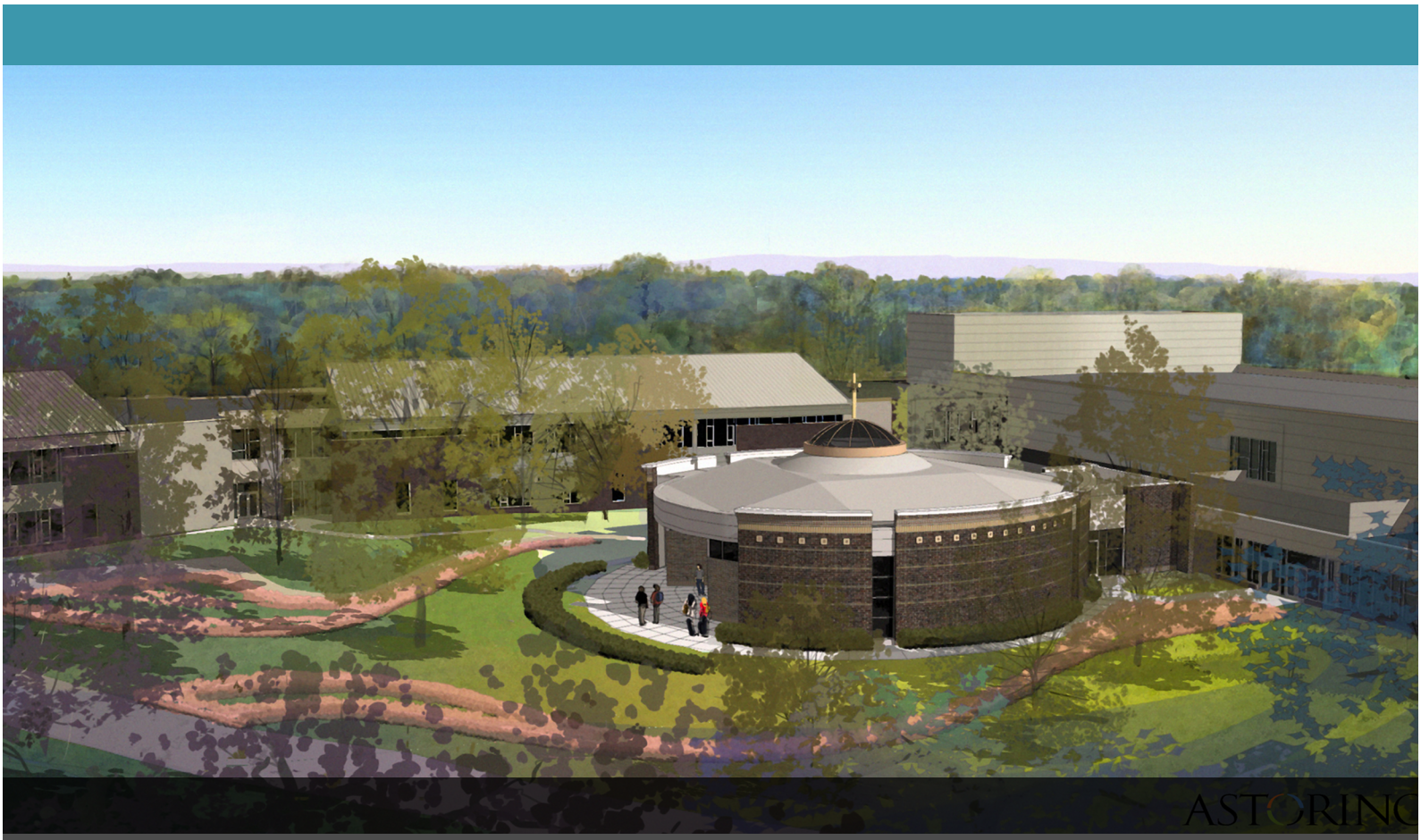

TECHNICAL REPORT III

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Construction Management

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Cardinal Wuerl North Catholic High School

Cranberry Township, PA

Friday, November 15th, 2013

Executive Summary

The purpose of Technical Report III is to determine aspects of Cardinal Wuerl North Catholic High School that are suitable for future research and analysis. Once these aspects of study are developed, they are further analyzed for options to determine alternative methods to improve them. These alternative methods may improve building aspects' efficiencies, schedule, quality, cost, etc. Analyses of CWNCHS' critical path schedule and value engineering considerations as well as critical industry issues at the 22nd annual PACE Roundtable Conference on November 7th, 2013 were evaluated to determine topics suitable for future research.

North Catholic's critical path was reduced to 8 major categories of activities that drove the project completion date. After a careful analysis of these categories in accordance with considerations from having experience on the site this summer, schedule acceleration scenarios were developed. When a potential schedule acceleration scenario was realized, it was applied to the high school to define what techniques and risks would be associated with implementing the acceleration. Careful consideration determined that using SIPS in conjunction with the structural system and possible offsite façade prefabrication and erection were the best courses of action for schedule acceleration.

