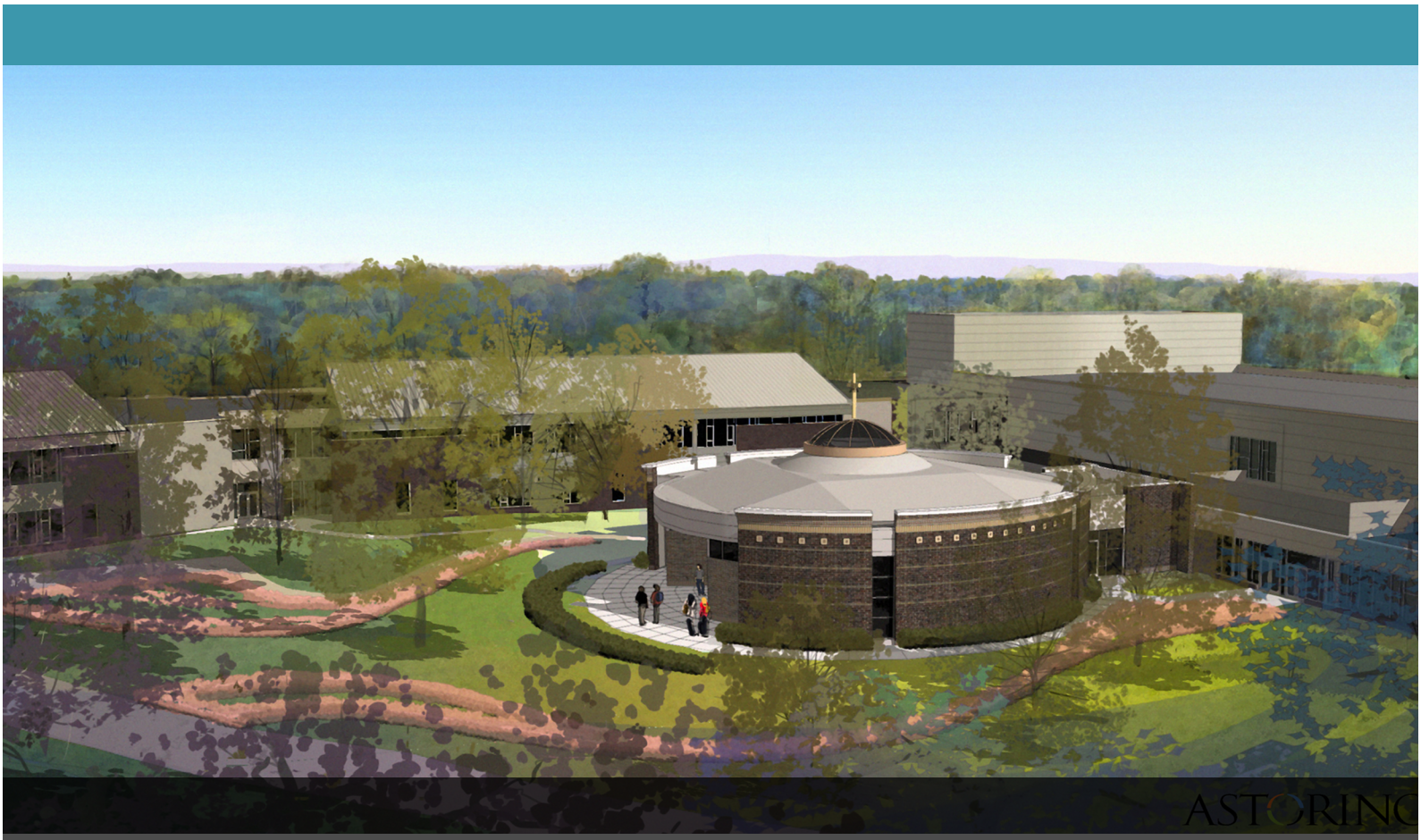

PROPOSAL

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Construction Management

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Cardinal Wuerl North Catholic High School

Cranberry Township, PA

Monday, December 16th, 2013

Executive Summary

Cardinal Wuerl North Catholic High School is a privately funded high school located north of Pittsburgh, PA in Cranberry Township. This newly constructed building had initial goals of quality, safety, environmental stewardship, a strict completion date, and a smooth turnover from construction to occupancy. These construction considerations allow an exploration of different opportunities that weren't initially considered as well as solutions to problems that were encountered during the building process. Therefore, this proposal serves to outline the construction analyses and breadths that will be pursued for AE 482 during the Spring 2014 semester.

