THE PENNSYLVANIA STATE UNIVERSITY
DEPARTMENT OF ARCHITECTURAL ENGINEERING
SENIOR THESIS

UPMC Passavant Pavilion

Pittsburgh, Pa

Technical Assignment 3

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Executive Summary

This technical report will further investigate the construction management and project management aspects of the UPMC Passavant Pavilion project located in Pittsburgh, Pennsylvania. Within this report three major constructability issues were indentified and analyzed. This analysis looked at the challenges associated with the constructability issue and how the project team overcame these challenges. The issues outlined in this report are related to the tie-ins from the new addition to the existing hospital, interior mockups, and the building enclosure system.

Schedule acceleration techniques and issues were also investigated in this report. The critical path of the schedule was identified and analyzed to determine what were the major risks associated with completing the building by the contract completion date. After determining the risks of the schedule it was necessary to investigate ways in which the schedule could be accelerated should the need arise due to the occurrence of one of these risks.

During any project it is at times necessary to investigate the cost and determine if it is on budget and if not what can be done to ensure that it is while still giving the owner the best value. This is done through the value engineering process which was investigated herein. When investigating value engineering areas and their implementation it is important to understand the goals of the owner and how these ideas will correlate or detract from that goal.

It is also important to identify problematic features of the construction process that will affect the manner in which the building is constructed or the performance of the system. The final portion of this report is devoted to determining a few of these problem areas and proposes analysis methods that will aid in the selection of alternative construction processes or systems to alleviate these issues.

Constructability Challenges

All construction projects present their own unique challenges and this is especially true for renovation and addition projects where the construction team may uncover challenges as they progress through the building. UPMC Passavant does not deviate from this commonality and has many constructability challenges of its own.

When renovation and addition work is taking place within the confines of an operating hospital and hospital campus the construction team must deal with not only the challenges associated with constructing the building but also the challenge of maintaining uninterrupted medical services. Due to the location of the existing operating rooms in relation to the construction site this task can be especially daunting.

Tie-ins with the Existing Hospital

One of the most challenging parts of the construction at Passavant is the tie-ins between the new Pavilion and the existing East Wing of the hospital. These tie-ins range from opening walls to create corridors from the new construction to the existing building to connecting the existing MEP systems with the new and vice versa. This is especially challenging when the areas on the existing hospital side of the temporary construction partition are being fully utilized by the hospital for their various functions.

When completing construction work within a healthcare facility it is essential that all of their operations be maintained at the highest level possible with a minimal amount of interferences on the part of the construction team. This is especially challenging when the schedule and budget are driving the project and the work in those spaces needs to be completed. In order to meet the needs of the owner, as well as, the needs of the construction project it is essential to plan and schedule these tie-ins thoroughly.

As construction is occurring within the fully functional areas of the existing hospital it is necessary to take the proper precautions to ensure that there are no interferences with the operations; i.e. air borne debris, odors, etc. This can be achieved through proper Infection Control Risk Assessment (ICRA) procedures as set forth by UPMC and the Pennsylvania Department of Health (DOH). Without the proper precautions the sterile and semi-sterile environments of the hospital could be compromised which in turn compromises patient health and the hospital's ultimate goal of extraordinary patient care.

P.J. Dick (PJD), the general contractor, aimed to minimize the risk associated with this challenge by thoroughly investigating and scheduling all tie-ins early on in the construction process. As the construction of the Pavilion was progressing all subcontractors were asked to provide the PJD with areas within the existing hospital where they would be making tie-ins and when they needed to do so. This information was then converted into a matrix which was conveyed to the owner. Through the use of this matrix PJD and UPMC were able to target the more complicated areas of the plan and focus scheduling efforts in that direction.

Interior Mock Ups

When constructing a healthcare facility a contractor not only must in conjunction with the owners of the hospital but also the doctors, nurses, staff, and maintenance. These user groups would like to have their spaces within the building be tailored to their needs and this is provided for in the contract specifications. Under this specification section the contractors are required to construct full scale mock ups in the exact location of the room within the building. Within these mock ups the contractors are to provide unfinished walls, locations of medical equipment and devices on the walls, locations of MEP fixtures without roughing in the work, and locations of equipment suspended from the ceilings must be shown on the floor.

Once the mock ups are constructed the contractor must contact the owner who then schedules a meeting time with the user groups of that particular room. From the time that the owner is notified they have one week to approve the room. During this approval time no other work can commence in this room, as well as, all rooms of the similar type. This can be detrimental to the construction schedule if this process is drawn out or delayed. If each of the approvals for the rooms were to take the full week it would set all work related to that room back the time it took for the approval to come in.

