THESIS PROPOSAL SANTA ROSA JUNIOR COLLEGE STUDENT CENTER

FINAL THESIS PROPOSAL

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2009 SENIOR THESIS

THESIS PROPOSAL
SANTA ROSA JUNIOR COLLEGE STUDENT CENTER

EXECUTIVE SUMMARY

The following proposal is intended to give glimpse of the four topics that will be researched and analyzed for a final thesis project on the Santa Rosa Junior College Student Center project. The four different areas include the use of building integrated renewable energy as an additional sustainability element, constructability and cost impacts of alternative façade systems, cost and schedule impacts of an alternative steel erection process, and the impact of an alternative prefabrication process as it is related to the precast concrete elements of the student center.

Critical Industry Issue
With energy costs continually on the rise, taking advantage of new building integrated renewable energy systems seems like a great solution. In the case of the SRJC student center it makes even more sense since the project is located in a geographic region that receives a large amount of sun annually. Although it would require a steep upfront cost, utilizing some form of renewable energy system would surely benefit the owner with its long term payback.

Analysis 1
Construction of the brick façade proved to be a challenging task due to the fact that the brick supports were attached to metal studs as well as steel members to tie the façade into the structure. Having two types of connections caused confusion during construction. Also, the connections to the structural steel were very difficult to weld, causing much time and money to be wasted. I believe that the use of a single type of connection would have sped up construction and minimized delays while saving money.

Analysis 2
The steel erection process used for the student center resulted in nearly three months of delays that resulted in excess spending. A single mobile crane and connection crew were used to complete the entire steel frame of the building, resulting in the need for a 72 day deadline extension. I believe that the use of multiple cranes and crews would have resulted in the structural frame being completed on time without a negative cost impact.

Analysis 3
The design-build prefabrication process used for the architectural panels on the student center resulted in incorrectly sized members due to the fact that exact field measurements were never able to be taken. I believe that the use of an alternative option such as design-assist would have resulted in a more efficient process that would lead to simplified installation and furthermore reduced cost and schedule impacts.

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Project Introduction

The Santa Rosa Junior College Student Center, also known as the Bertollini Student Center, is a 66,646 square foot structure located in Santa Rosa, California. The three story, $50,000,000, student center contains classrooms, offices, meeting rooms, a 2100 SF kitchen, and 4000+ SF student dining area. The structural system of the center consists of a structural steel frame and concrete slab floors. The façade is made up of a combination of brick veneer and precast concrete panels.

Despite being located in a geographic region that is prime for solar energy use, the student center fails to take advantage of this. The only major sustainable aspect of the building comes in the form of a geothermal heat pump loop, which is installed according to IGSHPA and ASHRAE standards and recommendations and greatly increases the thermal efficiency of the structure. The integration of some other form of sustainable design, such as solar cooling, is something that could be of interest to the owner, given the long term benefits and geographic location of the structure.

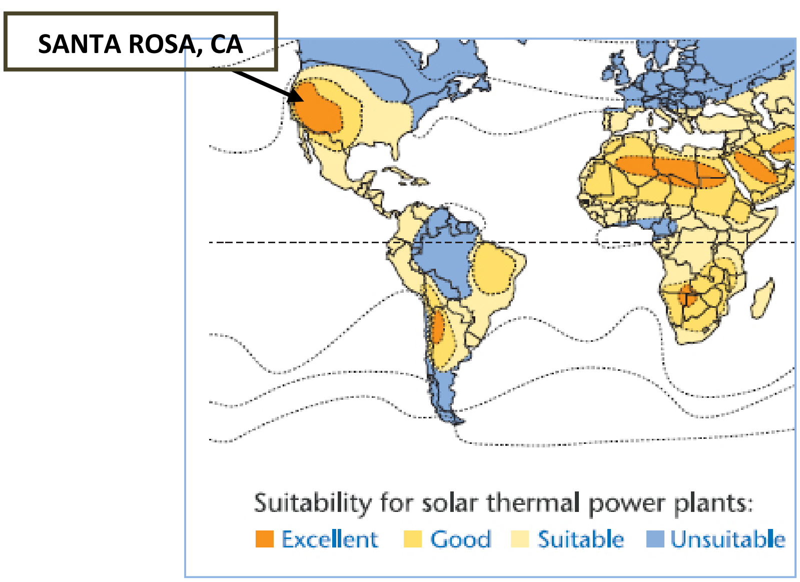
The overall project schedule had a duration of just under 24 months with construction beginning in December of 2007 and finishing up in late November of 2009. This duration includes a 72 day extension which was allotted after early delays. Taking this into consideration, other areas that I have decided to analyze include the cost and schedule impact of the building façade, steel erection process, as well as looking into opportunities to incorporate an alternative prefabrication process for the precast panels installed on the building façade.