The extensive exterior masonry scope creates opportunities to accelerate the overall schedule by prefabricating masonry panels and erecting them rather than setting up scaffolding and laying brick one-by-one. By prefabricating offsite, benefits including quality, safety, and possible schedule acceleration are created. Costs will need to be analyzed to determine if it is worth it for the owner to pursue this technique, considering the building will not be occupied until several months after it is completed. This analysis will also provide a structural breadth to determine if the structural steel members need to be redesigned to account for the weight of the prefabricated walls and to determine what connections are necessary.

Analysis #2 will focus on the lifetime costs of the value engineering decisions that were made at North Catholic. More specifically this depth will focus on the finish materials in the building and the costs associated with them during the course of the building's expected lifecycle, including but not limited to aesthetics, ease of installation, cleaning, routine maintenance and replacement. This analysis will conclude with a development of an "Owner's Guide to VE & Lifetime Cost Decisions" and a recommendation one way or the other whether or not the installed or proposed alternative materials, based on all considered factors, are preferred.

Considering that Phase I is nearing substantial completion without a facility manager hired and this was one of the major goals of the owner as well as the BIM Exection Plan, it's becoming a problem at North Catholic. It is believed by the consensus of individuals at the PACE Conference that it is vital to hire a facility manager as early as possible in order to engage in an effective and efficient turnover of information and this is not the case at North Catholic. The purpose of depth #3 is to research this process and determine the most effective means and methods of making this process meaningful and efficient. The result of this analysis will be a project specific checklist and suggestions as well as a process map for all owners on other projects that will aid them in the FM information turnover process.

My final analysis will be the implementation of a hybrid geothermal heat pump installed in the southeast of the 71-acre CWNCHS campus. It will serve the goal of environmental stewardship and provide the site's only source of renewable energy. This analysis also provides a mechanical breadth to determine heating and cooling loads and resize the existing systems to accommodate for the new one. All results will be compared to original techniques or systems and constructability/feasibility studies will be conducted to determine if the proposed systems are appropriate.

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Analysis 1: Prefabricated Exterior Wall Panels

Problem Identification

This topic is more of an opportunity to create a schedule acceleration scenario at Cardinal Wuerl North Catholic High School rather than a resolution to a problem. While the brick masonry production and spray applied air barrier activities were along the critical path in Areas A, B & D, they were finished on time. Regardless, if the project team considered prefabricated masonry panels, the overall duration of the project may have been reduced. While it was not terribly problematic, some issues with productivity of the mason on the jobsite were raised. There were also opportunities for interior finishes to get ahead in the schedule, which would have possible schedule acceleration implications. Photographs of the unique masonry scope and extensive scaffolding congestion are shown below:

Figure 1: Installed Masonry Scope & Scaffolding (Property of Mascaro Construction)

Background Research Performed

The large and geometrically unique scope of masonry work on the façade of Cardinal Wuerl North Catholic High School creates an opportunity to analyze the potential benefits of using prefabrication. Through the use of prefabrication, the congestion of masonry crews and their scaffolding for long periods of time along the building exterior can be greatly reduced. This will most likely involve the use of crawler cranes and the development of an erection plan in conjunction with a site logistics/feasibility analysis. Whereas the façade was often congested with scaffolding and large crews for weeks or months, a system of coordinated precast panels with a erection crews could reduce those durations to hours, days, or weeks depending on the size of the wall. In most circumstances, this growing technique raises opportunities for increased quality due to warehouse production, a schedule reduction if executed properly, and opportunities to save money. Some additional considerations that must be analyzed are crane availability, hoisting costs, deliveries, quality control, connections to the structural system, waterproofing, and various others. Additionally, cost savings may be gained if the masonry depth is reduced. A depth reduction may be necessary due to crane load limitations, which may have implications on the R-value of the façade and must be considered.

