Thesis Proposal

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Silverado Senior Living
Brookfield, WI

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EXECUTIVE SUMMARY

This proposal outlines potential opportunities to accelerate the schedule, reduce costs, or increase building performance and quality. Technical information was researched during the fall 2013 semester and used to determine multiple analyses that could benefit the owner. These evaluations will be performed over the course of the spring 2014 semester and listed below:

Analysis 1: Re-sequencing of the Project Schedule

Hunzinger had pour the slab on grade during the winter months in order to reach the firm September 2013 deadline. This meant higher costs associated with that process as well as longer pouring durations. Re-sequencing the project schedule could avoid these costs be postponing slab placement until March, but would require the remaining work to be completed quicker. In order to make up the lost time, multiple solutions are needed in addition to working overtime or increasing crew sizes. Analysis 3 and 4 explore these possibilities and ultimately this evaluation will determine if the savings from pouring the concrete in March is worth pursuing.

Analysis 2: Installation of Rooftop Solar Panels

Silverado uses wood trusses to support the roofing system, and because the large amount of open rooftop area, this analysis will focus on the installation of solar panels. The deadline for substantial completion is strict, so I will develop a schedule that will account for this work without missing the intended completion date. This study will account for any cost and schedule impacts on other trades as well as the panel's contribution to a potential LEED certification.

Analysis 3: Schedule Acceleration through SIPS

The facility contains 50 sleeping units which are broken up into three different layouts. Because of the repetitive design of these rooms, SIPS could significantly reduce the time needed for the MEP rough-in for the sleeping units. This evaluation will determine the magnitude of time saved by implementing this method and costs associated with the reduction in schedule. This process is dependent on early and frequent communication between the involved trades, so I will also create a process map that outlines proper implementation of SIPS.

Analysis 4: Prefabrication of the Interior Structural Panels (Critical Industry Issue)

The interior shear walls are already shop fabricated, so this study will explore incorporating the in-wall plumbing rough-in into the fabrication process. The relatively open site can provide a location to assemble these components, and ultimately could decrease installation time. This analysis will determine the savings associated with the reduction in schedule versus the additional costs needed to fabricate the panels.

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Building Introduction

Silverado Senior Living, shown in Figure 1, is a high-end assisted living facility located in Brookfield, WI next to several single family homes to the East and West and a church to the South. With a focus on memory care, this roughly 45,000 square foot building will ultimately house up to 90 residents in 50 separate sleeping units. Total cost for this one story project totaled about $10 million, and construction began in September of 2012 and was completed one year later in September 2013. Hunzinger Construction Co. was general contractor for this facility, and the delivery method was Design-Bid-Build.

The owner of the project, Silverado, owns and operates 31 facilities nationwide, and has established themselves as a premier industry leader in at home, hospice, and memory care for seniors. For this facility, Silverado utilizes a "Back-of-House" layout that separates the employee areas from the spaces inhabited by the residents. It also boasts features such as an enclosed courtyard with a gazebo, walking paths, a solarium, two bistros, and a great room that contributes to their esteemed reputation in senior care. Silverado implements a philosophy called "normalization" into their treatment plan for the residents in addition to traditional methods. This approach focuses on treating patients as they were prior to diagnosis, which can provide them with a renewed sense of purpose. Part of this principle includes techniques such as pet therapy and giving residents jobs around the facility. In order to successfully implement this paradigm, spaces for activities, pleasant eating areas, and high quality interior finishes help residents to live a relatively normal life.