Working with the different user groups that will occupy the different rooms within the building can be difficult as the needs of the different user groups may vary widely. What one group wants in their rooms may not be what the group occupying the other rooms wants. This is especially true for the operating rooms which are tailored to the needs of the individual surgeons that will be conducting surgery exclusively from their specified room.

The construction team tries to limit the amount of time that each of these mock up periods will consume by opening the communication lines between themselves, the owner, and the user groups. By facilitating meetings before the mock up walk through date they can strive to minimize the amount of changes that will need to be made and expedite the approval of the rooms which then releases those room types to the contractors for rough ins and finishes.

Building Enclosure Interfaces

In today's age of high performance and LEED certified buildings special care must be taken when designing and constructing the building enclosure system. The enclosure system is one of, if not, the main contributors to overall building efficiency. The most energy efficient mechanical systems will not function at their full potential without a sound building enclosure system.

A major source of these inefficiencies can arise from the use of multiple systems to make up the overall building enclosure system. While this may be a source of inefficiencies it cannot be stated that this system of enclosure should be avoided. It is merely essential that proper planning and due diligence be part of the management and construction of such a system.

In the case of UPMC Passavant, the enclosure system is composed of masonry veneer on either CMU or light gauge metal framing back up, aluminum and glass curtain wall, and metal panels. It is important to

note the each of these systems have their own construction tolerances, as well as, coefficients of thermal expansion which can lead to differential movement. With this in mind it can be realized that the interface between these materials with one another can be a source for water and air infiltration which will compromise the system integrity. Figures 1-5 below show the interfaces between the different materials, as well as, the different sealing conditions that will occur at these areas.

