



Images Courtesy of The Preston Partnership

SOLAIRE WHEATON



Image Courtesy of Clark Builders Group

Kevin Martyn
Revised Thesis Proposal
Construction Option
Adviser : Dr. Rob Leicht
2/5/2014

EXECUTIVE SUMMARY

This proposal will identify some of the problems on the Solaire Wheaton project and develop potential solutions to better plan and execute during the construction phase. The four depth analyses and two breadths provide ways to address industry issues, add value to the project through value engineering alternatives, ease coordination issues, and reduce the schedule.

Analysis 1: Self-Written Vs. Form Contract Weather Clause

Contract clause ambiguity in the owner contractor agreement was expressed by the project team as a challenge, particularly the weather clause. This analysis will interpret the self-written weather clause to that of form contracts in an effort to determine the most practical contract language. A recommendation will then be made to change the contract language to eliminate the ambiguities.

Analysis 2: Critical Industry Issue: Site Specific Safety Orientation

The critical industry issue of site specific safety orientation will be the topic of the second analysis, which investigates current approaches to safety orientation. The generic training videos and lengthy site specific safety plan documents are unable to effectively inform workers of the hazards they will encounter and their locations within the jobsite. The use of building information modeling will provide a more effective means of presenting safety information, as 83% of what we learn derives from what we see. This analysis will investigate effective ways to add value to the project safety orientation through the use of building information modeling.

Analysis 3: Modularization

With competing developers building apartments nearby, the main goal of the owner is to finish as soon as possible and sign lease agreements. Had there been a way to accelerate the schedule, the owner most likely would have approved the process, even with a potential cost increase. This analysis will determine the feasibility of implementing modularization on the Solaire Wheaton project. The podium structure design allows for the wood framed units to be constructed off-site and concurrent with foundation and reinforced concrete work. This construction method should reduce the current construction schedule by several weeks while providing a safer means of construction and less material waste.

Analysis 4: SIPS for Interior Finishes

Phase two of the project involves completing the interior finishes on floors three through six, while the building is potentially occupied. For obvious reasons, the contractor would like to turnover this phase as quickly as possible. The critical path method for scheduling does not provide a predictable schedule duration and is typically not met by contractors. Short interval production scheduling is a scheduling technique that is derived from accurate production rates, and therefore is more easily attainable. This analysis will implement SIPS on the interior finishes to better plan, manage, and track activities.

TABLE OF CONTENTS

PROJECT BACKGROUND 1
ANALYSIS 1 – SELF-WRITTEN VS. FORM CONTRACT WEATHER CLAUSE.....2
ANALYSIS 2 – CRITICAL INDUSTRY ISSUE: SITE SPECIFIC SAFETY ORIENTATION.....4
ANALYSIS 3 – MODULARIZATION.....7
ANALYSIS 4 – SIPS FOR INTERIOR FINISHES.....9
ANALYSIS WEIGHT BREAKDOWN.....11
CONCLUSIONS12
APPENDIX A. BREADTH STUDIES.....13
APPENDIX B. MAE REQUIREMENTS.....15
APPENDIX C. SUMMARY SCHEDULE.....17

PROJECT BACKGROUND

Solaire Wheaton is a 361,000 square foot luxury apartment building in the upcoming city of Wheaton, MD. The project consists of a 108,000 square foot semi-below grade two-story parking garage topped by six floors of apartments, totaling 232 units. The design consists of a podium structure with a cast-in-place concrete ground floor topped by five stories of wood framing. Podium structures are becoming increasingly popular allowing owners to build less expensively resulting in a shorter expected time for return on investment. The luxury apartment units come in twenty-one different layouts and have a modern style to them as illustrated in Figure 1.

In 2010 the owner of the project, Washington Property Company (WPC), began steps to develop the plot of land by demolishing the existing church, and building a new apartment building. WPC is seeking to take advantage of the opportunity in a booming area by offering affordable housing. The area of Wheaton is just north of Silver Spring, MD, approximately 10 miles from Washington, D.C. Located only two miles from the Georgia Avenue exit of the outer loop of the beltway, this site is a prime location for commuting professionals.