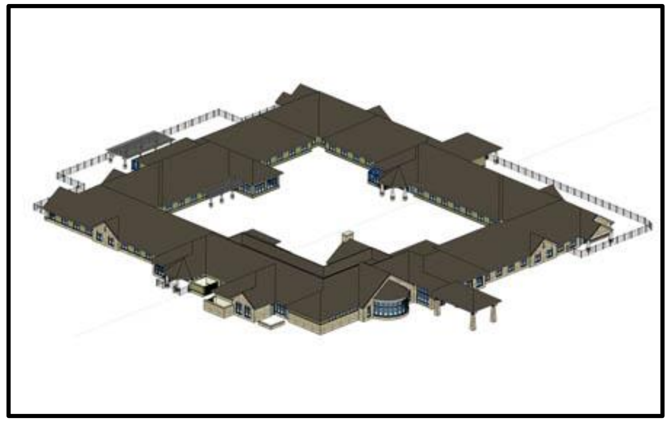


Figure 1 : Silverado Senior Living ***Courtesy of Hunzinger**

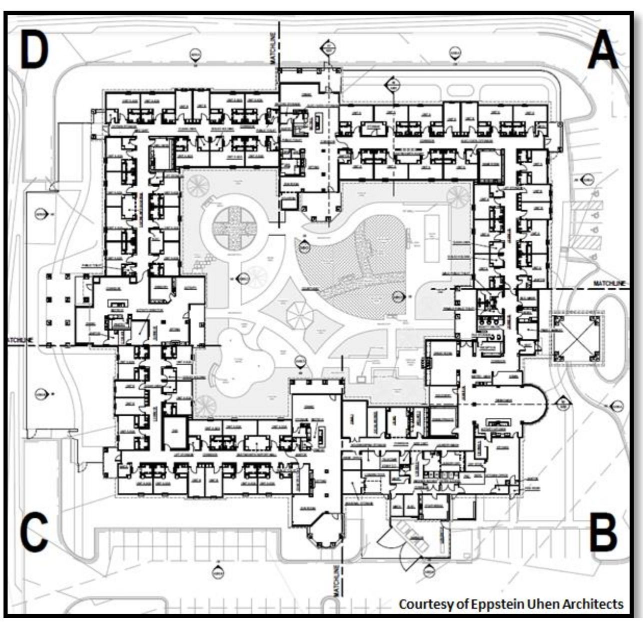


Figure 2 : Overall Floor Plan ***Courtesy of Hunzinger**

The facility is broken into four quadrants which contain an enclosed courtyard in the middle. The main entrance is on the East side of the building and is marked by a canopy so patients can be dropped off and are protected from potentially harsh weather conditions. The kitchen, mechanical rooms, and employee areas are located in the Southeast corner of the building in quadrant B. The other three quadrants contain 50 sleeping units which house up to 90 residents. Interior amenities such as the great room, bistros, and activity rooms are located throughout the building.

Analysis 1: Re-sequencing of the Project Schedule

Project Identification

Because of the strict September 2013 deadline stemming from financial constraints for the owner, Hunzinger began construction with the civil and sitework from September of 2012 to mid-November. This meant that unless work was halted from December to early March, the foundations and slab on grade had to be erected using cold weather procedures. Especially in Wisconsin, harsh winter temperatures mean significantly increased installation costs and activity durations because of additional manpower, equipment, and facilities needed to pour concrete in below freezing conditions. Also, erection of the exterior and interior wall panels could not begin until half the SOG was poured, which means the added risk associated with winter weather pouring increases the chance of an error that could delay any subsequent activities.

Figure 3 – Placement of the SOG ***Courtesy of Hunzinger**

Background Research

In order to mitigate the additional risks and avoid extra expenses from cold weather pouring, I plan to re-sequence the schedule so the SOG will be poured during normal conditions. Hunzinger self-performed all concrete work and allotted $175,000 for “winter conditions” in addition to the $47,500/month for general conditions costs.

The SOG was originally scheduled to be poured from Jan 9, 2013 to March 1, 2013, which totaled 40 working days in a harsh environment. With consistently cold temperatures, the chance for human error or equipment malfunction that could result in delays is increased. ACI 306 defines cold weather as when the average daily temperature is less than 40^{o}F for three consecutive days, and does not exceed 50^{o}F for more than half of any 24 hour period. To allow for placement of concrete during “cold weather”, all snow or ice must be removed so the subgrade can thawed. Portable heaters will warm up the space inside the temporary enclosure so the ambient air temperature is conducive to pouring and curing of the individual section of the SOG. Then after the concrete is placed in the correct location, then slab still needs to be protected until reaches the proper strength. For Silverado, this process included two enclosures, concrete buggies, glycol hoses, vapor retarder, heaters, and an accelerating admixture to create and maintain proper pouring conditions. Hunzinger rarely pours the slab during the winter, so quality control was a concern because this was not a normal practice.

