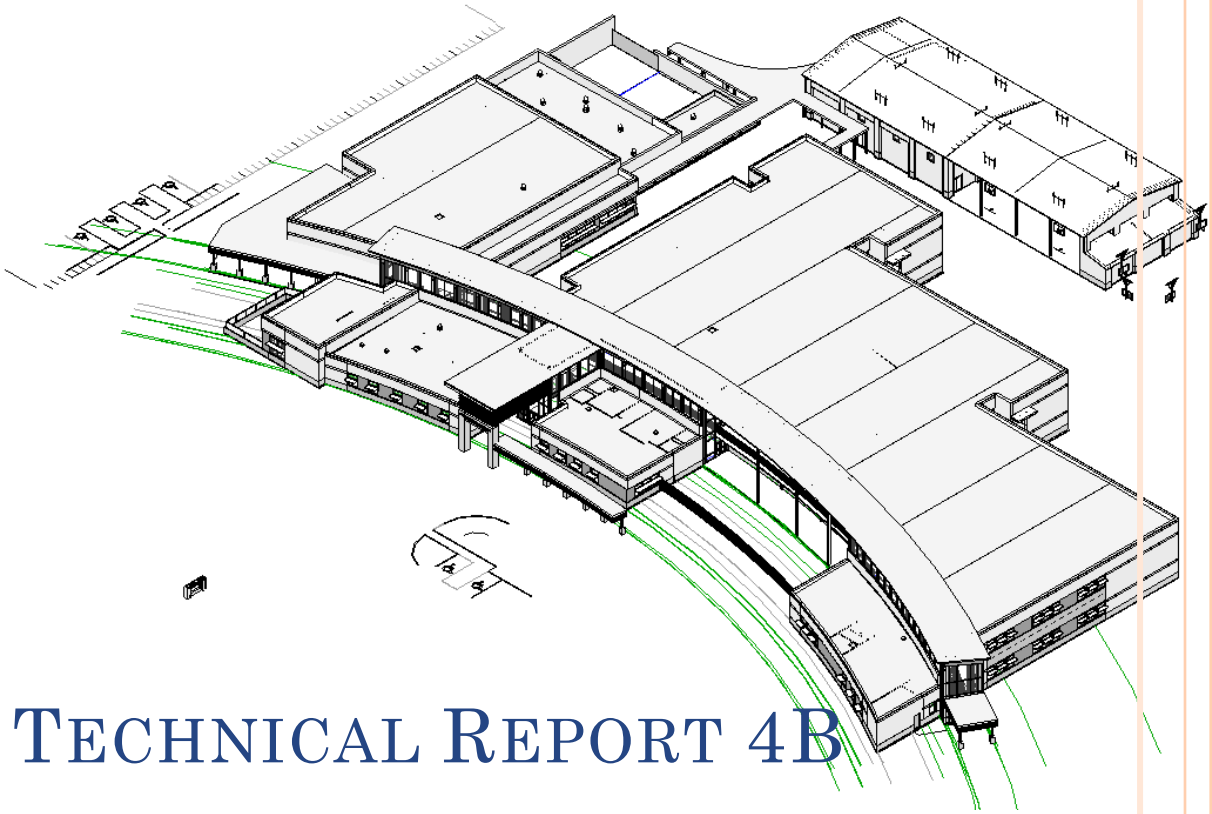

Technical Report 4B

Project Proposal and Schematic Design Summary

Proposal for the thesis work to be done in the spring semester, covering the schematic lighting design, and proposed lighting design depth, electrical depth, mechanical breadth, and structural breadth.

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Cypress Hill Elementary | Texas

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Executive Summary

This report discusses the proposal for the lighting and electrical systems of Cypress Hill Elementary School located in Texas. It also covers the initial schematic designs for the redesigned lighting spaces along with proposed breadth studies for the mechanical and structural systems. The lighting systems to be redesigned will be the south façade, the library, the cafeteria, and the lobby.

The lighting design will be fleshed out further in the next semester to incorporate the symbiotic nature of daylight and artificial light that the design is trying for. This will be carried out through the use of hand sketches and computer programs like EnergyPlus, AutoCAD, AGI32, 3DS Max, and Daysim.

The electrical depth will look at adding a daylight harvesting system to better serve the school's mechanical equipment along with a short circuit study. Because of the daylighting techniques introduced in the lighting redesign, a mechanical study will need to be done to see if equipment needs to upsized and a structural breadth will need to be done to measure the loads of the roofs once the daylight harvesting system is in place.

