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Thesis Proposal Resubmission

Pennsylvania State Employees Credit Union Corporate Headquarters
Harrisburg, PA

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Executive Summary

The Pennsylvania State Employees Credit Union (PSECU) Corporate Headquarters combines sustainability and modernity through design and materials. The modern, minimalistic architecture and clean, linear lines emphasize circulation.

The Spring Senior Thesis proposal consists of two depth topics and three breadth topics. Each redesign element presents an alternative design option for the Pennsylvania State Employees Credit Union Corporate Headquarters.

The lighting depth proposal proposes a new lighting design solution for the following four spaces:

An Outdoor Space | Building Façade and Entry Plaza

A Circulation Space | Lobby

A Large Workspace | Marketing Open Office

A Special Purpose Space | Board Room

Through the design concept inspired by ‘the transfer of money through space’, along with the lighting design goals of aesthetics, circulation, and the experience of the spaces, the desired lighting effects will be achieved. Also, the designs will be guided through both the IES 10th Edition Lighting Handbook and ASHRAE/IESNA Standard 90.1 – 2010.

The electrical depth consists of a redesign of the branch circuit distribution system for each of the four re-lighted spaces, a protective device coordination study, and two depth topics. The addition of a photovoltaic array will allow for the PSECU to further its vision of creating a sustainable building. Analysis of the cost savings will allow for the feasibility of adding a photovoltaic array to be measured. Additionally, a cost benefit analysis will be analyzed in order to compare the cost savings of increasing feeder sizes.

Within the open office, a daylight study will measure the efficiency of the current light shelf system. Also, analysis on redesigning the daylight harvesting system due to the addition of skylights in the open office will be performed. As a result of the addition of skylights, a mechanical heating and cooling load analysis will measure the change in loads, along with determine if any heating or cooling equipment must be resized.

A redesign of the entry plaza will be conducted in order to improve the entry area, along with further incorporate the lighting into the area.

