Images Courtesy of The Preston Partnership

SOLAIRE WHEATON

Image Courtesy of Clark Builders Group

Kevin Martyn

Technical Report 3

Construction Management

Adviser : Dr. Rob Leicht

11/15/2013

EXECUTIVE SUMMARY

The following report aims to identify potential analyses to improve the design and construction of the Solaire Wheaton project. The means of identifying analyses opportunities are through an interview of the project manager assigned to the project, as well as attending the PACE Roundtable held on November 7, 2013.

The project manager interview was centered around a discussion of schedule acceleration and value engineering topics. The critical path was identified as being through the exterior of the building for phase I and through the interior finishes on the 2nd through 6th floors in phase II. Ideas for accelerating the schedule in phase I include looking at the site logistics layout as well as the exterior enclosure and landscaping subcontractor productivity. The interior finishes are a repetitive process which involves ten major tasks within the residential units of the building. A more effective and manageable schedule technique for this process would be to use short interval production scheduling.

The second part of the interview focused on value engineering topics that were implemented or at least considered on the project. These include the light fixture package, stairwell construction, cabinets, and roof parapet design. The light fixture package was successfully value engineered by bringing in the light supplier to look at ways to save cost of on the project. The stair towers were engineered away from typical CMU masonry construction to wood faming which is constructed quicker and less expensively. By looking for more local cabinet suppliers, the lead time was decreased while keeping the cost similar. Finally the roof parapet design was made less expensive by utilizing false walls with forty-five degree supports instead of the traditional box construction.

The PACE Roundtable is a gathering of industry professionals and students to facilitate discussion and generate ideas and solutions for critical industry issues. The Roundtable is composed of several breakout sessions, a presentation by an industry professional, and feedback from an industry member on research ideas. The attended sessions include prevention through design, and multi-trade prefabrication and modularization. The prevention through design discussion was centered around bringing the architect and contractor together early in design to address safety issues related to the construction and facility management phases of a buildings lifecycle. The second session focused on considerations for different prefabrication processes on projects. Advantages of prefabrication were identified as increases safety and quality as well as a decrease in schedule and an opportunity to attract a new workforce.

The final aspect of the PACE Roundtable was feedback from an industry member on potential research ideas. This session produced the prefabricated floor system and modularization considerations with a wood structure. These research ideas represent a combination of the prevention through design and modularization topics.

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PROJECT MANAGER INTERVIEW

SCHEDULE ACCELERATION SCENARIOS

Due to the phased occupancy plan for the building, there are two critical paths on this project. As noted in previous technical assignments, the first turnover includes the entire site and courtyard, the first floor, and the amenity spaces located on both the first and second floors. The critical path for this turnover is through the building enclosure and site work/landscaping phases of the project. The issues related to this phase include access around the building and conflicting or interacting trades. With the tight site, access is limited to the east elevation as portrayed in the site logistic plans developed in technical assignment 2. Daily material deliveries would stop work on the east elevation and cause delays in the schedule. This is illustrated in the logistics plan, Figure 1, below. Notice the two access points on the East elevation and the congestion due to laydown areas and dumpsters. Subcontractor deliveries needed to be monitored closely to minimize the effect on current work in that area.

