

AE 482: SENIOR THESIS PROPOSAL

CRYSTAL LAKE ELEMENTARY SCHOOL LAKE MARY, FLORIDA



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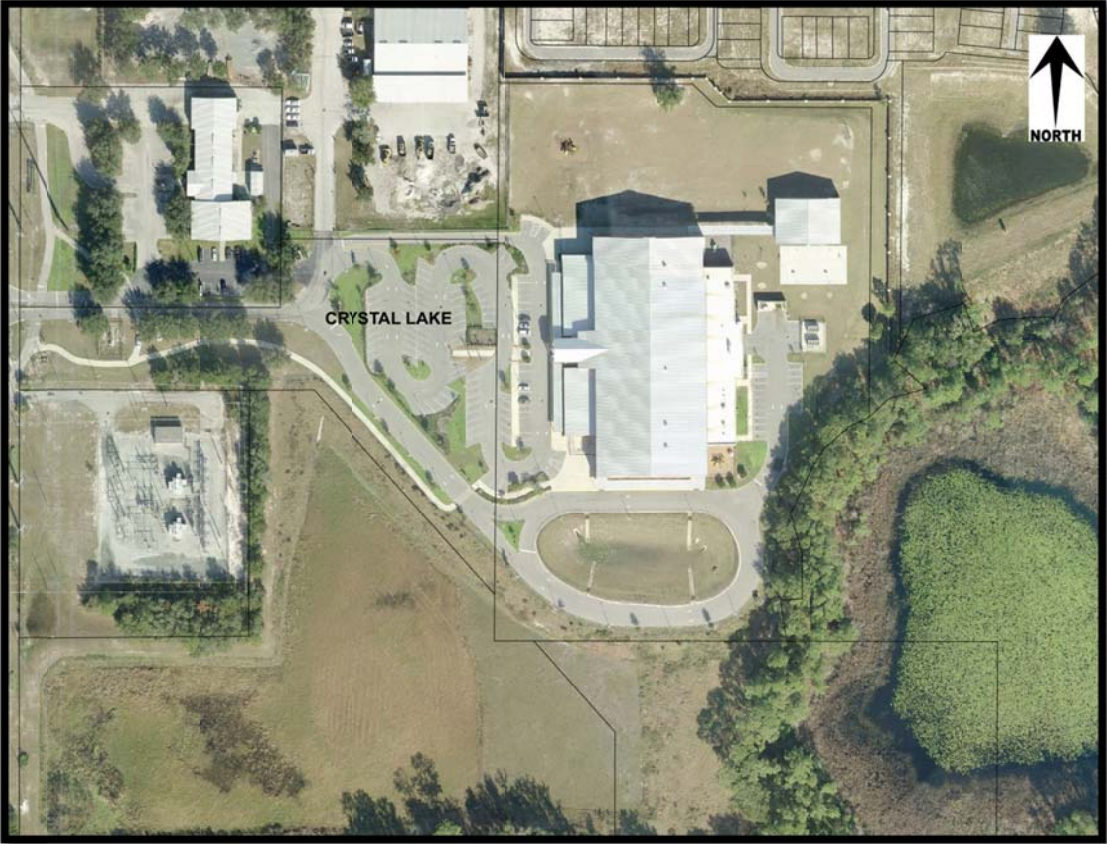
Executive Summary

The following proposal includes the work that will be completed in the 2010 semester for AE 482. This includes the requirements for the Architectural Engineering Senior Thesis. The requirements that will be completed are explained in detail in this report and include two depth topics and two breadth topics.

The first depth topic is in lighting and will be a redesign of four spaces within Crystal Lake Elementary School and implement the necessary controls for each space. The second depth topic is in electrical and will include the changes to the branch circuits made from redesigning the four spaces, a short circuit calculation, the use of a photovoltaic array to generate energy, and a comparison of using an emergency generator versus battery packs. The two breadth topics that will be completed include a mechanical redesign in the kitchen to use a solar water heating system, and an acoustic study in the auditorium.

Background

Crystal Lake Elementary School is located on an 11-acre piece of land in Lake Mary, Florida. The need for this educational facility came from the rapid growing population in the surrounding area. This building is mainly used as an educational facility that is designed to hold 780 students. This is an elementary school that teaches students from kindergarten through the fifth grade. The exterior of the building is designed with the surrounding residential areas in mind and fits in well with its brick veneer façade. Since this is a government funded building, the original design was designed to minimize cost. The main entrance to the building is covered and supported by six architectural columns that are visually pleasing. Upon entrance into the buildings there is a two-story lobby space that houses the main elevator and stairs for the building and is connected to the main corridor that circulates people throughout the building. This school contains many classrooms, a multipurpose room, administrative offices, and a media center. This building is approximately 114,000 SF and costs \$11.7 million dollars. Construction was finished in July 2006 and the school was opened in August 2006.