Potential Solutions

- Recommend implementing a prefabricated exterior wall system that creates potential for schedule acceleration, improved quality, improved safety and possible cost savings.
- Consider a prefabricated façade system as an alternative to the current method of on site masonry work that will have equally calculatable savings.
- Recommend against the implementation of a prefabricated exterior wall system since it has no added value and has a potential for losses compared to the stick built method.

Methodology

- Research case studies of prefabricating techniques and experiences on other projects
- Research if any current project members have experience with this
- Determine which subcontractors in the Pittsburgh area have experience with this technique
- Develop site plans/logisitics, safety concerns, an erection plan
- Research prefabricated systems and their connections
- Determine contractual cost savings for early finish
- Evaluate potential risks and create a risk prevention plan
- Evaluate feasibility of implementing prefabricated masonry panels at CWNCHS
- Communicate with industry professionals to attain accurate installation times
- Explore savings/losses associated with this installation technique (schedule, cost, quality, safety, etc.)
- Develop a recommendation for or against the prefabricated technique

Expected Outcome

It is of the belief that the implementation of a prefabricated exterior wall panel system will accelerate the schedule, enhance the quality of workmanship, and create a safer work environment on the Cardinal Wuerl North Catholic High School site. It may be in the contractor's best interest to finish the project early for potential cost savings. With the proposed detailed erection plan of the exterior panels, there will be less variability of installation and completion dates. The unique wall sizes and geometries can be confronted in a warehouse which will create a safer environment and lead to improved quality. In addition, a structural breadth will be conducted to ensure that the proper connections and loads for this type of system are considered. More information on this breadth is located in Appendix A.

Analysis 2: Lifetime Costs of Value Engineering

Problem Identification

During the process of Value Engineering, some professionals tend to choose the material with the most immediate cost savings and don't take into consideration the lifecycle maintenance and/or replacement costs compared to the expected or probable life expectancy of the building. For example, at CWNCHS, the ceramic tile scope was greatly reduced by epoxy paint applied to the CMU walls of the locker rooms and by semi-gloss in the bathrooms. While this tile needs to be cleaned approximately every year, the costs of cleaning compared to repainting every 5-6 years should be compared. Considering it is often overlooked, it is worth considering and analyzing on this project since over $800,000 worth of savings were reported on the VE program in the finishes division alone. The images below are some of the finishes that were installed in the building including a linear wood ceiling, tile carpeting, one of the 17 paint colors used, polished concrete flooring, and reclaimed lumber (from left to right; propery of Mascaro Construction).

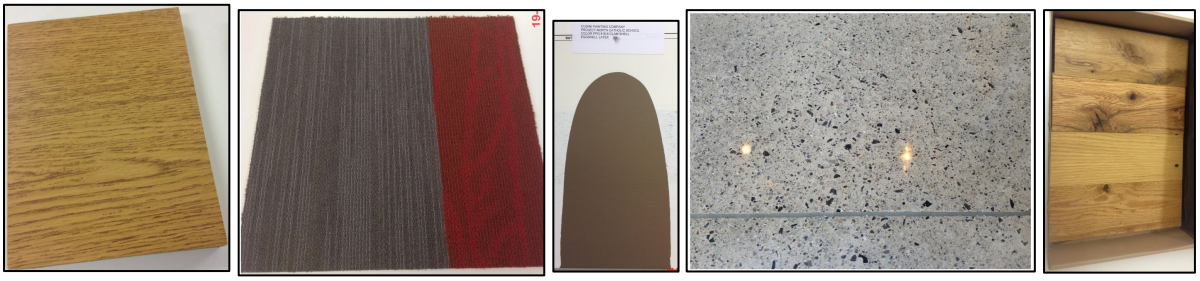

Figure 2: Installed Finish Materials (Property of Mascaro Construction)