Schedule is the most important factor to the success of the project as several other apartment buildings are being constructed in the area. The team’s goal is to complete the project first and lock in pursuing tenants. In order to make this possible, the owner required a phased occupancy plan with the first turnover in November 2013, seventeen months after the start of construction. The first turnover includes the garage and site, first floor, courtyard, and amenity spaces located on the 1st and 2nd floors. This enables the marketing team to show apartments and sign leases prior to substantial completion. Substantial completion is scheduled for March 21st, 2014, for a total of twenty one months of construction.



Figure 1. Interior Rendering Courtesy of Solaire

ANALYSIS 1 – SELF-WRITTEN VS. FORM CONTRACT WEATHER CLAUSE

PROBLEM IDENTIFICATION

The Solaire Wheaton project utilizes a self-written contract instead of more commonly used form contracts. The associated problem is that contractors are not familiar with self-written clauses, causing ambiguity. With an aggressive schedule on the project each weather day can cause effective delays. The past summer in the Wheaton area was particularly rainy with exterior enclosure activities occurring on the project. Window installation was halted during the poor weather and the site typically took an additional day to dry out. Work was being performed from boom lifts, halting work for days at a time, as the lifts would get stuck in the mud. The project team was looking into the weather delay clause to determine whether or not they had legal justification to recover days in the schedule. The self-written clause was not easily interpreted and required significant analysis to determine if rain days were recoverable.

BACKGROUND RESEARCH

Construction delays can be separated into two categories for contractual reasons: excusable and non-excusable delays. Non-excusable delays are foreseeable or within the contractor's control, and therefore are not excused by the owner. In this case, the contractor is not entitled to an extension of time nor delay damages that may have resulted. Excusable delays, on the other hand, cannot be predicted and therefore the contractor is not liable to the owner for them. Excusable delays are then subdivided into compensable and non-compensable delays. Non-compensable delays grant the contractor an extension of time only, whereas compensable delays grant the contractor an extension of time as well as financial compensation. The other linked clause that raises concern and must be analyzed in the contract is the 'no damages for delay,' which bars recovery of damages or extra costs by the contractor.

In researching AIA contracts, an owner contractor agreement for construction managers with a guaranteed maximum price contract was found. This form contract should relate most to the project as the existing self-written agreement is a guaranteed maximum price contract.

In researching the weather data for Silver Spring/Wheaton, Maryland, it was discovered that although the summer was filled with many rain days, June was the only month that produced rainfall above average. This is not to be alerting, however, because the contract focuses on the number of adverse weather days rather than average rainfall. Extreme weather conditions are defined in the contract as, "a weather event that results in adverse weather days in excess of the average number of adverse weather days for the project site for the applicable period of time, measure by data from NOAA over the last ten years for the twenty day period preceding the date of the weather event and the twenty day period following the date of the weather event within a 50 mile radius of the location of the project."

POTENTIAL SOLUTION

Analysis one will look at the owner and prime contractor agreement. This analysis will look at the weather clause, comparing the differences between form and self-written contracts. Clauses will be analyzed in terms of contract language ambiguity and risk allocation. Through this analysis a determination will be made as to whether or not the contractor had a claim to recover rain days with both the self-written contract and the form contract. In the process, the analysis will provide a recommendation of how to eliminate contract language ambiguity in the weather clause as well as whether the contractor should pursue the issue.

