November 16th, 2011

Technical Assignment 3

Unionville High School
Additions and Renovations

Michael Beam | Construction Option | Advisor: Dr. Messner

Executive Summary

Technical Assignment Three focuses on several important topics regarding the Unionville High School Building Additions and Renovation project. Information was gathered from the project team and the PACE roundtable discussions in order to put this report together. Issues to be discussed in this report include: **Constructability Challenges, Schedule Acceleration Scenarios, Value Engineering Topics, Critical Industry Topics, Problem Identification, and Technical Analysis options**.

Constructability Challenges are faced by nearly every project team on every project. As an educational project, Coexisting with Faculty and Students was a big challenge for the school. A Tight Schedule was the driving factor for the project and also proposed a challenge for the construction team. In a way, both challenges were addressed by creating a detailed Phasing Schedule. This allowed for strategic location of work and time throughout the entire construction process. Finally, Renovation Coordination during the project proposed unique challenges for the construction team.

As mentioned above, **the schedule** was the driving factor for this project. The Critical Path for the schedule is discussed and includes Phase 1, Cafeteria and Kitchen Renovations, and the construction of the New Gymnasium. Risks to the completion date are highlighted in this section as well. Finally, Acceleration Scenarios for the project are highlighted including restructuring of the phases, increased workforce, or work during premium time.

Value Engineering is a must in today's construction industry; separating yourself from the competition goes a long way in securing work. The project team proposed numerous ideas to the owner prior to construction. Several of the VE topics implemented on the UHS project include removal of rooftop AHU screens, warranty reductions, and material alternatives. Some items were proposed but not pursued, including duct alterations, pipe alterations, and insulation changes.

The Pace Roundtable provided valuable insight regarding **Critical Industry Issues** for those in attendance. Topics discussed during morning breakout sessions allowed students to hear industry professionals voice their opinions on such topics. Integrated Project Delivery and BIM implementation in the field are highlighted, discussing what issues are most prominent in the industry today. The afternoon panels also provided quality insight, with information regarding the Down Economy as well as Hands-on learning in Design and Construction. During the discussions, several topics seemed to be pertinent to the UHS project including Collaboration, Information Flow, and BIM implementation.

Finally, to help guide our proposals, **Problem Identification** was targeted. Several areas of interest at UHS include Coordination and Information Flow, Sustainability, Schedule, BIM Usage, the CMU Façade, and Renovation Challenges. These topics helped to provide potential analysis areas, which include **Information Flow, BIM USE, Schedule Acceleration,** and a **Sustainability and LEED Study.** These areas are all important to this specific project and the construction industry as a whole.

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Constructability Issues

Working with Faculty and Students

As is true with any renovation project, many people needed to continue to use the Unionville High School building throughout the construction process. Managing the project in a manner that allows contractors to work cohesively with faculty, staff, and students was the most important issue to consider during the development of the project plan. The primary strategy employed during design development in order create an efficient construction process was the implementation of **phased construction.**

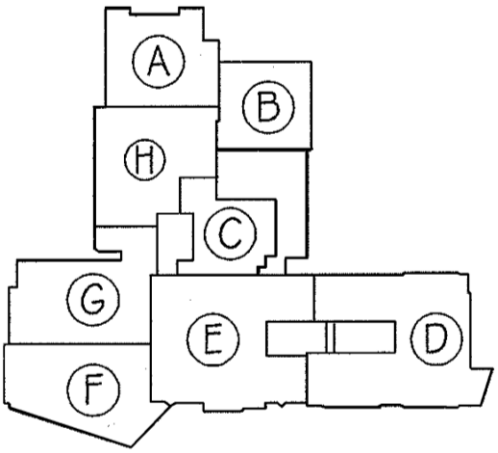

Figure 1: Building Area Key

Phased construction was the main focus for the project team in terms of keeping construction flowing smoothly. Without phased construction, a project of this size (319,000 square feet) and type (educational) would be extremely difficult to complete on time and under budget. By breaking the project into multiple phases, the construction team was able to strategically plan the entire construction process. Four main phases and 16 total sub-phases and 8 building areas (see Figure 1) have been created for the Unionville High School Building Additions and Renovations project:

Phase Breakdown

- **Phase 1**: Construction of the New 3 story addition, set to house the Unionville-Chadds Ford School District Administrative Offices, Classrooms, and Science labs.
- **Phase 2**: Demolition of modular classrooms, construction of the New Auditorium, Art rooms, and Family and Consumer Classrooms.
- **Phase 2A**: Renovation of existing Large Group Instruction, Library, Faculty Restrooms, Cafeteria, and Kitchen.
- **Phase 2B & 2C**: Renovation of existing District Administrative Offices into High School Offices, Science Labs, and Classrooms.
- **Phase 2D**: Renovation of existing High School Offices, Music Area, and Faculty Dining.
- **Phase 2E**: Renovation of existing Science Labs and Classrooms.
- **Phase 2F**: Renovation of existing Classrooms
- **Phase 2G**: Renovation of the existing Computer Applications Labs and Classrooms.
- **Phase 2H, 2I, 2J**: Renovation of existing Classrooms.
- **Phase 3**: Renovation of existing Auditorium into Choral Room and Tech Ed Classrooms.
- **Phase 4:** Construction of new Gymnasium, demolition of existing Classroom and Tech Ed Wing and Weight Room.
- **Phase 4A**: Renovation of existing Gymnasium, Locker and Team Rooms.
- **Phase 4B**: Demolition of existing Auxiliary gym.