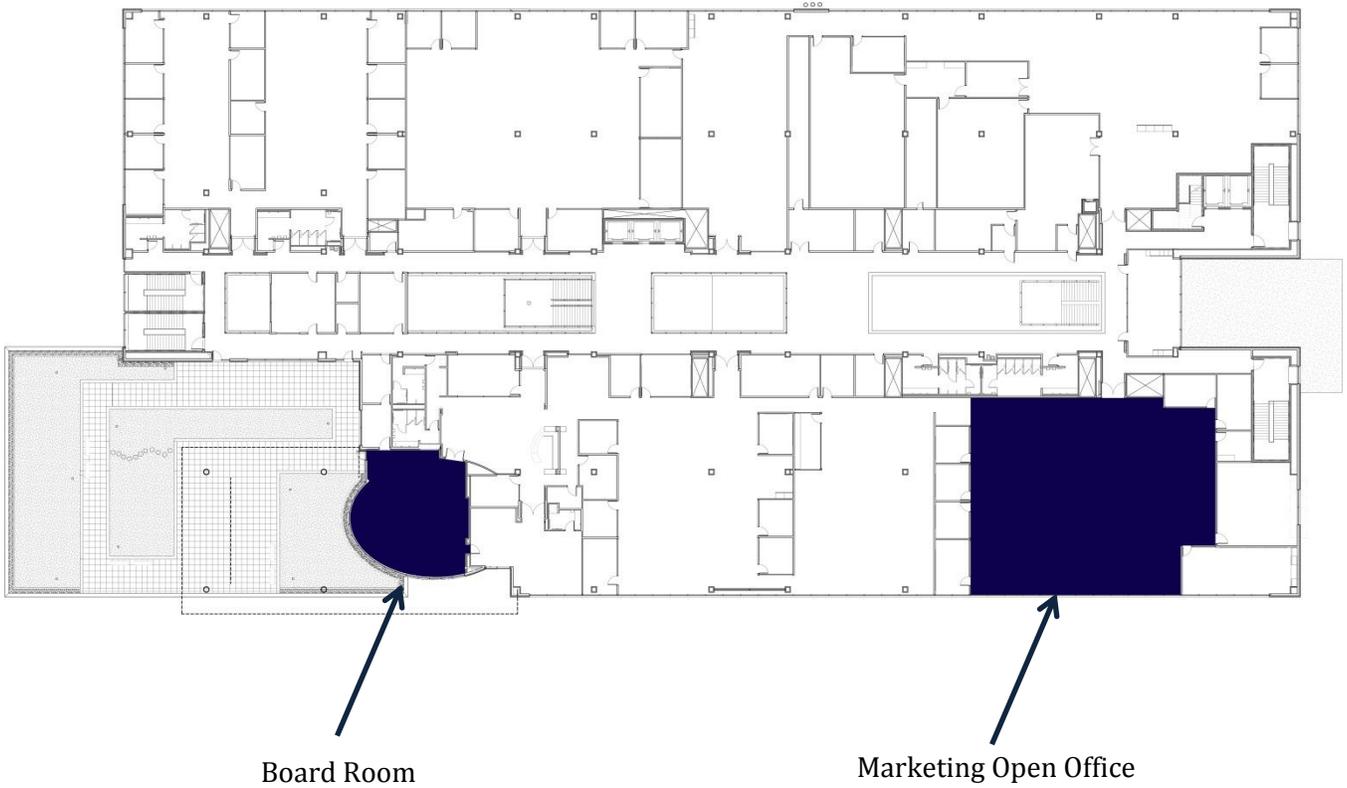
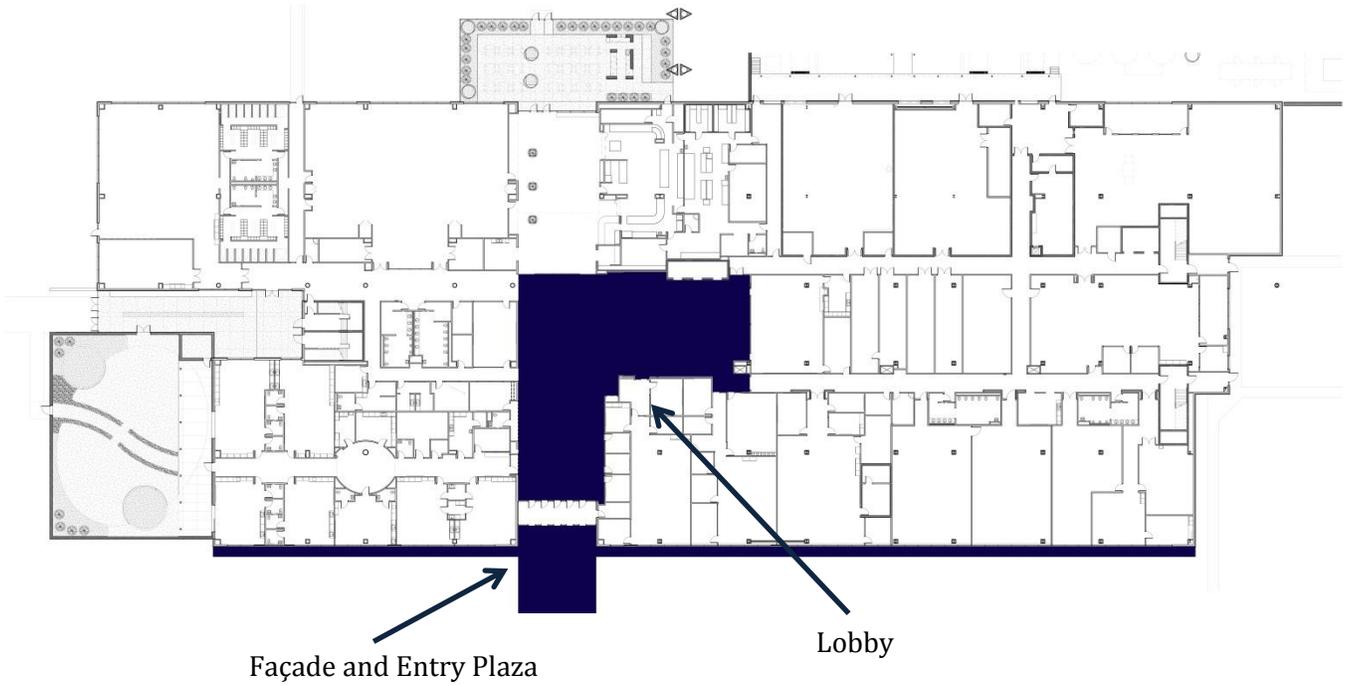
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Building Overview