Background Research Performed

I developed this idea from a side conversation at the PACE Conference this past November while attending the afternoon breakout session, "Efficient Delivery of Facility Management Information." One of the industry professionals mentioned that his company often does this sort of analysis since they occupy a large percentage of their buildings. With a very involved owner who will eventually oversee CWNCHS as the Chief Facilities Officer of Pittsburgh's Catholic Diocese, it may be of particular interest on this project. It was the general consensus of the other professionals in the room that their firms do not typically perform this type of analysis or consideration during the value engineering process. With very little of this sort of analysis occurring in the construction industry, it is worth determining if it is a valuable practice. It is also worth determining more specifically to this building whether or not the materials that were installed will be cost effective to the owner throughout the building's life cycle. The owner seemed to be excited about this analysis and supported it fully.

Potential Solutions

- Develop an "Owner's Guide to VE & Lifetime Cost Decisions"
- Recommend alternative materials based on all considered factors

- Consider alternatives based on aesthetics, ease of installation, replacement, etc. if costs are similar or little value is added compared to originally installed materials
- Do not recommend alternative materials on the basis that they do not produce cost savings or added value compared to original materials

Methodology

- Research past or ongoing research or studies on this subject
- Speak with facility managers, custodial staff, product manufacturers for cleaning, maintenance and replacement details
- Compile program of all finish materials at CWNCHS
- Determine expected lifetime of building
- Develop program of alternatives that were considered and other possibilities
- Consider sustainability, recycling, aesthetics
- Tie with Analysis #3 to aid in making recommendations for maintenance of installed finish materials
- Estimate costs of materials, installation, cleaning, routine maintenance, replacement, etc.
- Develop sample guideline of VE questions for owners, contractors, or architects
- Develop recommendations for or against Cost Analysis of VE & finish materials and the materials themself

Expected Outcome

I expect to develop an effective lifetime cost analysis of the finish materials installed at CWNCHS in order to compare them with materials that were either excluded during the value engineering analysis or materials that should have been considered during the value engineering analysis. I expect to find that some materials that were chosen (such as polished concrete) will prove to be cheaper and/or more durable throughout the building's life cycle, whereas others will have better alternatives. I expect that if an alternative is discovered it will have a negligable schedule impact but it will have a considerable aesthetic impact that architects and interior designers will need to analyze. Most importantly I expect to develop a set of checklists and guidelines for owners to consider when going through the VE process with the GC/CM and architect. I hope to help owners, contractors and architects alike in this aspect when choosing VE based on cost.

Analysis 3: Effective & Efficient Delivery of Facility Management Info

Problem Identification

Due to the owner's priorities in developing an effective facility management information turnover as well as the fact that with two months until substantial completion of Phase I at CWNCHS, a facility manager has not been hired yet, it is beneficial to determine the best course of action for FM Info turnover. This topic will serve as my primary research topic and critical industry issue. It was a key topic in the BIM Execution Plan and due to the lack of efforts in hiring a facility manager by the business manager at North Catholic to this point, the project is in jeopardy of sacrificing those goals. This topic was the subject of the afternoon breakout session I attended at the PACE Conference and it particularly caught my eye due to the relevance on my project. The following problem statements that were discussed at PACE will help me to develop my research:

- What inefficiencies 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 of high value to define more clearly and make repeatable?
- What infrastructure or tool support is needed to make these workflows consistent and interoperable?

Background Research Performed

Most of the background research I have performed was conducted during Technical Report II in my analysis of the project specific BIM Execution plan and during Technical Report III in my report of this specific breakout session at PACE. It seemed that the primary concern at PACE was avoiding the "paper dump" at the end of the project. Most of the industry professionals seemed to agree that utilizing a user-friendly BIM interface is the way to go. Since many facility managers are not of the intelligence level or experience to read contract drawings and specifications, let alone navigating a 3D model, the process to attaining the necessary FM information needs to be as simplified as possible. Another huge issue was that facility managers are not involved during the project's planning, design and construction. Their input can be beneficial even in the beginning of the project to develop the goals and information necessary to help them do their job. Another great suggestion was that the owner and GC/CM should meet up front to determine what level of asset management post-construction is to be expected so they know the level of effort to put in for the FM info transfer. 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 available operations and maintenance information.