Each phase has been carefully designed in order to provide the most efficient project possible. Phase 1 includes the construction of a brand new portion of the building set to house Administrative Offices, new classrooms, and new science laboratories. As this portion of the building is brand new, no faculty, staff, or students are displaced as a result of the construction during this phase. The new administrative offices are to be located on the ground floor, with the second floor designed to provide classroom space and the third floor to house new science laboratories. Figure 2 shows the breakdown of the phases based on floor and location within the building.

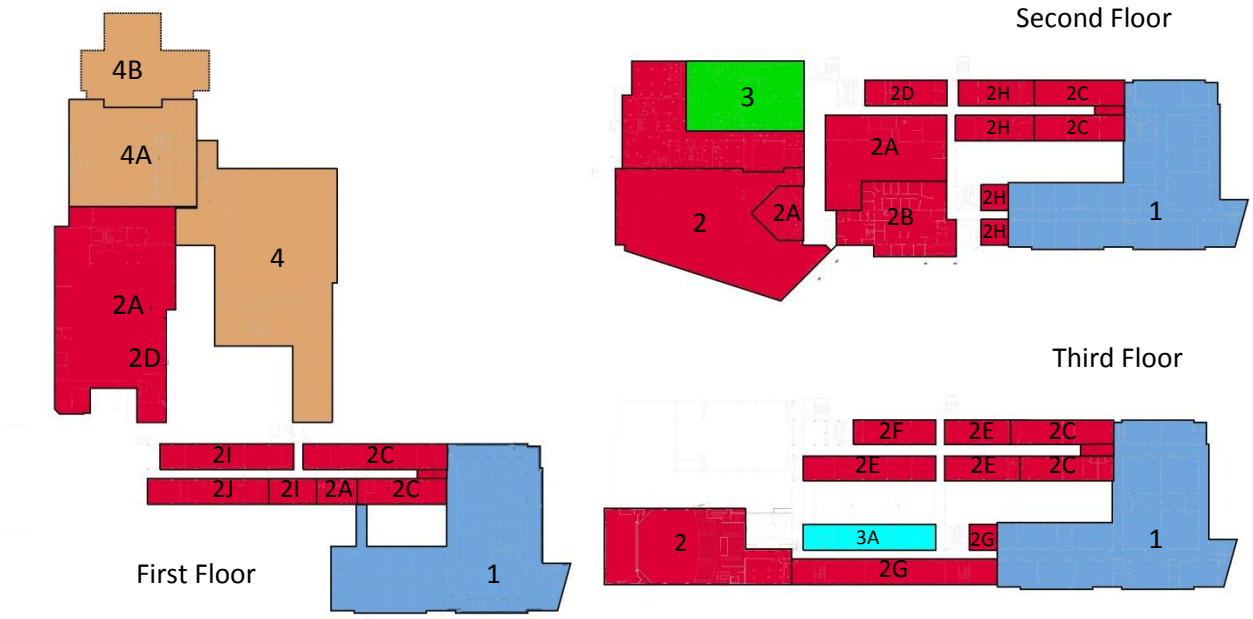

Figure 2: Phasing Plan

Phase 2 is split into eleven sub phases and focuses on the demolition of modular classroom space, the construction of the new state-of-the-art auditorium, and renovations of existing spaces within the building, including offices, the library, restrooms, and the cafeteria. During this phase students are to move into the new Phase 1 classroom space allowing the subsequent demolition of modular classroom space that had been created prior to this project as a result of increased population and lack of space within the building. Some existing spaces to be renovated during Phase 2 include large group instruction space, the library, restrooms, and the cafeteria and kitchen space. Two areas here are of great importance, the library and the cafeteria. These two spaces are used on a daily basis during normal school operation and without them the school simply cannot function (especially in regards to the cafeteria). Work on these areas could only be done during the summer, meaning that any schedule delay would surely force the work into the following school year. Also to be renovated during this phase is a large quantity of classrooms as well as the existing Unionville-Chadds Ford School District Administrative Offices, which are to be converted into the new Unionville High School offices. By scheduling the construction of the new administrative offices in Phase 1, the project team was able to move the faculty and staff into the new office space without having to displace

them for an extended period of time.

The existing Auditorium is to be renovated during Phase 3, with the space being transformed into Choral and Technical Education rooms. With the creation of the new auditorium during Phase 2, the existing auditorium is opened up for renovation following the completion of Phase 2. By scheduling the construction of the new auditorium first, the project is able to flow smoothly without rendering a key portion of the school useless.

Finally, Phase 4 will see the construction of the new gymnasium followed by the renovation of the existing gymnasium and the demolition of the auxiliary gymnasium. Construction on the new gymnasium is set to initiate Phase 4, with the renovation of the existing gymnasium and the demolition of the auxiliary gym coming thereafter. Again, by sequencing the order of construction in this manner, the existing gymnasium will remain in use until the new facility is ready for occupancy.