The Pennsylvania State Employees Credit Union Corporate Headquarters was designed in efforts to create a clean, flexible, energy efficient design with full lighting controls. The building combines sustainability and modernity through design and materials. As a LEED Gold certified complex, the three story, 234,000 square foot building strives to bring the outside in through its large glazed curtain walls and naturalistic materials. Located in Harrisburg, PA and costing \$54 million, the building provides offices, a data center, a conference center, a daycare, and a presidential suite. A roof garden comprises the third floor western end of the building. Currently, PSECU has branches in both Harrisburg, PA and Philadelphia, PA. Therefore, the complex serves to bring all of the necessary resources together in order to create a branchless company. Construction began in August 2011 and will end in August 2013 with the building opening in October 2013.

Materials that comprise the façade include terracotta stone, glazing, and metal panel work. Large glazed curtain walls allow for 75% views, while metal panel work accent the architectural features. The variety and complexity of materials and textures throughout the building provide interesting redesign and lighting opportunities.



Lighting Depth

The lighting design for the Pennsylvania State Employees Credit Union Corporate Headquarters will reinforce the client's goal of creating a clean, energy efficient design. In order to help achieve the LEED Gold rating in which the client is striving for, both luminaire selection and power density will be key factors in the redesigns. The overall goal in the lighting design of the complex is to create a comfortable work environment for all employees. The four spaces in which the lighting will be redesigned include:

An Outdoor Space | Building Façade and Entry Plaza

A Circulation Space | Lobby

A Large Workspace | Marketing Open Office

A Special Purpose Space | Board Room

Overall, the lighting designs of the four spaces will adhere to the design concept of 'the transfer of money through space', while also adhering to the client's goal of creating a clean, energy efficient design. The concept of the 'transfer of money through space' stems from the PSECU being a credit union that focuses on the transfer of information and money through the large data center.

Large glazed curtain walls and skylights line the building allowing for the outside to become the inside. Through the minimalistic architecture and clean, straight lines throughout the complex, the users become the features of the space.

Based on the feedback from the lighting designers at Lutron, the four designs will be further developed in order to incorporate their comments. Development will occur through the further analysis of the design criteria, in order to make clear the psychological and functional aspects of each space. Analysis of the designs will occur through building the spaces in AutoCAD and inputting the luminaires into AGI32. Renderings will then allow for the client to imagine each space.

Lighting Designer Comments

The following is a summary of the main comments by the three lighting designers at Lutron.

Shawn Good

- Slow down
- Presenting the history of PSECU was a good idea
- I presented a lot of spaces and a lot of options
- Whites need to be whiter
- He loved the creativity, but I need to consider sky glow
- I need to consider how the office cubicles will be moved around
- I needed to mention daylight more

Sandra Stashik

- Good presentation
- She liked how I stepped away from the original design
- Consider using uplight on the façade
- She liked how I tied the outside and inside together

- She was concerned that the office ambient lighting will create glare through the height of the upright component of the task ambient system
- Mention more about daylight and controls

Kari Nystrom

- Sketches were too dark
- Consider taking out some slides
- Concepts were showed well
- I compared the concepts well

Outdoor Space | Building Façade and Entry Plaza

As a result of the PSECU Corporate Headquarters being located in a suburban area of Harrisburg, PA, the lighting design is more focused on directing patrons to the entrance of the building than on highlighting the façade itself. The façade to be re-lighted is 513 feet long and stands 64 feet tall. It is also the main entry point of the building. A 3,400 square foot entry plaza sits in the center of the façade and includes benches, along with a water feature.