Contents

Building Overview

Location: Texas

Building Occupant Name: Cypress Hill Elementary School

Occupancy or Function Type: Occupancy type 'E', Educational

Levels Above Grade: Two

Construction Time Frame: 9/7/2012 – 11/26/2013

Building Cost: $82.3 Million

Project Delivery Method: Design-Build

Background

The building is a 105,000 square foot elementary school in the heart of Texas. The school serves grades kindergarten through 5th grade, approximately 800 students at a time. The surrounding urban texture is suburban in nature, just outside a major city. The school stands 2 levels above grade with no basement.

The main problem is the energy consumption.

Lighting Design Depth

For this lighting depth, four spaces will be redesigned. The spaces will be a façade, circulation space, media center/library, and the cafeteria. The lighting design for these spaces will proceed with a concept of "symbiosis". This is both a philosophical push as well as a tangible design. The main way this will be expressed will be through bringing daylight into the space, for a cleaner, more productive, more sustainable, and more natural feeling space. The daylight, working in tangent with the other prescribed electric lights, should help express the idea of two very different concepts working together to form one unique solution. However, the designs are still only in the schematic phase and must be fleshed out further in the upcoming spring semester based on comments received from professional lighting designers at Lutron.

Designer Comments

Lee Waldron's Comments

- Schematic drawings don't show daylighting
- Schematic designs doesn't show light realistically
- Does a school need façade lighting
- Show the façade lightings impact on the interior designs
- Media center skylight needs to be fleshed out
- Change the concept images so they are relevant to design

Lee Brandt's Comments

- Give more information about the material finishes
- Show the actual render before showing the darkened lighting image
- Further develop the daylighting and research because some of these may not work as expected
- How will the stacks in the library be lighted
- Scale is off on the pendant lights in hallway and library
- Refine reflected ceiling plan to show all lights used
- Create computer models for the spring to better express designs

Façade

While the façade may not be feasible in a practical sense, it is a requirement of the design. To help facilitate this concern, I will scale back the scope of the actual façade lighting and try to implement some site lighting

instead which a school would actually invest money. Performances will happen at this school so having façade lighting at the scope I proposed is not out of the question but the main concern is whether patrons will be able to find the entrance. Furthermore, it makes a visual statement and creates an identity for the school that could be a benefit to the district.

Circulation Space

The circulation space needs to be dynamic to ensure interest for the children since it is the first area they will see. The ability to navigate freely and accurately is a concern. This space is mainly about ushering the occupant through in a way that is both public when it needs to be for general hours and also private for small performances in the cafeteria (since they are connected).

Media Center/Library

The media center/library is the main work area of the school. Daylighting promotes a stronger work ethic and makes the occupant feel energized. For this reason, an overhead skylight will be implemented. However, because the daylight may be too bright or too dim at times, controls must also be used to ensure there is enough light on the work plane. Because this spaces serves many different functions it needs to be dynamic in its ability to address the library and work aspects in the design. Pendent lighting will be used to supplement the daylight to ensure it meets IES requirements.

Cafeteria

The cafeteria needs to be able to serve many functions also, through different modes. It should have a general dining mode along with a more private mode for when performances are taking place, since it has the ability to function as a stage and performance place. Lighting for general circulation on the fringe of the room also needs to be addressed.

Task and Tools

Task 1. Continue to develop the lighting designs for the selected spaces.

a. Continue schematic design so it can be fully fleshed out taking the comments from the designers into consideration. This will be done using hand sketches and programs like Photoshop and Illustrator.
b. Once the designs are out of schematic design phase, computer models will be built, using the geometries from the existing drawings and developed in AutoCAD. The AutoCAD models will then be imported into both AGI32 to accurately model the electric light added. This model will look at ASHRAE standards for lighting power densities as well as IES for illuminance levels in

the specified space use. Then the models will be imported into Daysim to assess whether the newly proposed daylighting solutions can be improved further.

c. Final solutions will then be rendered in 3D Studio Max for the presentation stage.