RESOURCES

- 10914 Georgia Avenue Fully Executed Original Contract
- National Oceanic and Atmospheric Administration (NOAA) - The contract defines this organization as the means of calculating adverse weather days.
- Jerry Pisarcik – Jerry is the instructor for the AE598D course, better known as The Legal Aspects of Construction and Engineering. He is also a practicing lawyer in civil law specializing in construction and engineering cases. Jerry will potentially be able to review my work in interpreting the contract language and solutions for eliminating ambiguity.
- Contract clause interpretation flowcharts from Dr. Thomas - the former instructor of AE598D

ANALYSIS STEPS

1. Obtain the AIA owner and contractor form agreement
2. With the assistance of Jerry Pisarcik, interpret the contract language of the form and self-written weather clauses (outline steps of claim through the use of flowcharts)
3. Provide suggestions on how to improve the contract language eliminating ambiguity

EXPECTED OUTCOME

The self-written contract is presumed to contain clause ambiguity in comparison to the form contract. It is expected that the analysis of claims for recovering rain days will be more difficult with the self-written agreement and may result in no basis for claims. It is expected that the self-written will result in an inability to recover schedule days due to unforeseeable weather delays. Through the comparison of contract language, a recommendation of contract language improvement can be made to eliminate ambiguities.

ANALYSIS 2 – CRITICAL INDUSTRY ISSUE: SITE SPECIFIC SAFETY ORIENTATION

PROBLEM IDENTIFICATION

A major issue in the construction industry is the site specific safety orientation of workers. On a typical project, workers are trained in orientation, often using a “generic” safety video normally produced by the general contractor or construction manager’s safety management staff. Although these safety videos have some relevant lessons, they present a multitude of irrelevant information that does not pertain to the current project. These workers are no more prepared to avoid the project specific safety hazards than when they arrived on site, as they don’t know what hazards to be aware of and where they are located. Safety information is not shared in an effective manner, and rarely are the experienced foreman able to contribute to the safety plan.

In addition, the construction manager on the project has a contractor controlled insurance program (CCIP). This is a policy where all the participants on a building project are covered by a single policy. This policy adds to the risk that the construction manager assumes. The project team has a part-time safety manager, and although all field supervisors are supposed to manage safety they could be more thorough. The flow of safety information on the project was in need of improvement, and the sharing of hazard recognition and solutions between contractors did not seem to be paramount. The question that arises is how can site specific safety information be shared more efficiently and presented in a more effective manner?

BACKGROUND RESEARCH

According to Mike Markel’s Technical Communication textbook, “some 83% of what we learn derives from what we see, whereas only 11% derives from what we hear (Gatlin, 1988).” If there was a way to visually present safety information that is specific to the project, workers will be more likely to remember the lessons, and avoid hazards.

According to the study *Why Operations Engage in Unsafe Work Behavior: Investigating factors on Construction Sites*, an interviewee revealed that training was a waste of time because he could not understand its contents. The worker said that he did not know about the scheduling of safety meetings. When and where were safety meeting held? No one invited me. He could not make sense of what was discussed in the safety meetings. He explained that he was an uneducated person and could only write his name. I cannot read safety material, he said. When asked how his workmates react to safety training, he responded they just sign their names on the training sheet and then walk away, saying “it is boring and wastes their time.” This indicates that workers’ attitude to training is not positive. The authors consider that during orientation training, the focus should be how to change workers’ attitude and then move on the technical parts of safety training.

POTENTIAL SOLUTION

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.

This analysis will look at the approaches to site specific safety orientation and the flow of information within the project team. The analysis will look at ways to use building information modeling to present safety information and lessons. The BIM safety information will not replace the other safety information but simply add to the training effectiveness. The information in the BIM graphics will be related to project specific hazards and be applicable 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.