If the slab was rescheduled to be poured during the spring, then the additional costs and risks could avoided; however, all subsequent trades would need to be pushed back and potentially expedited with additional crews on-site. Pouring the slab would begin approximately mid-March when the weather falls under normal placement conditions. As a result, work would be postponed roughly three months to accommodate for this modification. Normal pouring conditions would mean quicker and higher quality placement, so this delay could be significantly less than the original three months allotted for this process.

Potential Solutions

- Start pouring the SOG in March to avoid additional expenses and risks associated with cold weather pouring. Using various schedule acceleration techniques the September 2013 substantial completion deadline could still be met.
- Postponing installation of the slab of grade was cost effective, but the schedule acceleration techniques did save enough time to meet the September deadline.
- Re-sequencing is not feasible for this project to because of the strict deadline and inadequate time for the remaining trades to finish their work. The shortened schedule could result in a lower quality product because of added pressure for trades to complete their work in a shorter amount of time.

Methodology

- Evaluate schedule and cost implications for the sitework completed prior to erecting the foundations.
- Consult with the project team and other industry professionals to find the best solution.
- Continue researching the process of cold weather concreting and alternatives to placing the SOG in winter.
- Examine related case studies with similar circumstances to help produce typical durations for concrete work.
- Determine durations for normal placement conditions and the related personnel, crew size, material, labor, and equipment expenses.
- Explore means of accelerating installation of the slab to expedite the process.
- Evaluate impacts on other trades relative to the overall schedule as well as any constructability issues.
- Create a site plan that details the process and shows the re-sequencing of pouring under normal conditions.
- Perform a cost-benefit analysis that compares the expenses associated with the original placement plan during winter versus installing the slab in the spring.

Expected Outcome

Although three months is a significant amount of time to postpone the subsequent construction operations, pouring the concrete during normal conditions will ultimately reduce the project cost and avoid additional risks. Three months was allotted for pouring during the winter using only two heated enclosures at a time, so that number can be reduced because placing concrete under normal conditions is quicker and less expensive. Hunzinger budgeted $175,000 to account for winter conditions, and general conditions expenses were roughly $47,500/month, which means there are potential savings by avoiding the winter months and decreasing the overall project duration. Because of the time lost by postponing the installation date, it is likely that Hunzinger and potentially other trades will need to work additional shifts and weekends in order to make the September 2013 deadline. This will increase the cost traditionally associated to pouring a slab, but these expenses should not outweigh the savings and reduction in the overall project schedule.

Analysis 2: Installation of Rooftop Solar Panels

Problem Identification

Silverado incorporates multiple high-end products through the facility, but the owner did not want to pursue more expensive materials solely because they would increase the overall energy efficiency of the building. For example, premier components such as low flow plumbing fixtures, marble counter tops, LED light fixtures, and exhaust equipment were included because of the high quality interior spaces that are standard for all Silverado facilities. With the fact the aesthetics were important to the owner, Silverado Senior living could take advantage of the spacious rooftop area to install solar panels. Installation of these cells would initially raise costs, but after enough time, the power generated from these devices would eventually pay for themselves. In addition, these panels could contribute to a LEED certification that the project was already on the verge of earning. The challenge with installing the rooftop panels would be integrating the work into schedule with causing significant delays.

