Proposal - Massachusetts Public Library

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Lighting and Electrical Systems Design Proposal

AE Senior Thesis Project

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Executive Summary

This proposal summarizes the intent for the re-design of Massachusetts Public Library. Two depth topics, a master focus topic, and two breadth topics of study are proposed for Spring 2009. There are very few inadequacies in the existing building systems and the re-design will address these few issues as well as suggest new solutions. Primarily the re-design will address the lighting and electrical systems. All the topics are linked to some degree; the results of one design will impact other areas of study.

The first depth study addresses the lighting systems of four specific spaces. The four chosen spaces were portrayed within Technical Report 1, and schematic designs were generated for Technical Report 3. The lighting depth study will develop the schematic design and further continue through the stages of design. A supplemental study will address daylighting for the MAE requirements. The state-of-the-art curtain wall façade maximizes views of the library's park setting, celebrates the library's openness and accessibility, and provides abundance of daylight.

The daylighting study of the curtain wall will impact a breadth study of the heating and cooling loads to the building. If the material or properties of the wall are changed it will impact the heating and cooling loads throughout the space. The second breadth study will focus on the acoustics of the "special meeting room" in the basement. If architectural details are changed due to the lighting scheme it will impact the dynamics of the room and acoustics of the space. Therefore the study will complete a full analysis of acoustical reverberation for the auditorium.

The second depth study addresses the redesign of the branch circuit distribution for the four spaces that are being re-lighted. It will also include a protective device coordination study that addresses a single-path through the distribution system. In relation to the breadth study of HVAC loads, an electrical study will be computed for the redesign of the building's HVAC system. Distribution equipment and protective devices for the south section of the building will be selected. Because the building is striving to be LEED certified, comparisons of energy efficient electrical equipment will also be conducted.

Background

The Massachusetts Public Library was originally opened in 1889. In 1982, the building was listed as an important landmark on the National Register of Historic Places. Today it is being renovated as a state-of-art public library facility and is striving to be LEED certified. An additional 70,000 square foot expansion is being added to a renovated existing historic library space of 35,000 square feet. The extensive use of a state-of-the-art curtain wall façade in the new design maximizes views of the library's park setting, celebrates the library's openness and accessibility, and provides abundance of daylight. Including on the top floor of the new library addition is a children's wing, featuring a tree-like ceiling that connects the space to the canopy of park trees outdoors. Separate craft and story rooms are also provided. A young adult area, with media stations and informal seating, is deliberately placed in the old building to bring new vitality to all parts of the project. New below grade parking for 70 cars allows for the park above to be restored and provides an open green space for the community and adjacent School. In addition, a new 230-seat underground auditorium and a number of smaller conference/ meeting rooms will provide opportunities for the library to greatly expand is programming for the public.

The building's existing lighting systems compliment and accentuate the style of architecture in the two buildings. The interior of the library is lit with a comprehensive lighting system utilizing well over 60 different 277V or 120V fixtures that include fluorescent, metal halide, LED and incandescent lamping. Daylighting and occupancy controls in conjunction with a Lutron dimming system allow for event lighting while also contributing to energy savings. Capacity for theatre lighting is also built into the large meeting room in the basement of the Addition. At night the building truly "glows". The addition interior vertical surfaces are washed with light which is visible from the building's exterior at night.

The building is serviced by a 2000 kVA service entrance transformer by NSTAR Electric, which is then transformed by both 480V primary and 208/120V secondary systems. Emergency power is fed from a 300kW/375kVA, diesel Generator which outputs power at 480Y/277V, 3-Ph, 4 W with a 65 K AIC rating.

Lighting Depth Study: Re-design of Four Spaces

The four spaces which will be re-designed include the main entrance, exterior space; the 1st floor lobby and hall, circulation space; the 2nd floor stacks and seating, large work space; and the basement meeting area, special purpose room.

Problem

The Massachusetts Public Library will function as a gathering place for the community. Though the current lighting design effectively addresses the requirements as stated by the IESNA changes could be made to improve or alter the building's performance. Performance issues that will need consideration will include but are not limited to: illuminance levels, illuminance ratios, glare, power density and maintenance.

Overall Design Solution

The new lighting design will compliment and accentuate the architectural style of the building. Light will be used to guide occupants throughout the library. Lighting will also support the transparency and connection between spaces. The lighting equipment will be efficient, and aid in achieving the LEED certification desired for the project.