RESOURCES

- Jason Reece – Jason is part of Balfour Beatty Construction. He is very knowledgeable in building information modeling, and has presented in class about implementing BIM into safety training. Jason will potentially be able to help with modeling.
- Tommy Rumley – Tommy is the project manager on the Solaire Wheaton project.
- Charlie Liesfeld - Assistant superintendent on the Solaire Wheaton project.
- Jim Faust - Jim is the instructor of AE472, a class in which site specific safety plans were a topic.
- *Why Operations Engage in Unsafe Work Behavior: Investigating factors on Construction Sites*

ANALYSIS STEPS

1. Interview the project manager of the biggest safety hazards on the site
2. Research current industry approaches to site specific safety orientation (NYC BIM Manual)
3. Develop a model of the building and site
4. Develop snapshots of different phases of construction illustrating the safety hazards to viewers
5. Evaluate the value during a specific phase of the project by comparing relative information in the safety training video with that of the new approach using BIM. This step will also involve an analysis of lost time and money spent on non-value adding safety orientation.
6. Develop a matrix decision guide to determine the applicable level of BIM use according the project characteristics

EXPECTED OUTCOME

This analysis is expected to discover some of the flaws related to the flow of safety information within the parties of a construction project. The goal of this research analysis is to evaluate the use of BIM to present safety information allowing the construction manager to more effectively and better prepare workers to avoid project specific hazards. A best practice approach will be developed as a way to share safety information and lessons learned. It is presumed that the use of BIM will provide a more informative and effective way of presenting site specific safety hazards.

CRITICAL INDUSTRY INTERVIEW QUESTIONS

1. What is the current approach to safety orientation and how effective is it in preparing workers for the hazards seen on the jobsite?
2. Do the current approaches to safety orientation prepare the workers for site specific safety hazards (is the process value adding)?
3. How can building information modeling be used to pass along safety information?

ANALYSIS 3 – MODULARIZATION

PROBLEM IDENTIFICATION

The most critical success factor for the project from the owner’s point of view is schedule. As previously noted, the goal is to complete their apartment building prior to the competitors in the area. Experience on the project showed that the competing apartment building being constructed down the street was following along at a similar pace and would be completed soon after the Solaire project. Had there been a way to accelerate the schedule and construct the building quicker, the marketing team would have a better opportunity to lease units. There have also been delays related to weather, lead times, design changes, and inspections, adding risk to completing the project on schedule. On-site productivity is also being driven down by the site constraints, aggressive schedule demanding increased manpower, and stacking of the trades.

BACKGROUND RESEARCH

Modular construction is an innovative construction technique which utilizes off-site fabrication of modules, while on-site work occurs concurrently. This significantly shortens the overall construction duration while allowing for earlier building occupancy. According to Commercial Modular Construction Services, most modules arrive at the site 60-90% complete with structural and MEP systems installed and inspected.

In addition to schedule reduction, on-site productivity is increased as there are less workers and materials on the jobsite. This eliminates the stacking of trades allowing for a smoother work flow.

POTENTIAL SOLUTION

The third analysis will evaluate the use of modularization, and determine if implementation on the Solaire Wheaton project is feasible. Modularization allows project teams to integrate the design and construction phases. Construction of the modules can take place during the foundation and cast-in-place concrete phases of the project. Modularization has many benefits including schedule and safety hazard reduction, elimination of waste, and increased field productivity.

A value engineering option applicable 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 into one material. 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. A case study of a project at Millersville University by Benchmark Construction showed the use of ZIP sheathing on prefabricated exterior wall panels. This material would be applicable to modular construction, although it is also suitable for on site installation.

RESOURCES

- Ted Border – Ted is a part of Whiting Turner and presented a modular case study in the AE 473 class.
- Benchmark Construction – Millersville University off-site prefabrication case study
- Dr. Rob Leicht - Instructor of AE570 production management in construction course
- Issa Jafar Ramaji - Graduate student at The Pennsylvania State University studying modular building
- *Modular Prefabricated Residential Construction Study*

ANALYSIS STEPS

1. Define the modular unit scope and develop the module layout
2. Site survey - Analyze site restrictions & opportunities (study of how many hours of fall hazard exposure are avoided by looking at superintendent daily reports)
3. Develop an execution strategy and plan
4. Develop a schedule for modular units and compare to the stick built schedule

EXPECTED OUTCOME

The shift of work to an off-site location allows for the simultaneous sequencing of work. This approach will allow the wood framed structure to be built at the same time as the foundation and cast-in-place parking garage and first floor. As the structural concrete phase wraps up, the modules can begin to be transported to site and set in place by the tower crane. It is expected that the implementation of modularization on the Solaire Wheaton project will result in a schedule reduction of several weeks.