Some of the major value engineering topics at Cardinal Wuerl North Catholic High School included exchanging two areas of TPO roofing in Areas F & G for standing seam metal, a reduction of insulated metal panel façade scope, realizing a redundancy of an electrical dimmer in the theater equipment, reduction in the scope of ceramic tile work as well as a reduction in the tile $/SF, a substitution of aluminum in the place of copper feeder conductors (size #1/0 and higher), and a realization of the seeding costs at the storm water management ponds. While value engineering was used as an attempt to benefit from cost reduction in some parts of the building, it was also used to increase quality in other areas despite a possible price increase. Items that are pending or were rejected are also presented in this report and a full list is available in Appendix A.

Lastly, the critical industry issues discussed at the PACE Roundtable are outlined in the end of this report. The highlighted topics of safety prevention through design as well as efficient delivery of facility management information that were discussed at the two breakout sessions of the day are explained in detail. These topics were researched to determine if they were appropriate for further examination. One topic that came from this research may be an appropriate to use; the evaluation of maintenance costs throughout the lifecycle of the building to determine if the finished materials were cost effective or not.

All of the above stated items will be put into consideration after Technical Report III as a basis for my proposal development, presentation, and final proposal. While Cardinal Wuerl North Catholic High School has been considered an overall success to this point, there are certainly areas of improvement worth considering. Some areas that could be further analyzed are energy efficient electrical and mechanical systems due to available space, an acoustical analysis of the HVAC noise and attenuator effectiveness, integration of SIPS, prefabricated façade panels, and a lifecycle maintenance evaluation.

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Schedule Acceleration Scenarios

Cardinal Wuerl North Catholic High School began delayed at the very beginning due to permitting issues with Cranberry Township. Approximately one month was lost from the original schedule developed by Mascaro Construction. Mascaro vowed to the owner that they would get the project back on track despite the permitting delay being unforeseeable. This goal was accomplished by the end of May 2013 (gained one month within nine months). The schedule that I used to develop this schedule acceleration scenario and critical path analysis was last updated on September 26, 2012, the date that the site was turned over to the prime contractors. This was done to accurately represent the challenges that the project team was confronted with realistically due to the loss of one month from the project schedule. This goal was more important for the general contractor than the owner because they wanted to demobilize at that date in order to be able to move their team to future projects if necessary. The school was not due to open until August 2014, so even if it were finished by early summer, the owner could begin his FF&E activities at that point and allow teachers to decorate their rooms and move in within a comfortable time period. The aforementioned consideration was the goal in the development of the chapel schedule (Phase II) substantial completion date of May 30, 2014.

Critical Path Evaluation

The primary goal of the critical path is to complete the project by the originally accepted date of January 31st, 2014 for Phase I. When the owner decided to build the chapel as Phase II in early June, the schedule development team decided that it could be completed in 9 months, or by the end of May 2014. These dates were accepted by the owner, considering that there was ample time for owner FF&E activities and the teacher move-in process. CWNCHS' critical path is followed by the diagram shown below. It flows through the building's foundation and structural skeleton naturally since it is a newly constructed building. The schedule is then followed by slab-on-deck activities in F & G as well as slab-on-grade construction in A, D & G. Building envelope activities for the TPO roofing system and masonry/insulated metal panel façade systems drove the project in order to allow for the 9 month interior rough-in and finishes process in areas A, B, D, E & G. After the conclusion of the interior activities, building commissioning in Phase I began and capped off at the end of January 2014, when the critical path transfers to the Phase II schedule. The critical path follows the chapel completion schedule until May 2014. At this date or possibly sooner, the complex will be turned over to the owner.