Potential Solutions

- Develop a project specific checklist for CWNCHS to determine the best path to efficient and effective FM info turnover
- Recommend a template of a process map for owners and GC/CM's to follow together for the efficient turnover of this information

Methodology

- Conduct interviews with facility managers, owners, and contractors to determine their experience and suggestions to make this a better and more effective process. Also helps to develop statistical evidence of trends in the industry, what's actually happening, and what industry professionals believe should be happening. (Refer to Appendix A for sample questions)
- Speak directly with the owner of this project to determine his goals and his opinions for this matter
- Utilize BIM Execution Plan to determine project specific goals and work with Mascaro Construction's Virtual Construction Engineers to determine what technology is available
- Utilize PACE notes to gather an industry consensus
- Communicate with the Master's student who developed this study that we talked about at PACE
- Answer problem statements mentioned above
- Determine cost implications of involving a facility manager early in the process and if there are any third party consultants to aid in the process of FM info turnover
- Develop project specific recommendations for the best course of action to effectively and efficiently turnover FM information
- Develop an owner guideline for any project to help determine their goals in asset management and how to achieve those goals

Expected Outcome

I expect to conduct extensive industry research through the use of questionaires, conversations and interviews with influential members of this process. This will help to develop an owner guideline that can be suggested for use on all projects when the turnover of FM information is a critical item. More specifically, communication with members of the Cardinal Wuerl North Catholic High School team that influence this process will be conducted in order to determine the best course of action for an effective information turnover on their building. It will provide me with a roadmap for project success on all projects as well as this specific project.

Analysis 4: Hybrid Geothermal Heat Pump

Problem Identification

Cardinal Wuerl North Catholic High School has a very expansive site containing 71 acres of land. Very little of this land is utilized for sources of renewable energy. There is a great opportunity with such a great wealth of land to add a system that will aid in the reduction of heating and cooling loads. The eleven air handling units and 180,000 square feet of space that the mechanical system must heat/cool alone are grounds for considering a source of renewable energy. The primary open space that exists on the CWNCHS campus will be used for a small courtyard, parking lots, or athletic fields. The large athletic fields that will eventually be built at the Southeast end of the campus close to the lower level mechanical rooms seem to be the best spot to install a geothermal heat pump.

Background Research Performed

The point of the geothermal system is to utilize the available land for the Earth's natural heat and its capacity to reject heat into it. High-density polyethylene tubes carry water through them and absorb heat in the winter to heat the building and reject exhaust heat in the summer to cool the building. A sub soil investigation must be conducted first to determine if the soils at the site are compatible with this type of system in the first place and to what depth or configuration the system's loops should be placed in. These loops must tie in to the current system of chilled water pumps, natural gas heating, and air handling units to create an efficient hybrid system that operates well throughout the year. Site logistics/phasing considerations, initial allocation of funds for a very "up-front" expensive system, contractor availability in Pittsburgh, constructability/feasibility of a geothermal system, and scheduling concerns must be considered for this analysis.

Potential Solutions

- Recommend implementing a hybrid geothermal heat pump that creates potential for renewable energy, reduced heating and cooling loads, low maintenance requirements, LEED benefits, and a short payback period
- Consider a hybrid geothermal system as an alternative to the current chilled water & natural gas system due to equally calculatable savings, i.e. little added value.
- Recommend against the implementation of a hybrid geothermal system since it has no added value and has a potential for losses compared to the current mechanical system.

Methodology

- Conduct research of the geotechnical report to determine feasibility of system with site soil conditions
- Determine best location for geothermal system based on geotechnical results, above ground usage and proximity to mechanical space within the building
- Determine compatability with current system in order to deem this a hybrid system

- Communicate with Renick Brothers (mechanical contractors) to determine if they offer this service and seek their expertise if so.
    - If not, determine contractor availability in the Pittsburgh area
- Analyze the constructability and feasibility of the system
- Develop several options pertaining to size of the geothermal system for different system efficiencies, capacities and payback periods
- Determine schedule implications
- Determine safety implications
- Evaluate potential risks and create a risk prevention plan
- Communicate with industry professionals to attain accurate installation durations
- Explore savings/losses associated with this system (schedule, cost, QC, safety, etc.)
- Develop a recommendation for or against the hybrid geothermal system