ANALYSIS 4 – SIPS FOR INTERIOR FINISHES

PROBLEM IDENTIFICATION

The critical path for the second phase runs through the interior finishes on floors three through six, as this is the only remaining work to be completed. Experience on the project proved that the critical path method (CPM) schedule presented unrealistic durations that were not met by finish contractors. For this reason contractors were not able to flow from floor to floor or space to space. Instead contractors were forced to mobilize each time workspace was available. This stems directly from the unrealistic durations and inability to create flow and throughput of trades. CPM scheduling has proven to be ineffective at correcting these issues, as it is not derived from production values. This analysis will be used to determine a scheduling method to produce a more detailed and predictable plan that is more executable and enables smooth work flow through the spaces.

BACKGROUND RESEARCH

Short interval production scheduling is a scheduling technique that is used to derive a predictable schedule using accurate production rates. This approach to scheduling has been implemented on construction projects that incorporate repetitive processes. Taking an assembly line approach to construction, the building is divided into similar spaces and workers move through the building in a sequential pattern. With constant durations, each crew is given the same amount of time to complete their work in a space before moving to the next.

This approach was used on the Pentagon renovation project which started in March of 2002 and had an initial 42 week schedule. The schedule involved forty 10,000 SF areas and 26 major activities. The renovation project used week durations for the spacing resulting in 26 weeks of renovation per space. This number may seem high, however, the “waterfall” effect of short interval production scheduling results in turnover of a space per week and an overall renovation duration of 65 weeks. Although the schedule duration was increased, it is important to note that SIPS provided a predictable schedule.

POTENTIAL SOLUTION

The fourth analysis will present an implementation of short interval production scheduling on the second phase of the project for the interior trades in the residential units on floors three through six. 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. Similar to the Pentagon renovation project, Solaire Wheaton has a large building footprint with fairly repetitive spaces.

RESOURCES

- Pentagon Renovation - SIPS implementation example
- Parade of Trades: Impact of Work Flow Variability
- Dr. Rob Leicht - Instructor of AE570 production management in construction course
- Dr. Craig Dubler - Instructor of AE 473

ANALYSIS STEPS

1. Obtain superintendent daily reports showing manpower for the finish trades during the interior stage of the project and an updated schedule
2. Choose a constant production rate and calculate the manpower necessary to meet production requirements for SIPS
3. Develop a matrix schedule by define the optimum number of building sections, defining the sequence of activities, and calculating production rates using the daily reports and updated schedule
4. Compare the short interval production schedule to the planned and actual schedules
5. Develop graphical representations of the manpower curves and compare
6. Develop a detailed breakdown of one trade showing activities and flow through the space

EXPECTED OUTCOME

The implementation of short interval production scheduling will provide a more accurate and detailed plan. This will make the interior finishes stage more predictable for all parties involved. The contractor and owner will not have to deal with delays and damage claims due to unmet schedule deadlines. Subcontractors will have a more predictable interior finishes plan from which they can form their work plan.

It is expected that when the actual activity durations are discovered, they will prove to be longer than the initial schedule durations. The short interval production schedule should result in a schedule reduction while providing an easier way to manage the trades and track progress.

ANALYSIS WEIGHT BREAKDOWN

Table 1 shows the percentage breakdown of the four major analyses. This matrix represents the appropriate amount of time that will be allotted to each analysis, and therefore should be graded according to these percentages. The analyses are categorized as: critical industry issue, value engineering analysis, constructability review, and schedule reduction. As depicted in Table 1, most of the time will be allotted to critical industry issue. This is representative of the amount of research that will be required for each of the first three analyses. In the same sense, the third analysis of modularization will be the most work intensive and accordingly will be worth the greatest percentage.