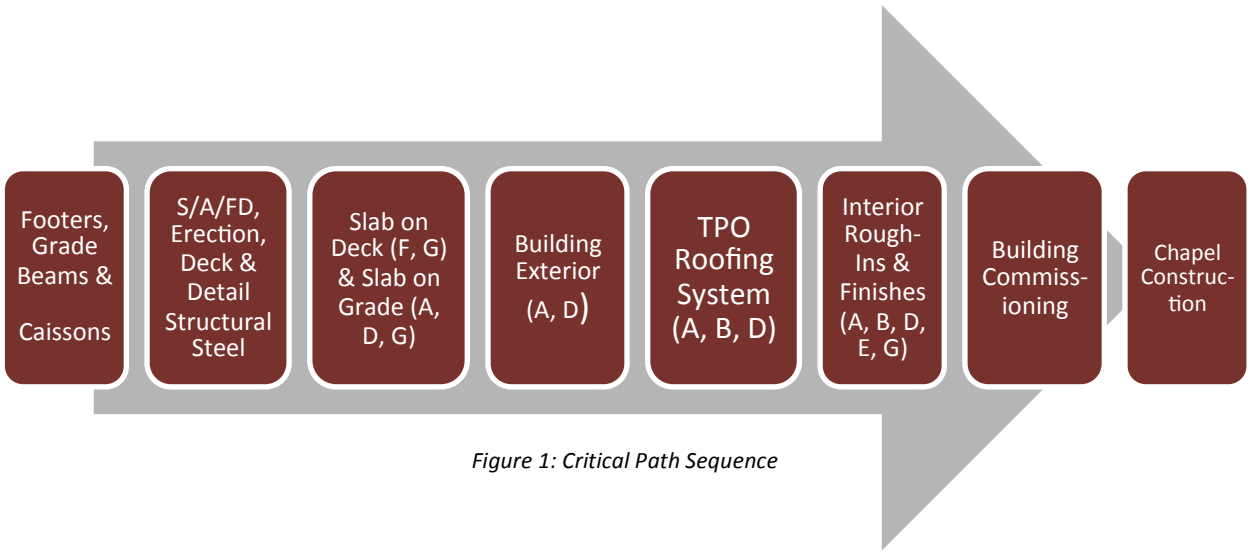

Figure 1: Critical Path Sequence

Risks

As it was stated above, one of the biggest risks in the construction process was the permitting from the township. The permit was not approved, which delayed the project schedule by one month. The project team decided that they wanted to keep their substantial completion date, which added a number of risks to the project. The prime contractors could have renegotiated the contract's completion date with the owner at this point but they had faith that the task could be done. This left them open to huge risks, but Mascaro took the lead by redeveloping a schedule, which allowed them to be finished by January 31st. If the project was not completed in time, they put themselves at a risk of losing money for each potential day that they lost.

To manage and mitigate this risk, it was necessary to do more frequent critical path and float analyses with each schedule update to determine where time could be made up or if it was being lost anywhere. One of the more critical risks was to ensure that all of the submittals, approvals, fabrications and deliveries of the structural steel were on time. The initial schedule could have been lost here, but the project team had extra time to work on submittals during the permit delay, so this was not a problem and actually helped to advance the schedule a few days.

Another huge risk was getting all of the prime contractors to buy into this schedule and have their foreman comply with the accurate weekly updating of the schedule. There were some problems initially with the foreman reporting to the person who was attempting to conduct the schedule updates (often Mascaro interns), but all problems were smoothed out quickly. The other primes were mostly MEP & specialty contractors who worked on interiors. This phase of the project had a duration of 9 months (1/2 of the project) and there was a lot of time available to be lost in these activities if all activities were not watched closely. Ultimately, all risks were managed and mitigated effectively and as of September 10, 2013, the project was on track to finish on January 28, 2014 (2 days early).

Potential Acceleration

Cardinal Wuerl North Catholic High School unfortunately lacks a repetitive design in any aspect of the building. This holds back skilled laborers from developing a good production rate since work is often different and requires double-checking and careful attention. I believe that there are two scenarios for schedule acceleration that would be ideal for this project.

First of all, the steel construction on this project took approximately 3 months including all beams, columns, girders, and floor & roof decking. I believe that by the integration of SIPS and careful site layout, this duration could be greatly accelerated. Increased crew sizes and equipment could be utilized to make up for the lack of repeatability in the structural design. This acceleration would then allow the roofing, façade, and some other interior activities to begin, which could possibly speed up the critical path even further than expected from the short interval production scheduling techniques alone. While SIPS isn't always beneficial for non-repetitive activities, it can be with careful management and planning.

Secondly, the building exterior took approximately 4.5 months to complete. There were several issues with the subcontractors developing an acceptable production rate. Also, quality of work for some subcontractors that contributed the multiple layers of façade work was below the standard. These situations are ideal for offsite prefabrication of the unique sizes and scopes of wall construction. The various façade constructions consisted of cold formed steel framing, exterior sheathing, spray-applied air barrier, rigid insulation, & brick masonry or insulated metal panel as well as insulated metal panel on 8" CMU. The benefits to this process are schedule acceleration by developing a sequence of deliveries and erection of these wall panels and possible cost savings. Risks are accumulated with offsite prefabrication because these panels may not fit correctly on the shell of the building, which would delay work rather than accelerate it. This could provide a possible architectural breadth by detailing connection sequences and other aspects of architectural installation.

Value Engineering Topics

Value can be increased by improving function or decreasing cost. In a Value Engineering standpoint, we want to retain as much of the benefit of the system, function, or object as possible while decreasing costs. "How" & "why" questioning techniques of the items under analysis are the forum for discussing how to increase project value. The owner's goals were placed in these principles of Value Engineering and attempted to reduce some of the cost associated with a high quality building. The Catholic Diocese of Pittsburgh ensured that the education curriculum and programming of Cardinal Wuerl North Catholic High School were not sacrificed or altered unless deemed appropriate by the project team. This included project goals/objectives, building user and occupant requirements, total building area and scope of work. Overall, the cost value engineering benefit amounted to $3,502,964.00.