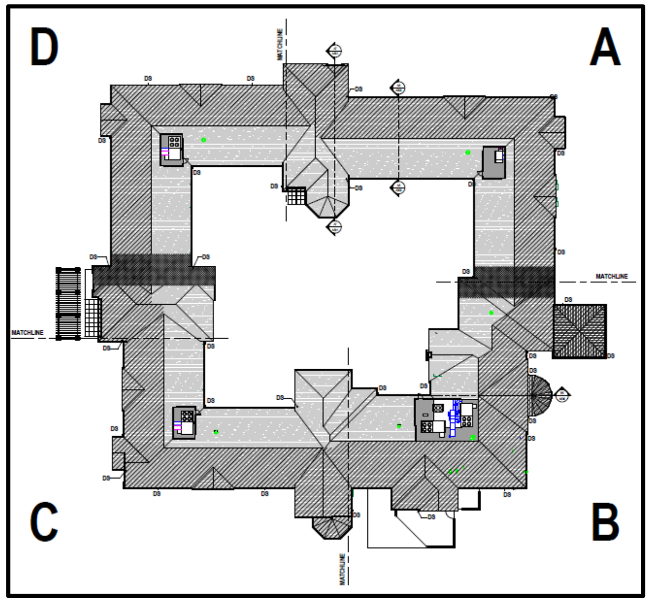


Figure 4 – Overall Roof Plan *Courtesy of Hunzinger

Background Research

The focus of this analysis will explore the cost and schedule implications of adding the panels to the current design as well as determine the magnitude of the contribution to a LEED certification. First, these panels need to be oriented properly to maximize exposure to sunlight. Silverado's layout is a rectangle with roughly equal sides, so this study will determine which locations are the most cost effective based on their orientation. A solar study will to estimate how much sunlight the panels could potentially absorb during each season, and from those results, I will be able to quantify the cost saving based on local utility rates.

In addition to providing a renewable energy source, the panels will also need to be installed quickly to avoid missing the September 2013 substantial completion deadline. This process will affect multiple trades, in particular the asphalt roofing, rough carpentry, mechanical, plumbing, and electrical subcontractors. To avoid interfering with other work being done, the schedule will need to be re-sequenced to include the installation or the panels, as well as tying them into the current electrical system. Silverado is one story tall and contains an uninhabited attic space that is conducive to hiding equipment and distribution components from view. Also because there is excess space in the attic, this will help to avoid clashing with other subcontractors during installation.

Since the panels will located on the roof, there will be design changes that will affect the quantity of asphalt shingles. This will result in material, labor, and equipment savings because decreased surface area that requires asphalt shingles. However, rooftop solar panels are notorious for causing leaks, so there will be emphasis on quality control to prevent unwanted moisture from seeping into the attic.

Potential Solutions

- The re-sequenced schedule is able to accommodate the additional work, and the cost benefit analysis shows long term cost savings within a reasonable amount of time. The panels satisfy enough LEED criteria to earn a LEED certification.
- The project still meets the deadline in September, but the extra material expenses, overtime, lack of sunlight, and potential repairs needed for leaks does not make this a profitable endeavor.
- The panels provide enough power to be cost effective within a reasonable amount of time, but the added work, coordination efforts with the other trades, and tying the panels into the original electrical system is too complex and slow of a process to complete the project on time. This cost the owner money due to financial constraints from their lender, as well as lost revenue from moving the residents into the facility as planned.

Methodology

- Perform cost-benefit analysis comparing the added material, labor, and equipment expenses with the long term savings from reduced utility costs.
- Re-sequence the schedule to account for the installation process. This may require subcontractors to work additional shifts or weekends to ensure the September deadline is met. Enclosing the building will be a significant milestone that may need may need to be altered.
- Interview suppliers as well as related trades to determine how the panels would affect their type of work.
- Determine the appropriate crew personnel, size, and equipment needed on-site to install the panels.
- Find accurate product data and specifications for the solar panels. This will include material costs, installation durations, operational expenses, energy absorption properties, necessary supporting equipment, recommended means of distribution, unit weights, optimal placement location, and other data that could impact project cost, schedule, or performance.
- Redesign the electrical system to tie the panels to the current design and determine the effect on cost, schedule, and quality (Electrical Breadth Located in Appendix A).

- Outline the estimating, submittals, procurement, and installation processed in a manner that makes it easy to comprehend.
- Calculate the increase in load from the panels on the roof trusses as well as the structural panels (Structural Breadth Located in Appendix A). From these calculations, I will determine the next proper course of action which could mean redesigning the trusses and load bearing walls.

Expected Outcome

If the change in aesthetic appearance is okay with the owner, then these panels should pay for themselves in the long run. Implementing the system into the current electrical system will initially be more expensive, but analyzing the solar gains and associated savings will show when the owner can expect to see positive returns. Also, since this work is primarily located on the roof, integrating the installation of the panels should be an attainable goal because the work will generally stay out of the other trades way.