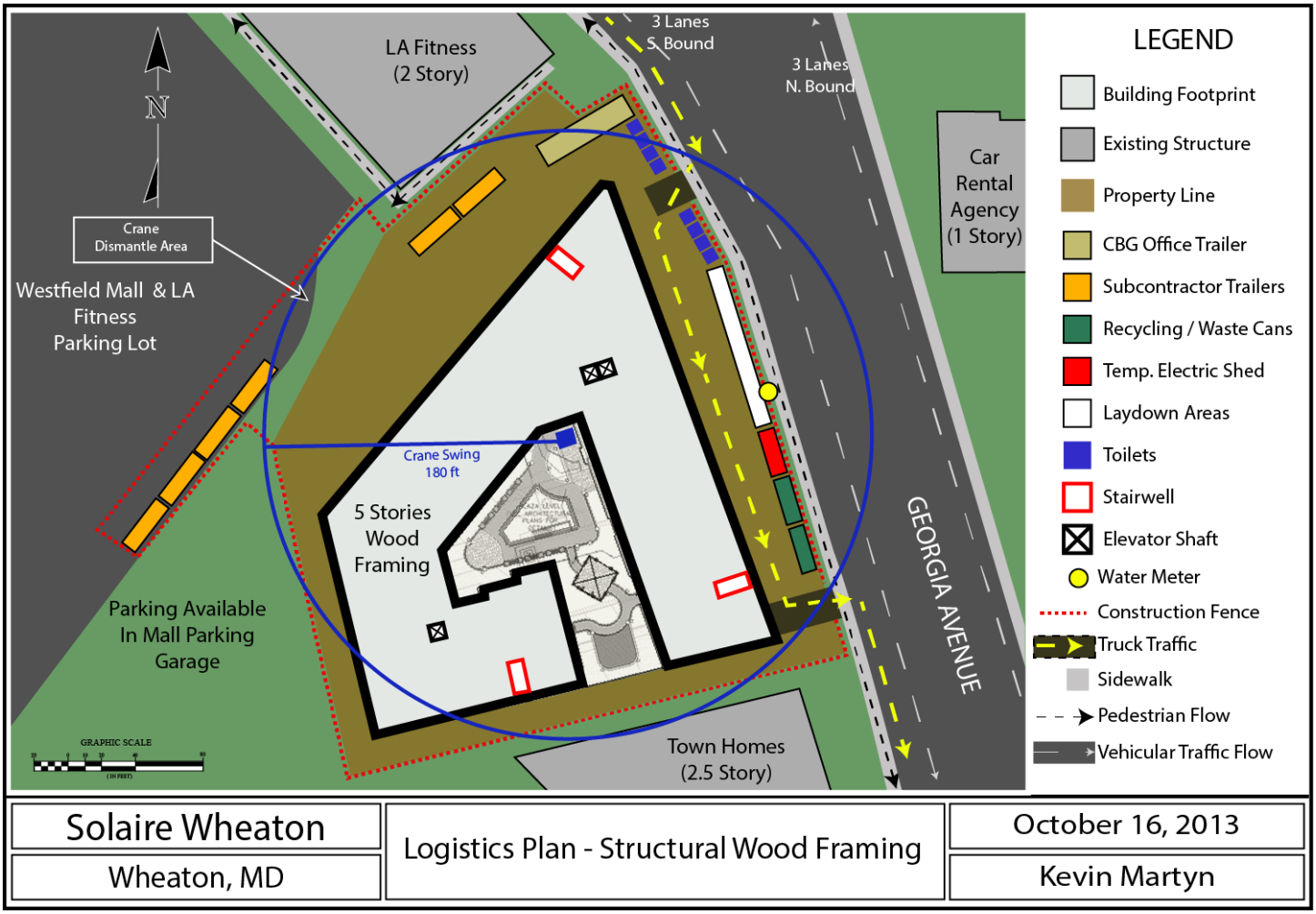


Figure 1. Site Logistics Plan

The second turnover of the project included the residential

units on floors two through six. At this point, the only remaining activities are interior finishes. This repeatable process looks at how many units can be completed daily. The project timeline below, in Figure 2, shows a representation of the major activities and how they overlap. As you can see, there is significant buffer time for the finishes, however, it is more profitable to complete the work ahead of schedule. During the interior phase, many contractors are involved and therefore flow of trades is extremely important. One delay in the schedule affects everyone down stream and requires them to accelerate.

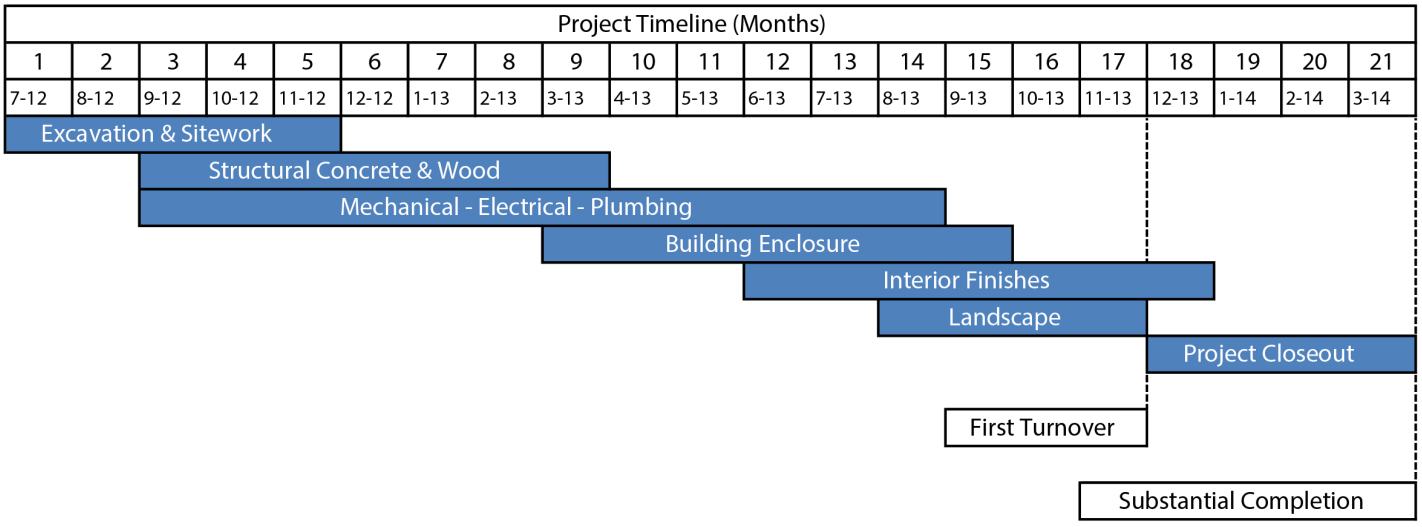


Figure 2. Project Timeline

The most significant risks to the project completion are the access issues and changes in the design. As noted before, the site constraints cause blocked access and an increase in trade interactions resulting in productivity losses. This stems from the constant changes in daily plans to accommodate material deliveries and other activities particularly on the east elevations. One area to study could be related to detailed delivery schedules and logistics on the east elevation. The other risk to project completion deals with owner and design team changes. With the aggressive schedule, the project team was forced to start the project with an incomplete design and react to situations and adjustments on the fly. These change decisions need to made in a timely manner in order to avoid affecting the critical path of the project.

Major areas that have potential schedule acceleration are in the structure and enclosure phases. The structural wood framing was able to accelerate during the project and make up for lost time in the structural concrete phase. This was done by adding manpower in the framing crews. As the enclosure had many issues dealing with site access, a more detailed and easily understandable plan could aid in schedule acceleration. The material loading of the building on the east elevation could have been more manageable with a material hoist which limits access issues to one section of the exterior of the building. This solution was considered, however, it was deemed unfavorable as work cannot be performed on that section until the hoist is disassembled. The project team eventually procured additional scaffolding for the mason so that the entire east elevation could have scaffolding at the same time. This allowed the mason to spend more time putting work in place and less time moving sections of scaffolding. The combination of additional scaffolding and increased manpower resulted in an increase in productivity and throughput for follow on trades.

VALUE ENGINEERING TOPICS

One of the major value engineering areas for this project was with the light fixture package. By bringing in the light supplier, the project team was able to save a large sum of money on the light fixtures. Because the building contains 232 residential units, a few dollars saved on a certain light fixture can go a long way.