Each phase was developed with the intent of creating the most efficient construction plan possible all while minimizing the disturbance caused to faculty, staff, and students during the construction process. Phasing the project helped to keep the contractors out of the way of the school occupants while still managing to complete the project on time. Relocation of any building residents was not necessary as the construction schedule was designed to avoid working on any portion of the building that would displace building occupants. By breaking the entire project down into simpler, more manageable sections, the project team was able to lay out exactly how the construction process would ensue.

Tight Schedule

Another key constructability issue for this project was the **tight schedule**. Educational facilities rarely have time off from use, meaning that time is of supreme value; this particular project was no different. With a contract value of around $52 Million Dollars and a building size of 319,000 square feet, the UHS building project comes with significant importance. Hundreds of people use the building every day, so a minimal project schedule was very important. Any delay during the schedule would surely disrupt those who use the facility on a day-to-day basis; a domino effect of sorts would occur should any one phase be delayed. Ultimately, avoiding disruptions is not merely the goal, but the only option.

The strategic phasing of the construction process allowed for careful control over project flow. Certain portions of the project needed to be completed before others could begin. As mentioned before, school projects are very time sensitive; some portions of the building simply must be occupied at all times. For this reason, along with numerous others, some work had to be done during the summer when school was out. With students and some of the faculty off for the summer, this is the optimal time frame to perform construction on an existing educational facility. Figure 2 above shows the detailed breakdown of the phases within the schedule.

Work on the Unionville High School building began in the summer of 2009. The new Administrative Offices were scheduled to begin on June 22nd 2009 and complete on June 25th 2010. Any delay during this process would push the end date back and, in turn, delay the renovation of the existing Administrative Offices into UHS offices (Phase 2). As you can see, each critical item within the project or even within each phase directly affects another, if not multiple other areas of construction.

The most sensitive area of the building in this regard was the renovation of the cafeteria and kitchen. At no time during the school year can either of these spaces be tied up for an extended period of time. The kitchen and library are both used on a day-to-day basis and, without them; the school can simply not function as necessary with these spaces out of operation. Again scheduled during the summer (scheduled to begin on June 14th 2010 and conclude on August 15th 2010), the renovation of the cafeteria and accompanying spaces put a huge squeeze on the project team. Any delay during this phase of construction would not only delay other phases of construction, but would also begin the accumulation of liquidated damages for the project team.

Overall, the phased schedule for the Unionville High School project was purposefully developed in order to prevent the disruption of building inhabitants and helped to provide better management of the schedule throughout the construction process. As a result of this detailed schedule, the timeframe in which each phase is to be completed takes on great importance. Even a slight delay is not an option and great care must be taken to ensure that no such interruption occurs.

Renovation Coordination

New construction is an undertaking that can introduce a never ending array of challenges. A renovation project, however, presents many challenges that new construction projects sidestep. On this project, the construction team faced numerous such challenges throughout the construction process. Combining new construction with renovation work only adds to the pressure of successfully completing the renovation of an existing building. Figure 3 outlines the footprint of the building including both existing structure and new additions.

Throughout the course of the project, the entire project team must remain in constant contact in order to facilitate efficient communication. This means that all involved parties must interact effectively in order to complete the renovation work as needed; communication between the Owner, Contractor, and Architect is vitally important. Wohlsen Construction was fortunate enough to not only have a cooperative Owner for this particular project, but to also have constant communication with the owner whose office is located within the building.

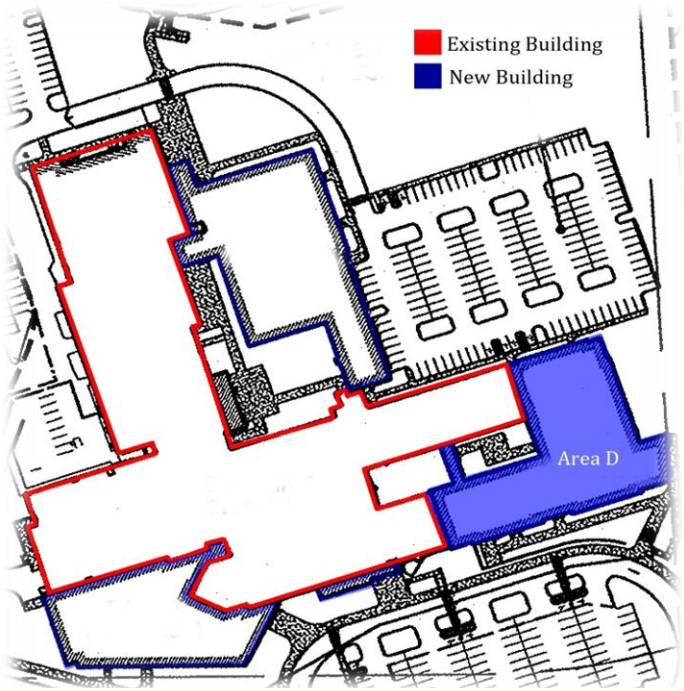

Figure 3: Building Footprint

A common occurrence during renovation projects are the dreaded unforeseen conditions. Depending on the structure of the contract, the responsible party for these items differs. This project, as is true with most renovations, encountered its fair share of unforeseen conditions. One such instance came during the beginning of Phase 4, when ground was broken in order to begin the foundations for the new gymnasium. At the northeast corner of the plot of land on which the gymnasium was to be built the project team discovered a large concrete tank. The tank was significantly large and squarely in the way of one of the footings in the process of being laid out. The ability to communicate effectively and efficiently allowed for the quick resolution of this problem and minimization of any delays.

