Thesis Proposal for Spring 2007 Semester

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Lighting/Electrical
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Executive Summary

During the Spring 2007 Semester, I will be redesigning aspects of the lighting, electrical, and mechanical system in the Geisinger Health System Center for Health Research and Rural Advocacy (CHRRA). I will also be researching and analyzing sustainable design methods that will be applied to the LEED silver building.

For my lighting depth, I will be redesigning the lighting for the multipurpose room, main lobby, auditorium, open office and exterior circulation areas. The redesign will include concept sketches, renderings, illuminance and luminance calculations, fixture schedules, circuiting, and controls. The open office will require a detailed daylight study in order to optimize the energy and daylight from the south-west facing glass curtain wall façade.

For the electrical depth, I will be focusing on several different areas of the electrical distribution system. I plan to redesign the electrical circuiting and equipment for the five lighting redesign spaces. I also plan to change the lighting from a 120v system to a 277v system and complete a cost analysis of the proposed change. I will be looking at changing the linear fluorescent lamps in the building from a T8 to a T5HO will be minimize the number of lamps and fixtures needed in each space and create additional energy savings. I will also complete a cost analysis of this proposed change. Finally, I will be looking at the effects of the mechanical system breadth on the electrical distribution system. The central mechanical equipment will be resized due to the changes; therefore, changes in distribution sizes and protective devices may be necessary.

For the breadth topics, I have chosen to focus on the mechanical system and LEED sustainable design. For mechanical, I propose changing the single duct VAV system to a fan powered VAV system. This will require the addition of a return air plenum; however, the change will allow for possible energy savings, equipment downsizing, and less ductwork. A payback period analysis will be used to determine the feasibility of the new system.

For LEED, I would like to focus on the feasibility and environmental impact of adding a storm water reclamation system to CHRRA. This will increase the water conservation percentage for LEED points, but will also help to rejuvenate the water table and minimize run off. The building currently has a partial green roof so I will look at the impact of the current system and the impact of the addition of the proposed system.

Building Introduction:

The Center for Health Research and Rural Advocacy (CHRRA) is a 63,000 sq ft building located on the Geisinger Health System Campus in Danville, Pa. The curvilinear structure has three levels above grade (1 below grade) and is slated to become LEED silver upon completion. Construction on CHRRA began in May 2005 and is scheduled to be completed in February 2007. CHRRA serves as the Geisinger research center for common health issues that occur with age. This building is the gateway between the hospital and the community of Danville.

Depth Work Proposal

Lighting:

For the spring 2007 semester I will be analyzing and redesigning the lighting systems for the following five building spaces: the main lobby; the multipurpose room; the auditorium; the first floor open office; and the exterior circulation spaces including the main entrance, the pedestrian pathway, and the south side terrace. CHRRA is the mainframe of knowledge for Geisinger, the data center of new ideas, and the information highway of medical improvements. The lighting for the building should reflect the precise, sleek, and fast pace technical advances of the employees of CHRRA.

Main Lobby:

The main lobby is the first place a visitor to the building will experience. There is a curved glass, double height curtain wall on the North façade of the space which creates the opportunity for natural daylight to enter the building. A metal open staircase follows the curved façade up to the second floor of the main lobby

The design goals for the main entrance lobby are to create and interesting space that will be visually pleasing from both the interior and exterior, balance the natural and electric light, and create a comfortable transition from the exterior to the interior. The double height area of the main lobby is solely for circulation; however, the break out space surrounding the lobby has moveable tables and chairs where reading and writing will take place. The main stairs and two elevators are also located in this space.

I plan to redesign the space with a combination of pendant and recessed lighting systems that will transform the lobby into a glowing beacon from the exterior. Programs such as Autocad, AGI32 and Lightscape will be used for modeling, rendering and calculations. A daylight study will be coordinated using AGI32 or Lightscape to determine the natural light present in the space and to analyze the possible need for photosensor dimming.

Auditorium:

The auditorium along with the main lobby are the two most visitor trafficked spaces in CHRRA. It is important that this unique 300 seat auditorium be aesthetically pleasing and create a memorable experience for the occupants. The space is ellipsoidal in shape and has a front projection screen along with speaker podium at the bottom of the space. The seating is set up stadium-style so that the stage is visible from all areas.

The design goals for this space are the implement a flexible lighting system with multiple control zones in order to create appropriate lighting scenes for presentations, lectures, and discussions; minimize direct glare while also providing adequate vertical illuminance for facial modeling; and to create and atmosphere that will enhance group discussion.

I plan to redesign this space with a combination of perimeter accent lighting, key lights for the speaker, recessed down lighting for the front and back areas, and recessed slot moveable fixtures for over the audience seating. Programs such as Autocad, AGI32, and Lightscape will be used for modeling, rendering, and calculations. Lutron Electronics will be consulted for lighting control systems and wiring.