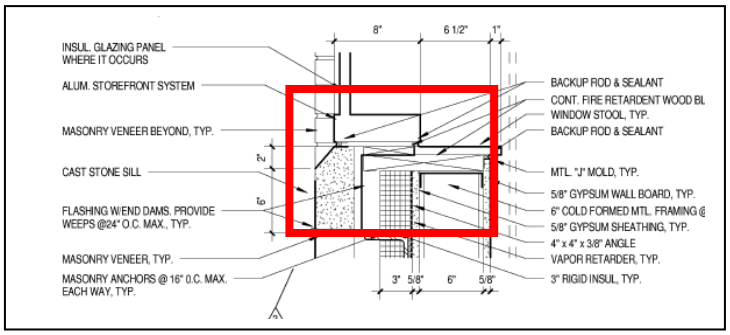

Figure 1. Cast Stone and Curtain Wall Interface

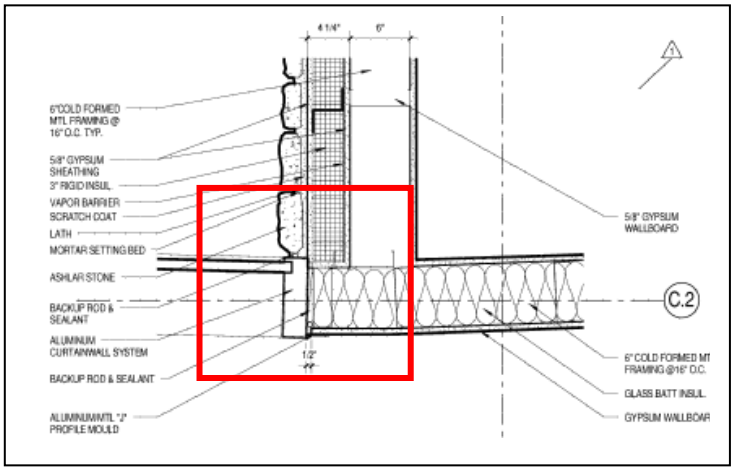

Figure 2. Ashlar Stone and Curtain Wall Interface

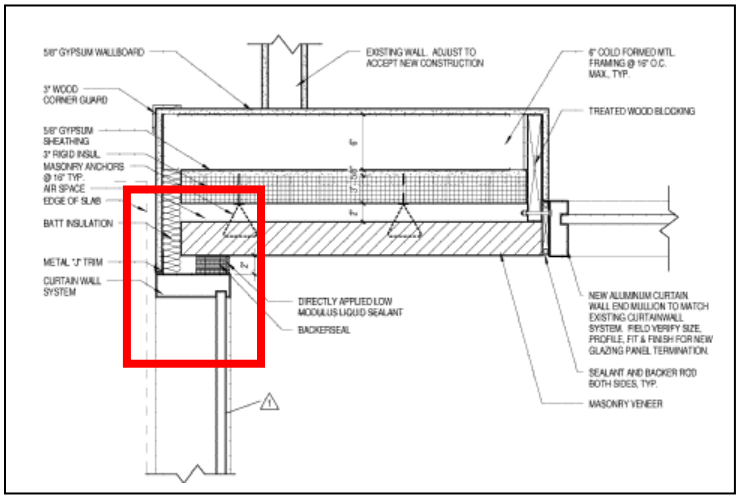

Figure 3. Masonry Veneer, Interior Finishes, and Curtain Wall Interface

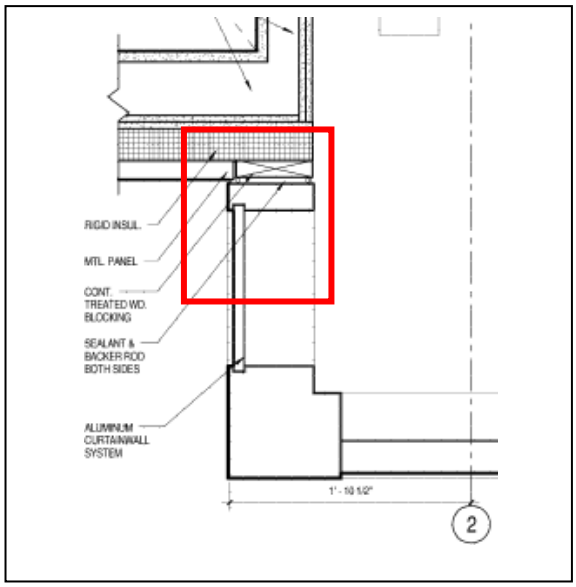

Figure 4. Metal Panel and Curtain Wall Interface

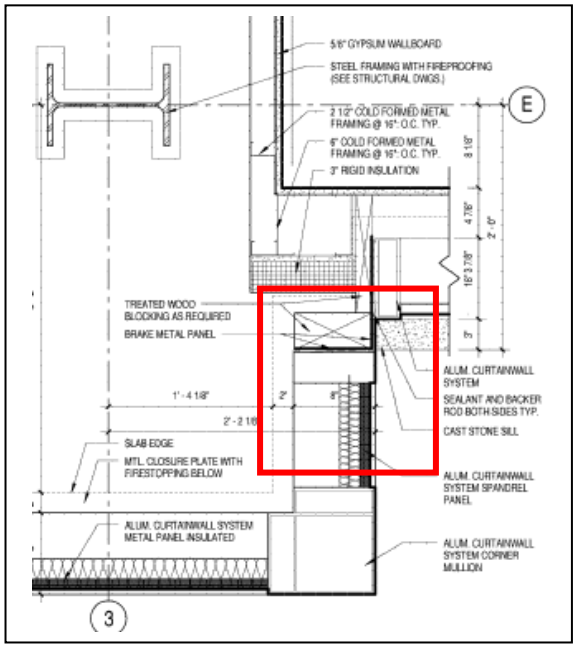

Figure 5. Curtain Wall Corner Detail

Through thorough coordination between the various subcontractors, vendors, general contractor, and architect the challenges associated with building enclosure systems can be alleviated. In order to ensure the smooth transition between systems, PJD conducted coordination meetings with the various parties listed above. These meetings were conducted individually to review shop drawings, details, and scheduling information and jointly to discuss any discrepencies in shop drawings and to coordinate interfaces and the sealing activities that would be required to be performed at these locations. The goal of these meetings was to determine as many constructability issues as possible prior to the construction of the systems. This would not only aid in the construction of the system but to also limit conflicts later in the process when the pace of the schedule is critical and time is of the essence.

Schedule Acceleration

Critical Path

The critical path of a construction project schedule is one of the most important aspects of any project. When completing an activity that is on the critical path it is essential to finish on time since any overrun will negatively affect the duration of the succeeding activities. Conversely, any savings in time during the completion of these activities could possibly decrease the total construction duration which would positively affect the project. With these two things in mind it can be seen that the activities that are part of the critical path are the most crucial parts of the project and should be managed closely and effectively.

The critical path of the UPMC Passavant Pavilion Addition is generally based upon the site excavation and the structural steel activities. Critical path activities begin with the installation of barricades and temporary protection and site demolition activities. These activities are essential to the timely start of the construction activities since the construction process cannot begin until the existing structure has been cordoned off and the foundations have been excavated.