The ability to contact the owner and receive nearly immediate feedback is a luxury that not all construction teams enjoy. As mentioned before, with such a time sensitive project, quality communication is an enormous advantage. Quick resolutions to issues like the one discussed above, as well as smaller issues, allow the project team to maintain the schedule with minimal glitches.

Schedule Acceleration Scenarios

A total of 16 subphases have been developed to efficiently manage the Unionville High School Building Additions and Renovations project. Completing the project under budget is important much like most construction projects, but the schedule is the driving force behind this particular project. Completion of this project must happen as scheduled, for activities within the school directly depend on having specific portions of the building available at previously determined times. Each phase of construction follows a similar structure, depending on whether the phase included new construction, renovations, or both. Generally speaking, the project schedule for each new construction phase is as follows:

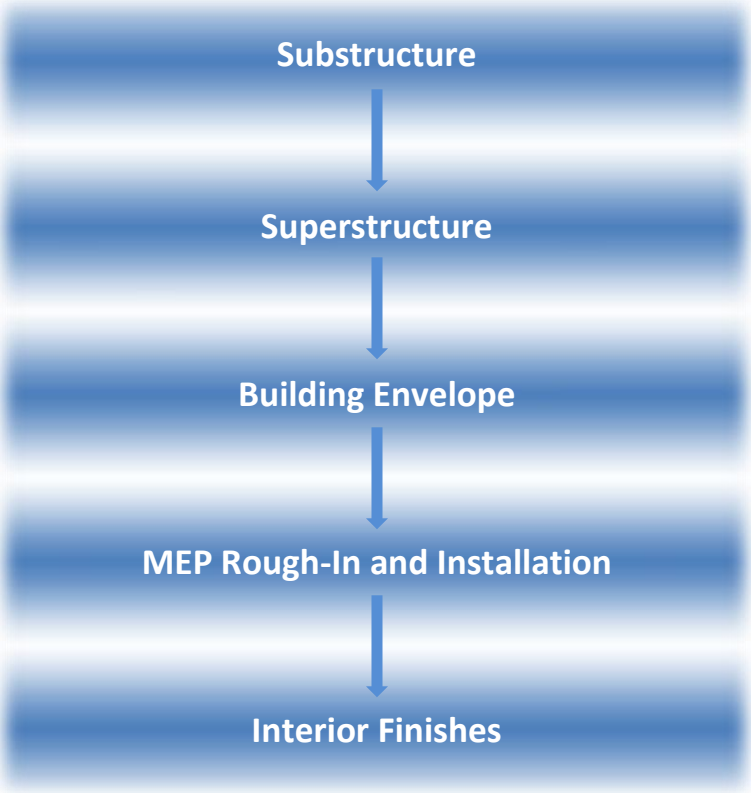

Figure 4: Project Flow

Critical Path

The critical path for the project is made up of several key components within the project schedule. Obviously, some phases are directly connected to others and cannot begin without the completion of prior phases. Specifically, the following items are most critical to the project team: **Phase 1, renovations to the Cafeteria and kitchen area, and construction of the new Gymnasium.** Each item is highlighted and potential risks to schedule completion are mentioned regarding each item.

Phase 1 is critically important to the success of the project as it is the first phase of the project. During Phase 1, the new Administrative Offices will be constructed. The primary reason that Phase 1 is integral is because Phase 2 is affected directly by its completion date. Without the completion of the new Administrative Offices, Phase 2 (the renovation of the existing Administrative Offices into the new Unionville High School offices) cannot begin. Should Phase 1 experience any type of delay, the project schedule would be dramatically affected. Not only would the end date of the project be moved back, but scheduled move in to the new portion of the building would not occur as the needed date.

Another critical portion of the project is the renovations to the school's Cafeteria and kitchen areas. Obviously, these areas are of extreme importance to any high school; without them, the school cannot function as needed. This work is scheduled to be completed during the summer of 2010 when students and much of the faculty will be off of the campus. Should anything push the completion of this portion of the project to a later date, school would be unable to function properly. Frankly, completing this work on schedule was the only option for the project team.

The last critical section of the schedule comes during Phase 4, when the new Gymnasium will be constructed. Construction of the new Gymnasium precedes renovation work on the existing gymnasium. Any delay during the new gymnasium construction will push back the existing gymnasium renovation work. Delays to the renovations of the existing gymnasium would in turn delay the demolition of the auxiliary gymnasium and ultimately, the completion of the project.

As a side note, weather plays a large part in many construction projects. Should any type of natural disaster or a high frequency of bad weather days occur, completion of the project ton time could be at risk. Additionally, business in this down economy is extremely difficult to come by. Some companies are constantly at risk of going under and, should something like this occur, the project team and the project itself could experience delays.

Schedule Acceleration

The driving factor for this project is the schedule; completion of construction on time is a necessity. Breaking the construction schedule into multiple carefully planned phases made the most sense and allowed for optimal work flow. Each phase was directly tied to at least one other, if not multiple phases, meaning that any delay to one phase would directly affect others. Throughout the project, schedule accelerations were achieved by moving up the start date of several phases for various reasons. Listed below are the changes to the schedule (as of the creation of this report).