Table 1. Analysis Weight Breakdown

Description	Critical Industry Issue	Value Engineering Analysis	Constructibility Review	Schedule Reduction	Total
Analysis 1: Weather Clause	15%	-	-	-	15%
Analysis 2: BIM for Site Specific Safety	15%	-	15%	-	30%
Analysis 3: Modularization	5%	15%	10%	5%	35%
Analysis 4: SIPS for Interior Finishes	-	-	5%	15%	20%
Total	35%	15%	30%	20%	100%

Refer to the summary schedule in Appendix C for the breakdown of analysis steps per week. As you can see the goal is to complete analyses one and four by the end of January as they will presumably take the least time. That will allow for a month to complete each of the remaining analyses, which will require the most time devotion. This allows for focus on one analysis at a time during these months.

CONCLUSIONS

These four analyses provide the opportunity to further my knowledge in the construction industry while providing ways to improve the construction process on the Solaire Wheaton project. They provide the opportunity to research critical issues such as contract language and safety orientation, while analyzing ways to reduce the schedule and increase field productivity.

Eliminating contract clause ambiguity allows for both parties to better understand the agreement and opportunities for claims. Site specific safety orientation and the flow of safety information on a project has much room for improvement, preparing workers better for the safety hazards on specific projects. The shift of work to an off-site location through modularization allows for concurrent construction activities and overall schedule reduction. Finally, using short interval production scheduling allows for an easier way to plan, manage, and track activities and should provide some schedule reduction.

These analyses will provide different approaches to contracting, safety, and construction methods, enhancing the Solaire Wheaton project by meeting the goals of the project team.

APPENDIX A. BREADTH STUDIES

BREADTH STUDIES

ARCHITECTURAL BREADTH

The third analysis to determine the feasibility of modularization on the Solaire project will require an architectural layout redesign. Modularization is most effective on repetitive processes; however, the current design incorporates twenty-one different unit layouts. Performing an architectural breadth to reduce the number of layouts to a single digit number will make modularization more effective. Every effort will be made to preserve the architectural features, particularly the facade projections. A typical floor will be analyzed as floors three through six have the same layout.

The deliverables will be graphical representations of the final unit layouts, a typical floor plan, and elevation renderings to compare the aesthetics in the facade projections.

STRUCTURAL BREADTH

To aid in determining the plausibility of modularization in analysis three, a structural breadth will analyze the performance of the crane to be used for setting the modular units. Although modular units are typically set using a mobile crane, the site restrictions make this an unlikely possibility. In addition, the tower crane will still be in place from the structural concrete phase. It is presumed that due to the large loads associated with modular units, the tower crane and foundation pad will need to increase in size and strength.

The deliverables for this breadth will be an analysis of the crane reach and strength based on the estimated weight of the modular units. If necessary, the crane will be resized to meet these parameters. This will then be followed by calculations to size the crane foundation pad and its reinforcement.

APPENDIX B. MAE REQUIREMENTS

MAE REQUIREMENTS

The knowledge acquired through the construction integrated masters program has guided the analysis selection process and will provide resources for completing each analysis. Knowledge of construction and engineering law learned through the AE 598D course will aid in the first analysis. The course, known as Legal Aspects of Engineering and Construction, dealt heavily with design and construction contracts. Lessons in delay clauses will relate directly to the weather clause analysis.

The AE 570 course, better known as Production Management in Construction, will be applicable to both the third and fourth analyses. The third analysis of modularization was formed through modularization techniques learned through the AE 570 course. Modular case studies and technical reports in this course will aid in the research and implementation of modular construction. The fourth analysis of short interval production scheduling was also a concept learned through AE 570. The Pentagon Renovation project was presented in this class and is the model for the implementation of SIPS on the Solaire Wheaton project.

As part of the mechanical breadth, the study of the enclosure details will involve lessons from the AE 542 course, also known as Building Enclosure Science and Design.

APPENDIX C. SUMMARY SCHEDULE