The underside of the roof garden canopy is highlighted in order to draw the eye upwards. The entry plaza will feature ingrade square LED luminaires in a pattern to direct patrons into the complex. After hearing the designers' comments, I will reevaluate the issue of sky glow within this design. The water feature will also be highlighted. As the overall lighting design is based on a walkthrough of the complex, the exterior entry plaza and lobby lighting designs are integrated together. Overall, the façade and entry plaza lighting provide an energy efficient design that will adhere to sky glow requirements set forth by LEED.

Circulation Space | Lobby

The lobby comprises the outer lobby, inner lobby, and elevator lobby. The lobby measures approximately 4,425 square feet with ceiling heights of approximately 28 feet. Separating the spaces are turnstile card readers. Terracotta stone lines the walls of the space, while the large, curved wood panel wall grabs attention through its prominence. A large glazed curtain wall faces south and provides natural light for the outer lobby. Skylights line the ceiling of the inner lobby and elevator lobby, providing daylight. An exposed staircase with glass railings is the main feature of the inner and elevator lobby, along with a water feature.

As the initial impression of the building, the space should feel warm and comfortable, along with promote circulation. Three schematic lighting designs were chosen that each emphasized the overall design goals and concepts. After hearing the designer's comments, the lighting design with hanging pendants will be revised in order to fulfill the design goals. Also, in order to fully integrate daylight harvesting into the lobby, photosensors and controls will be incorporated.

Large Workspace | Marketing Open Office

Lining the marketing open office is a south facing glazed curtain wall with a light shelf and automated shading to control direct sunlight. As a space where employees will spend the majority of their day, the marketing open office will emphasize comfort and privacy. The proposed lighting design incorporates a task ambient lighting design. After hearing the comments of the lighting designers at Lutron, I will redesign the proposed lighting design to incorporate direct-indirect pendants, along with cove lighting. Task lights will be at each individual cubicle to provide user adjustable lighting. As a south facing space, daylight harvesting will be implemented.

Special Purpose Space | Board Room

Located on the south western side of the building, the oval-shaped Board Room comprises a multiuse space that will host a variety of events, including Board Meetings, lunches, etc. The walls are lined with cloth and the space overlooks the roof garden. An oval-shaped conference table sets in the center of the space with a secondary row of chairs set off the conference table in an oval pattern. The wood paneled ceiling brings a naturalistic feature to the space.

As a result of the glazing within the curved walls, daylight harvesting is a key feature to be incorporated into the design. Another key feature is scene control due to the different activities of the space. The Board Room will incorporate the psychological impressions of closure versus spaciousness. The closure setting will be implemented for Board meetings. A large pendant that replicates the shape of the oval conference will incorporate downlights for general task lighting and facial recognition. Cove lighting will provide low ambient lighting. For the spacious setting, additional downlights will line the exterior of the space replicating the curvature of the walls. Also, the cove lighting will be at a higher light level to provide more ambient lighting.

Due to the comments from the designers at Lutron, I will reevaluate the design to strengthen the design criteria and goals, along with the psychological impressions.

Overall, the design will employ an energy-efficient solution that integrates both daylight harvesting and scene controls.

Tasks and Tools

Schematic Lighting Design:

Continue to develop the proposed lighting designs from Technical Report 3.

Model Spaces:

Use AutoCAD to accurately model the four spaces in three dimensions.

Select Tools:

Select luminaires that will be implemented into the four lighting designs.

Analyze Daylighting:

Use Daysim and AGI32 to evaluate the daylighting penetration for each space.

Analyze Electric Lighting:

Use AGI32 and 3D Studio Max to perform lighting calculations in order to ensure that the lighting

designs comply with the 10th Edition Illuminating Engineering Society Handbook. Power densities will also be calculated in order to ensure the feasibility of the designs set forth by ASHRAE 90.1.