Expected Outcome

It is of the belief that a hybrid geothermal heat pump system will be feasible with the site conditions, have scheduling/coordination implications, will be located in the athletic fields on the southeast of the site, achieve compatability with the current mechanical system and will overall be a feasible system at CWNCHS. This system will have added benefits of reduced cooling and heating loads that will contribute to a system installation payback period within 10-20 years to receive optimal usage of the geothermal system's benefits. The location I plan on adding this system to is the least congested spot on the site and should have a minimum of logistical and site planning issues but they must also be considered as well as safety. I expect that with the addition of this system it will provide the building with additional LEED benefits that may push the certification to a Gold value or keep it from dropping below the target of Silver if any interior finish points are lost throughout the analysis of the lifetime costs of VE & finish materials (Analysis #2). Additionally, this depth will provide me with a mechanical breadth which is outlined briefly in Appendix A.

Conclusions

The occupancy stage, safety, and environmental stewardship of Cardinal Wuerl North Catholic High School were the most important considerations throughout construction. Analyzing the turnover process from construction to occupancy as well as lifecycle costs of occupancy are therefore very beneficial to consider and will be the focus of Analyses 2 & 3. The safe installation of the masonry façade will be achieved by prefabricating the brick offsite and by reducing the amount of scaffolding. This will be the focus of Analysis 1. While the owner stressed being responsible environmental stewards, costs were also a factor in the pursual of those goals. I intend to develop a source of renewable energy on site that has a relatively quick payback period and will benefit the school and environment for years to come. It is of firm belief that all of these analyses will create a safer construction site, reduce overall schedule duration, promote environmentalism, create a longer building life, and produce overall desirable results for the owner, project team, and future occupants of Cardinal Wuerl North Catholic High School.

Appendix A: Breadth Topics

Structural Breadth

In reference to Analysis #1, the prefabricated exterior wall panels will require a structural study to determine the connections to the foundations they will sit on and/or the structural steel they will attach to. This will provide an additional structural load that must be considered in case the sizing or configuration of members needs to be altered. Loads will be calculated to illustrate the impact of the prefabricated wall panels' additional weight to the structural system. Once these loads have been calculated, a structural system redesign with connection considerations will be performed in the necessary areas. I will analyze the shear and moment forces on the steel rigging and will reference the AISC Steel Manual for beam sizing due to the self weight of the panels.

Mechanical Breadth

Pertaining to Analysis #4, the geothermal heat pump will require a wealth of mechanical system considerations. After the size of the geothermal heat pump system and number of wells has been determined, a cooling/heating load reduction for the current system must take place to make the addition of this system effective. Then, a reduction in currently installed equipment such as chillers, air handling units, and chilled water pumps may need to occur. This analysis will consider all aspects of both systems individually and the integration of them together that are required to compare the two systems.

Appendix B: Sample Interview Questions

Analysis #2 Questions

1. Do you have experience with this sort of analysis?
2. What were the results of the cost analysis?
3. Were the findings used again in the future on projects?
4. Was this an effective and useful analysis?
5. Where did you find accurate cost values and maintenance durations?
6. Were any mockups or samples used?
7. Was there a significant aesthetic impact?
8. What materials do maintenance workers/owners prefer?
9. What were the biggest factors in choosing between the installed materials and the alternatives?
10. During what stage of design or construction was this analysis performed?
11. Which party (arch/eng, owner, construction team) performed this analysis?

Analysis #3 Questions

The following questions will be asked to owners, architects, and contractors if not already answered by contributors at the PACE conference:

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

The following questions will be asked to maintenance professionals and facility managers:

1. Have you ever been involved in the turnover from construction to occupancy?
2. How efficiently was the required operations and maintenance information delivered to you?
3. How could it be delivered better?
4. Were you ever involved in the training process before occupancy?
5. What is the earliest you've been involved in a turnover process?
6. Do you think you have more to offer earlier on?
7. Are you computer literate?
8. Do you have any experience with 3D modeling or reading construction drawings?
9. Would you be willing to learn to do this?