Concurrent to the above activities is the structural steel shop drawing process. Steel fabrication, and consequently, steel erection cannot begin until the shop drawings are approved. Any delay in the approval of steel shop drawings can be devastating to the schedule of a project because of its effects on mill orders and fabrication schedules. Time slots must be allocated for both of these activities and if they are delayed it could be difficult to complete the fabrication and delivery within the scheduled period.

Steel fabrication and delivery are also activities that are on the critical path. Impacts to the fabrication and delivery schedule again can affect the entire project. If steel is not delivered to the site it cannot be erected thus creating a delay. However, if fabrication can be completed faster than anticipated it can help to speed the overall erection process.

The final structural steel activity that is on the critical path is erection. As shown above, this activity relies upon a number of activities prior to it to remain on schedule. Any delay in the erection process will be felt throughout the remainder of the project if not dealt with promptly. A delay at this stage would in turn delay the installation of floor decks and MEP rough ins. These activities would then delay the installation of the concrete slabs. These delays would then continue through the remainder of the schedule if no schedule acceleration was to occur.

Another critical portion of the schedule revolves around the building enclosure activities; exterior metal studs and sheathing, masonry veneer, curtain wall, and roofing installation. These activities are important because prior to their completion none of the interior finishes can begin. If the building is not watertight it can be difficult to install MEP rough ins and finishes because of the impact water can have on them. The installation of interior partitions can also be impeded unless higher grades of gypsum wall board are utilized.

They also must be completed in a timely fashion due to the nature of the weather in Western Pennsylvania. Temperatures begin to decrease as November and December roll around. If the building is not enclosed near this point of the year it can be difficult to install the temporary heating system. This system is essential to the project schedule because many finishes rely upon minimum interior temperatures being maintained to be completed. Low interior temperatures can also adversely affect the productivity of the construction workers. Human dexterity begins to decrease as temperatures decrease which can lead to a decrease in productivity. This in turn can lead to increased activity durations and possibly schedule delays.

As stated above a delay in the building enclosure and temporary heating can affect the completion of the interior finishes. This is an important statement because the installation of drywall is also a critical path activity. This task requires dry conditions to prevent decay and more importantly mold growth. It also requires a minimum temperature to complete the finishing and painting. If these activities are delayed the remainder of the interior activities are delayed.

The final activities on the critical path are the majority of the inspections that must take place prior to substantial completion and occupancy. If any of the activities listed above are delayed and the time is not recouped then substantial completion will be delayed. If this occurs the owner cannot occupy the building on the schedule date which then could lead to liquidated damages and affect the bottom line of the project.

Schedule Risks

Anytime that a construction project is undertaken there are always certain risks involved that can affect the schedule and ultimately the completion date of the project. Many of these risks pertain to the activities associated with the critical path of the project and were outlined in the above section. Some of these activities are more of a risk to the schedule than others.

One of the biggest risks to the schedule is the structural steel activities. As stated above these activities include shop drawings, fabrication, delivery, and erection. If at any time one of these activities is delayed there is a possibility that the remaining activities will be adversely affected. Any sizeable delay at this stage of the project could impact the scheduling techniques and strategies utilized throughout the remainder of the project because all of the remaining work relies upon the timely completion of the structural system. These impacts could cause a domino effect throughout the project as one activity would be delayed by the previous and in turn would delay the succeeding and so on and so forth.

The interiors finishes are also an activity that could pose a risk to the project completion date. These activities rely upon the majority of the activities that occur prior to their beginning and can be greatly affected by any prior delays. For example, if the building dry in date is delayed the finishes cannot begin. If this occurs the start of the interiors would be delayed and in turn could delay the substantial completion date if measures were not taken to alleviate the time delays. When delays to the interiors affect the substantial completion date it also affects the date on which the owner can occupy the facility. If this date is delayed the contractor will incur liquidated damages and the owner will be unable to capture the revenue that would have been realized had the project been completed on time.

Acceleration Techniques

Steel Erection and Detailing Acceleration

In the event that the schedule begins to slip and delays are evident it may be necessary to accelerate certain aspects of the construction process to maintain the contractual completion date. The main focus of acceleration techniques should be on the activities that affect the most subsequent activities. It is important, however, to look at the impact that acceleration can have on the productivity of the workers and also on the impact that it will have on the budget since more workers and/or more hours may be involved in these techniques.