It is clear that the Value Engineering items that were approved would not in any way affect the quality of education of a high school student. The goals of the Catholic Diocese were not sacrificed in this process whatsoever. VE items that were considered and rejected may not have been implemented for several reasons. One contributing factor to this circumstance was the building's LEED aspirations. Wooden lab casework, linear wooden ceilings, operable windows, sound attenuators at VAV terminal units and day lighting design considerations were either kept or added to increase value on the CWNCHS project as well as to maintain the LEED goals and high aesthetically valuable interior. The major goals of the owner were met and overall throughout the Value Engineering analysis, value was added either by decreasing costs, enhancing the indoor environment, or showing that quality as well as programming goals should not always be sacrificed at the hand of a cost reduction. Tables included in Appendix A show a comprehensive list of Value Engineering items that were accepted, pending or rejected as of January 6th, 2012. I was not able to receive a list that was updated beyond this date but after some consideration of what I observed at the project this summer and after communicating with the project team I believe that all of the VE items in said tables are accurate. The following are key examples of the VE efforts at CWNCHS:

Standing Seam Metal Roof

The standing seam metal roofing system was introduced as an accompaniment of the clerestories in the 2nd floor hallways of Areas F & G. The clerestories on the north elevations of these corridors were included to allow for more natural light to enter the corridor. So, rather than creating an box that seemed to protrude directly from the roof in order to provide natural light from both sides of the corridor (accompanied by a flat TPO roof), it was decided to add one elevation of clerestory accompanied by a sloping steel roof that concludes at the south elevation. This standing seam system produced an added architectural element to the exterior design of the building that is immediately noticeable upon examination and the slope of the roof ended up being the motivation for the curved ceilings in the upstairs corridors. According to Mascaro Construction, this change also provided a cost savings of $237,000 in addition to the

additional added aesthetic value. A picture of the standing seam metal roofing system is shown below:

Figure 2: Standing Seam Metal Roof (Property of Mascaro Construction)

Insulated Metal Panel Façade Reduction

The amount prefabricated insulated metal panels (IMP) that were installed at Cardinal Wuerl North Catholic High School was dramatically reduced and exchanged with brick masonry to reduce the high costs of offsite fabrication and the expensive metal material. The owner desired to determine the cost savings of reducing the originally IMP heavy façade design by replacing many areas with brick masonry. Approximately 32,000 SF of IMP was changed to brick around the gym and auditorium for a cost savings of approximately $850,000. This was the biggest cost reduction and just so happened to have the largest overall exterior design change. In my opinion, the façade materials still work very well together despite the change and the cost savings were worth it. With an already high $/SF value for CWNCHS, it was necessary to make attempts such as this to drive down the cost.

Dimmer Redundancy in Electrical Pex

Theatre & stage equipment were vital parts of the scope for CWNCHS considering they were serving a 1000-person auditorium. As with most stage productions, a light dimmer is needed for lighting effects. A mistake was made during the programming stage which was corrected during the preconstruction and value engineering stage by Mascaro Construction that saved the electrical prime contractor roughly $200,000. The dimmer was to be provided by Pittsburgh Stage (specialty stage equipment contractor) but it showed up twice by appearing in the electrical contractor's scope as well. Before purchasing occurred this mistake was recognized and the above savings were achieved.

Seeding Reduction at Storm Water Management Ponds

This VE item is very short and simple. By introducing the four storm water management ponds on the north and south ends of the CWNCHS site, the site contractor was able to reduce their seeding costs after excavation by roughly $400,000. By a simple inspection of the layout and size of the ponds, it is understandable how large savings may be attained from their seeding reduction. The storm water management ponds are shown in the diagram below:

Figure 3: Site rendering displaying storm water management ponds (property of Astorino)

Ceramic Tile Reductions

Ceramic tile was originally chosen to cover a majority of the walls in the locker rooms and bathrooms as well as some of the flooring. The scope was reduced by ½ of the material that was originally necessary. In these circumstances, the bathrooms introduced a more organic floor finish in the polished concrete finish and a more durable/cheap option compared to ceramic tile in the locker rooms by using epoxy paint on the CMU walls. These changes did not affect the function or maintenance of the spaces and no major aesthetic impact was sacrificed. In addition to the reduction of scope, the material being used was reduced from $17.80/SF to $12.00/SF for further cost savings. All in all, the ceramic tile value engineering considerations saved the owner roughly $205,000.

Substitute Aluminum for Copper Feeder Conductors - Size #1/0 and above

While the price of copper per linear foot is much more expensive, it is much more conductive and requires less cross sectional area to achieve the same required level of current. The project team decided that this additional surface area that is required for aluminum feeder conductors was beneficial on the basis of cost savings for sizes #1/0 and larger at the 3,000 A switchboard. This change did not affect any other aspects of construction and was simply a material switch-out. The proposed cost savings were roughly $40,000.