Phase Start Date Advances

- **Phase 2A**: Start date moved from June 14th 2011 to June 2nd 2011
- **Phase 3**: Start date moved from July 4th 2011 to June 9th 2011
- **Phase 4:** Start date moved from January 2nd 2012 to July 7th
- **Phase 4A**: Start date moved from June 18th 2012 to May 24th 2012
- **Phase 4B**: Start date moved from November 5th 2012 to April 28th 2012

As a result of the combination of these schedule advancements, construction for the Unionville High School Renovations and Additions project is anticipated to complete on **September 28th 2012** rather than the originally scheduled completion date of **December 28th 2012**, a savings of exactly **three months.** After sitting down with the owner and discussing an earlier start date, the project team agreed that the plan proposed would work and the schedule was adjusted. Saving a quantity of time as significant as this on an educational project, especially one of this size that affects so many people, is invaluable. The ability for the owner to settle into the new building three months early allows all involved parties to return to normalcy at an earlier time.

Within the construction industry, numerous options exist in terms of accelerating a project schedule. One way in which the schedule for the Unionville High School Project could be accelerated, if needed, is to adjust the schedule to begin multiple phases at the same time. To accomplish this shift in the schedule, a larger workforce would be required on the job at one time than is normally scheduled. As a result of the increased work force, labor costs would increase, providing an area of concern should this option be explored. Schedule acceleration is the primary focus of this type of change which may justify the added cost, depending on which factors drive the project.

Phase 2 of the Unionville High School Additions and Renovations project is primarily focused on renovations, with multiple subphases containing renovations on various portions of the building. By **combining several phases** together, a significant chunk of time could potentially be saved. Starting Phases 2E, 2F, and 2G at the same time, all of which involve work on the 3rd floor of Area E within the building, could potentially save the project valuable time. Phase 2E is the longest of the three, spanning 31 days, with Phase 2F and 2E spanning roughly 12 and 15 days respectively. If combined and started on the same date, renovation work on the three phases would begin on January 3rd 2011 and complete around February 14th. Combining the three to Phases into one phase in which all work is to be worked on simultaneously could save the project up to **one and one half months.** One drawback to this option, however, is the necessity to displace building users during construction. Phasing for this project has been developed in order to prevent large displacement during the construction process; lumping multiple phases into one phase would remove more useable area from the building and in turn would put a strain on the building inhabitants.

Another option to accelerate the schedule is to employ a **larger workforce** on any given phase during the construction process. Providing more workers for the project would speed up the project based upon the volume of the labor increase. Conversely, cost would rise just as much based on the new workforce additions. Although this option is not ideal, it is frequently an option if schedule is of the utmost importance and an acceleration of the schedule is necessary. Along the same lines, **premium time** work could be employed at various stages of the project. Premium time can come in the form of overtime, 2nd and 3rd shift work, or weekend work. Providing manpower during this time would accelerate the project, although the cost increase likely would deter the team from using this option. Like an increase in manpower, however, employing the workforce during premium time is usually an option should a project come between a rock and a hard place.

Value Engineering Topics

Value engineering (VE) is a valuable service that a construction team can provide to the owner before and even during construction. For the Unionville High School Building Additions and renovations project, VE was implemented prior to construction. Many areas were targeted with the ultimate goal of saving the owner time and money in mind. All VE ideas were presented to the owner and reviewed, determining which items fit in with the Owner's goals while sacrificing no quality. This section will highlight some of the larger VE ideas to be used on the project and will also mention several items that were not approved.

AHU Screen

A popular method of disguising rooftop mechanical units is to hide the AHU using mesh fences to cover the large pieces of equipment. Although the fence would improve the aesthetics of the building by covering units that are visible from the ground, this particular project and owner did not view the screen as a requirement. Removal of the screen was a VE idea that was accepted and used on the project with the primary reason being to save the owner money; the actual amount of money saved by removing the screen is not known. Figure 5 shows Area D of the building, the new addition containing the Administrative Offices, with rooftop AHU's without fences.

Figure 5: Rooftop AHU without screens

Warranty Reductions

Another VE idea used on the project is the reduction of several warranties. Initially, both the new HVAC and Plumbing systems were to be lumped together as one system with a 2 year warranty. The owner requested a split of the two systems and a reduction of the warranties. The project team responded with a proposed reduction of each warranty to one year, which would result in a savings of **$82,500**.

Locker Room Flooring alternative

The original design for the new locker room space specified rubber floor tiles for the finished floor. As an alternative, the project team proposed the use of epoxy flooring, a floor finish already scheduled to be used in other areas of the building. Figure 6 shows an art room with the same finished epoxy floor to be used in the locker room area. The owner accepted the alternate flooring and agreed to the change, resulting in a savings of **$38,000**.

Figure 6: Epoxy flooring in new Art Room

Pipe Insulation Alternative

The piping within the new plumbing for the project was specified to use Vaporwick Insulation. The project team proposed an alternate insulation, standard fiberglass pipe insulation, in order to cut down on costs while achieving similar quality. This idea was approved by the owner and resulted in savings of **$24,300.** Figure 7 shows in place pipe using the alternate insulation proposed by the project team.

Figure 7: Installed Pipe Insulation

VE Ideas not Implemented

Although many Value Engineering applications were used throughout the project, several items never made it into the field. The list below highlights which items were not used and the reason for discarding them.