Depth Proposal – Lighting

Although the current lighting design meets the recommended lighting criteria, a redesign will be done for four different spaces: the Covered Entrance and Walkways, the Lobby, a Primary Classroom, and the Multipurpose Room. In each of these spaces the lighting equipment will be changed and proper controls will be implemented. This redesign will be completed using various computer software including AutoCAD, AGI32, Autodesk Revit Architecture, and Autodesk 3D Studio Max.

The redesign for these four spaces will be tailored to the desires of the owner. Therefore, the building lighting design needs to be energy efficient and minimize the number and types of luminaires. Ultimately, cost needs to be minimized. Since this building is an educational facility, the lighting design needs to create a public and spacious feeling that will enhance the learning environment within each space.

Lighting Design for the Covered Entrance and Walkways

This building is rarely used at night since it is mainly used as an educational space. The exception to this is when this building is used as an assembly space for the community or an emergency shelter. Therefore, the lighting on the exterior of the building will rarely be seen. When it is in use at night the lighting design should welcome people to the space without using unnecessary lighting that will waste energy.

When it is in use visitors will pass through the covered walkways and covered entrance to enter the building. The proposed lighting design will provide adequate lighting within the covered entrance and covered walkway to provide safety for the occupants in the space. There must be enough lighting for smooth circulation. In addition, the perimeter of the building will be lit to provide added security for the building from possible theft, as well as accentuate the façade of the building and the building material. By providing enough ambient lighting within these spaces and providing the necessary extra lighting to the perimeter, the lighting will create a welcoming environment for guests and direct them to the entrance of the building.

Lighting Design for the Lobby

The lobby is the first space that all visitors see when they enter the building. Once in this space visitors should immediately feel welcome and comfortable. It is important that the students feel comfortable, since this is their first time in school.

The proposed lighting design will provide ambient lighting to prevent shadows on the floor of the space, since the main purpose of this space is welcoming people into the building and then circulating them throughout the building. In addition, there will be perimeter lighting that will

highlight displays that are on the wall that contain current student works and important school information. To accentuate the height of this space to provide a spacious and public feeling the columns within this space will be lit with decorative lighting.

Lighting Design for Primary Classroom

The primary classroom is the space where students will be doing their learning. These spaces are located on the first and second floor of the building around the perimeter of the building. Therefore, each space will receive natural lighting through windows. It is important that the lighting in this space give a public feeling in order to make students feel comfortable.

The proposed lighting design will create uniformity on the workplane to enhance the learning environment. To assure that students feel comfortable in this space and get the feeling of a public space a uniform lighting layout will be used. Since this is an elementary school, the majority of the work will be hands on at the students' desks; however, some teaching will be done at the front of the classroom with the use of a whiteboard. The whiteboard should be uniformly lit to direct focus to this educational tool in the front of the room.

Lighting Design for Multipurpose Room

The multipurpose room is a large space with various uses: Cafeteria, assembly space, auditorium, and emergency shelter. There is also a partition down the middle to create two smaller spaces when needed. The main use of this space is a cafeteria which is used every day that school is in session.

The proposed lighting design needs to be suitable for all of these uses and can be achieved by using different controls such as dimmers or different switching controls to achieve the various scenes desired. Uniform lighting will be needed throughout the space on the workplane when necessary. Adjustable lighting on the stage is necessary to accommodate the various uses of the stage. Also, the perimeter needs to be lit to highlight the different information posted on the walls throughout this room.

Designer Comments from Lutron Presentations (12/08/2010)

Shawn Good:

- Entrance should have less lighting layers
- Columns might look better not lit and in silhouette
- Chose fixtures so that the light is the important feature not the fixture
- Examine fixture lighting whiteboard to make sure it will work the way desired
- Make sure to explain why light is needed and how I accomplished it

Charles Stone:

- Be careful how the layers of light are shown, sometimes can be confusing
- Be careful with the term “design criteria,” “design goals” would probably be a better word choice

Sandra Stashik:

- Since the building is mainly used during the day, simplify the night time lighting on the exterior
- Try creating different scenarios on the exterior lighting for the different uses of the building
- When “I need higher footcandles,” state what these values are and what I am trying to achieve
- Utilizing daylight is a cooling issue not a heating issue
- The stage needs to be lit in every scenario; always need front lighting

Depth Proposal – Electrical

The electrical portion of this senior thesis will consist of the effects to the existing branch circuits for the four spaces that are being redesigned, a short circuit analysis, and two electrical depth topics.