By providing their own source of renewable power and consequently reducing utility costs, Silverado should be able to earn a LEED certification without chasing points and unnecessarily raising costs. Also, the roof trusses and shear walls will most likely need to be redesigned to support the additional load.

Analysis 3: Schedule Acceleration through SIPS

Problem Identification

Silverado will ultimately house up 90 residents in 50 sleeping units which are located in quadrants A, C, and D. These units consist of three different layouts, which also vary slightly depending on whether they facing the interior courtyard or exterior façade. With the strict deadline and potentially shortened schedule due to pouring the slab in March as opposed to January, these areas provide a good opportunity to make up lost time.

Background Research

Short Interval Production Schedule (SIPS) is a means of analyzing on specific operation down to each basic step. Durations, which can be down to the minutes, are assigned to each activity and communicated to the corresponding trades. SIPS function similar to an assembly line, with one trade following the other in a fluent and efficient manner. Although typically used for larger scale buildings with repetitive layouts, this strategy could be productive for Silverado because the sleeping units have similar designs.

Implementing SIPS on any project requires early collaboration between all parties in order to develop the most efficient sequence of operations. This requires the project team, subcontractors, material suppliers, safety officers, and anyone who plays a role in the process to be brought onboard as soon as possible so the schedule can adjusted to maximize efficiency.

In Silverado's case, the mechanical, electrical, plumbing, and fire protection wall and ceiling rough-ins (only ceiling for Plumbing) are scheduled to begin March 6, 2013 and finish on June 21, 2013. This totals a duration of 77 work days not including weekends. Because that duration includes all interior spaces not just the sleeping units, the number is likely to be significantly reduced because most of the MEP intensive areas are located in quadrant B. Even with reduced duration for those activities, there is ample room to accelerate the schedule if needed.

Potential Solutions

- If implemented properly, SIPS could significantly reduce the time needed for the interior MEP rough-in. Considering that pouring the slab will potentially be pushed back until March, any means of accelerating a given process needs to be explored. Although it will take more coordination early on, the reduction in schedule will be accompanied by some cost savings from the general conditions.

- If the process is not thoroughly communicated to each party involved, then delays could arise when trades begin to overlap. SIPS may still reduce the schedule, but because Silverado is not the same scale that SIPS is usually implanted on, time lost due to the learning curve did not have a chance to be recovered. This would result in postponing the following trades and require additional means of accelerating the schedule in order to meet the September deadline.
- SIPS was not implemented properly and did increase productivity due to relatively small size of Silverado. This process should not utilized on a project such as this because there is not schedule, cost, or quality benefit to the project.

Methodology

- Divide each process into individual activities and determine appropriate durations.
- Sequence the detailed schedule using the calculated durations and break up each activity by trade and personnel.
- Maximize productivity for each crew based on man power, trade, typical task durations, and amount of work to be completed.
- Research past projects that implemented SIPS, especially ones similar to Silverado. Interview personnel on those projects if possible.
- Determine if the overall project schedule needs to be re-sequenced. If needed, then consider the impact on other trades not directly involved in SIPS and look for additional areas to reduce the schedule. Figure out if working additional shifts or weekend is needed to help accelerate the schedule.
- Create a process map that outlines the SIPS from conception to the completed MEP rough-in.
- Perform a cost-benefit analysis to conclude if the reduction in overall schedule justifies the expenses associated with implementing SIPS. Determine if Silverado is large enough to utilize SIPS.

Expected Outcome

Implementing SIPS has good potential to reduce the durations of the ceiling and wall MEP rough-in. If prepared properly and communicated to each trade, then the process should run fluently enough to make up some lost time. Because Silverado is a relatively small building to practice SIPS, time lost from the learning curve needs to minimized or eliminated altogether. This construction method will only be effective if each trade learns to work together to expedite the process. Combining this process with the prefabricated structural panels, re-sequencing of the overall schedule, and possibly working overtime, Silverado could be completed by the September deadline even if the slab on grade was poured three months later. In turn, savings from winter conditions expenses and general conditions would compensate for any additional expenses stemming from SIPS.