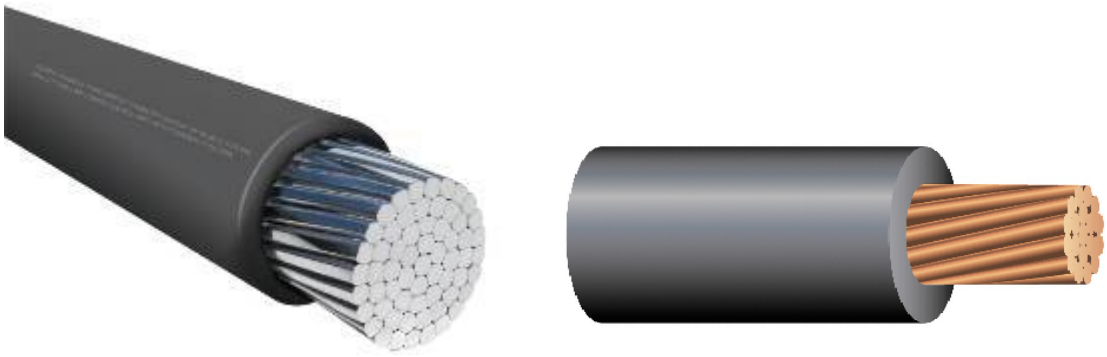

Figure 4: Aluminum vs. Copper Feeder Conductor (Property of Google Images)

Critical Industry Issues

The annual PACE (Partnership for Achieving Construction Excellence) Roundtable was held at the Penn Stater Conference Center on Thursday, November 7th, 2013 between 8AM – 4PM. In attendance at the Roundtable were top industry professionals as well as Penn State Architectural Engineering department faculty, staff and students. PACE provided us with "*Whole Project Delivery*" as the topic of the day. The Roundtable's conversations opened with Dr. Leicht & Dr. Messner describing the research that the AE department is currently involved with. At the conclusion of the introduction, the two sets of three breakout sessions of the day were introduced. The morning topics were all personnel based whereas the afternoon topics were all integration based. The broad topics of discussion for all three breakout sessions in both the morning and the afternoon were:

1. Sustainability
2. Information Technology
3. Integrated Processes

Each one of the three sessions focused on a more specific topic pertaining to the more broad category of the breakout session. While these breakout sessions were facilitated by AE faculty, they encouraged the professionals and students to provide feedback as well as differing points of view in the conversation. These conversations are intended to motivate thoughts and ideas in students pertaining to their senior thesis proposals. At the end of these breakout sessions, the Roundtable was divided into smaller groups of industry professionals and students for feedback sessions. The forum of these feedback sessions was to discuss a topic from the breakout sessions that was deemed most appropriate for the students' projects. My project was discussed with the Chief Facilities Officer of the Catholic Diocese of Pittsburgh and Owner Representative on my project, Mike Arnold. The next sections are dedicated to the two breakout sessions that I attended, respectively:

Breakout Session #1 – Safety: Prevention through Design (PTD)

The first breakout session, led by Dr. Leicht, focused on safety and its integration in the early phases in the design of a building. This concept is called Prevention Through Design (PTD). Dr. Leicht introduced the history of PTD at the beginning of the session. This was followed by industry members introducing themselves, which led to discussions about their experience with PTD on projects as well as their general backgrounds. The following questions helped to guide the group through the session and provide topics of conversation:

- How aware is the design community of the impact they have on construction safety?
- How is safety typically approached during the design and preconstruction process?
- What examples of improving safety during design have you seen?
- What opportunities exist to improve/increase the focus of design on safety issues?
- What concerns or issues might prevent designers or owners from considering safety in the design process?
- What could be done to begin influencing this process?

These questions will be answered in the following paragraphs respectively. Based on the response from the question about the design community's awareness of safety, it's safe to say that the consensus of the construction industry is that designers are not aware or disregard it as much as possible. Andy from Southland was the only design engineer in our forum and thought that whatever safety that is incorporated into modern building design in the early stages is a positive byproduct of BIM. Design teams consider safety the responsibility of the construction professionals and the amount that it is incorporated on a project is largely dependent on owner requirements, contract language, the delivery method (DB vs. DBB), and the point during design that a construction professional is incorporated. As far as contractual language, the forum seemed to agree that incorporation of safety in design needs to be defined and budgeted for because there are incurred costs for the design team putting man-hours into a safety effort (despite savings at the end). Ultimately, designers should be aware of safety, but we would like to avoid this dictating means and methods of construction too severely.

Safety is approached in one of two different ways according to the industry professionals in the forum. In traditional Design-Bid-Build work, it gets close to no consideration during the design and preconstruction process. Construction professionals are not involved early in the process and this usually means that it gets little consideration. In a Design-Build project delivery method safety is considered much more during the design stages. The design stages become integrated with preconstruction and change orders, RFIs, and even safety issues are worked out much more quickly.

Several examples of improved safety during design were thrown around. Bill Moyer introduced a window washing station that was tied into a high rise's concrete structure rather than utilizing a temporary station which created a 70-ft cantilever as a washing station. This idea was introduced during the early design stages by James G. Davis Construction and greatly reduced the risk of an accident occurring while washing the windows of the high rise. Albert from Skanska mentioned that he has seen

many examples during preconstruction where they have reduced the necessity of facility managers to use a ladder by integrating PTD. Albert added to this statement by expressing his view that occupancy & operations/maintenance concerns are the primary consideration when attempting to incorporate safety through design; “access to equipment is always very important.”

