Thesis Proposal

The Pennsylvania Academy of Music
Lancaster, PA

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Lighting/Electrical Option

December 19, 2006

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EXECUTIVE SUMMARY

This proposal for my thesis includes depth studies in lighting and electrical aspects of my building. I am proposing to redesign the lighting for five spaces in the building. In addition, I am proposing to redesign the associated electrical systems to a more efficient distribution system. In addition, I will be further analyzing my electrical system along the path to the light fixtures in the spaces that I will redesign. In addition to these depth studies, I propose to analyze architectural and structural aspects of my building as part of my breadth work. I will be looking at adding features to the Roof Terrace to enhance the utility of the space. In addition, I will be analyzing the structural impact of these changes on the building.

BUILDING OVERVIEW

This building will be the new permanent home of The Pennsylvania Academy of Music musical education conservatory located in downtown Lancaster, PA. The building, designed by Philip Johnson Alan Ritchie Architects, started construction April 14, 2006 and will be completed in the first quarter of 2008. The building has three stories above grade and one story below grade. When it is completed, the Academy will be about 65,000 square feet, including just less than 10,000 square feet retained from the structure previously on the site.

The building will be primarily used for music education. However, the building will also be used as a concert venue, musical library and conservatory, hosting events, as well as audio and video recording and broadcasting. The new building will have several performance spaces, the largest being a 364-seat auditorium. The building will also house practice and instruction rooms for instrument and vocal uses. A music library is located on site as well. The building had a double-height entrance lobby as well as a plaza on the roof.

LIGHTING DEPTH

Problem

The lighting system at The Pennsylvania Academy of Music is designed in accordance with traditional methods of designing a lighting system for a performance space. The system uses mostly incandescent sources and very few sources at all. However, the building met all of the IESNA and ASHRAE 90.1 standards for illuminance levels and power densities. There is also potential for saving money and energy by converting to more efficient sources and distributions as well as integration of daylight harvesting into the exterior spaces.

Proposed Solution

I have selected five spaces to redesign. I will make use of glowing volumes and surfaces to make the Exterior Façade inviting and draw attention to the building. Just inside, the Grand Foyer will showcase the Recital Hall as well as provide circulation to most of the major spaces in the building. The Recital Hall, the heart of the building, will have its architecture accentuated subtly to create a relaxing atmosphere. The Library will use diffuse light to eliminate shadows in one of the only spaces where the primary task is visual, not auditory. Lastly, the Roof Terrace will be designed to enhance the gathering functionality of the space.

Further information about these spaces, the concepts involved, and the schematics utilized are available in my Technical Report 1 and Technical Report 3. Additional comments from lighting designers about these designs for Technical Report 3 are also available. These documents are located on my CPEP website.

Methods

The complexities of these spaces dictate that they will need to be modeled in as accurate and complete of a method as possible. I will be utilizing AutoCAD to create three dimensional models of the spaces. After this, I will also be utilizing AGI32, an implementation of the radosity solution method, to calculate the lighting levels, making sure that they will be in compliance with the IESNA recommendations. The model will incorporate accurate textures on the surfaces to generate accurate reflectances for light, and photometrically accurate light sources will be used to generate a final solution. AGI32 will also be used to generate models of the daylight that would enter the building through these same methods. Additionally, I propose to make use of 3D Studio to generate realistic rendered images of the spaces with my solutions in place. This program uses many of the same methods as AGI32, however when presented with a choice, its algorithms tend to side with visually appealing rather than numerically accurate.