Analysis 4: Prefabrication of the Interior Structural Wood Panels (Critical Industry Issue)

Problem Identification

The superstructure of Silverado is composed of shop fabricated, wood shear walls as well as a roof truss system. These are assembled, delivered to the site, and set into location with a 160 ton crane. With a relatively open jobsite, there is potential to accelerate the schedule by adding the plumbing rough-in to the fabrication of the interior structural panels. With added coordination during the schematic and design phases, Hunzinger could take advantage of the open space to assemble these on site.

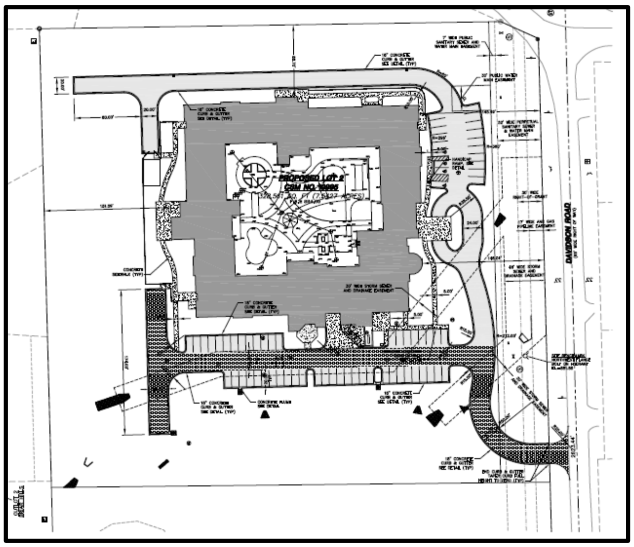


Figure 5 – Project Site *Courtesy of Hunzinger

Background Research

Prefabrication has become an increasingly popular means of reducing installation time on a variety of different types of projects. By collaborating with the involved trades early in the preconstruction phase, the project team can work with the subcontractors to design components that are preassembled on or offsite, and then are ready to be installed once they arrive at the jobsite. This process typically raises initial costs stemming from providing a location for fabrication, transportation expenses, larger hoisting equipment, additional safety measures, and a more time intensive design procedure. Because of these added expenses, this method is frequently used on projects with short and strict deadlines for substantial completion.

The plumbing rough-in and insulation phase for Silverado is scheduled to take 35 work days from March 26 to July 19. With earlier involvement of the structural and plumbing engineers and corresponding subcontractors, the total duration could be shortened if the plumbing rough-in located in the interior structural wood panels was assembled prior to erecting the shear walls. A location on the west side of the property could be allocated for this process, which would provide a more controlled atmosphere for the tradesman to construct each panel. This increases the overall quality of the components because assembly takes place in a controlled environment as opposed to working around and protecting existing work.

Silverado has a firm September deadline, and if pouring the slab is postponed until March to avoid cold weather placement conditions, then prefabricating the interior structural panels could be a means of making up time. An important factor of making this process a success is determining how long the assembly process of each panel takes. This will help determine how the onsite fabrication will need to begin. Because this will occur during the winter months, a temporary enclosure will be needed to protect the components as they are built. The panels will arrive on site with the rough carpentry already completed and ready for the plumber to do begin his rough-in work, so it is important that an accurate estimate of an average panel assembly is calculated. If carried out properly, then once each panel is completed, it can be installed short thereafter which then frees up space inside the enclosure to assemble the next component.

Potential Solutions

- Prefabrication of the interior structural panels is cost effective and results in the desired reduction in installation time.
- Expenses are higher than anticipated due to unforeseen issues and ends up over budget. Installation time is still decreased enough to meet the September deadline, but the additional cost up front is too high to be considered a “cost effective” solution.
- Prefabrication is too costly and will not produce the desired reduction in installation time.

Methodology

- Determine when during the project’s schematic and design phases team member need to be brought onboard to properly design, procure, assemble, and eventually install the interior structural panels.
- Calculate assembly and installation durations bases on productivity rates provided by industry professionals.
- Create a project schedule that implements prefabrication of the structural panels and determine if overtime will be needed.
- Assign an onsite location for assembly and determine the proper size needed to create a fluent assembly process. Also determine additional expenses to procure, construct, maintain, dismantle, and haul off site once finished.
- Analyze case studies that implement prefabricated components and are a similar type of building.
- Consult with structural and plumbing professionals to discuss the feasibility of prefabrication the structural panels with the in-wall rough-in. Obtain realistic assembly times for the plumber to complete the rough-in for an average panel.
- Obtain installation durations and costs for the original plumbing rough-in and panel installation process to use in performing a cost-benefit analysis of the two methods.