Appendix C: Spring Schedule

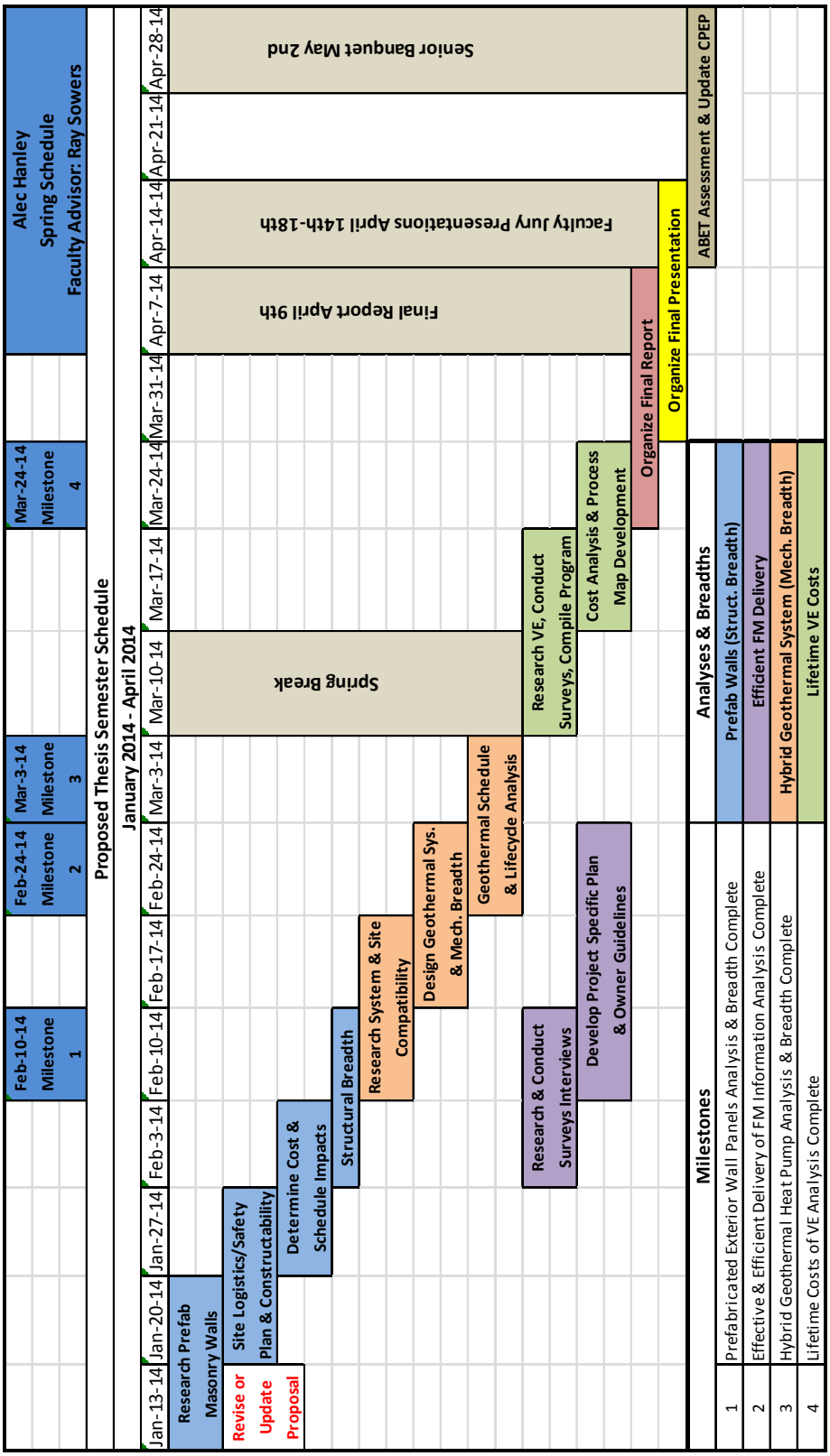

Figure 3: Proposed Spring Schedule