The stair towers were also looked at as an area of value engineering. Although typically built with CMU masonry, the design team decided in favor a wood framing. The assembly still met code, however, is more prone to settlement and in the eyes of the construction manager more difficult to construct. This decision was based on price as CMU masonry construction is significantly more expensive when compare to wood framing. These decisions were in line with the goals of the owner to provide affordable housing.

A major topic of value engineering was the roof parapet walls. The original design called for a box construction which is fairly typical and easy to construct. These blocked walls were eventually changed to false walls with 45 degree angle supports as seen in figure 3 to the right. This reduced the necessary materials, however it became significantly more difficult to construct.

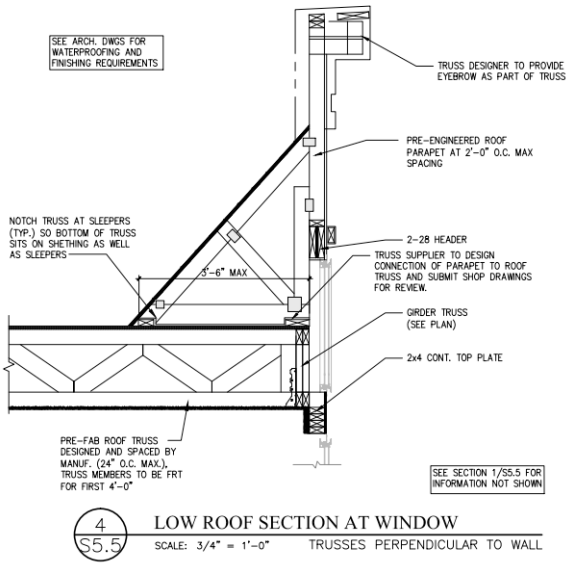


Figure 3. Roof Parapet Detail

One item that was value engineered less successfully were the cabinets. The original cabinets were planned to come from Italy, so the project team tried to find a similar cabinet locally. This would decrease the lead time while making replacement parts more readily available. The issue was that the owner had already fallen in love with the cabinets from Italy and was unwilling to bend. The project team was able to find the same cabinets produced in China. Although they were the same price, the lead time was decreased, adding value for the construction manager. This was the product of the company from China having a better supply chain.

PACE ROUNDTABLE

The 22nd annual PACE (Partnership for Achieving Construction Excellence) Roundtable was held at the Penn Stater on November 7th, 2013. The Roundtable includes a gathering of industry professionals, Penn State professors, and students of the architectural engineering program. The topics identified by the advisory board for this years discussion were: sustainability, information technology, and integrated processes. The discussion approaches include two breakout sessions, a presentation by an industry professional, and a meeting of several students and an industry professional to spark potential research opportunities.

CRITICAL INDUSTRY ISSUES

Each session of PACE Roundtable brought industry professionals and students together to discuss some of the leading topics that the industry currently faces.

Listed in Table 1 below are the different breakout sessions that could be attended. Highlighted in bold are the session that I attended.

	A. Sustainability	B. Information Technology	C. Integrated Processes
Personnel	**Session 1A:** **Safety - Prevention through Design**	Session 1B: Information Management for the Workforce	Session 1C: Assembling Effective Cross Functional Teams
Integration	Session 2A: Owner Phasing Decisions for Cost Effective Retrofits	Session 2B: Efficient Delivery of Facility Management Information	**Session 2C:** **Criteria and Drivers for Effective Multi-trade prefabrication and Modularization**

Table 1. PACE Breakout Sessions

The breakout sessions that were of interest to me were the prevention through design and multi-trade prefabrication discussions. Safety is an overwhelmingly important issue in the construction industry today. There is no limit to the improvement that can occur, however, this must be a topic from the earliest stages of design. The prefabrication discussion is related to the safety discussion in that the off site fabrication presents a controlled environment with safe working conditions. In addition to the minimized hazards, the prefabrication is also a Lean process that eliminates waste, adds value, and increases the overall success of the project.

BREAKOUT SESSION #1- PREVENTION THROUGH DESIGN

The first breakout session focused on prevention through design (PTD). This breakout was facilitated by Dr. Rob Leicht and the industry members in attendance were Albert Schultz of Skanska, Bill Moyer of Davis Construction, Jason Reece of Balfour Beatty, Dan Buchta of Barton Malow, and Patrick Harrison of SYSTRA. The discussion was centered around the consensus that the design community is not aware of the impact that they have on construction safety. Safety is looked at by designers as a byproduct of constructability analyses conducted by the construction manager. Rarely are the safety managers and subcontractors who put work in place involved in these meetings. The view of safety in the industry is sometimes looked at as non-value adding to the project.

Safety needs to be considered for construction methods and end user maintenance. For this reason, design assist contractors and facility managers need to be involved at an early time in the project. Timing of involvement has an extremely large effect on safety success on the project. Designers don't want to incur the extra cost for collaboration, however, at the same point they lose profit from redesign. It is important to realize that with enough collaboration early on in the project, there should be no redesigning. As illustrated in Figure 4 from a presentation from Bucknell University's Mike Toole, the earlier involvement, the more ability to effect the success of the project.

