAQ plan for pre-occupancy. This is a prime example of a simple item that can be drafted for an additional point, and requires very little effort and money to implement.

Research to expand unused LEED credits would require consulting with a LEEP accredited professional and sitting down with the owner and architect to see what they are willing to pay for, and what is totally impossible to achieve. This is maybe more of a qualitative analysis to help my understanding of the LEED system, but can certainly have a financial analysis tied to it. I may be out of line in saying that the LEED scored card was underused, but I feel the topic deserves some review, and we may be able to set the bar higher. A successful analysis will yield almost any results. As long as I have learned the decision making process for LEED items, and some common reasons to negate or approve those points, then the analysis will have been worth it from an educational standpoint.

References

1. Williams, Steve. General Superintendent, Barton Malow Company. Phone Interview on 16 November 2010.
2. Gilroy, Michael. PSU Architectural Engineering Class of 2011, Mechanical Option. Personal Interview on 27 November 2010.