Task 2. Determine whether there will be additional heat gain because of the added daylighting solutions and assess whether another solution can be found to supplement the added energy needed to cool the building.

a. EnergyPlus will be used to model the school and determine the extent of the solar heat gain.
b. A proposed solution will be the implementation of a photovoltaic array. First the roof will be looked at to consider how much of the roof is available to use (local building codes, zoning, and international building codes will be used in this section).
c. Once a plan is in place for the exact square footage that the PV array can use, the energy gain will be assessed using EnergyPlus. To maximize pay back, 3 different types of photovoltaic cells will each be modelled (monocrystalline, polycrystalline, and thin film). Then, government subsidies will be taken into account to determine the best type to use.
d. The solar array hook up to the schools existing power and to the grid will be laid out as a part of the electrical depth.
e. Supplementary to this part of the electrical depth, a short circuit study will be performed to ensure that the new equipment works safely with the existing equipment.

Task 3. Determine whether the existing structural members will be able to support a new photovoltaic array.

a. The existing members will be looked at to determine their maximum capacity.
b. Once a finalized photovoltaic system is chosen, the weight will be determined based on manufacturers data.
c. New structural members will be chosen to accommodate the new weight of the roof should it be determined that the old roof members will not be able to hold the new PV system.
d. The roof of the library will specifically be completely redesigned because of the added skylight proposed in the lighting depth.

Task 4. Determine whether the photovoltaic system is the most cost effective way of supplementing the additional energy from the solar gain.

a. The mechanical equipment from the existing plans will be looked at to determine whether simply upsizing all the equipment in the required spaces would be more cost effective.
b. Another alternative will assessed so there will be at least three options moving forward. The final proposed solution is a geothermal mechanical system to supplement the school's mechanical needs.
c. Data will be gathered looking at existing geothermal systems already in place. Geothermal systems are similar to heat exchange pumps, so a heat pump will be sized based on building use, then that data will be translated to a complimentary geothermal system. The main difference being there is low maintenance cost and no energy use, so the only cost is upfront.
d. All three solutions will be compared to determine the most effective based on buy back period for the school district.

Electrical Depth

The electrical depth will look at the ability to add a photovoltaic array to the roof as well as a short circuit study to look at the safety and efficiency of the existing design. In addition to these, controls will also be selected and utilized for the daylighting systems expressed in the redesigned lighting spaces.

Photovoltaic Array

I'd like to implement a photovoltaic array for the school system as the main part of the electrical depth. The school's footprint is approximately 85,000 square feet which is 80% of the total school's interior square footage. This means there is a very large roof surface area for a photovoltaic array. The school's location of a Texas town makes it very conducive for a photovoltaic array because of the large amount of sun it would be getting year round. The biggest concern is the high cooling loads for the school which is a potential strain on the mechanical systems in place. These PV arrays would try to supplement that. This cooling load is already accounted for through the existing mechanical design but passive heating may take place because of the implementation of daylighting systems in the redesigned lighting spaces. This study will be looking at whether it is not only possible, but profitable in a certain amount of time. The study will look at different placements along with comparing the cost and energy gained through a monocrystalline array, a polycrystalline array, and a thin film array.

Short Circuit Study

A short circuit study will be performed in order to ensure the equipment is protected because it looks at the proper interrupting ratings. This also protects personnel which is important in a school setting. Even though rooms should be locked and access should be denied to the children and faculty, anything that can further ensure the safety for the school is a benefit. This simple study will also potentially save the school a large amount of money. If a piece of equipment were to exceed the rating of the protective device, equipment could become damaged or ruined leading to replacement and downtime. Ultimately, it comes down to whether something can be done that is safer, more efficient, or less costly. This study will help show that.

Mechanical Breadth

The daylighting in the redesigned lighting spaces may increase the cooling loads because of the passive solar heating loads that they would add to the school so a mechanical breadth study would be the best way to determine if some of the mechanical equipment needs to be resized to facilitate the increased loads. Furthermore, I'd like to look at the possibility of utilizing a geothermal system to supplement the existing mechanical systems and see if geo cooling would better help the school than the PV system supplementing the existing mechanical design.

Structural Breadth

Because of the photovoltaic array on most of the roofs along with the daylighting implemented in the library, a structural study is required. Some mechanical equipment may have to be moved because of the photovoltaics which could be that some roofs will be need to be resized either because there is no longer equipment or because there is new equipment and the loads have increased. Also, a structural study would need to be performed on the daylighting in the library since half of that roof would be completely changed and removed. This would determine the best design for a roof that has a skylight system built into it.

Thesis Schedule