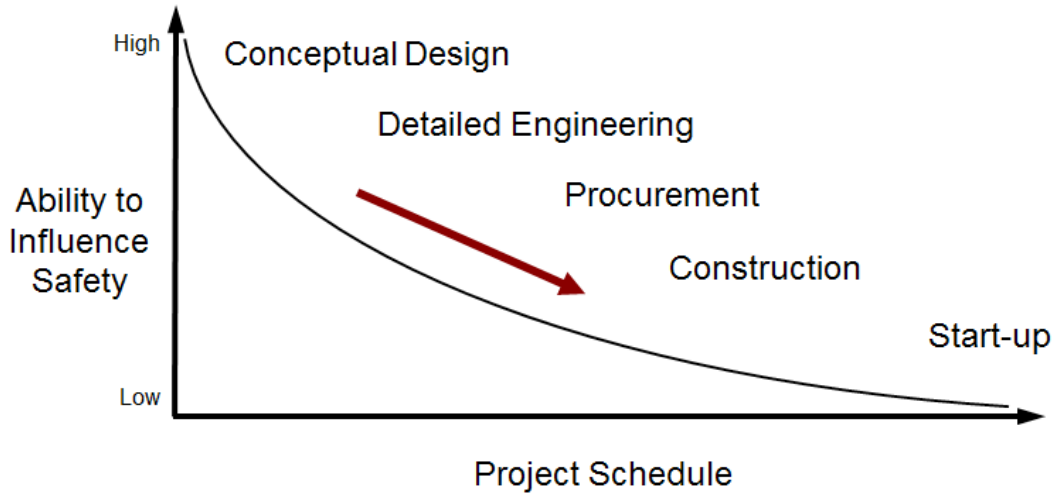


Figure 4. Safety Influence Curve

A major reason for the absence of safety analysis and prevention through design is that the architects and engineers are not liable in any way for construction safety. Designers get away with designing without safety in mind. The AIA contract specifically rids the designers of any liability for construction safety. According to section 3.6.1.2 of the AIA B101 standard form of agreement between the owner and the architect:

> "The architect shall not have control over, charge of, or responsibility for the construction means, methods, techniques, sequences or procedures, or for **safety precautions** and programs in connection with the work,..."

The major push for prevention through design needs to be in implementing it into the contract language. Like most innovative industry processes, this needs to be pushed by the owners. They have the ability to hold both the contractor and designer to a higher standard of safety.

Building on the liability discussion, the delivery method tends to have a great effect on the amount of prevention through design implemented on the project. As the team becomes more collaborative, PTD becomes more possible. The traditional delivery methods allow for no input from the construction manager or general contractor and therefore prevention through design is not possible. The construction team is faced with a design that they must read and react to. With a design-build delivery method, the contract between the designer and builder make them liable to each other, causing them to work together towards a safe and successful project. PTD in this case is possible because safety can be considered on day one. As seen in Figure 5 to the right from *The Owners Dilemma*, the longer the project team waits to make a decision, the greater the opportunity cost. If prevention through design is not incorporated from the very beginning, potential added value to the project is lost.

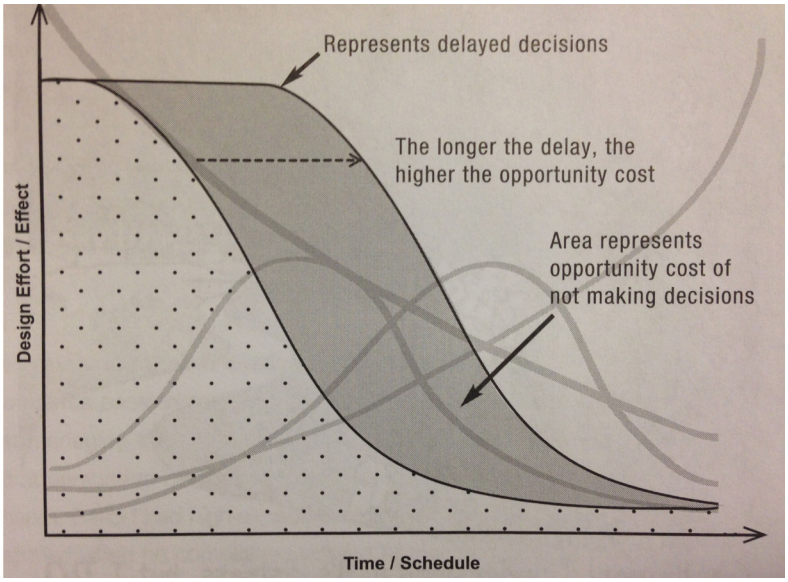


Figure 5. Opportunity Cost Curve

Several examples were provided by the industry professionals of prevention through design. One of the more obvious yet overlooked issues is raising window sills to 42 inches to eliminate the need for temporary safety rails during construction. Another common issue was the implementation of tie-off points into the design. This is especially important on roofs and during steel erection. This is also of concern to the owner who may need tie-off points in order to service the facility, particularly when working on rooftop equipment. The addition of these items in the design also allows them to be bid on, providing more accurate estimates of work. This reduces change orders to the owner and cost overruns to the contractor.

The main point that was taken away from the session was that when the designer and contractor collaborate there is still that learning curve and disconnection as this process is unknown to both parties. The designer is unaware of the different safety issues on which the contractor is focused. At the same point, the contractor does not typically fully understand the design process and the designer's way of thinking. It was expressed during the session that there may not be a list of all of the common safety issues that can be explored during design. This list would include the key items that would make the biggest impact on the project. One idea taken from this session was to implement safety considerations into the designer's decision making tool. Whether the decision making tool be target value design or house of quality, etc., safety should be incorporated as a line item. The Solaire Wheaton project did have a pre-construction period; however, like most projects safety was not a paramount project. For example the project had over 800 opening that required safety rails while they could have been avoided by raising the sill height.

BREAKOUT SESSION #2 – SYSTEM INTEGRATION

The second session of the day was titled system integration and was presented by Patrick Harrison of SYSTRA, seen to the right in Figure 6. SYSTRA is a specialist in planning, engineering, design, program management, and construction management for transportation systems and their associated facilities.