Multipurpose Room:

The multipurpose room is commonly a lecture and presentation space for CHRRA, but it also equipment with supplemental furniture for a banquet set up. The space has two moveable partitions which allow for the additional flexibility of having one large space or three smaller spaces.

The design goals for this space include creating multiple lighting systems that will work together, avoid direct glare and veiling reflections due to possible VDT use, provide adequate vertical illuminance for facial modeling of the speaker, and providing the appropriate light levels for reading and writing.

The lighting for this space should have the ability to change the occupants' perception of the room. Uniform light patterns along with strong perimeter lighting should create a visually clear and focused atmosphere for the presentation and lecture set up. The same lighting system will need to transform the room to a relaxed and intimate atmosphere using perimeter lighting with non-uniform light patterns during a banquet set up. I plan to use a combination of perimeter wall washing, key lights for the podiums, and pendant direct/indirect fixtures to create the two lighting Flynn modes. There are no windows in the space so a daylighting analysis is not necessary, however; Autocad, AGI32, and Lightscape will be used for modeling, rendering, and calculations.

First Floor Open Office:

The open office is an area of the building solely for the employees. The researchers and their staff will be using the open offices (one on the first floor and one on

the second) for their day to day needs. It is important that the space reflect these specific needs.

The open office has a large, curved, glass curtain wall façade on the south-west side which provided a great deal of natural light to the space. Currently, there is a circulation space directly adjacent to the glass, which has tall partitions will filing cabinet storage. Behind this area, moving away from the glass, are the partial height cubicles, followed by another smaller circulation space that separate the open office from the private offices.

The design goals for this space include: avoiding glare and veiling reflections due to intensive VDT use, create a system that will allow for daylight harvesting, choose a lighting system that will avoid creating shadows due to partition and cubicle walls, and incorporate an option for task lighting.

I propose changing the architectural layout as part of my lighting design for this space. The high partitions around the filing cabinets block all visible views for the occupants of the cubicles. The walls also block a great deal of daylight from entering the cubicle area which could potentially create a great deal of energy savings. As part of my redesign, I would like to address moving the smaller circulation space adjacent to the glass, moving the cubicles closer to the curtain wall while creating better views, and move the filing storage area between the open and private offices. The lighting system will reflect this change, by having pendant direct/indirect fixtures aligned parallel to the curtain wall that will provide light for the cubicle areas. The filing storage will use recessed fixtures due to the lower ceiling height.

A detailed analysis of the daylight must be conducted for this space in order to determine dimming zones for the pendants, the need for automated motorized shades, and the possible energy savings that will result from the increase of daylight harvesting.

This portion of the lighting depth will take a great deal of time and effort. AGI32 and Lightscape will be used to do a daylight study, SPOT will be used for photosensor placement along with critical point calculations, and Lutron Electronics will be consulted for programming the fixtures, photosensors, and motorized shades in the space.

Exterior Areas:

The exterior of CHRRA is very unique for this campus in that it is the only curved glass façade. It is important to highlight this façade without creating a great deal of light pollution. The main entrance leads directly into the main lobby which will be lit as a glowing beacon drawing visitors toward the building. The pathways leading up to the building come off the main drive to the hospital. The employee terrace is located on the south side of the building and will most likely not be used very often at night so minimal lighting is necessary.

The design goals considered for the exterior are: minimizing glare off the glass into the eyes of pedestrians or drivers, centralize the focus on the main lobby, provide adequate illuminance levels for the pathway, and minimize light pollution.

I propose lighting the vertical surface leading to the main entrance with a recessed blue LED fixture that will mimic the cove in the main lobby while also accentuating the curved exterior surface. The pathway will be lit with low bollards to avoid drawing attention away from the glowing main lobby. The terrace will be lit with cut off pole fixtures providing minimal light levels.

The exterior lighting redesign will require using AGI32 and Lightscape for calculations.

All of the proposed lighting designs reflect the comments from the Lutron presentations on December 15, 2006. The presentation was very helpful and allowed for additional advice and guidance on the proposed lighting concepts.

Electrical:

The electrical depth for the spring semester includes a partial redesign of the power distribution system for CHRRA. The electrical work for the five lighting redesign spaces will include: revised panelboard schedules, re-circuiting, load calculations, resize the panelboards if necessary; resize the feeders for the new panelboards, and layout branch circuits and controls.

I have also proposed changing the voltage of the lighting in the entire building from 120V to 277V. This will allow for more luminaires on a circuit and will create the need for fewer runs of wiring and conduit. The change will also create a need for fewer panelboards, relay panels, and dimming panels. A cost analysis of the savings due to equipment and installation will be conducted in order to compare the existing and proposed electrical solution.

I also propose changing all the lighting in the building to high efficient lamp sources. The building is currently designed using only T8 lamps for the linear fluorescent sources. Switching to a T5HO lamp will allow for fewer fixtures and will therefore increase savings. I will look at all the spaces in the building using linear fluorescent sources and use AGI32 to perform illuminance calculations in order to determine the number of fixtures needed to obtain the same average illuminance in the room using T5HO lamps. I will then do a cost analysis using lamps, fixtures, and installation costs to determine the savings from the proposed electrical redesign.