A big reason that designers do not engage in PTD by their own free will is due to liability issues. An example of this issue given during the discussion dealt with structural steel design and erection. If issues are raised with steel connections & their corresponding designs and an erector gets injured, the architect/engineer may be considered liable. So if design professionals are concerned with liability, we need to determine a way to begin these conversations of safety PTD earlier in the process. Several options were thrown around amongst the group including government intervention, more contractual language ideas and resistance of PTD altogether. Dr. Leicht introduced us to the idea of government intervention and was met with resistance almost immediately. The UK has some policies in the way of constructability and fire egress (basically OSHA for design) and some wondered if the US should engage in these policies. The major consensus was that any further governmental regulation would be a sign of our industries lack of safety competency and that we should be able to manage this by creating a safety culture within our organizations.

The questions of what opportunities exist to improve/increase the focus of design on safety issues and what could be done to begin influencing this process can be answered together. Several examples and ideas were brought up along the lines of these questions. The first concern was that no composite database/tool/matrix exists to make decisions for every product or design. Whether this would be a good thing or not was debated, but it left us with the fact that design & safety are not black and white issues. So, maybe a more generic safety PTD regulation to stimulate the thoughts of designers should exist as a guideline rather than a list of set in stone requirements. A 5th year CM student, Brad Williams, suggested a punch list similar to the LEED’s. It would evaluate safety with broad goals throughout all phases of design, construction and occupancy. This got a lot of feedback and support from industry professionals and led to a suggestion of doing a 3rd party design review. A 3rd party professional would review the OSHA “Focus Four” hazards and provide suggestions to the designers before the drawing was stamped for construction. Two other ideas were placing safety in the Target Value Design stage and having designers become “Safety Certified Construction Supervisors”. While 100% safety prevention through design will be near impossible to achieve, any improvement is better than none.

While there have been no recordable incidents at Cardinal Wuerl North Catholic High School at this point in construction, safety PTD would have been a benefit to CWNCHS. First of all, there is still a chance that an incident could occur and it is worth it to evaluate the design of the building in order to determine if any safe practices could have been implemented to avoid an incident. Also, it is worth it for occupancy also to reduce the risk of any injuries for the facility manager and his crew. Bill Moyer provided the group with a lot of valuable examples and seemed to contribute the most valuable information. If I utilized this as an area of study for my project I could contact him at:

Mr. Bill Moyer
James G. Davis Construction Corporation
12530 Parklawn Drive
Rockville, MD, 20852
bmoyer@davisconstruction.com

Breakout Session #2 – Efficient Delivery of Facility Management Information

The second breakout session, led by Ed Gannon and Craig Dubler, focused on efficient delivery of facility management information. With buildings becoming populated with more and more complicated systems, the facilities manager needs to be knowledgeable enough to maintain said systems effectively. This requires a proper turnover of FM information so that they can do their job and keep the building running how it was intended to. Following a brief introduction of the aforementioned issues, industry members introduced themselves. This led to discussions about their experience with FM information turnover on projects as well as their general backgrounds. The following questions helped to guide the group through the session and provide topics of conversation:

- What inefficiences exist now for transferring information between phases effectively?
- What information needs to be turned over for facility management?
- What takes the most time and effort to compile and transfer?
- What relationships or contracts may be hampering the process for efficient transfer of information?
- What workflows would be high value to define more clearly and make repeatable?
- What infrastructure or tool support is needed to make these workflows consistent and interoperable?

The initial inefficiency that was discussed pertaining to information transfer from construction to occupancy was the “paper dump” that occurs when thousands of pounds of paper in banker’s boxes are left with the facility manager and often sits in a basement never to be looked at. After some brief exchanges of back and forth conversation, a few new issues developed. First of all, with the advent of BIM, the next logical step is to provide the owner with a Facility Management BIM Model at substantial completion. This model would contain all relevant submittals and O&M Manuals that are necessary for the Facility Manager to do their job. But how would the FM utilize this model? The observation was made that it’s common that the head of maintenance in a building does not have a computer on the job, let alone the skills to use it effectively. Many of these employees do not know how to read drawings, so asking them to figure out a 3D digital model may be a difficult. The other primary issue was that FM goals are not always developed in the contract or in the beginning of the project. This leaves the CM team without much direction of what to do in order to deliver the FM information efficiently. The owner and GC/CM should meet up front to determine what level of asset management post-construction is to be expected. The construction team can then determine the level of effort to put in throughout the project at the very beginning.

So, what relationships or contracts may be hampering the process for efficient transfer of information? It was also observed that face-time between the construction management team and the eventual facility management team is vital. This gives the CM team and owner and idea of what is necessary to educate the building occupants of rather than sending them into a brand new building with no clue where to start. Mike Arnold expressed some aggravation with what was happening at Cardinal Wuerl North Catholic High School because the A/E and GC are taking the time to develop an FM model per his request and a facility manager has not been hired yet. This issue led to the idea that it may be difficult to specify a facility manager so early on due to payroll reasons. While the building is being constructed, the facility manager will not be working in it full-time, which means they are not being paid. With FM personnel already receiving low wages and often living paycheck-to-paycheck, it may be difficult to get an FM onto the project early unless the owner wants to start paying them without starting work yet. Their compensation at such an early point would be education based and some owners may not like this idea. If the owner is buying into their FM program, it might be a necessary investment.