Figure 6. Patrick Harrison

Aside from his contributions in the breakout sessions, Patrick was able discuss his experience with rail construction and in particular the New Jersey transit project. He spoke of the many complex systems involved with rail construction and how they are integrated. System integration is defined as the combination of subsystem components into one system. This type of integration starts at the beginning of the project as there is significant planning required. Once the system is installed there also needs to be an large alloted amount of time for quality checks on the system.

BREAKOUT SESSION #3 – MULTI-TRADE PREFABRICATION

The third session which focused on multi-trade prefabrication dove into the process and impact that this technique had on projects. The discussion was facilitated by Professors Ray Sowers and John Messner, and the industry professionals in attendance were Bill Moyer of Davis Construction, Dan Buchta of Barton Malow, Patrick Harrison of Systra, and Chuck Tomasco of Truland. As noted in the prevention through design session, early involvement was echoed in this session. Especially important with multi-trade prefabrication, the planning requirements make it conducive to have certain trades involved at an early time in the project. Efficient teams also tend to be a product of contractors that have worked together previously. This reduces ambiguity in capabilities and expectations, contributing to the success of the project.

The issue of labor consideration would need to be taken into account. Prefabrication should be considered especially on prevailing wages projects, as it has been identified that the wages in a prefabrication shop are significantly less than that of prevailing wages. This goes along with the interesting thought of attracting a new workforce. With work being done in a nice environment at a constant location, construction may be viewed as a more popular career path option. Prefabrication is done in a controlled environment out of the cold and harsh weather conditions, and at the end of the day workers can return to their families within a reasonable time. This could reduce and possibly eliminate the constantly traveling workforce.

Work conditions in a factory are superior to that of the field. Workers are in a safer environment as they are not subjected to harsh conditions, falls, etc. In addition, quality has been seen to increase with the implementation of prefabrication. Building information modeling has become the enabler for prefabrication and made it a top current industry topic.

Although there are many advantages to prefabrication, there are some disadvantages which were discussed. An issue that was identified during the discussion was controlling tolerances when assembling the prefabricated pieces. With this process, a small yet consistent assembly error over several modules could result in an unaligned and faulty system. For this reason it was expressed that tolerances would need to be checked every few pieces of the assembly to identify an issues before they cause a domino effect.

Another curious topic that arose as a disadvantage associated with multi-trade prefabrication was that of liability. In the case of an accident during transportation to the jobsite, who would be liable? The contact language would have to clearly spell out the allocation of this liability. It is presumed that the responsibility would fall on the transportation company; however, this is an ambiguity.

Full unit modularization was not discussed in much detail during this breakout, however, this may be an option to look into for research. There was also the discussion of prefabricated bathrooms which could also be utilized on my thesis project.

FEEDBACK FROM INDUSTRY ROUNDTABLE

The session with an industry professional was particularly helpful in identifying potential areas of research. During the session with Karl Kauffman of the Quandel Construction Group research ideas were discussed and fine tuned into relative topics to study.

The prevention through design session formed a few research ideas including creation of a list of typical safety issues that could be prevented through the design. The issues related to the Solaire Wheaton project would then be identified and studied. Another potential research idea would involve analyzing the decision making tools utilized by the project designers and incorporate safety considerations. As noted before, this could be implemented on tools such as target value design and house of quality. This could help the construction manager and designer collaborate during pre-construction by allow them to understand each other's processes and needs. The safest solutions during construction and facility maintenance could therefore be considered during design.

The research ideas formed from the multi-trade prefabrication included mechanical shaft prefabrication and using a prefabricated floor system with the current pre-engineered floor trusses. The mechanical shaft prefabrication would include fabricating the ductwork and three sides of the shaft liner. The construction of the shaft liner caused sequencing issues on the project and delayed close-in inspections and drywall. These pieces could then be transported to site and dropped in during framing erection, minimizing its effect on the critical path. Once connections are made, the close-in inspections could be performed and the fourth side of the shaft would be assembled on-site. The prefabricated floor system would include either off-site or on-site fabrication of the trusses and subfloor on the ground. Instead of being exposed to a fall as seen in Figure 7, the floor could be assembled and set in place by the tower crane, similar to what is seen in Figure 8. This minimizes the fall hazard for the framers. Instead of having framers working off of the trusses or framed walls below, they could work off of the level secure decks. Considering the tight-site restrictions, the floor system could be constructed in the courtyard, however the effect on other trades needs to be considered.

Figure 7. Framer Exposed to a Fall
Courtesy of Clark Builders Group

Figure 8. Prefabricated Wood Floor System
Courtesy of Donaldson Timber Engineering

Key Research Ideas

After hearing of the fatality that occurred on the project caused by a fall during structural wood framing phase, Karl was intrigued and suggested a study of comparison between the cost of a fatality and the cost of prefabrication or modularization which could have eliminated the fatality The lost efficiency due to a drop in morale by the crews also needs to be considered. A suggested resource was a study by a Bucknell University professor of fatality costs during construction. Although this study was not found during research, a related document titled *The Price of Inaction*[1] was discovered. This document was written to identify the cost of work related injuries particularly in the construction industry. The document references a study and quotes:

> "The 2004 Waehrer et al. study found that the 1993 cost of fatal occupational injuries totaled $232 million across Maryland's private industry occupations. This translates to a cost of $3.5 million per fatal occupational injury, or $5.2 million in 2010 dollars."

Being that the study was conducted in Maryland, this would be a reliable source as the Solaire Wheaton project is located in Wheaton, Maryland.

There is assumed to be an upfront cost for the planning of modularization and therefore would not save money on this project. On the other hand, the schedule savings could be viable to the owner as it aligns with their goal of completing the project ahead of nearby competitors. The general conditions and labor savings due to the schedule savings could result in a cost reduction for the project. This analysis could look at providing a safer working environment to avoid fatal injuries, as well as gaining schedule savings and savings of the cost of a fatal occupational injury.