Render Spaces:

Use the 3D model of each space and manufacturer .ies files to accurately render each space using AGI32 and/or 3D Studio Max.

Documentation:

Document each design, including cut sheets, luminaire schedules, reflected ceiling plans, and lighting plans.

Electrical Depth

The electrical depth of the spring semester senior thesis consists of a branch circuit distribution redesign, short circuit analysis, and two additional depth topics discussed below.

The existing electrical distribution system is a primary selective system with a 12.47/7.2kV service entrance in the main electrical room of the building. The high-voltage cable feed splits into three feeders and services the double-ended main substation and fire pump substation switchboards, which are all owned by PSECU. The double-ended main substation services an additional switchboard under emergency conditions. It is normally serviced through a high-pressure natural-gas microturbine generator with heat recovery. Two primary transformers, rated at 2,500kV each, step down the voltage to a 480Y/277V, 3Ph, 4W voltage system, which feeds most of the building loads. The primary transformer in the fire substation switchboard steps the voltage down to a 480Y/277V, 3Ph, 3W voltage system which feeds the fire pump loads.

Within the lighting depth of the spring semester thesis, the four spaces to be re-lighted include the building façade and entry plaza, the lobby, the marketing open office, and the board room. The proposed lighting design of the façade and entry plaza focuses on the entry plaza as a means of circulation. Within the lobby comprises a large curved wood panel wall, which is the focus of the redesign. Small hanging pendants will draw the eye upward in order to highlight the wood panels. The marketing open office is a space in which coordination is a key task among employees. Therefore, preventing glare through indirect pendants allows for comfort of the users. Lastly, the Board Room is the special purpose space that requires flexibility in the lighting controls. A large pendant will be built that replicates the large oval conference table and cove lighting will provide the ambient lighting for the space.

Branch Circuit Distribution

For each of the four spaces to be re-lighted, a branch circuit distribution system will be redesigned. In order to do so, the feeders and panel boards will be resized, where necessary, for the new lighting schemes.

Short Circuit Analysis

A protective device coordination study will extend from the utility primary to the main switchboard MDP1. The path through the distribution system will show the coordination of protective devices for the new system components as a result of the redesigned systems and short circuit calculations.

Depth Topic 1: Photovoltaic Array

As a LEED Gold building that focuses on energy-efficiency, a solar photovoltaic array will be designed in order to emphasize the building's desire for sustainability. A design layout will be developed in AutoCAD in order to create the most efficient design and the path to the electrical distribution system will be determined. Cost estimates of all materials will be evaluated and a payback period will be calculated in order to determine the system's feasibility.

Depth Topic 2: Cost-benefit Analysis of Increasing Feeder Sizes

Depth topic two consists of analyzing the energy savings for increasing feeder sizes in the data center. The study will compare the low first cost of smaller wire sizes versus the potential energy savings of utilizing larger wire sizes. The energy savings is due to the reduction in resistance. A minimum of three demand loads will be evaluated and the results will be graphed. The results will determine which system is more cost effective in terms of utilizing smaller versus larger wire sizes.

Breadth 1: M.A.E. Focus: Daylight Analysis

The third floor open office space is partially enclosed with a south-facing glazed curtain wall. The curtain wall encompasses a light shelf and automated roller shades. The space currently implements a daylight harvesting system, but I would like to measure the degree to which the daylight harvesting system works. In order to measure the effectiveness of the daylight harvesting system, an exploratory analysis on the effectiveness of the light shelf will be completed, along with any redesign of the light shelf. This includes lengthening the light shelf or changing materials or reflectances. The system will be calculated in either AGI32 or Daysim. The data to be compared includes daylight penetration and horizontal illuminance levels during the solstices. A roller shade system is also implemented and I will compare utilizing a roller shade system that is mounted below the light shelf rather than above it.

Also, a skylight system will be implemented into the space. The clearstories will be built as additions onto the roof, which will also act as mounting locations for the photovoltaic system to be added in the electrical depth. The analysis will be performed in Daysim and the data to be compared includes daylight autonomy and energy savings.