A prime example of one of these activities would be the structural steel activities. In order to accelerate these activities it is important to investigate the balance between man hours, man power, and the constraints of the site. Due to the constraints of the site only one crane can be utilized during erection process. This in turn limits the number of pieces that can be placed per hour and per day. The overall daily production rate during steel erection could be increased by requiring longer work days and longer work weeks.

The total duration of the steel erection is currently 63 days. Assuming this is based upon a 40 hour work week this equates to 504 total hours per ironworker. If a 10 hour work day and 50 hour work week were utilized the total duration would be decreased to 50.4 days. This is a time savings of about 12 days.

Steel Erection Acceleration			
Work Hours/Day	Duration (Days)	Total Hours	Duration(Days) of 10 Hour Day
8	63	504	50.4
10	50.4	504	

Figure 6. Steel Erection Acceleration

This acceleration plan would not be without added cost. Due to the 10 hours of overtime each week the hours billed would be 55 per worker instead of 50. Over the duration of the activity this would increase the number of hours billed for each worker to about 556 from 504 for a difference of 51.5 hours.

Associated Costs/Worker					
Work Hours/Day	Duration(Weeks)	Hours/Week	Overtime Factor	Hours Billed/Week	Total Hours Billed
8	12.6	40	1	40	504
10	10.1	50	1.5	55	555.5
				Difference	**51.5**

Figure 7. Steel Erection Acceleration Costs

The 50 hour work week scenario would also need to take into consideration the productivity of the detailing crew. In order to increase the speed of the erection the speed of the detailing would also need to be increased to ensure that work on the lower floors could still progress as steel erection is occurring overhead. Currently it takes about 74 days to deck and detail the entire structure. If only the increased work hours were utilized this would be decreased to about 59 days. As long as the detailers can complete the decking required to maintain overhead protection there should be no need for increased manpower in this scenario.

Steel Detailing Acceleration			
Work Hours/Day	Duration (Days)	Total Hours	Duration(Days) of 10 Hour Day
8	74	592	59.2
10	59.2	592	

Figure 8. Steel Detailing Acceleration

Similar to the steel erection, the steel detailing acceleration would incur an added cost due to the overtime being worked. This would add about 57 billable hours per worker to the cost.

Associated Costs/Worker					
Work Hours/Day	Duration(Weeks)	Hours/Week	Overtime Factor	Hours Billed/Week	Total Hours Billed
8	14.8	40	1	40	592
10	11.8	50	1.5	55	649
				Difference	**57**

Figure 9. Steel Detailing Acceleration Costs

While the steel erection and detailing acceleration scenario of working a 50 hour work week would add cost to the project it would also shorten the duration of the process by about 3 weeks. This decrease in duration could then be utilized to accelerate subsequent activities such as MEP rough in and concrete slab on deck placement. Even greater time savings could be realized from this scenario as some activities are overlapped and occur concurrently with the steel detailing.

Concrete Acceleration

Another method of acceleration would be to re-coordinate the concrete pours. Currently the pours are broken up by floor and by zone in the same manner that the structural steel is erected. This sequencing seems to be the most logical method since it allows the concrete to be placed while steel is still being erected. Before accelerating the concrete placement it is important to understand what activities must occur prior to it. In the case of the Pavilion the steel detailing occurs first and is then followed by the

installation of MEP sleeves and hangers that will be embedded in the concrete. After the sleeves and hangers are in place the prep work for the slabs can begin.

If the MEP work was allowed to work multiple floors ahead of the concrete before slab placement begins the number of slab sections placed per week could be maximized. With this method there would be minimal increases in cost due to need for no extra man power. The only extra man power that would be associated with this change would possibly be more iron workers from the concrete company to place the wire mesh on multiple floors instead of a floor at a time.

Along the same lines as accelerating the pace at which the concrete is placed the MEP sleeves and hangers could be installed at a greater rate. This method could accelerate both the MEP rough in and the concrete slab placement as there would be less down time between the placement of the sleeves and the slabs. Again the only cost incurred would be from a few extra laborers being needed to work on the multiple floors.

Both of these scenarios could possibly allow the MEP rough ins to begin ahead of schedule and allow scheduling efficiencies to be realized. If the rough in occurs ahead of schedule this would allow the interiors work to begin sooner. Whenever a scenario in which a decrease in duration can be realized at minimal cost it should always be investigated to see if it will in fact be able to be done and to what extent will it aid in shortening the overall duration of the project.