Critical Industry Issue: Building Integrated Renewable Energy

Problem:

Recent issues with energy overconsumption and diminishing resources have caused many people to think differently about how they access and use energy. This crisis has caused the price of energy to go up all over the world. The construction industry is one of many areas that have been affected by this issue that is growing every day. Increased costs of energy, increased greenhouse gasses, and depletion of oil supply are only a few of the numerous negative aspects relating to this issue. This energy problem has caused many people to look into the use of alternative forms of energy as a remedy. The only problem associated with the use of alternative energy sources is that these new technologies are often very expensive which deters many potential buyers who are unwilling to pay the upfront cost or are unaware of the long term potential benefits.

Although the SRJC student center incorporates a geothermal loop, it fails to make use of the increased amount of sunlight that is very common to California. The use of building integrated renewable energy could be very beneficial to the structure, the only problem being that the owner does not wish to sacrifice the architecture of the building. Finding a way to incorporate renewable energy while meeting the owner's standard of approval for the architecture of the project poses a challenge.



Goal:

The goal of this research is to develop a plan that would that would implement building integrated renewable energy technology as a means of reducing overall energy costs for the owner. This research will focus on the implementation of distributed production (using energy where you create it) as it is related to solar thermal technology and the use of absorption chillers and solar cooling, as the SRJC student center is located in a prime geographic location to benefit from the use of this technology.

Methodology:

- Research DC power distribution.
- Research solar thermal technology and its uses.
- Analyze case studies in which solar thermal technology is used and analyze initial cost vs. payback period.
- Calculate the load added to the building from solar panels and analyze how the existing structure is affected.
- Analyze how the use of a renewable energy source will affect the architecture of the structure.
- Contact Southland Industries to inquire about absorption chillers and design implementation.
- Research Santa Rosa weather patterns to calculate how much power can be generated with the use of solar panels.
- Compare energy costs of the building with the use of solar technology to the original costs.

Preliminary Resources and Tools

- Industry Professionals
- Current events and literature
- Structural and Electrical Engineering Faculty
- Owner Representatives
- MEP Engineer on project
- Southland Industries

Expected Outcome:

Through extensive research and a thorough analysis, I expect to find that implementing building integrated renewable energy through solar thermal technology would provide cost and efficiency benefits in the long run.

Analysis I: Alternative Façade Design

Problem:

The current façade system on the SRJC student center is made up of brick veneer and precast concrete panels. The minute tolerances and complicated connections of the brick veneer to the structure created numerous headaches on the job site. The brick is connected to the structure by the use of small ledger angles that are then connected to either metal studs or steel members (WT's). The connections to the metal studs were not too big of an issue but the connections to the steel were a completely different story. The steel connections provided trouble because it is much harder to install structural steel to small tolerances than it is to install metal studs. Also, the fact that the steel sub attached the steel to the bent plates in the shop rather than waiting to do so in the field only added to the problem. The complications created by these issues made it nearly impossible to keep the plates to the required tolerances of ¼" both vertically and horizontally.

The steel sub was forced to fix his mistake by correcting the placement of his WT steel members both in the horizontal and vertical directions. The challenge of fixing this mistake began by having the building lines surveyed to provide exact locations of where the outside face of the brick needed to be. The next step was to transfer the acquired layout vertically up the building so that the metal studs would be installed perfectly, even thought the structural steel locations varied by significantly more than the ¼" tolerance. The placement of the vertical ledger angles were also laid out by a surveyor so that they would be exactly where they needed to be.

Goal:

The main focus of this study would be to investigate the method used for connecting the brick veneer to the student center and then determine whether or not it was the best method that could have been used in that situation. The goal is to find a way to redesign the structure so that only one of the two types of connections is utilized (preferably metal studs). The next step is to determine and analyze the effects that the new design would have on the schedule and budget to demonstrate any worthwhile improvements.

