Bradley Sisenwain
Lighting / Electrical Option
Faculty Advisor: Dr. Houser

Gateway Community College New Haven, CT

Proposal

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Executive Summary

Outlined in this document is the proposed scope of work to be done during the Spring semester for AE 482. Included is a lighting depth which will redesign the four proposed spaces (Student Gathering, Tiered Classroom, Roof Garden, and Library). An electrical depth will redesign the branch circuit distribution for the four spaces, develop a coordination study for the path and protection devices from service entrance to panel HLP2S1, study the existing photovoltaic array and proposed integration to building, and analyze modified design HVAC loads. In addition to the two depth studies, a daylighting breadth for the Library and Student Gathering will be completed and integrated with a HVAC breadth. These studies will then be merged with the electrical depth for the main purpose of reducing the total used load in these spaces.

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Section One: Introduction

Building Description

Gateway Community College (GCC) is a 360,000 SF new campus building located in New Haven, CT. Classrooms, laboratories, offices, and various gathering spaces make up the majority of the space types in the building. The new campus for GCC is meant to "create a meaningful identity for the College while enhancing the urban qualities of the surrounding New Haven neighborhood." A new identity created from joining programs from the Long Wharf and North Haven campuses will have a LEED Gold rating when completed and a number of sustainable implementations. Planned construction for GCC will begin in 2009 and be completed by 2012. The estimated cost for the project is 147 million dollars.

My AE Thesis

The main focus of my thesis will be to analyze and redesign the current electrical lighting scheme for four spaces in Gateway Community College. Also, an electrical distribution redesign will follow any changes made in the lighting design or equipment. In addition to the lighting/electrical portions of this project, I have planned two breadth studies to analyze the effects of daylight and the corresponding integration with HVAC equipment within two spaces.

Section Two: Lighting Depth

Existing Conditions

The existing lighting design consists of primary use of linear/compact fluorescent and metal halide luminaires. All lighting is on a Digital Addressable Lighting Interface (DALI) system. These luminaires will either be controlled by local occupant input, automatic dimming from daylight sensor integration, time clocks, or astronomical time clocks.

Proposed spaces

The four spaces to be analyzed and redesigned are: the main gathering Space, Tiered Classroom, Roof Garden, and Library/Reading Lounge. Since some of these spaces are not completely enclosed, additional work will be completed when out-of-scope areas are an integrated into proposed spaces due to perimeter openings. (Please see Technical Report III for more detailed information of lighting implementation)

Summary Design Solution

The main purpose of the lighting design in GCC is to accentuate and support the overall architectural concepts found within the forms and features of the building and Perkins + Will's objectives for the new campus location. As stated in the architectural design intent, GCCs foremost purpose is to create a new identity for the education facility housed in the urban center of New Haven, Connecticut. In that respect, the lighting will reflect contemporary ideas and aesthetics as it assimilates into the current architectural design.

Within the proposed spaces, an optimum visual environment will be maintained by avoiding glare, extreme levels of transient adaptation, and unflattering patterns and shadows created by luminaires. By abiding to these cautionary standards, lighting will enhance productivity and not hinder working or social interactions. Furthermore, integration with the exterior environment is a key feature for the prosperity of proposed areas. Daylight shall be used effectively and efficiently in the attempt to supplant the need for electric lighting and therefore lower electrical consumption.

Gathering Space

Student gathering is the central transition space in GCC, and is meant to be P+Ws version of an interior street. Similar aesthetics to existing exterior lighting conditions should be mimicked to help connect the concept to the occupants. The five-story-high white masonry unit wall continues from the gathering space to the roof garden and will be lighted similarly to maintain cohesiveness between spaces. Dynamic lighting and emphasis on walls will contribute to the impression of preference while additional general non-uniform lighting will facilitate passage through the space. Daylight is an important factor in this space as well. Like the library, daylight should be used to conserve electric power and efficiently light the space (when possible). Localized lighting will be placed to illuminate ground plane and higher luminances will mark means of access to other areas of the college.