- Duct Wrap in lieu of Duct Board for Exposed Insulated Ductwork
  - The owner determined that Duct Board was necessary for this application, due to the type of activities that would occur in theses spaces.
- Victaulic Grooved Piping System in lieu of Welded System for HVAC
  - Due to extremely tight space requirements, welded connections are preferred. Also, welded connections protect against leaks better than mechanical couplings
- Sound Traps in lieu of Double Wall ductwork
  - Sound traps take a large pressure drop compared to double wall ductwork; this pressure drop could change fan specifications and terminal unit sizes.
- Single insulation Spiral in lieu of Double Wall insulation in Gym and Fitness Area
  - Single wall spiral keeps external insulation but eliminates the interior insulation; this barrier against moisture could be compromised if the external insulation is ripped or damaged.

Critical Industry Issues

PACE Roundtable Discussions – Breakout Sessions

The 2011 PACE Roundtable provided the opportunity for industry professionals and students alike to come together with the intent of discussing pertinent issues within todays Construction industry. Broken into several different sessions, the annual function provided multiple opportunities for discussion regarding different topics. Two morning breakout sessions, each separated into three more specific areas of discussion, had a large group consisting of both students and industry professionals. During the first breakout session, I elected to attend the **Assembling/Procuring an Integrated Team** discussion.

The individuals who chose to attend this specific topic created a well-rounded group for the discussion. Large firms were represented, as well as smaller firms, subcontractors, professors, and students. The varied assembly brought many different points of view to the table and promoted quality discussion throughout the meeting.

Integrated Project Delivery (IPD) quickly developed into the primary focus of the meeting and for the most part drove the discussion. An interesting and overwhelming opinion throughout the group was the need for **trust** among all parties involved. Without trust, everyone involved in the process is at a disadvantage; confidence in one another helps to remove separation within the group and allows all involved parties to work as one for the group's overall benefit. This discussion also led to the topic of accountability. Selection of the proper team members is key, as everyone is working together as one unit and sharing the risk involved.

Another issue brought up was the presence of multiple **barriers** in regards in implementing IPD. The logistics necessary to implement this new delivery system came up frequently and were viewed as a large hurdle. While Design-Build is fully implemented within the construction industry and has been for some time now, the paperwork and contracting needed to form an IPD team seemed to be an area of concern. Another barrier seems to be the transfer of information between different parties. The ability for all involved parties to obtain necessary information at any given point in time is invaluable. Project transparency is difficult to obtain however, and without it, the flow of the project is greatly compromised.

Finally, an individual brought up the idea of **IPD 'lite'**. Essentially, IPD lite refers to using IPD for specific applications or to certain portions or areas of a project. This topic in particular interested me greatly; using IPD for more specific applications within a project rather than the project as a whole may still provide value to the owner. Integration could potentially be inserted at key points of the building process or to key scopes within the project in order to benefit the project as a whole.

During the second breakout session, I sat in on the discussion about **Strategies and Opportunities for Taking BIM into the field.** BIM has grown in efficiency and popularity in recent years and there are no signs of the movement slowing. One of the great challenges today within the construction industry regarding BIM is determining how to bring this new technology into the entire project to benefit.

Recently, the use of **tablets or iPads** in the field has increased. Having the information physically available in the field is extremely valuable. While BIM stations, computer setups using large screens, have been and continue to be used in the field, the ability to move throughout the jobsite all while having the BIM information at ones fingertips is a truly exciting thought. Information flow drives construction and increasing the availability of this information can only help a project.

Another interesting topic discussed is the relationship with the owner regarding BIM. It seems as though owners are not completely aware of exactly what BIM technology can offer the job. Obviously, value is seen by the owner when a model is displayed prior to or even during construction, but is there more that this new technology can provide to the project? Interaction with the owner can help to keep them up to date and in the loop on what is going on throughout the construction process. Rather than simply showing the results of collaboration between other parties, collaboration including the owner can also be achieved. One way of improving this relationship could be to provide up to date information to the owner in order to keep them on the same page as the rest of the project team.

Along the same lines of the IPD lite mentioned earlier, the idea of implementing BIM in a more specific sense was mentioned as well. Some of the difficulty in implementing BIM comes from the fact that many of the people who are actually performing the work, the people who provide the trade work on a project, are set in their ways. Construction has been built from two dimensional drawings since the industry began and changing that culture is one of the largest hurdles to overcome. By catering BIM and its uses to specific trades or instances, the learning curve can be eased for those involved.

Lastly, the **future of BIM** implementation was discussed. Just how much information can be combined and accessed within BIM technology and models? Currently, difficulty in removing information from models creates issues on project. Should the process to extract information from a model improve, the efficiency and effectiveness of using BIM on a project would increase exponentially. Functionality of these models has improved over the years, however, as models are now being used for construction rather than just design. BIM's true value and effectiveness can only be seen if the majority of the professionals with the industry are comfortable with its use rather than the minority. As of today however, many people within the industry simply do not have the knowledge required to properly implement the new technology.

PACE Roundtable Discussions – Industry Panel

The afternoon session of the PACE Roundtable was again split into two main portions. Leading off the afternoon was the **Industry Panel,** which focused on **Differentiation in a Down Economy.** In light of the difficult times that the industry has been facing as a result of the economic down turn, this topic was certainly appropriate.