- Evaluate the weight of each panel post-assembly and conclude if a larger crane is needed for installation.
- Research means of protecting existing work once in place as well as potential impacts on other trades work. In particular, examine how the plumbing rough-in affects installation of the other engineering systems within the panels.

Expected Outcome

I anticipate the onsite prefabrication of the structural panels will initially raise costs because of the additional coordination efforts and assembly costs associated with the process. Because of the postponed date for pouring the slab on grade, the savings and decreased risk of avoiding cold weather placement conditions will prove sufficient enough to justify prefabrication of the panels. If this is not the case, this analysis will show what needs to be different in order for the project to be successful.

Analysis Weight Matrix

Analysis Weight Matrix					
Description	**Critical Issue Research**	**Value Engineering**	**Constructability Review**	**Schedule Acceleration**	**Total**
Re-sequencing of the Project Schedule	0%	10%	5%	10%	25%
Installation of Rooftop Solar Panels	0%	15%	15%	0%	30%
Schedule Acceleration through SIPS	0%	0%	10%	10%	20%
Prefabrication of Interior Structural Panels	15%	0%	5%	5%	25%
Total	15%	25%	35%	25%	100%

Table 1 – Analysis Weight Matrix

Conclusions

Once each technical analysis has been completed, the feasibility, quality, cost, schedule, and adherence to the owners needs will be determined for each area. The primary objective is to avoid the additional expenses associated with cold weather placement of concrete, and each of these topics directly or indirectly have an effect on that outcome. Re-sequencing the project schedule postpones installation of the slab until March, so the new schedule will need to make up for that time. Installing solar panels will not accelerate the schedule, but since most of that work will take place on the roof, most other activities should not be negatively impacted. This analysis will determine potential modifications to the structural panels and trusses because of the increased rooftop load, as well as the contribution to a LEED certification and potential savings from the power generated from them. Schedule acceleration through SIPS for the 50 sleeping units is one of the means of making up a portion of schedule. Because the work involves the ceiling and wall rough-in of the MEP systems, this analysis is influenced by both the installation of the solar panels as well as prefabrication of the interior shear walls. The critical industry research issue for this project will explore the benefits of onsite prefabrication of the interior wood structural panels with the in-wall plumbing rough-in. Each of the three analyses, which can be implemented in conjunction with each other, has the potential to either generate savings or accelerate the schedule as needed in order to meet the September 2013 deadline for substantial completion.