Methodology:

- Contact the trades involved and ask them about any other issues with the veneer installation method and what caused them to pursue the method used on the student center.
- Analyze the constructability of the current system vs. an alternative system to determine if an alternative could be used for a cheaper cost or easier/quicker installation process.
- Compare schedule delays that resulted from rework to the construction duration of an alternative system.
- Analyze the cost required to rebuild the system to required tolerances.
- Compare the cost of the alternative system to the rework cost.

Preliminary Resources and Tools:

- Industry professionals
- AutoCAD 2010
- MS Project

Expected Outcome:

Through this analysis I expect that an alternative method of connecting the brick veneer to the structure in which only one type of connection is used would result in less complicated connections, thus eliminating installation issues and the rework that came with them originally. In addition to this, I also expect to reduce the project duration and cost. I expect to achieve this through the comparison of the installation simplicity and costs involved with using each type of connection individually instead of a combination of the two.

Analysis II: Alternative Steel Erection Process

Problem:

The structural steel frame of the SRJC student center is another problem area on the project. The method of erecting steel on the student center resulted in long delays that held up many other activities on the project which in turn delayed the project completion date by 72 days. Although the steel shop drawings were completed on time, the steel erection process started one month late and the completion of the erection and welding of the steel ended up being almost 3 months late, resulting in the need to be granted a 72 day extension to the original schedule. These problems were in part due to the use of a single mobile crane and welding crew throughout the erection process.

Above: Single crane and crew used during erection process

Goal:

This analysis would involve the incorporation of 4D modeling to analyze the details of the original erection process as well as those of an alternative erection method. The use of multiple cranes and welding crews as opposed to what was used on the project will be investigated along with the cost of using an extra crane and labor. The benefits of an alternative erection process such as schedule acceleration and cost reduction will be researched and compared to original data.

Methodology:

- Analyze the constructability of an alternative erection process vs. the original method.
- Analyze the schedule delays caused by the original steel erection process and compare to the duration of an alternative method.
- Develop and alternative schedule that looks into the use of an alternative erection process.
- Analyze the site layout plan to determine if a more efficient one could be developed.
- Develop a 4D model to make visualization of the erection process easier.
- Compare the cost of an alternative method of steel erection to the original method.
- Contact trades involved to determine why the original method was chosen in the first place.

Preliminary Resources and Tools:

- MS Project
- Industry Professionals
- Navisworks Manage 2009
- AutoCAD 2010

Expected Outcome:

Through this analysis I expect to find that an alternative erection process would have resulted in a shorter duration, minimizing if not completely eliminating construction delays and reducing the overall project duration. In addition, I also expect to reduce the overall project cost through minimizing crane use and labor time.

Analysis III: Alternative Prefabrication Process

Problem:

Above: Precast concrete panel being lowered into position

The prefabricated concrete panels that wrap the perimeter of the student center created yet another problem area on the project. The panels were prefabricated very early on in the project at a location very far away (Mexico) which resulted in installation issues and schedule delays. The reason that this occurred was that the precast concrete was made a design-build element on the project. The early prefabrication took place long before the building had been constructed to the point that field measurements could be taken to verify exact sizes. This led to the installation problems and schedule delays mentioned earlier.

Goal:

The main focus of this study would be to investigate the design-build process used for the prefabrication and compare the results to alternative options such as design-assist. The goal is to find a more efficient prefabrication process that would result in simplified installation and therefore reduced cost and schedule impacts.

Methodology:

- Research Design-Assist and the benefits of its utilization on the student center project.
  - Look at instances where design-assist was implemented with successful results.
  - Develop a list of strengths and weaknesses of the design-assist method to determine if it is a viable alternative for the student center project.
- Analyze the schedule impacts of the original prefabrication process and compare them to those of an alternative method.
- Analyze the costs required to fix errors that resulted from the original prefabrication process and compare them to the costs associated with an alternative method.

Preliminary Resources and Tools

- MS Project
- Industry Professionals
- Relevant Literature

Expected Outcome:

Through this analysis I expect that an alternative prefabrication process would have not resulted in the installation issues and schedule delays that the original, design-build, method encountered. This would result in reduced costs due to rework along with reduced schedule impact due to delays.