There is an extraordinary amount of information that needs to be turned over for facility management. Dr. Dubler expressed that this issue was confronted at OPP by combing through the documents that they are given to help reduce the amount of paper or electronic documents that the FM would have to search through to find one piece of information. For example, some paint colors and redundant as-built and shop drawings were deleted because they would be of no use to the facility manager. This was one solution to reducing the mountain of as-built drawings, close-out documents, operations and maintenance manuals, and other miscellaneous information that is attained during the submittal process. The third question of what takes the most time and effort to compile and transfer can be answered partly by the previous sentence. If a BIM Model is required, it often takes an extraordinary amount of time to load all of the information into the model. The models are often very large in the sense of computer memory and require a time investment in transferring them from one computer to another. Another issue that came out of this conversation was the multiple steps it takes to find the necessary information and what infrastructures and tools would be used to achieve this. One gentleman commented that a BIM Model would not be practical until the facility manager could navigate through the model quickly, click on the air-handling unit (for example), and be given a menu of the available information. Often times the FM will only need to know the size and MERV rating of a filter for this AHU so this information should be very easily accessible. In conclusion, the goals of the owner should be identified early on & contractually, the GC/CM should be on board and understand these goals, the owner should attempt to attain a facility manager as early in the construction process as possible, the infrastructure for accessing FM Information needs to be as simple as possible, and the facility manager should be educated to utilize the infrastructure and FM Information (otherwise the entire process was a waste).

CWNCHS is attempting to work out a lot of the kinks that are occurring with FM Information Delivery. I worked on attaining a lot of the information necessary for close-out documentation this summer while on my internship and would be curious to see what Mascaro Construction's Virtual Construction Engineers do with this information and how they make it accessible to the Facility Manager. If I decide to

pursue this as an area of study, it may be beneficial to contact Mike Arnold for his experience with FM Information turnover on my specific project at:

Mr. Mike Arnold
Roman Catholic Diocese of Pittsburgh
111 Boulevard of the Allies
Pittsburgh, PA, 15222
marnold@diopitt.org

Summary

The PACE Roundtable proved to be a very beneficial event to attend. It was very informative and thought provoking not only for developing and making progress with my senior thesis project, but for gaining knowledge of hot topics in the construction industry. It always helps to be aware of the emerging trends in the construction industry. The breakout sessions were the best part of the day in my opinion because they were designed by the facilitators and graduate students to be thought provoking and conversational in nature. These conversations amongst everyone in the room were able to help everyone develop a more informed and diverse opinion. In particular, I was surprised at the informal nature of the breakout sessions. I was expecting a set up similar to a large lecture hall where a professor would stand in front of the group and ask questions while the audience would raise their hand and wait to speak. It was very interesting in the circular set up of the breakout sessions that everyone was able to look around to see everyone's facial expressions and physical reactions to questions/answers. Another interesting surprise to me based on my predisposition of the event was the group was able to talk back and forth with one another and sometimes talk over one another without always having to answer to the facilitator. The industry members in attendance were able to offer their experiences throughout their long careers in the construction industry. This gave the breakout sessions another great dimension that often goes under the radar between students and professors alone. In conclusion, all discussions and conversations that were had at the PACE Roundtable were informative and great for professional development. All of the topics that we discussed were relevant and the collective opinion of the event was that it was in one way or another very beneficial to the students involved and hopefully the same thoughts were garnered with the industry professionals and AE faculty.

Feedback from Industry Roundtable

Mike Arnold was the industry member that I spoke with regarding professional feedback for CWNCHS. I have been working with Mike extensively throughout the life of my senior thesis report and thought this would be a great opportunity to get feedback from him. While considering the "Key Feedback" portion of the evaluation, Mike's primary suggestion was to reduce the width of the main corridor at CWNCHS. In his opinion, even though the corridor serves large gathering spaces like the 1500-person gymnasium & 1000-person auditorium, it was still too wide. This sort of analysis may result with a reduction in total

building cost and a more efficient corridor design. A corridor width reduction may act as an architectural breadth in theory, but it is not a feasible area of study due to the limit of analysis compared to the required amount of analysis necessary for this senior thesis project. With the benefit of hindsight, it may have been more beneficial to talk with someone who had not worked directly with the project.

After this brief conversation, I talked with Mike about some of the ideas that I had been considering for Cardinal Wuerl North Catholic High School. His feedback with these topics proved to be a bit more helpful. He seemed to think that my suggestions for a ground source heat pump due to the large site area and a photovoltaic system on the very large roof were good ideas. Mike provided me the phone number of Travis Kroll at Renick Brothers for an industry contact (724-794-4200). Renick Brothers are the prime mechanical & plumbing contractor at North Catholic and they should be able to provide me with guidance and information with my research of a geothermal system. My ideas for the use of SIPS and prefabrication of façade panels offsite were met with some resistance due to the lack of repeatability in the building design, but these ideas may be a possibility. This information serves as the addition of page 23 from the PACE Roundtable booklet.