Four Spaces to be Redesigned

1. **Covered Entrance and Covered Walkways - Located in the front of the building the covered entrance is in the center of the front west facing façade and is connected to two covered walkways that extend in front of the front façade.**

This space is an exterior entrance to the building. The current lighting design consists of linear fluorescent luminaires in the covered walkways and wall mounted luminaires at the entrance of the building. The proposed lighting design will decrease the energy usage on the exterior of the building, while creating a more visually pleasing entrance at night.

2. **Lobby - This space is the first room people enter into through the covered entrance on the west side of the building.**

This space welcomes all visitors to the buildings. It is the main circulation space that connects all the corridors within the building. The current lighting design consists of a combination of recessed fluorescent downlights, recessed HID downlights and wall mounted fluorescent uplights. The proposed lighting design will incorporate an energy efficient lighting, while creating a welcoming and visually pleasing lighting design.

3. **Primary Classroom - This is a typical classroom within the building that is located on the first floor around the perimeter of the building.**

This is a learning environment within the building with the sole purpose is to create an environment that enhances the students ability to learn. The current lighting design consists of linear fluorescent luminaires in a uniform pattern. The proposed lighting design will create an energy efficient design that can produce the recommended light levels on the workplane uniformly, while minimizing the lighting hardware and wattage. The proposed lighting design will create a more visually pleasing environment for students.

4. Multipurpose Room (this is located in the center of the first floor)

This space is used as a cafeteria, an assembly space, an auditorium, and an emergency shelter. The current lighting design consists of linear fluorescent luminaires throughout the space and on the backstage with track mounted luminaires to provide front lighting for the stage. The proposed lighting design will have various controls to create one layout that can be used appropriately for each application within the space. The design will minimize hardware, but will apply light to within the space to create visual interests on the perimeter.

Short Circuit Analysis

The primary source of electrical power is supplied through a utility transformer. The utility transformer then feeds the main distribution panel, which distributes power to the entire building. Short Circuit calculations will be provided for this path.

Electrical Depth Topic #1 – Photovoltaic Analysis

A study will be conducted to determine if the use of photovoltaics will decrease the energy cost enough to outweigh the initial costs of system. The problem will initially design a photovoltaic array that will work with this building and determine the cost to the owner. Then the current electrical system will be studied to determine the current use of energy and its cost. These two systems will then be compared to determine if the energy savings from the photovoltaic system will outweigh the initial cost of the system. The payback period will be analyzed to determine if the use of photovoltaics will be beneficial to the owner.

Electrical Depth Topic #2 – Generator vs. Distributed Batteries for Emergency Lighting