Timetable

The schedule below represents the breakdown of the overall amount of time I expect to spend on my research. **(Note that these times are subject to slight variations.)**

Task Name	Duration	Start	Finish
Critical Industry Issue Research	**35 days of work**	**12/16/09**	**4/2/10**
Literature Review and Interview Industry Professionals	15 days	12/16/09	1/1/10
Analyze Costs	7 days	3/14/10	3/20/10
Develop Execution Plan	5 days	3/21/10	3/25/10
Summarize and Document Findings	5 days	3/26/10	3/30/10
Review with Dr. Magent	1 day	3/31/10	3/31/10
Revisions	2 days	4/1/10	4/2/10
Analysis 1 Research	**30 days of work**	**1/2/10**	**1/31/10**
Review and Analyze Current Design	7 days	1/2/10	1/8/10
Interview Project Team	5 days	1/9/10	1/13/10
Develop New Design	5 days	1/14/10	1/18/10
Analyze Impacts	5 days	1/19/10	1/23/10
Summarize and Document Findings	5 days	1/24/10	1/28/10
Review with Dr. Magent	1 day	1/29/10	1/29/10
Revisions	2 days	1/30/10	1/31/10
Analysis 2 Research	**30 days of work**	**1/2/10**	**2/18/10**
Review and Analyze Current Design	7 days	1/2/10	1/8/10
Interview Project Team	5 days	1/9/10	1/13/10
Develop New Design	5 days	2/1/10	2/5/10
Analyze Impacts	5 days	2/6/10	2/10/10
Summarize and Document Findings	5 days	2/11/10	2/15/10
Review with Dr. Magent	1 day	2/16/10	2/16/10
Revisions	2 days	2/17/10	2/18/10
Analysis 3 Research	**30 days of work**	**1/2/10**	**3/13/10**
Review and Analyze Current Design	7 days	1/2/10	1/8/10
Interview Project Team	5 days	2/19/10	2/23/10
Develop New Design	5 days	2/24/10	2/28/10
Analyze Impacts	5 days	3/1/10	3/5/10
Summarize and Document Findings	5 days	3/6/10	3/10/10
Review with Dr. Magent	1 day	3/11/10	3/11/10
Revisions	2 days	3/12/10	3/13/10
Form Final Report	**5 days**	**4/2/10**	**4/7/10**
Form Final Presentation	**7 days**	**4/5/10**	**4/12/10**

Weight Matrix

The weight matrix below represents how I will be distributing my time among the research and analyses previously mentioned within this proposal.

Description	Research	Value Engineering	Constructability Review	Schedule Reduction	Total
Sustainable Design Features	20%	15%	5%		40%
Alternative Façade Installation		5%	10%	5%	20%
Alternative Steel Erection			5%	15%	20%
Alternative Prefabrication Process	5%	5%		10%	20%
Total	25%	25%	20%	30%	**100%**

Appendix A: Technical Analysis Studies

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Introduction:

The following topics take a look into the technical options within the architectural engineering major which will be investigated through a detailed analysis. Both of the topics mentioned relate to the previously mentioned, Building Integrated Renewable Energy, section of this proposal.

Technical Analysis 1: Architectural

The architectural design of the SRJC student center was one of the primary concerns of the owner from the very beginning. That being said, the idea of "ruining" the owner's vision of the building by placing solar panels on the tile roof for use with a building integrated renewable energy system poses a problem with the current design. The current roof design has very little flat space, thus making nearly every inch of the tiled design visible from ground level by pedestrians. Placing solar panels on the current roof has been deemed unacceptable by the owner solely on the fact that being able to see the panels on the roof would compromise the architecture that the SRJC has envisioned.

This analysis aims at finding a way to redesign the current roof to meet the owner's architectural standards while also permitting space for solar panels that will be needed in the proposed renewable energy system for the student center.

Technical Analysis 2: Structural

The current structural system of the SRJC student center supports a roof comprised of concrete tiles that are fastened to two layers of 30 pound self-adhering asphalt saturated felt. This structural system was designed without the addition of a large solar array calculated into the loading.

This analysis will involve calculating the effect of a large solar array on the existing structural system and then comparing that to the maximum load allowed under the current system. Should the maximum load be exceeded by the solar panels, I will need to develop a way to further support the roof of the student center through an in-depth look at the structural system which would focus on ideas such as alternative member sizes, added reinforcement, etc.