APPENDIX A – Value Engineering Tables

Approved Value Engineering Items		
Division 2	*Existing Conditions*	House Misc. Demolition
Division 4	*Masonry*	Deduct Glazed CMU & Replace w/ Standard CMU w/ Epoxy Paint
		Split faced CMU in lieu of Ground Face CMU
Division 5	*Metals*	Eliminate Decorative Pipe Trees In Corridors
Division 7	*Moisture Protection*	Change Metal Panels at Gym/Audit. - 16,000 SF to Brick w/ Polyisoboard
		Change Metal Panels on Other Areas to Brick
		Change Flat Roof w/ Tapered Insulation to Sloped Steel w/ Flat Insulation
Division 8	*Doors & Windows*	Provide 1-3/4" medium stile in lieu of 2" monumental aluminum storefront doors
		Provide solid flush wood doors - keep one sidelite
Division 9	*Finishes*	Delete Level 5 Finish on All Drywall - Walls & Ceiling
		Ceramic Wall Tile Design - Reduced Material by 1/2
		Reduce material price of Tile - $17.80/SF to $12.00/SF installed
		Use polished concrete in lieu of Linoleum
		Use a standard rubber base in lieu of custom rubber base - Take Half
		Use sealed concrete in place of carpet underneath Auditorium Seating
		Use different Rubber Athletic Flooring manufacturer
		Armstrong School Zone Fine Fissured rather than Ultima Ceiling Tile
		Curved Drywall Ceiling in-lieu of the Wood Linear Ceiling in the 2nd Floor Corridors (F & G)
Division 11	*Equipment*	Loading Dock Equipment/Scissor Lift - Receiving & Stage Workshop
		Kitchen Equipment
		Theatre/Stage Equipment - Eliminate Dimmer in Electrical Pex
Division 12	*Furnishings*	Library Furniture - Check to see if package includes Tables & Chairs
Division 23	*HVAC*	Act 45 Tax Savings
Division 26	*Electrical*	Reduce Decorative Pendant Bowls from $1,100 --> $600 each
		Substitute aluminum for copper Feeder Conductors - Size #1/0 and above
		Act 45 Tax Savings
		Eliminate Blue Ray from Decorative Down Lights
Division 31	*Earthwork*	Reduced Seeding Costs at Storm Water Management Ponds
		Increased topsoil productions to Dry Weather Applications
		Reduced Excavation quantities in Building Pad Area to 150,000 CY
		Clearing & Grubbing - Sub Quote Updated
Division 32	*Exterior Improvements*	Add Concrete Curb at Parking Island - 2,000 LF
		Reduce Guard Rail by 1,000 LF
		Increase Landscape Planting allowance
		Increase Monumental Signs to $25,000 each
Division 33	*Utilities*	Eliminate Half of Roof Collection System - Drain on Surface
		Aggregate Backfill/Production Adjustments at Storm Piping
		Need Empty Conduit to Cross Roads for Future
Total Approved VE Savings:		**$3,502,964.00**

Figure 5: Approved VE Items

Pending Value Engineering Items		
Division 1	*GCs & Mark-Ups*	Delete Bond Requirement
		Sales Tax Exempt
		B&O Tax
		Act 45 in addition to MEP - Loose Equipment can't take with 1.02
		Building Permit
Division 3	*Concrete*	Change joints from 10' OC to 5' OC
Division 7	*Moisture Protection*	Change Metal Panels at Gym/Auditorium - 16,000 SF to Hard Panels
Division 9	*Finishes*	Reduce Kinetics Ovation Reflector Ceiling Panels in Auditorium by 2,000 SF
		Use Vinyl Enhanced Tile instead of linoleum in all rooms
		Reduce Carpet Material by by $10/SY
		Use a Drywall Ceiling in lieu of the Wood Linear Ceiling in 1st Floor Corridors
Division 10	*Specialties*	Display Cases - Reduce by Half
Division 12	*Furnishings*	Wood Laboratory Casework
Division 21	*Fire Protection*	Eliminate Pre-Action System from Server/Security/Technology Head-End
Division 23	*HVAC*	Eliminate Sound Attenuators at VAV Terminal Units
Division 26	*Electrical*	Eliminate Day Lighting feature in Base Bid Classrooms
Division 31	*Earthwork*	E&S Controls - Pending Completed Drawings
Division 32	*Exterior Improvements*	Eliminate Parking Bumpers at Stalls with Curbs
		Change 3,000 SF of Site Sidewalks to Crushed Limestone
Division 33	*Utilities*	Gas Line by Utility
Total Pending VE Savings		**$ 3,506,382.00**

Figure 6: Pending VE Items

Rejected Value Engineering Items		
Division 6	*Woods & Plastics*	P-Lam Sills in lieu of Solid Surface
Division 7	*Moisture Protection*	Change Metal Panels at other Areas - 12,200 SF to other Manufacturer
Division 8	*Doors & Windows*	Eliminate Clerestory Windows - 1st Floor F & G
Division 23	*HVAC*	Packaged Rooftop Units in lieu of Chilled Water System
Total Rejected VE Savings		**$ 552,200.00**

Figure 7: Rejected VE Items