Appendix A

Breadth Topics

Structural Breadth

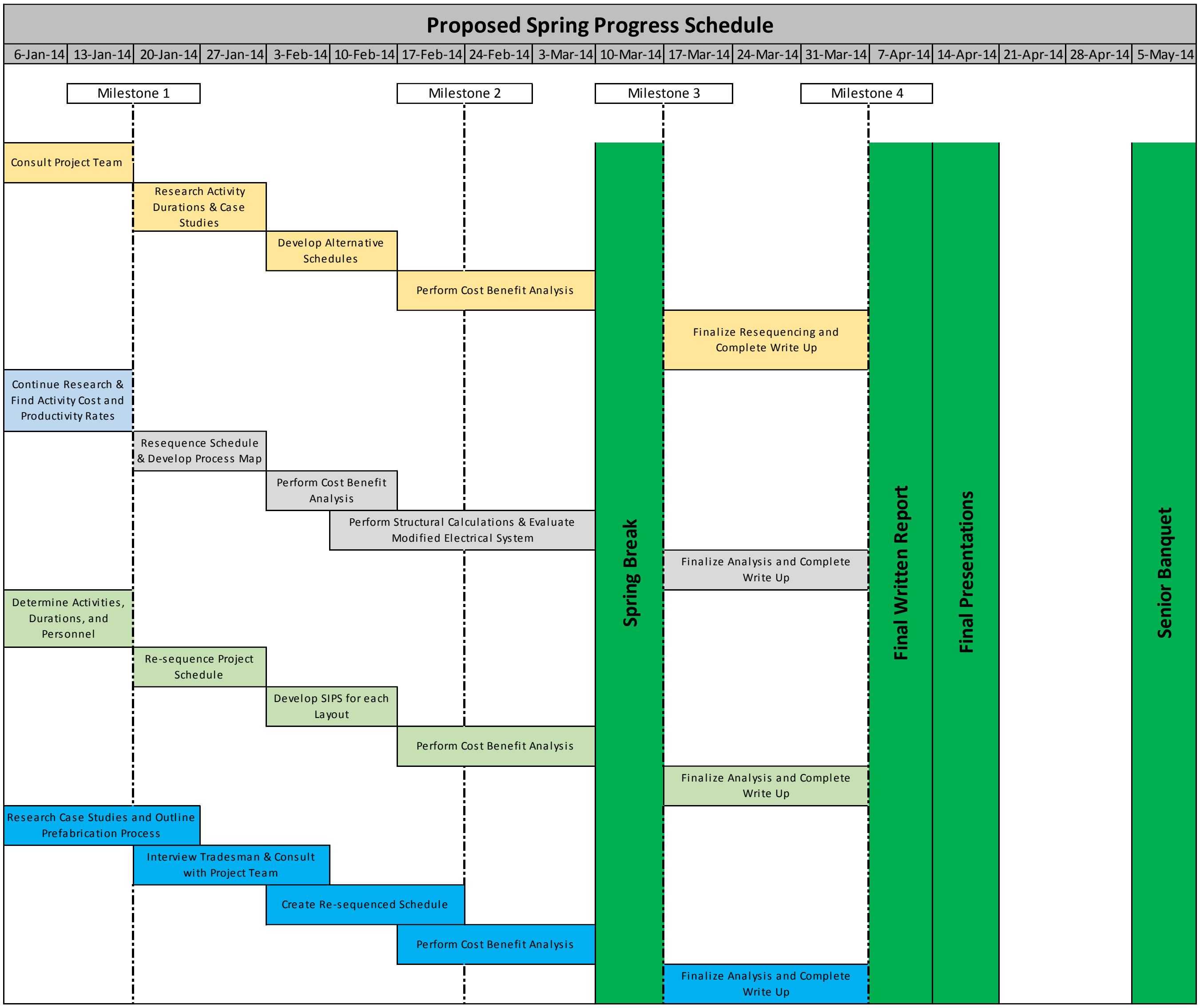
This breadth will focus on the design and performance implications of installing rooftop solar panels. Because of the increased load on the roof trusses and loadbearing shear walls, calculations are needed to determine if the original structural design is capable of handling the added weight. If this evaluation shows that the roof trusses are inadequate, then stronger wall panels and trusses must be used. The costs and schedule implications will vary based on how much larger or stronger the structural members need to be. The goal of this breadth will ultimately determine the impact the solar panels have on cost, schedule, quality, and constructability of modifying the original design.

Electrical Breadth

This breadth will explore what efforts are needed in order to synchronize the solar panels with the current electrical system. Additional equipment will be needed in order to recirculate the generated power back into the building and distribute it to the rest of the facility. This also may require resizing of current electrical equipment in order to accommodate the additional load. Because Silverado will then supply a portion of their own power to run the facility, utility costs will be lower. Eventually, the panels should pay for themselves, and this breadth will quantify those savings and provide a timeframe for when the owner can expect to break even. Silverado is also already close to earning a LEED certification, so this evaluation will also conclude what contribution can be expected by installing rooftop solar panels.

Appendix B

Thesis Progress Schedule



Analysis Key	
	Re-sequencing of Project Schedule
	Installation of Solar Panels, Mechanical, Electrical Breadths
	Sleeping Unit SIPS
	Prefabrication of Interior Structural Panels

Milestones	
1	Preliminary Research 90% Complete. Begin Re-Sequencing of Project Schedule.
2	Performing Cost Benefit Analyses and Selecting Final Solutions.
3	Analysis 95% Complete. Ready to Begin Final Write-Up.
4	Write-Up Complete. Prepare and Practice Presentation