Tiered Classroom

Classrooms often incorporate a number of activities—which means a number of tasks—into lessons. This classroom is no different. The lighting should reflect the variability within the space and the specific task at hand at any time. Uniform lighting will be needed for typical classroom activities and to add to the impression of clarity. Peripheral modes could be incorporated during multiple tasks for added light (and interest) into the space. A variable control of systems should be available to occupants; who will have the need to change lighting effects and settings per task. Glare and distracting lighting elements should be avoided.

Roof Garden

As a public space, the roof should be a preferred space to escape to, as well as a relaxing area where one can experience a more natural environment amongst the urban setting. Nature's "modulations" should be accented in an attempt to connect the space more with the natural environment. Lighting surrounding walls on the roof is one way to strengthen impressions of relaxation, pleasantness and preference. A lower light level will be used (as compared to interior spaces) to reflect upon the outside setting. The roof garden will serve as an exterior continuation of the library at night. Light emanating from within the reading lounge will be topped by the soft glow from the garden above. The result will be a less dramatic drop in luminance from space to space and a more cohesive flow created from light. Additional accent will be placed on localized areas that are most occupied.

Library and Reading Lounge

As a work space, comfort level is extremely important. A uniform lighting scheme with glare elimination will allow the occupants to stay productive and will increase visual clarity. By accenting peripheral walls and around the opening to the second floor visual interest can be added to the space, further increasing its quality and visual clarity. Daylight should be taken advantage of—and controlled—within this space. The enormous span of the South-facing curtain wall allows for a large amount of options for daylight management. It will be a focus of this space to limit the amount of light entering through the glass to an exitance that will eliminate the need for a considerable amount of electric light. This limitation however, should not decrease the amount of exterior views from the Library. During nighttime hours, exterior views should be maintained as much as possible, while still providing adequate light levels for a productive environment. The curved library corner serves as the conceptual "gateway" in Perkins + Will's architectural theme. This will be reinforced by reflections from interior surfaces making the curtain wall glow (from within) at night.

It is essential in this design to integrate a control system (into each of the four spaces) that is an equivalent to or better than the current DALI system. This system should be able to communicate to the owner and maintenance employees complete information for each luminaire and ballast combination in the design while also notifying occupants about energy use and savings. This is important for a LEED rated building; to not only inform the owner and people who will upkeep lamps/luminaires, but to inform the public and create a "sustainable" identity for the building.

Other considerations will consist of abiding by LEED criteria for gaining as many points as possible—increasing the building's total rating—while not sacrificing lighting quality.

Designer Comments from Tech III Presentation at Lutron (12.11.08)

Sandra Stashik

- Consider changing black background
- Good presentation of design criteria
- Will wash in gathering space benefit facial modeling?
- Consider multiple uplight options in the classroom
- Sconces in the back may not be appropriate
- The roof was overdone
- Consider the view from the ground level
- Look at LEED criteria

Lee Brandt

- The classroom may not achieve needed illuminance level
- Consider how to make the pavers glow from behind and how it would be accessed
- Third option may distract drivers on the street
- The curved light in the Library could be recessed cove
- The section showed was confusing

Adjustments from Designer Comments

Besides general aesthetic issues with the presentation, I will use the advice given by the designers to help better my current designs for the four spaces.

In the Student Gathering space, I will consider using light from multiple angles above the occupant to better model faces. Special consideration will be given to the occupants in neighboring classrooms where light boxes are a feature on the Eastern (back) wall. In this example, the goal is to not distract the students from their activity in the space.

In the classroom, I will be considering multiple uplighting techniques and different luminaires in the back to add light to the ground plane. The possible use of high-output T5 fluorescent lamps may increase the amount of light on the horizontal task plane.