Tasks and Tools

1. Finalize Lighting Layouts
    a. Conceptual designs from Technical Assignment 3 will be refined and finalized
    b. Layout will be adjusted to match the desired IESNA illumination levels as necessary
    c. Alternate layouts will be created as necessary
    d. Mounting details will be generated where needed
2. Select Fixtures
    a. Luminaires will be selected based on desired performance and efficiency

   b. Efficient lamps and ballasts will be selected and specified based on desired control scheme

3. Generate Software Models
   a. AutoCAD models will be created to accurately represent the spaces
   b. AGI32 will be used to gather accurate illumination levels and daylighting conditions
   c. 3D Studio will be used to create photorealistic images of how the spaces will look

ELECTRICAL DEPTH

Problem

As I analyzed in Technical Assignment 2, the electrical systems of the building are sufficiently sized to handle all of the loads in the building. However, as I mentioned before, many of the spaces rely on incandescent lighting. This inefficient and lower voltage source requires more circuits and more current going to each fixture.

Proposed Solution

I propose to enlarge the existing, but limited, higher 480Y/277V distribution system for use with more efficient lighting systems. In turn, I would be able to reduce the need for the 208Y/120V that most of the building currently utilizes. As part of this proposal, I will study if this proposal would also be able to reduce the number of circuits and thus the installation cost of the building.

Methods

The loads in my re-lighted spaces will be analyzed utilizing the NEC 2005. The new loads will then be applied to the panels and conductors which will then be resized and repositioned to aid in efficient distribution. Conduits, transformers, and overcurrent protection will subsequently be resized as well.

Tasks and Tools

1. Redesign Branch Circuits for Re-Lighted Spaces
    a. Analyze new lighting loads in these spaces
    b. Specify new circuiting for these loads
2. Analyze 277V Lighting vs. 120V Lighting

    a. Study cost benefits to determine economic feasibility of proposed system

3. Analyze Major Distribution Panelboard
    a. Study new requirements for conductors and protective devices
    b. Redesign based on new loads
4. Conduct Protective Device Coordination Study
    a. Size protective devices on redesigned system
    b. Analyze short circuit current protection

BREADTH TOPICS

Architectural Breadth

The Roof Terrace is a very plain space as currently designed. Though its austere nature keeps it a flexible space, it also prevents it from being as useful of a space as it could potentially be. I propose to add to the architectural aspects of the space to enhance its functional capabilities. The potential for outdoor performances, classes, and practice in this space would create significant added value to the Roof Terrace. After analysis of similar spaces, I will attempt to create a series of outdoor rooms that will provide flexibility while keeping the space as intimate and unintimidating as possible. This space will then subsequently be re-lit as part of my lighting depth.

Structural Breadth

The Roof Terrace is located directly on top of the Recital Hall. The structural system will thus have to be redesigned for the added loads that I am proposing for my Architectural Breadth. This analysis will include analyzing the moment and flexural capacity of the span over the recital hall as well as the shear walls that both support this load. These massive walls also isolate the recital hall acoustically by providing a great deal of attenuation due to their density.

TIMELINE

Time	Task
Break	Research breadth topics and finalize conceptual schematic designs
1/15 – 1/21	Build computer models for analysis
1/22 – 1/28	Select luminaires and ballasts Collect data for lighting and electrical calculations Import models into AGI32 for calculations
1/29 – 2/4	Determine lighting layout Determine electrical loads Generate lighting fixture schedule
2/5 – 2/11	Create lighting plans Analyze daylight and electric lighting conditions Resize electrical system components as necessary
2/12 – 2/18	2/16 – Preliminary submittal of two spaces for lighting and electrical redesign Create electrical plans Finish daylight analysis
2/19 – 2/25	Determine control zones for daylight Start on breadth studies
2/26 – 3/4	Continue work on breadth studies Import models into 3D Studio for renderings
3/5 – 3/9	Wrap up breadth studies Create 3D Studio renderings
3/10 – 3/18	Spring Break
3/19 – 3/25	Flex time – Wrap up breadth studies, finishing renderings Start compiling final report
3/26 – 4/1	Compile final report
4/2 – 4/8	4/6 – Final report due Flex time - Compile final report Start generating presentation
4/9 – 4/15	Finish generating presentation
4/16 – 4/20	Thesis Presentations