Early on in the discussion, it became clear that adjusting to the change was a must. Construction is said to lag other industries by 18 months for construction only occurs if other industries need work done. Despite recent improvements, the economy is still not where it was just a few years ago when construction was booming. The overwhelming opinion on this topic was that the best option was to adjust to this economy rather than waiting for circumstances to return to 'normal'.

The Down Economy has promoted the use of **Lump Sum** contracts, or contracts with a predetermined fixed cost in addition to a small fee. In this situation, where work is at a premium, these fees can shrink from small to miniscule. Another change in philosophy has been moving away from the strategy of obtaining several large projects and moving towards obtaining multiple smaller projects. Small projects obviously provide less revenue for a company, but the decrease in projects size allows for the turning over of projects at a higher rate.

PACE Roundtable Discussions – Combined Panel

Session number two consisted of a combined panel, with members including a contractor, an owner, a graduate student, and an undergraduate student. During this session, the topic was **Hands-On Learning in Design and Construction.** Much of the discussion centered on students' transition into the construction industry. Differentiation for individuals is an enormous benefit; separating oneself from others with a similar educational background can provide companies with a better understanding of who you are and what you will bring to their company, not only immediately but down the line as well. A continuous desire to learn and the ability to be proactive will go a long way to show your worth. Sitting around and waiting for direction may be necessary sometimes, but thinking outside of the box is another way to make a name for yourself.

Relevant Issues for UHS

To some degree, each construction project faces similar challenges despite differences in size and scope. Pinpointing issues specific to a project and correcting them is the true challenge of construction; refining the process and increasing efficiency will remain the goal of the construction industry until the end of time. Several issues discussed during the PACE Roundtable event are pertinent specifically to this project, Unionville High School Additions and Renovations. One issue brought up during the PACE conference that may be relevant to the UHS project is the potential need to increase **collaboration** throughout the project. Working more efficiently within the project team not only saves the owner time and or money in the end but can provide value to the construction team as well. Increasing collaboration within project teams can help individuals to learn from one another and ultimately produce a higher quality project. The implementation of IPD for some portions of this project may be an effective way to promote more collaboration.

Another issue that could affect the UHS project is **information flow**. The flow of information is vital on any project and realistically will usually have room for improvement. Optimizing how easily information is shared between parties and how quickly responses are obtained could greatly benefit a project. As a large project spanning multiple years, the Unionville High School project would undoubtedly benefit from optimization of information flow. Almost any delay in the construction process would parlay into a later end date, which realistically is not an option. One final issue to look at is the implementation of **BIM** on the project. Although BIM use for the entire project may not be the best application, uses in specific instances could certainly benefit the project team and owner alike. Specifically, a study regarding the existing conditions of the portions of the building that are to be renovation could provide the project team with invaluable information. Information gathered from this type of study could be translated into few changes, less cost increases, and faster turnover times.

Key Contacts

One of the best sources of information on all of the above issues is the faculty here at Penn State. Each faculty member has seen a multitude of projects and issues during their career and continues to stay up to date with new challenges within the industry. Dr. Leicht and Dr. Messner are two valuable resources with experience in BIM as well as the construction industry as a whole. Outside of the faculty, industry members who have experience with dealing with different issues are of great values. Some firms haven't touched BIM while others use it on every job. Rob Grottenthaler of Barton Malow provided insight into the construction industry while and remains cognizant of our struggles as students due to his age, which may be a big help for me. Finally, owners of jobs who've experienced some of these issues may be a great helps as well. A viewpoint from the other side of the table can be invaluable and could help to push an analysis in a new direction.

Problem Identification

Every construction project has strong and weak points. Topics below highlights areas of the project that could potentially be investigated in order to improve the process. Although not every item is necessarily a problem, these items provide an opportunity to improve efficiency or go about the process in a different way. The next section will discuss more specific areas, taken from the identified problem areas, to be targeted for analysis.

Coordination and Information Flow

Every construction team faces struggles to optimize information flow during the construction process. Communicating effectively with each party of the construction team is not always easy. Extended turnover time for RFI's, change orders, and submittals can cause small delays throughout the project, resulting in lost time for the construction team. By increasing the efficiency of information flow, time and money can be saved due to elimination of delays and an overall better understanding of the project as the construction process goes on.

Sustainability

This project, designed in 2007, is scheduled to receive a LEED Silver Rating (based on the 2007 system). If judged based on the 2009 system, the UHS Building is only on pace to receive a LEED certification. Many areas were targeted to achieve LEED credits, but a number of other credits could be obtains with little effort. Some areas within the LEED analysis make more sense for this specific project, and could be investigated further to determine which areas are realistic to target.

Schedule Significance

As an educational building, the schedule is of utmost importance and is the driving factor for this project. With multiple phases and subphases, it is key to ensure that construction occurs on time and that the schedule does not get extended. Investigation into possible schedule acceleration is of value to the owner in order to move up the completion date to allow the school to return to normal operation at an earlier date. Although the schedule is scheduled be completed on time, and acceleration of the schedule can provide the owner with valuable time to return to normal operation.

BIM Usage

This project chose not to implement BIM at any point during the proejct. Although using BIM for the *entire* project may not be the most efficient usage for this particular project(due to the renovations within the building), partial utilization could have helped to increase coordination. Ultimately, the design and construction process could possible be eased by using BIM tools and can help to cut down on changes throughout the project, saving time and money.