For the Roof Garden, I will reduce the amount of ambient light and uplight to better abide by LEED criteria for sustainable sites. Since light trespass and pollution are more prevalent for this exterior space, more in-depth studies will be made to limit the total amount of light going up and out of the space's boundaries. Additionally, simpler solutions for providing light on the ground plane, plantings, and the continued white masonry wall will be proposed.

In the Library, more detail will surround the custom chandelier and implementation of custom linear luminaries for the ceiling. Since a *true* curve is impossible to achieve with standard recessed luminaries, it will be an attempt to design a custom luminaire that will fit standard fluorescent lamps that will actually curve in the ceiling.

Solution Method

Conceptual designs will be updated with comments from faculty advisers and design professionals. Equipment will be chosen based upon design considerations made in Technical Report I, and will be incorporated into computer model calculations. Calculations will be modeled with accurate luminaire definitions, architectural geometry, and material properties. For final solutions, all equipment cut sheets and information, lighting plans, energy code compliance, and calculation results/renderings will be presented.

Tools

Regulations in ASHRAE Standard 90.1 will be followed to ensure a realistic and feasible design. Guidelines set in the IENA Handbook will also be followed when design is based on a known and legitimized standard within the lighting practice. Implementation of these standards or recommendations will be set by design considerations in Technical Report I.

AGI 32 will serve as the main reinforcing 3D computer simulation for quality control of designs. Additional calculations and renderings may be prepared in 3D Studio Max.

Tasks

1. Conceptual Design

    The conceptual design will be substantially complete by the end of Fall semester. During winter break, the design will be fine-tuned in accordance with professional feedback from the Lutron presentation. The design will be finalized by the beginning of the Spring semester.

2. Equipment selection

    Equipment will be selected to match the conceptual design. Custom fixtures will be designed and coordinated with considerable detail. Other equipment, including daylight sensors, daylight dimming control, and other lighting controls will be selected.

3. Preliminary Renderings

    AGI 32 will be used to create preliminary renderings and verify desired illuminance levels.

4. Calculations

    Illuminance and luminance levels will be verified using AGI 32. Power density calculations will be done in Comcheck, with verifying calculations in excel.

5. Design Review

    All models and calculations will be scrutinized and checked to verify accuracy and legitimacy.

6. Documentation

    Design documentation will included lighting plans, fixture schedules, calculation summaries, and fixture cut sheets.

7. Final Renderings

    AGI 32 and 3D Studio Max will be used to create final renderings.

Section Three: Electrical Depth

1. Following the redesign of the four spaces (Student Gathering, Tiered classroom, Roof Garden, and Library), a redesign will be done for the associated Electrical branch circuit distribution.

2. A protective device coordination study will be completed. This study will address a single path through the distribution system. This path will be from the service entrance to panel HLP2S1. This path is from the service entrance in the North tower, to panel MSB-BS, to panel HLPS1.

3. A study of existing photovoltaic array will analyze the cost effectiveness of utilizing the array for the given location of New Haven, CT will be completed.

   Problem
   Currently it is designed to incorporate 448 photovoltaic panels, two combiner boxes rated with 10A fuses (600VDC), two 50kW inverters (480/277VAC), and two 200A (480VAC) AC disconnect switches. The panels themselves have been mounted on steel structure so they hover above the Student Gathering (or atrium) roof. This type of mounting and structure make the panels themselves segregated from the building (or considered *not* to be "building integrated"). Additionally there is doubt for such a moderate climate as New Haven to prosper and produce considerable energy from the array.

   Solution & Methodology
   My study will investigate the initial cost of the PV panels in respect to their cost-savings over time. The payback period for installing and operating the panels will be found and analyzed in respect to the given geographical area. An annual study will also follow that will summarize the energy collected over a one year period. In addition to the first analysis, a second investigation will address the feasibility of making the panels "building integrated," or making the panels serve more than one purpose for the building. One common way to do this include making the panels part of the roof membrane. In the end the panels would serve to collect energy as well as provide a moisture barrier to the building. This use could also apply for a LEED Building Innovation credit. Also, this utilization of the panels will have potential cost savings for actual roofing material and structural framing (for PVs) that would be used in the current design. A final comparison will be made between the as-designed and redesigned PV layouts.