With twenty-one layouts in the Solaire Wheaton design, it was agreed that this number would need to be reduced should the modular unit study be conducted. This would constitute an architectural redesign. As you can see in Figure 9, the abnormal building footprint and odd shaped corner units would make this task challenging.

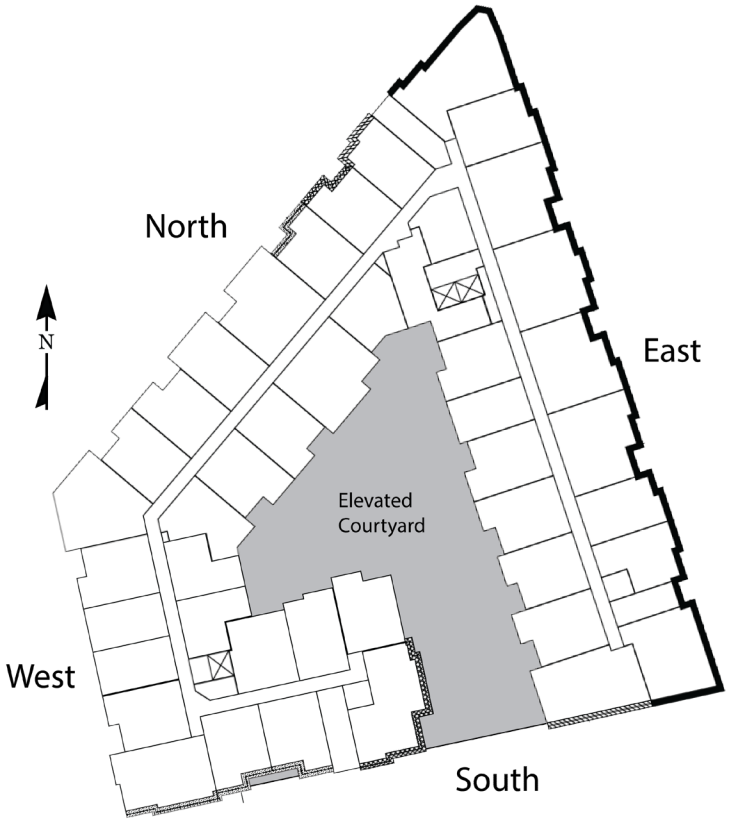


Figure 9. Building Footprint

[1] "THE PRICE OF INACTION." PUBLIC CITIZEN. (2012): 8. WEB. 14 NOV. 2013.

CONCLUSION

The PACE Roundtable was a very informative seminar. The collaborative and transparent thinking that the Roundtable is based upon is a reflection of where the industry is heading. As seen in Figure 10, the construction industry is inconsistent with the other industries in terms of productivity increase. This is due to the competitive nature and unwillingness to share ideas. The topics presented at the PACE Roundtable were relevant to the industry and both professionals and students were able to benefit from the sessions. These gatherings are instrumental in changing the pattern seen below and increasing productivity in the industry.

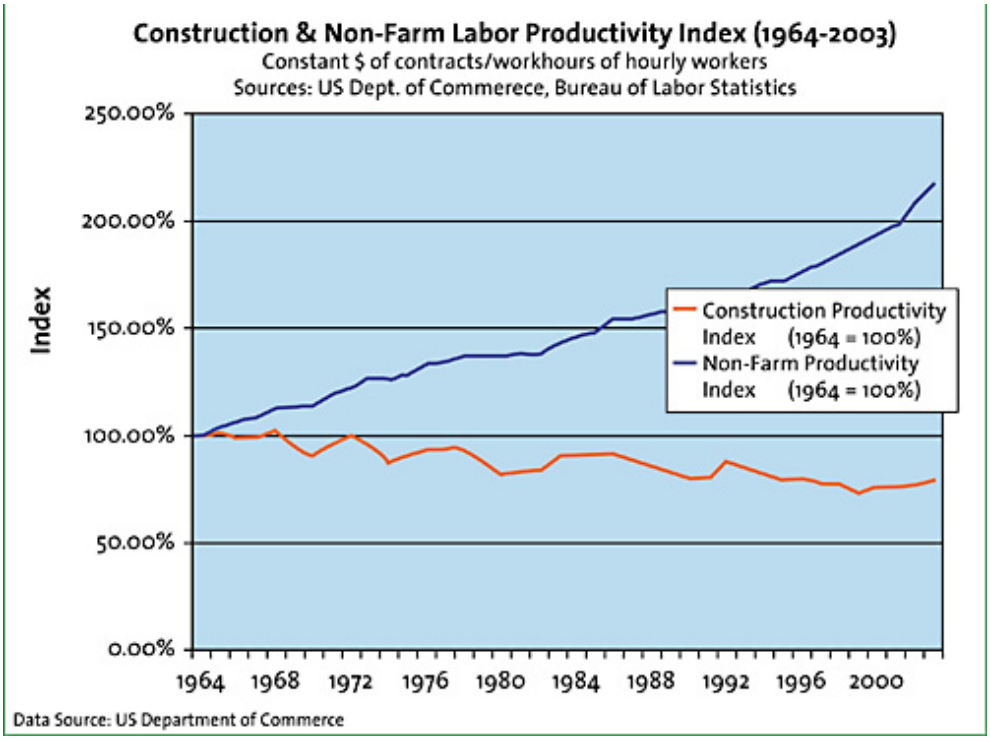


Figure 10. Construction Productivity
Courtesy of McGraw Hill

APPENDIX A. PACE NOTES

The 22nd Annual PACE Roundtable

Student Name Kevin Martyn

Session 1: Topic: Prevention Through Design

Research Ideas:

1) List of typical issues for safety that could be prevented in the design. Analyze which ones could be implemented on my project