Main Entrance Walkway

In the evenings light should guide occupants to the main entrance and light the pathway. The lighting for this area should be way-finding and provide safety. The entrance lighting must be consistent with the architecture of the building, very linear in appearance. At night the building truly "glows" from within, and the exterior lighting should not detract from this.

Lobby and Hallway

The lighting in the lobby and main hall is important because it will create a first impression of the library for most building visitors. An entrance lobby is similar to that of the cover of a book, it should create a big impact. The most important areas of this space are the stairs, elevators and help desks and should be highlighted to create visual hierarchy. Lighting within the room should enhance the flow of openness in the space.

Stacks and Seating

The stacks and seating area located on the second floor is flood with daylight through the state-of-the-art curtain glass façade wall. Due to the curtain wall, daylight sensors should be utilized for this area. Because of the tasks involved in this space the main impression of the room should be visual clarity. Similar to the other rooms, the lighting for the stacks and seating area should enhance the flow of open space.

Meeting Room

The special purpose room with 230 seats has multiple functions. Therefore for each of its functions there should be different lighting schemes. Layers of light should be created that can be turned on or off, or dimmed. Lighting should be comfortable to view speakers and video projects. There should also be adequate horizontal illumination for writing and reading tasks. Architectural details such as the undulating walls should also be highlighted.

Comments from designers at Lutron presentation (12/12/07)

Lee

-Overall organized and good presentation
-Useful criteria for spaces

Exterior Space

-For the exterior rendering use a darker background
-For the vestibule in the entry use a photo of the fixture

Circulation Space

- A ceiling plan would have helped to show ceiling heights
- 1st concept- for the stair linear fixture, show that it is at a different ceiling height
- 2nd concept- make sure there is enough light from the pendants- may need to incorporate some downlights for extra light- specular, round would help to tint ceiling red
-Long elevation is not critical
- 3rd concept- will words take away from the red ceiling? You would need the opinion of owner

Workspace

-Make sure that there is enough light at the bottom of the stacks
-Liked the open book idea in the seating area
-May want light closer to the task plane- think about the height of the plane the layout and furniture.
-How will this look if it were viewed from the exterior?
-I liked the rendering and idea of auditorium- but may be stretching the overall idea
-Just make the concept a side note for the spaces

Auditorium

-Make sure the ramp and steplight get the same light
-Be careful of lighting word ceiling- no reflected light and watch w/sf
-Good light with linear and dowlight- may want something continuous
-Don't want to highlight wood panels if continuous light slots

Overall Comments

-There will be enough daylight in stacks to reduce cave effect
-Mention uniformity on exterior
-Think more about lighting walls behind the info desks
-Think more about what you want to standout the go back and choose fixtures

Sandra

-Good presentation and use of pointer

-Be consistent with illuminance units
-Make sure that if you say criteria (w/energy) that it works out

Exterior Space
-Make sure that entrance stands out and not the fixtures

Circulation Space
-Concept 1- Need sense of direction when you enter lobby- don't focus as much on linearity but more on points of direction (Info desk and reception)- This is the most important part of space
-2nd concept think about how pendant works with linearity of other spaces

Workspace
-If double linear fixtures over stacks doesn't work or meet criteria then don't show it

Auditorium
-Down really mention the "book down" idea- may get wrong impression
-Be careful about linear fixtures on wood panels if things look differently
-May not need linear fixtures over stage if there is already lighting focused over the stage
-For undulating walls- may want to wash them and uniformly light them
-May want to make dimmable for different scenes
-Just think about the surrounding walls a little more

Overall
-Make sure to think about hierarchy

Solution Method

The lighting design, declared in technical report three, will be developed with the assistance of the Lutron Board. Comments from designers as well as computer studies will aid in completing the design process.

Tools

Multiple computer programs will be utilized to envision the spaces and evaluate the performance of the lighting systems. AutoCAD will be used to build a three dimensional model, and two dimensional lighting plans. AGI32 will be used to calculate light levels and create three dimensional renderings. AGI32 will also be utilized to analyze the daylight in the stacks and seating area. Energy10 will be used to calculate energy density in the four spaces to ensure that the lighting design meets the Massachusetts codes.

Tasks

1. Complete the schematic lighting design with the assistance of lighting designer comments and further studies of the spaces.

