Images Courtesy of The Preston Partnership

SOLAIRE WHEATON

Image Courtesy of Clark Builders Group

Kevin Martyn

Thesis Proposal

Construction Option

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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 compare the self-written weather clause to that of the AIA form contract. Through analysis of both weather clauses, a determination will be made as to whether or not the contractor had a claim to recover rain days. 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 and information flow will be the topic of the second analysis. This analysis will look at current approaches to safety orientation and training, and determine why they are ineffective. The generic training videos and lengthy site specific safety plan documents are unable to inform workers of the hazards they will encounter and their locations. The use of building information modeling will allow for a more effective means of presenting safety information, as 83% of what we learn derives from what we see.

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, even with a potential cost increase. This analysis will determine the feasibility of implementing modularization on the project. The podium structure design allows for the wood framed units to be constructed off-site 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

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 an argument to recover days in the schedule. The self-written clause was not easily interpreted and required a significant analysis to determine if rain days were recoverable.

BACKGROUND RESEARCH

Construction delays can be separated into two categories: 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 clause that raises concern and must be looked for in the contract is '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.

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.

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. Interpret the contract language of the form and self-written weather clauses (outline steps of claim through the use of flowcharts)

3. Perform analysis to determine whether the contractor had a case with either contract clause

4. If necessary, re-write the self-written weather clause to eliminate 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, there should be some way to rewrite the language eliminating the 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 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 look for and where they are located. Safety information is no 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 it rarely occurs. The flow of safety information on the project was poor, 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 create safety training videos. Videos have the ability to present more information in an amount of time than a written document. These videos will not replace the other materials but simply add to the training effectiveness. These videos 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 help.
- Tommy Rumley – Tommy is the project manager on the Solaire Wheaton project. I will interview Tommy to develop the list of the major safety hazards on the site.
- AE 472 – Site specific safety plan requirements and example
- *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

3. Map the current flow of safety information

4. Develop a model of the building and site

5. Develop a 3D model walk through to show site specific safety hazards to viewers

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 find better approaches to information presentation and flow that allows the construction manager to provide safety information 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 was 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. How much input is given or requested from the subcontractor foreman on site specific safety training?

3. What hinders the flow of safety information and lessons learned within a project?

4. Is there any type of database of lessons learned and if not how effective could this be?

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. Develop a schedule for modular units and compare to the stick built schedule

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 the scope of modularization

4. Develop the size of the modules (architectural redesign)

5. Develop an execution strategy and plan

6. Analyze the thermal characteristics and feasibility of ZIP sheathing vs. traditional OSB and tyvek

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 do 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 numbers 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
- 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 project and an updated schedule

2. Calculate production rates while comparing the reports to the updated schedule

3. Define the optimum number of sections to divide the floors into

4. Define the sequence of activities

5. Choose a constant production rate and calculate the manpower necessary to meet production

6. Develop a time scaled, resource loaded bar chart in Microsoft excel and

7. Develop graphical representations of the manpower curves and compare

8. Compare the short interval production schedule to the actual schedule

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 alloted 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 alloted 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 has 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. The building footprint will remain the same, although minor adjustments may be made. A typical floor will be analyzed as floors three through six have the same layout. Every effort will be made to preserve the architectural features, particularly the facade projections.

MECHANICAL BREADTH

Analysis three will incorporate the use of exterior wall ZIP sheathing as a value engineering alternative to traditional oriented strand board sheathing with tyvek building wrap. ZIP sheathing combines the OSB sheathing and building wrap into one material, consequently eliminating the building wrap installation step in the process. This change in the wall assembly component constitutes a mechanical breadth to analyze the thermal and moisture characteristics. This breadth will compare the wall assemblies of ZIP sheathing and traditional OSB with tyvek building wrap to determine if performance value is added to the project.

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.

APPENDIX C. SUMMARY SCHEDULE

Solaire Wheaton Thesis Proposal Schedule

Activity	Dec 2013		January 2014				February 2014				March 2014				April 2014				May 2014	
	W3	W4	W1	W2	W3	W4	W1	W2	W3	W4	W1	W2	W3	W4	W1	W2	W3	W4	W1	W2
Obtain AIA Form Contract															Compile Final Report & Presentation		Faculty Jury Presentations		Awards Jury/ Senior Banquet	
Interpret language of both contracts																				
Perform claim analysis of weather clause																				
Rewite weather clause if necessary																				
Interview project manager for site hazards																				
Research current industry approaches																				
Map the current flow of safety information																				
Develop a 3D model of the project site																				
Develop 3D model walkthrough																				
Develop schedule for modular & stick-built																				
Analyze site restrictions & opportunities																				
Develop the scope of modularization																				
Develop the size of modules (layout redesign)																				
Develop execution strategy																				
Analyze wall system thermal characteristics																				
Obtain daily reports and updated schedule																				
Calculate trade production rates																				
Determine optimum number of sections																				
Define sequence of activities																				
Choose constant production rate																				
Develop resource loaded bar chart																				
Develop manpower curves & compare																				
Compare schedule durations (SIPS vs. CPM)																				

Key
Analysis 1: Weather Clause
Analysis 2: BIM for Site Specific Safety
Analysis 3: Modularization
Analsysi 4: SIPS for Interiors
Spring Break: March 9th - 15th

Milestones	
Analyses 1 & 4 Complete	January 31st, 2014
Analysis 2 Complete	March 7th, 2014
Analysis 3 Complete	March 28th, 2014
Final Summary Reports Due	April 9th, 2014
Faculty Jury Presentation	April 14th-18th, 2014
Awards Jury/ Senior Banquet	May 2nd, 2014