2) Design Matrix tools that could help CM collaborate with designers in preconstruction. Could show which solutions are selected (Chain of Quality) (Target value design)

Session 2: Topic: Multi-Trade Prefabrication

Research Ideas:

1) Mechanical Shafts prefabrication
   - Three side and dropped in place by tower crane.
   - Fourth side completed in the field

2) Prefabricated Floor system - pre-engineered floor truss system
   - off-site or on-site on the ground
   - Could be assembled in the courtyard. (what kind of effect on the other trades - windows)

Session 3: Topic: Facility Management

Research Ideas:

1) Building turnover activities into schedule and starting it earlier on in the process so it doesn't get pushed and forgotten

2)

The 22nd Annual PACE Roundtable

Industry Member: Karl Kauffman - Quandel Group

Key Feedback: *Which research topic is most relevant to industry? What is the scope of the*

offsite labor rates are lower

Prefab/Modular

Research fatality cost / efficiency Lean PPS

Buckeach professor - checklist and study related to fatality ~~[illegible]~~ costs and compare to the cost of ~~[illegible]~~ modularization

Modular Apartments vs. Stick built

- Increased revenue savings calculated with schedule savings
- owners interest - quicker schedule.

Suggested Resources: *What industry contacts are needed? Is the information available?*

Buckeach professor study of fatality costs

APPENDIX B. PRESENTATION & SUMMARY OF OPTIONS

Images Courtesy of The Preston Partnership

SOLAIRE WHEATON

Image Courtesy of Charlie Liesfeld - CBG

Kevin Martyn

Technical Report 3 – Part II

Construction Management

Advisor: Dr. Rob Leicht

12/4/2013

EXECUTIVE SUMMARY

The unique building layout, site constraints, and contract agreement produced some issues on the Solaire Wheaton project that have threatened the success of the project. The project team has reacted to these issues the best that they could. These problems will be described in detail followed by an explanation of the potential analyses to avoid the constructability, safety, schedule, and contract issues.

PROBLEM IDENTIFICATION

A major issue that led to several issues on the project involves the project site logistic constraints. Land in metropolitan areas such as Wheaton is difficult to come by, and the architect on the project used as much as they could. This presented issues for material delivery and staging, AND multiple trades working on top of each other. Stacking of the trades occurred when sequencing did not necessarily fit with the site logistics plan causing daily plans to change impacting the flow of trades.

An issue that came about during the construction phase was ambiguity in the owner and contractor agreement. This is assumed to be due to the use of a self-written contract instead of a form contract. A particular clause that was questioned was the weather clause and how to recover rain days during a month where rain and site dryout caused delays in the schedule. The weather clause was extremely difficult to decipher and can be interpreted in many different ways. In addition, the claims would involve significant research into weather data to prove.

The project schedule is atypical and constraining, causing logistical issues. This ultimately stems from the phased occupancy plan requested by the owner. The first turnover includes the garage, first and second floor, courtyard, and site. The second turnover involves completing interior finishes on floors three through six. This creates logistic issues as the building must be loaded with material prior to the first turnover. The building will be occupied at this point and therefore the elevators will not be for the construction team's use. Management of the deliveries and material loading during final grading and landscaping will need close coordination.

There has been several safety risks associated with the design and construction methods used on the project. The standout issue occurred during the wood framing phase when framers are subject to falls. These risks resulted in a fatality when a worker fell from a floor truss to the floor below. Although this accident has been said to be related to underlying health issues of the individual, this could have been avoided by prevention through design practices.

The designer for the project specified an aluminum window for the project that came in single, double, and triple sections. Aside from the windows not being delivered on time, there were also tasks that needed to be performed on site to prepare the windows for installation. The window installation involved a multitude of steps that caused the installers to visit openings several separate times during installation. This made the window and balcony door installation difficult to plan for and this task ultimately surpassed the planned finish date.

TECHNICAL ANALYSIS OPTIONS

Analysis 1: Prefabrication Implementation

The first analysis will address a critical industry issue and evaluate the use of prefabrication to determine the most appropriate level of implementation for the project. The implementation levels include an onsite pre-assembly, offsite prefabrication, and full modularization of the units. This in depth analysis would involve several core areas including: critical issue research, and constructability review. Instead of taking a schedule reduction standpoint, this analysis will be based around safety and accident prevention. In addition, this analysis allows for the following breadths:

Architectural Breadth: Architectural layout redesign (reduction in unit layouts from 21)

Structural Breadth: Modular unit connection or analysis of the bracing required for prefabricated floor system

A value engineering option for this project which relates to this analysis is the use of ZIP sheathing. ZIP sheathing is a material that combines the oriented strand board sheathing and the building wrap. This eliminates the step of installing tyvek building wrap on the building, although the seams are still required to be taped. This system provides for a quicker installation and more quality product.

Mechanical Breadth: Thermal resistance of sheathing options

Analysis 2: Short Interval Production Schedule Implementation for Interior Finishes

The second analysis will present an implementation of short interval production scheduling for the interior trades in the residential units on floors three through six. The critical path for the second phase runs through the interior finishes. Short interval production scheduling provides an easier way to manage specialty contractors, plan, and schedule work. This scheduling method eliminates stacking of the trades, while allowing for cleaner and less congested work areas. This also allows for specialty contractors to level their resources. Instead of having to mobilize multiple times because work areas are not ready, crews can remain consistent. Experience shows that a more detailed and predictable plan is more executable by the specialty trades.

Analysis 3: Form vs. Self-written Contracts

Analysis three will look at the owner and prime contractor agreement. As described in the problem identification section, the project utilizes a self written contract instead of the more commonly used form contracts. The associated problem is that contractors are not used to. This was the case of ambiguities on the project. This will be centered on the red flag clauses within the contract and comparing the differences between form and self-written contracts. Ambiguous contract language is interpreted against the party by which it is drafted. Clauses will be analyzed in terms of contract language ambiguity and risk allocation. Through this analysis a determination can be made as to which party benefits from each clause.