Delivery Method

As a Single Prime hard bid public works project, the UHS project delivery method is different than the normal delivery method for education buildings in Pennsylvania. Use of an Integrated Project Delivery (IPD) method, at least for portions of the project, could help to increase efficiency.

Rock Face CMU Facade

The initial design for the façade for the new portions of the building consists of Rock Face architectural CMU blocks with red brick accent courses and limestone lintels. As a stick built system, construction of this wall takes significant time as each course must be laid by hand. Using another façade system could allow for schedule acceleration. Also, with “punch-out” windows, minimal natural light fills the new spaces. An alternative façade system could be used to increase day lighting without compromising the aesthetics of the building.

Partial Occupancy/Renovation challenges

Working within an occupied space is always a challenge for the construction team. On this project, renovation spaces are adjacent to occupied spaces which can lead to unwanted interaction between the construction team and building occupants. Certain aspects of construction can be enhanced in order to eliminate unwanted interaction and improve the renovation process for all involved parties.

Technical Analysis Methods

This portion of the reports highlights which areas of the project could be investigated for future research. Each topic is discussed and the method used to enhance that specific item is outlined.

Information Flow

Optimization of information flow on a project can make all the difference. Increased productivity, reduced cost, and shortened schedule due to the minimization of changes and delays are all possible outcomes of a better coordination process. By implementing new strategies and technologies, the process in which information changes hands can be much more efficient. In order to determine the best means of distributing information between all involved parties, several areas of research must be investigated.

Possible technological solutions such as Vela are available, but the costs of implementing them could be high. A study regarding the cost to implements such systems and the value provided to the owner will be completed. Determination of whether the groups involved in the construction process have the means of operating this technology efficiently must also be explored. Another option to improve information flow includes a detailed submittal schedule to provide better information as to which information is needed during which phase of the project. Improvement of the information flow on the project can allow for money and schedule savings, allowing relocation of this money to other areas of the project; possible areas of interest regarding the saved money include the addition of sustainable features to new portions of the building.

BIM Implementation

Previous reports have discuessed how no BIM whatsoever was used on this project. With the ever growing interest in BIM and its various uses come increased knowledge, technology, and applicability. BIM can be applied to a project for a nearly countless amount of reasons. Research will be done to see just how realistic it is to use BIM on this project. Although using BIM on the whole project may not be realistic, using BIM for portions of the project may be.

Specifically, implementing BIM for the new portions of the building may be of value to the owner. Not only can BIM be used prior to construction for 3D coordination and 4D modeling, but the owner can benefit from BIM after construction is over. A record model may be produced in order to provide the owner with a visual representation of the new building, helping to eliminate issues should work need to be done on the building in the future. 4D phasing will be researched to determine if its use could better the phase planning on the project. If applicable, phase planning using BIM may provide building inhabitants with information regarding the various areas of the building that are under construction. Research will be done to determine if the owner has the capability of using a BIM model, or if the cost incurred to implement this new technology is manageable.

Schedule Acceleration

One of the most important factors for construction on the UHS project is the tight schedule. Although the project is on schedule to finish on time, any acceleration of the schedule benefits not only the project team but the owner and all school inhabitants as well. Returning to normal every day operation is the ultimate goal for everyone involved, so an early completion is desired by everyone. Different methods of accelerating the schedule will be researched to determine the best way, if possible, to shorten the schedule.

The new construction on the building provides the best opportunity for schedule acceleration. Redesigning the façade for the additions can be analyzed to determine if there is another system that could be used to allow acceleration of the schedule. With a structural steel frame as the structural system, there exists the possibility for a precast façade system. If feasible, the structure system will be analyzed to determine the type of connection needed to implement the new façade system. Using this alternative system could benefit the project by taking less time to install and even saving money over the stick built CMU façade as originally designed. Along with this, the phasing plan may be studied to see if re-phasing any portions of the schedule would benefit the project. In this case, renovation phases may be the best opportunity to save time on the schedule. As mentioned before phase planning may also help to optimize the phasing. Again, money saved as a result of schedule acceleration methods may be applied to other areas of the project.

Sustainability and LEED study

LEED is already part of the design of this building, although the level to which the implementation goes is minimal; it does not appear as though LEED or sustainable practices are of high importance to the projects. Several areas have been targeted to a minimal degree, while others have not been touched at all. In order to determine what other areas could be targeted, several studies must be completed. Ultimately, the study will aim to push the project certification to LEED Silver for the 2009 system. Primarily, the research will focus on

As for sustainability, Photovoltaic cells, although not prominent in educational project, are a sustainable feature that could be analyzed. With a primarily flat roof there is more than enough room to place a large array of PVs. Feasibility must be determined based on the building's location, startup cost vs. lifecycle cost, payback time period, and other controlling factors. Other solar features could also be researched, including solar heating of water. Another sustainable option to be researched is wind energy, and if the site that UHS is on could incorporate it. Day lighting is another sustainable feature that could be applied to the UHS project. Studies have shown that students are more productive when natural light is introduced to the space in which they are working. Again, location of specific spaces would need to be analyzed to determine is this option is realistic. Methods and legislation for transforming UHS into a Net Zero Energy school may also be researched.