The study will be conducted through utilizing the knowledge gained through AE 565: Daylighting.

Breadth 2: Mechanical

Due to the skylight system to be implemented into the open office in MAE Breadth Topic 1, a mechanical system study will be performed in order to measure the new heating and cooling loads within the open office. The open office space will be built in Trace and analyzed. Two models will need to be built, one model without the clearstories and another with the clearstories. The heating and cooling loads will be compared and if any additional heating and cooling loads exist, the mechanical system will need to be analyzed as to whether the system size needs to be increased.

Breadth 3: Landscape Architecture

The entry plaza serves as the main entry point to the Pennsylvania State Employees Credit Union Corporate Headquarters. As the main entry point, the plaza needs to make a statement of the type of building the PSECU Corporate Headquarters is, along with emphasize the key architectural features. In order to do so, a redesign of the entry plaza will be performed, which further incorporates the lighting design of the plaza. The analysis will include a redesign of the plaza, a redesign of the water feature, and selecting the materials. The entry plaza will mimic the curvature of the building entry along with the linear lines of the building. I will also examine the parking lot to create a flow from the parking lot into the building. Additionally, redesigning the walkways, whether that be through materials or location of the pathways will allow for further fluidity of the entryway.

Senior Thesis Preliminary Schedule for Sarah Wujcik

| | | | Lighting:Space 1 Completed | | Lighting 2: Space 2 Completed | Lighting 3: Space 3 Completed | | Spring Break | Lighting 4: Space 4 Completed | | | | | | | |
|--|------------------------|-----------|-------------------------------|----------|----------------------------------|----------------------------------|-----------|-----------------|----------------------------------|-----------|-------------------------------------|------------------------------|---------------------------|-------------------------|---|--|
| 1/9/2012 | 1/16/2012 | 1/23/2012 | 1/30/2012 | 2/6/2012 | 2/13/2012 | 2/20/2012 | 2/27/2012 | 3/5/2012 | 3/12/2012 | 3/19/2012 | 3/26/2012 | 4/2/2012 | 4/9/2012 | 4/16/2012 | 4/23/2012 | |
| Finalyze 3D Models; import models into AGI32; fixture selections | | | | | | | | | | | | | | | | |
| Complete Lighting space 1: façade and entry plaza | | | | | | | | | | | | | | | | |
| Complete Lighting Space 2: Lobby | | | | | | | | | | | | | | | | |
| Complete Lighting Space 3: Board Room | | | | | | | | | | | | | | | | |
| Complete Lighting Space 4: Open Office | | | | | | | | | | | | | | | | |
| Renderings | | | | | | | | | | | | | | | | |
| Design Entry plaza | | | | | | | | | | | | | | | | |
| Design skylights for open office, Daylighting calculations in AGI32 and Daysim for open office | | | | | | | | | | | | | | | | |
| Calculate new mechanical loads for open office | | | | | | | | | | | | | | | | |
| Branch circuit analysis, Short circuit analysis | | | | | | | | | | | | | | | | |
| Design photovoltaic array | | | | | | | | | | | | | | | | |
| Cost-benefit analysis of increasing feeder sizes | | | | | | | | | | | | | | | | |
| | | | | | | | | | | | Compile all information into report | | | | | |
| | | | | | | | | | | | | Finalyze thesis presentation | | | | |
| | | | | | | | | | | | | | Final Thesis Presentation | | | |
| | | | | | | | | | | | | | | Fix any report problems | | |
| | | | | | | | | | | | | | | | Senior Banquet / Final report due: April 27th | |
| Breadth Key | Lighting | | | | | | | | | | | | | | | |
| | Electrical | | | | | | | | | | | | | | | |
| | MAE Study: Daylighting | | | | | | | | | | | | | | | |
| | Breadth 1: Mechanical | | | | | | | | | | | | | | | |
| Breadth 2: Landscape Architecture | | | | | | | | | | | | | | | | |