Value Engineering

When investigating value engineering ideas it is also important to keep in mind the goals of the owner. The main goals for UPMC were to complete the project on budget while still achieving a LEED Silver Rating and meeting the needs of all the users groups that will be utilizing the new facility. The manner in which UPMC approaches value engineering is similar to other owners. They describe value engineering as a process of identifying savings potential on a systems-by-systems basis while maintaining the design intent and scope. It is an opportunity to verify the intent of the systems and to evaluate if the intent must be maintained, or if it can be altered without affecting the functionality of the project. If the functionality is affected the difference must be acceptable to the owner for the proposed value and the functional change must be acceptable as well.

When evaluating value engineering ideas P.J. Dick placed them into three categories. These categories were based on the priority with which decisions should be made due to their impact on different aspects of the building. Priority 1 items are those that require early decisions because they affect the immediate critical path of the building structure and long lead items. Priority 2 items are those that deal with finish materials and do not impact the building structure or long lead items. Priority 3 items have no impact on the building itself as they relate to the site work and will not be discussed in this report.

By prioritizing the value engineering items they can maximize the benefits to the owner. If the list were not prioritized in such a manner some items may slip into the fray and not be realized until it is too late in the construction process to implement them.

Priority 1

As stated above the Priority 1 value engineering items are those that affect either the critical path schedule activities or those activities which are long lead time items. It is important that these items be dealt with quickly in the construction process because of the impact they will have on the schedule. Many of these items deal with the MEP systems of the building due to the long lead time that exists for fabrication and delivery. A major VE item associated with the plumbing system was changing the underground sanitary and storm piping from cast iron to PVC schedule 40 piping. Other changes to the plumbing system dealt with changes to the fixture models.

A major portion of the total VE savings was associated with changes made to the HVAC system. The largest of these savings was realized by changing the pumps and variable frequency drives from 4160 volts to 460 volts. The original basis of design utilized the higher voltage pumps for their more efficient use of electricity. This allowed the conductor size to be reduced and energy consumption. When studied further the cost differential between the two voltages was great enough that the pay off period for the use of the larger pumps was indefinite. Other major savings came from the elimination of redundancies in system monitoring and mechanical equipment finishes.

The final items from which savings were realized were from the curtain wall, elevators, and electrical systems. The curtain wall system was refined so that the finishes would be more in line with the clean architectural lines of the exterior. This was achieved through the use of only spandrel and vision glass

instead of the multiple glazing types that were proposed and streamlining the closure system by removing metal panels and utilizing snap covers in their place. The manufacturer, Wausau Windows & Wall Systems, also proposed a unitized system that was accepted. This system replaced the stick built system and allowed for not only the clean lines mentioned above but also the construction process to span multiple floors. The new system also decreased the fabrication and installation times which in turn contributed to the schedule and budget savings that were realized.

The elevator interiors were also modified from the specified finishing system to the standard interior system as supplied by the elevator company. This savings idea reduced the overall material and installation cost of the elevator system. Savings related to the electrical systems were gained from changing the corridor cable trays to j-hooks and changing the conduit from metallic conduit to aluminum healthcare facilities cable. Current codes require that all electrical wiring be metal clad. Generally this means that the conductors must be housed within metal conduit, however, advancements in manufacturing techniques have allowed metal clad cabling construction to meet or exceed the requirements of conduit. This allows for both cost and time savings.

Priority 2

Priority 2 VE items are related to the finishes within the Pavilion. The goal of these items was to provide a product that performed similarly but for less cost. Many of these changes dealt with flooring, wall finishes, ceilings, and casework. The largest savings in this category was realized from changing the floor finish in the operating rooms from a poured floor to a sheet product. Savings from the ceiling system were primarily made by substituting ACT and other ceiling finishes. Wall finish VE items primarily consisted of removing unnecessary wall panels and certifications on finishes. Casework savings were a result of changing countertops from solid surface to plastic laminate and altering some of the finishes.

Unaccepted Value Engineering Items

Not all VE ideas that were submitted to the owner and architect were accepted. This is the case with many projects because the savings idea may solve a current budget issue but it will affect one of the other criteria the owner has for selecting products. In the case of the Passavant Pavilion the items that were not accepted were rejected because of maintenance or aesthetic concerns. Below is a brief listing of some items that were not accepted for these reasons.

Priority 1 items that were not accepted were changing copper fittings to press fittings on small diameter domestic water piping, changing piping materials that pass through the elevated slabs, and reducing coil tubing thickness in HVAC units.