   Tasks & Tools
   By using AGI 32, the amount of daylight hitting the panels will be found and used to estimate the amount of power that could be collected. Then it will be compared to the cost of power from the utility. Also, a cost analysis will be done based on RS Means and cost of material, and a rough estimate of installation costs.

4. *Problem*

   In conjunction with my daylight studies an HVAC breadth will be completed for both the Library and Student Gathering. Because the daylighting properties of the windows will change, so will the windows properties (specifically related to heat transfer). This will necessitate an HVAC redesign for the spaces.

   Solution and Methodology

   The HVAC equipment and design will be analyzed and any substitutions or changes will be adequately made. Since the two spaces account for a large amount of space, it is very likely that daylight changes will reflect on the HVAC system.

   Tasks and Tools

   A computation of modified designed loads will follow. Selection of distribution equipment and protective devices (including the building's main distribution equipment; the transformer and switchgear) will also be completed.It will be a goal of this portion of the project to decrease the cooling load used by HVAC equipment and by doing so, reduce the electrical load needed to power the given HVAC equipment.

Section Four: Daylighting Breadth

A daylighting study will be conducted for the Library and Student Gathering atrium. Since the Library incorporates a curtain wall that takes up a majority of the south façade it will be an integral part of the project to determine the amount of daylight entering through this large expanse of glass; which will not only effect the lighting design of the space but HVAC equipment used to cool and heat the area. Similarly, the Student Gathering space (which is itself a four story atrium) has clerestories on the east and west walls which will provide daylight. An analysis of the current design will find the daylight contribution to the various interior surfaces of the space.

It will be a focus of this breadth to integrate the daylight into the electrical lighting design. Automatic dimming and/or switching control of the electric lighting will serve to harvest daylight and limit electrical loads of the two spaces. An annual study will be conducted to find an estimated savings for the year. A combination of AGI 32 and Daysim will be used to find the daylight availability and the possible LEED credits that could be achieved.

Section Five: HVAC Breadth

A HVAC breadth examination will integrate the electric lighting, daylight, and heating/cooling equipment of the space. Since these areas will affect each other it is imperative to properly analyze them as a whole. It will be a focus of this portion to limit the total loads of the spaces—including those created by electric lighting and by daylight entering the space—to limit the final cooling loads associated with the final design of the HVAC equipment.

An energy model will be used to analyze the cooling/heating loads of the space, and integration of the loads created by electric lighting and daylighting.

Section Six: AE 482 Schedule

AE 482 Schedule of Work		
Dates	Area	Description of Activities
12.18.08 - 1.12.09	LTG	Fine-tune schematic design
	ARCH	Begin 3D modeling of four spaces
1.12.09 - 1.30.09	LTG	Complete schematic design + fixture selection
	ARCH	Complete 3D modeling of four spaces
1.30.09 - 2.10.09	LTG	Complete initial lighting calculations in AGI 32 + equipment selection
	DAY	Start initial daylight calculations
	HVAC	Start energy model
2.10.09 - 2.30.09	LTG	LPD calculations + design documents
	DAY	Daylight calculations
	HVAC	Energy model
	EL	PV panel analysis + Branch circuit redesign
2.30.09 – 3.15.09	LTG	Design documents
	EL	PV panel analysis + Branch circuit redesign
3.15.09 – 3.30.09	LTG	Final design documents
	DAY	Finish daylight models
	HVAC	Finish energy model + equipment analysis/selection
	EL	Modification due to HVAC design loads + Protective device coordination study
3.30.09 – 4.3.09	LTG	Final renderings + documentation
	DAY	Documentation
	HVAC	Documentation
	EL	Finish protective device coordination study + modification due to HVAC design loads
4.3.09 - 4.8.09	ALL	Complete final report
4.8.09 – 4.13.09	ALL	Complete final Power Point presentation