Analysis 4: BIM for Site Specific Safety Training

Technology has enabled the construction industry to grow and improve in many aspects; however, safety is not one of them. Efforts have been made to use building information modeling during design to perform constructability reviews and comment on safety improvement. BIM has not yet made its impact on safety during the construction phase. A major issue during construction is the site specific training of workers. On a typical project, workers are trained using a generic safety video normally produced by the general contractor or construction manager's safety management staff. Workers listen to the first few minutes and then become preoccupied. The video is full of safety hazard training that is unrelated to the project on which they will be working. Eventually the superintendent shuts the video off before completion, gives them their safety training stickers, and sends them to work. These workers are no more prepared to avoid safety risks than when they arrived on site.

This analysis will look at ways to use building information modeling to create safety training videos. These videos will be related to project specific hazards and be relatable once people walk on site to perform or observe work. Workers will be knowledgeable of the exact project hazards and their locations on the jobsite.

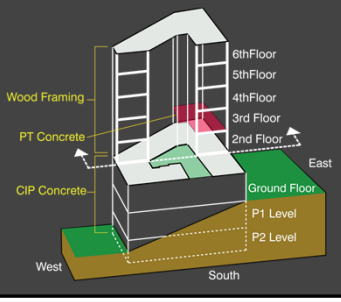
Analysis 5 (Option): Supply Chain Management & Site Logistics

The fifth analysis option could look at the supply chain management and site logistics on the project. This analysis will address the constructability review and schedule reduction areas. Research will be conducted on different methods of delivery scheduling to determine the method that is most applicable to the project. Delivery scheduling methods will include just-in-time delivery, designated delivery times (possibly after work hours), and designated delivery days per trade. There could also be a re-sequencing of the schedule to ensure that at the peak of material delivers, work on the east elevation is completed to minimize congestion. The delivery techniques could be evaluated through 4D logistics planning.

Technical Analysis Options – Solaire Wheaton

Image Courtesy of The Preston Partnership

- Location: Wheaton MD
- Multi-family residential apartment
- Size: 361,000 SF
- CM @ Risk with GMP Contract
- Phased Occupancy:
  - 1st Turnover: site, garage, first & second floor
  - 2nd Turnover: interior finishes floors 3 through 6



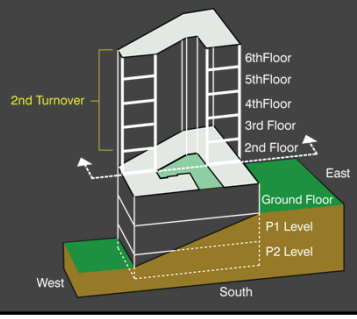
Kevin Martyn
Construction Management
Advisor: Dr. Rob Leicht
December 4th, 2013

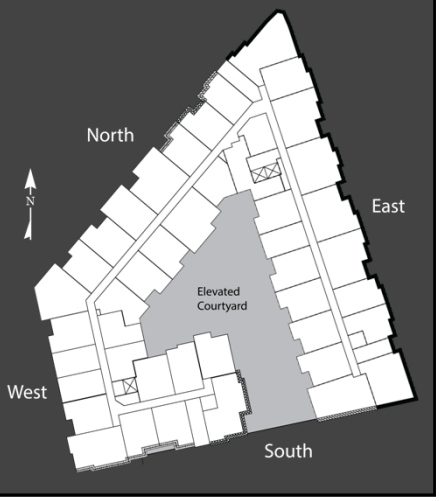
Analysis #1 – Prefabrication Implementation

- **Problem:** Safety fall hazards
- Research Opportunity
- Three levels of implementation
  - Onsite Pre-assembly (on ground)
  - Offsite Prefabrication
  - Full Modularization
- Architectural Breadth
  - Reduce No. of Unit Layouts (21)
- Structural Breadth
  - Module connection analysis
- ZIP Sheathing (Value Engineering)
- Mechanical breadth
  - Thermal resistance analysis

Analysis #2 – SIPS Implementation

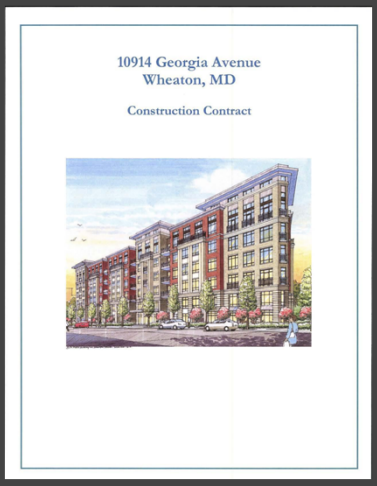
- **Problems:** No detailed plan & flow of work
  Understaffed field management crew
- **Solution:** SIPS for interior finishes
  - 2nd Turnover (Floors 3 through 6)
  - 44 Units per floor
  - 7 Interior Contractors





Analysis #3 – Form Vs. Self-written Contracts

- **Problem:** Self-written clause ambiguity
- Red Flag Clauses
  - Dispute Resolution
  - Changes Clause
  - Differing Site Conditions
  - Delays Clause
  - Weather Clause
  - Termination/Default
  - Damages
  - Payment Terms
- Form contracts to compare
  - AIA 133 (GMP Project)
  - Consensus Docs



Analysis #4 – BIM for Site-specific Safety Training

- **Problem:** Non site-specific safety training videos
  - Generic videos
  - Unrelated safety hazard training

- **Solution:** BIM Technology
  - 3D model walk-through
  - Site specific safety issues
  - Eliminates irrelevant information
  - Workers know exact project safety hazards and their locations