Reducing the size of the tubing thickness would affect equipment that is mission critical to the Hospital. If the HVAC units were to fail due to greater stresses on the tubing and the overall decrease lifespan of the span then operations within the hospital would cease. If the HVAC system cannot function the hospital cannot house patients and in turn cannot collect revenue. While this change would generate some savings it was in UPMC's interest to accept the upfront cost in order to maintain the lifecycle performance that is necessary.

Unaccepted Priority 2 items were centered around changes to flooring and ceiling systems that did not meet the criteria listed above. These included alternatives to the flooring changes made to the operating rooms and changes to wall finishes. Other savings that were not accepted were changes to ceiling finishes at central stations, flooring changes, and countertop changes.

Problem Identification

Infection Control Risk Assessment (ICRA)

When constructing additions and renovations to an existing healthcare facility it is important to understand the risks that are associated with such work. These risks are not only to the budget and schedule but also to the operations of the existing facility. When working in these environments it is essential that the status quo be maintained throughout the construction operations. Often this entails the use of varying levels of ICRA. These varying levels range from a simple plastic drape to a full enclosure with negative pressure and ventilation. With these varying levels come cost and schedule implications. These costs must be evaluated and the proper level of ICRA selected based on the requirements of the hospital and the Department of Health, as well as, the economy of the project.

Site Layout and Congestion

The site of the UPMC Passavant Pavilion and Addition is within the confines of the existing Passavant Campus and as such creates a limited construction site. As shown in previous technical reports the site is limited to the footprint of the building with small lay down areas to the East and West. These constraints of the site can cause sequencing issues when multiple trades are onsite and this is especially true in the case of deliveries and material storage. While some materials can be stored off site at the new parking areas many materials must still be stored on site which further limits the space available to the trades.

Deliveries can also be a problematic issue due to the constrained site conditions. Cumberland Road, which runs parallel to the South elevation of the site, is the main entrance to the hospital and its facilities. While this road is maintained as a private drive the hospital does not allow access to be restricted to one lane under most circumstances. This leads to further site congestion as the tractor trailers must be within the site fencing while off loading. When this occurs only a limited number of deliveries can be made at one time and they must be scheduled in advance and must occur on time.

Building Enclosure Detailing and Tolerances

As stated previously in this technical report, the building enclosure is one of the most integral parts of the overall building efficiency. The integrity of this system can be affected by the materials and workmanship that it is made of. In the case of Passavant the building enclosure is a mix of masonry veneer, curtain wall, and metal wall panels. Each of these materials has their own characteristics and construction tolerances which can lead to issues in regards to sealing and water and air infiltration. The interface of these materials with one another should be review thoroughly to ensure that the tolerances are able to be met and that they will not compromise the integrity of the system. Also the connection and interface details should be coordinated by all related subcontractors to ensure that the curtain wall receives all the necessary primary and secondary seals and that the other materials are terminated correctly.

Integration of Mobile Information Technology Documents

A unique feature of the construction management program for UPMC Passavant is the use of the FASTTAC mobile information technology document platform. Through the use of this technology all contract drawings are placed on a server and made available on portable computer units. The premise of having the electronic documents is that the most current and accurate set of drawings will be available at all times. This is achieved by uploading the drawings within a relatively short period of time after the architect or engineers release a construction change directive or sketch.

The electronic documents are also updated as an as built set. By incorporating all markups to the drawings it further allows the users of the system to have the most update information as some changes may be made to the drawings without the issuance of a new full size drawing. FASTTAC also has the capability to contain more information. All project information including contract drawings, vendor drawings, RFIs, sketches, cut sheets, etc can be included within the system. This enables the construction team to have the most up to date information virtually at all times.

The implementation of such systems can be somewhat problematic in the construction industry as many of the workers and some managers are not inclined to use electronic technology. Finding ways to implement this technology in a manner that will allow all parties to be included in its use is essential to the success of the system.

Technical Analysis Methods

Infection Control Risk Assessment

When evaluating the extent of ICRA levels required to renovate spaces within an existing healthcare facility it is essential to pair the proper level of protection to the criticalness of the space in question. While a lobby may only require a plastic drape for the duration of the renovation a sterile corridor outside of operating rooms requires must more stringent measures and justifiably so.