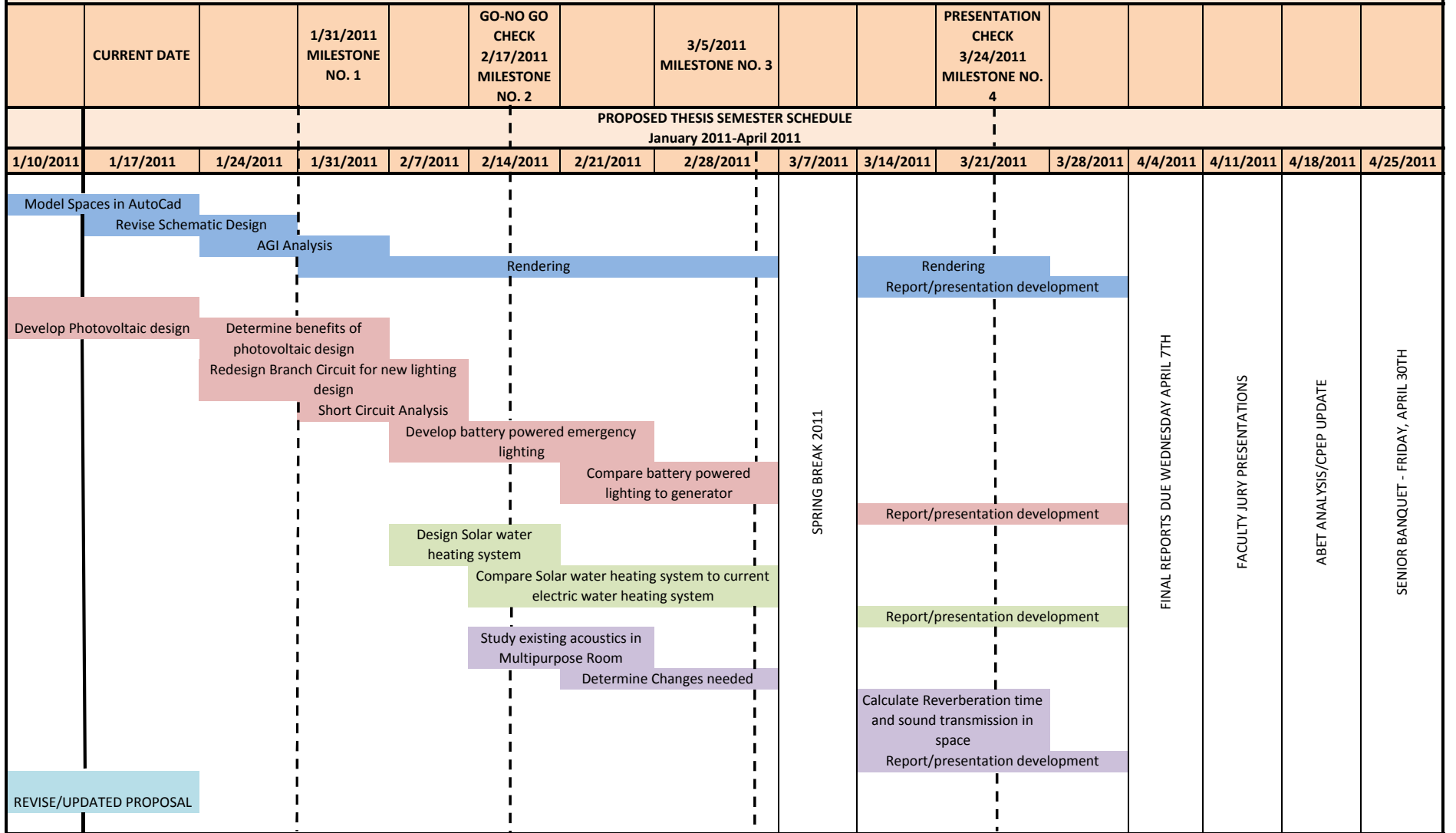
The current emergency power is generated from a generator outside the building. The life safety and critical emergency branches will be redesigned to be powered by distributed battery packs. The cost of the necessary number of battery packs and its installation and the costs of the current generator system will be compared to determine which option is the best for the owner.

Breadth Proposal #1: Mechanical

The kitchen in this building currently uses an electric water heating system. To help reduce the energy usage of this building, a change to the current electric water heating system will be made to a solar water heater. An analysis will be performed to determine if the cost of the solar water heating system is outweighed by the savings in energy over time when compared to the current electric water heating system.

Breadth Proposal #2: Acoustics

The Multipurpose Room in this space is used for various purposes: Cafeteria, Assembly Space, Emergency Shelter, and Auditorium. Therefore, there is the potential for noise throughout the space to become an annoyance to occupants. An acoustical study of the reverberation time in the Multipurpose Room will be performed. Based on the current designs reverberation time, materials in the room may be changed or added to obtain a desirable reverberation time. In addition, the sound transmission class of the walls within this space will be studied to determine if the current design is efficient or if the wall material or thickness needs to be changed to prevent sound leak into the surrounding spaces.



MILESTONE ACTIVITY LIST

1. FINALIZED LIGHTING DESIGN WITH TWO COMPLETED ROOM CALCULATIONS AND FINALIZED PHOTOVOLTAIC DESIGN
2. LIGHTING DESIGN COMPLETED AND CALCULATIONS COMPLETED. PHOTOVOLTAICS AND SHORT CIRCUIT CALCULATIONS COMPLETED
3. LIGHTING AND ELECTRICAL DESIGN COMPLETE WITH TWO ROOM RENDERINGS COMPLETED. MECHANICAL BREADTH COMPLETED.
4. ALL DESIGN COMPLETED AND PRESENTATION ROUGH DRAFT COMPLETED.

- ANALYSIS #1: LIGHTING DEPTH
- ANALYSIS #2: ELECTRICAL DEPTH
- ANALYSIS #3: MECHANICAL BREADTH
- ANALYSIS #4: ACOUSTICAL BREADTH