As stated in my mechanical breadth, I plan to research and redesign the VAV system to include fan powered VAV boxes rather than single ducts. This will change the sizing of the air handling units and other mechanical equipment which will in turn effect the electrical system distribution. The redesign will include computing the new design loads for the changed mechanical system and selecting the proper distribution equipment along with protective devices. This redesign will include the main distribution equipment (transformer and switchgear).

Breadth Work Proposal

Mechanical:

The CHRRA existing mechanical system already includes: a single duct VAV distribution system with the following features to increase efficiency and sustainability: a plate and frame heat exchanger for free cooling during the winter months (able to turn off the chillers and save energy), variable flow primary chilled water pumping system (uses variable frequency drives on the pumps and chillers to vary flow), carbon dioxide monitoring and reset (minimizes the amount of ventilation air), daylight harvesting, and a full direct digital control system (controls the entire building including integrated lighting control).

I propose replacing the single duct VAV boxes with a fan powered VAV system. The proposed changed with improve air flow and distribution in the spaces because the supply air rate is constant by utilizing plenum return air, minimize reheat load because heat gain from lights can be used in the return plenum to help heat the spaces, and minimize central system size because plenum air is used to meet minimum airflow/square foot requirements instead of the central system air. The existing CO2 monitoring capabilities will be extremely useful with the new system because it will allow unused ventilation air to be spread out over the entire floor area.

I will have to analyze the existing structural partitions in the space to determine the feasibility of adding a return air plenum to the building. Transfer ducts may be needed in order to make the return air plenum possible. Because the new system does have a higher initial cost, I will look an analysis of the pay back period incorporated with the fan powered VAV system. The cost analysis will include installation, ductwork, new central system sizing, and energy consumption.

LEED: Rain Water Catchment System

CHRRA is slated to become a LEED silver building upon completion in February 2007. The building includes a green roof over top the auditorium adjacent to the first floor open office. I would like to research and study the impact of this partial roof garden as a rain water catchment system. I would also like to look at adding a storm water reclamation system to CHRRA which will add to the building's water conservation percentage for LEED points. Currently, in the use 340 billion gallons of water are being withdrawn from water table per day. It is important to look at alternative methods of water conservation in the building market.

There are four components to the rainwater reclamation system that must be addressed: catchment, delivery, storage, distribution. I will go into detail researching these components in the upcoming spring semester and will determine feasibility based on first cost, payback period, and impact on the environment.

Schedule for Spring 2007	
Week	**Task**
Jan. 16-21	Spring Semester Begins
Jan. 22-28	Finish 3d models and Get all materials for lighting spaces: IES files, fixture cuts, etc.
Jan. 29-Feb. 4	**Electrical Depth:** calculate new T5HO lighting fixture layouts in AGI **Lighting Depth**: Run AGI calculations to determine layout of spaces and wattages, after layout is determined start circuiting/controls
Feb. 5-11	**Electrical Depth:** re-circuit all lighting to 277v lighting panels and dimmers, circuit lighting for new layouts from Lighting Depth **Lighting Depth:** start finalizing 2 spaces for submittal feb. 16
Feb. 12-18	**Electric Depth:** Cost analysis of the new T5HO layout vs the T8 luminaire configuration plus the new 277v system vs the 120v system. **Lighting Depth**: high quality renderings for two lighting spaces plus report due
Feb. 19-25	**Lighting Depth:** Daylight analysis on open office, **Electrical Depth**: photosensor placement and automated shades circuiting on panelboards, begin cost analysis of new shading system
Feb. 26-Mar. 4	**Mechanical Breadth**: Study structural system connections to determine the need for transfer ducts in the structure for the return air plenum, add fan powered vav system and remove the existing return ducts, resize the air handling units based on new ASHRAE requirements for return air plenum.
Mar. 5-11	**Mechanical Breadth**: Complete calculations for equipment, **Electrical Depth**: change mechanical equipment on single line diagram and resize the feeders. Complete cost analysis of the new electrical equipment.
Mar.12-17	SPRING BREAK MIAMI
Mar. 19-25	**Lighting Depth**: Complete daylight analysis of open office space and the 4th lighting layout for redesign and write remaining of the lighting portion of final report.
Mar. 26-Apr. 1	**Rain Water Catchments Breadth:** begin researching LEED rainwater catchments system, work on writing report
Apr. 2-8	**Rain Water Catchments Breadth**: size the necessary equipment for the system and determine a payback period on the system, Finish compiling report, edit

Apr. 9-11	Final revision on report, take to printers
Apr. 11	THESIS FINAL REPORT DUE, complete presentation pulling together lighting renderings, cost analysis information, etc and practice presentation with feedback.
Apr. 18	Thesis presentation: 11:20 am in engineering 107
Apr. 18-May	Post final presentation, final report and reflections on the CPEP website, complete ABET evaluation.