The use of the varying levels of ICRA must be evaluated based upon cost and the critical nature of the space. The contract drawings specifically call out what level of ICRA is required throughout the existing hospital. A thorough review of these plans along with the ICRA requirements of UPMC and the Department of Health may allow for cost savings due to a lower level than what was specified being needed. Schedule impacts correspond to these cost savings as well. The varying levels of ICRA not only vary in cost but also in the time it takes to construct the barriers or to set them up on a daily basis. By reviewing the cost and schedule differences among the varying levels simultaneously, a more complete analysis of the systems can be obtained.

Constructability can also affect the level of ICRA that is chosen because of the limits they place upon construction. This is also linked to the impact that the construction operations can have on the existing hospital facilities. Many times the work within the hospital must occupy a very limited amount of space while in other spaces the construction team may be able to occupy large portions of the area. ICRA levels must then be review based upon the constraints that they will place upon the construction operations.

Through a thorough review of the ICRA requirements of UPMC and the Pennsylvania Department of Health possible cost and time savings may be realized when compared to the initial construction requirements. This process would also allow one to better understand the varying level of importance within healthcare facilities and how this affects the construction methods that are used during renovations.

Site Layout and Congestion

Site layout can be one of the largest limiting factors for a construction project. The constraints of the site can affect everything from lay down areas to delivery scheduling. They can also have adverse affects on the budget and schedule of the project if the space is not utilized to its full potential.

A review of site logistics and usage can also incorporate delivery scheduling and construction phasing. In the instance of UPMC Passavant delivery scheduling may prove to be very important. With multiple trades on site the opportunities for conflicts over delivery space can be numerous. This is especially true when the only deliver access to the interior of the building is along the South elevation and requires crane lifts to place the materials on the appropriate floors. Due to the limited amount of space this allows for only one crane on site and at most one delivery at a time.

Through a review of the construction schedule and the constraints of the site a more exact delivery schedule may be produced. This maximized schedule would allow for a more fluid construction process and less down time as materials would be delivered as needed and would not be delayed by missed opportunities. This maximized schedule could also be reviewed for cost and time savings.

Building Enclosure Detailing and Tolerances

As stated above the variability in the materials that compose the overall building enclosure system can have an impact on the quality and integrity of the system. It is important to understand how all the pieces fit together and the tolerances with which each material and construction process associated with that material must conform to. Investigating these tolerances and processes may allow for a maximization of productivity and quality.

Through a review of the construction documents and possibly the shop drawings for the different systems will allow for a more coordinated approach to the building enclosure. Determining which process must occur first and which is to follow the last would help to alleviate conflicts during the construction process and create possible cost and time savings.

This review could possibly also create opportunities to suggest alternative systems that may decrease the risks associated with construction tolerances. One of these alternative systems could be the use of precast concrete panels inlaid with brick veneer in place of the masonry veneer that is proposed in the drawings. The cost and time implications of such alternatives could then be compared to the current schedule and budget of the project.

The effect of the building enclosure on the mechanical systems could also be evaluated. Energy losses due to the inefficiencies of the sealing of the systems could be a point of investigation. These losses and inefficiencies could also be evaluated for the alternative systems. This investigation could in turn aid in the resizing of the mechanical system if more efficient alternatives are proposed.

Implementation of Mobile Information Technology Documents

The amount of information that it requires to construct a building today can seem endless. From construction drawings and specifications to RFIs and sketches the process of managing this information can be challenging especially when the information is constantly changing. Disseminating this information to the workers in the field that actually put the work in place can be equally challenge. In order to construct a quality facility the most accurate information available is needed in the hands of the field staff. This can be achieved through the use of mobile information technologies that aim to maintain a current set of documents at all times.

Aside from the constantly changing amount and quality of information there are also problems with the perception of technology among construction workers. While the project management staff, for the most part, has accepted technology the field workers may be hesitant to accept it. This can limit the effectiveness of the technology and its uses within the construction of the project.

Through an investigation of the apprehensions to the use of technology within the industry and more useful implementation plan may be developed. This investigation could include the use of surveys in which subcontractors would respond to questions about their thoughts on the use of technology such as FASTTAC in the industry and their perceptions on its effectiveness.

After gathering and evaluating this information the implementation plan could be developed. Within this plan possible solution could be identified on how to ease the transition into the use of the technology. These solutions could include the use of larger screens or units and having digital drawing tables within the building.

The possibilities for this technology seem endless and they can save a project both cost and time as they keep the most accurate information in front of the contractors at all times. This can help to eliminate removal of work that is put in place due to changes that were lost in the fray as well. It is for these reasons that contractors should welcome this advancement and realize the budget and schedule implications that it provides.