2. Select equipment which meets the requirements of the schematic lighting design.

3. Perform calculations using AGI32 and Energy10 to ensure that the light levels and power density meet the criteria.

4. Create final renderings of the four spaces using AutoCAD.

5. Document the design with all appropriate support material.

Daylighting Depth Study: State-of-the-art curtain wall

Calculations will be done in the seating/stacks area using AGI32. The calculations will be done for different daylighting conditions, different times and different months for a complete evaluation. If the current curtain wall appears inadequate then ways to improve it will be researched. Other knowledge and tools gained in AE 565 will be used to fully evaluate the curtain wall.

Electrical Depth Study: The redesign of portions of the power distribution system

Problem

The current electrical distribution system is adequate however, after the redesign of the lighting system is made, all electrical systems will need to be re-analyzed. The protection devices will need to be resized to provide for the change in electrical load experienced by the system. Also all branch circuit distributions for the four re-lighted spaces will need to be redesigned. In relation to the breadth study of HVAC loads due to changes in the curtain wall, an electrical depth study will need to be computed for the redesign of the building's HVAC system. Because the building is striving to be LEED certified, all electrical equipment should be made as energy efficient as possible. Therefore for the second lighting study the energy efficiency of the electrical transformer should be analyzed.

Solution

Per my redesign scope, the design loads shall be altered and distribution equipment resized as necessary. The four redesigned spaces include: 2nd floor stacks/seating- large work space; 1st floor lobby / hall- circulation space; basement meeting room- special purpose room; and a library park – exterior space. Protective devices will be resized in a coordination study that addresses a single path through the distribution system shall be performed. A study will also be done for the electrical loads due to changes in the HVAC system which include selecting the main distribution equipment and protective devices. The solution to the energy efficiency of the building will involve the comparison of the NSTAR equipment currently specified to energy efficient transformers such as Powersmith.

Solution Method

Electrical loads will be recalculated per the 2008 National Electric Code with consideration of appropriate design factors. Affected electrical panel boards will be relocated to satisfy the needs of the redesigned lighting loads. Other electrical components including: conductors, conduits and over current protection devices will then be resized per NEC 2008.

Tasks and Tools

1. Calculate loads -New lighting loads to be determined for redesigned spaces per NEC 2008
2. Redesign the branch circuit distribution for the four spaces that are being re-lighted.
3. Conduct a protective device coordination study that addresses a single-path through the distribution system, showing the coordination of protective devices for your redesigned system components along this path. Calculations of short circuit current should be included.
4. Compute any additional/modified design loads required based on the redesign of the building HVAC system and select the distribution equipment and protective devices for that section of the building. The curtain wall encompasses the entire south wall; therefore this is a very large section of the library. This redesign will also include the building's main distribution equipment (transformer and switchgear).
5. Compute the energy efficiency of the current transformers in the building to the energy efficiency of a Powersmith transformer and state which of these is superior.

Breadth Topic 1: Façade System and Solar Loads

Massachusetts Public Library features a state-of-the-art glass curtain wall façade. In addition to light penetration, the wall will also create solar heat gains and heat loses due to poor insulation. In the depth topic the daylighting will be studied and within the breadth the solar loads will be evaluated. The façade system will be studied to determine if a better system is available. The solar gains and heat losses of both the existing system and the re-designed façade will be calculated.

Breadth Topic 2: Acoustics

If architectural details are changed due to the lighting scheme it will impact the dynamics of the room and acoustics of the space. Therefore the study will complete a full analysis of acoustical reverberation for the auditorium. Changes will be made if the room is proved to be inadequate. Acoustical equipment such as sound absorbers will be incorporated into the room if necessary.

Tentative Schedule

Week	Objective
Christmas Break	**Begin building room models in AutoCAD, Finalize Schematic Design.**
01/11 - 01/17	Import 3D models into AGI. Begin selecting materials with the appropriate reflectance values.
01/18 - 01/24	Begin research on curtain wall for daylighting analysis and HVAC breadth topic
01/25 - 01/31	Focus on the completion of one lighting space with fixture selection, calculations and layout. Complete material for one breadth topic
02/01 - 02/07	Collect .ies files for all other spaces and compile manufacturer cutsheets and ballast information.
02/08 - 02/14	Continue working in AGI and creating luminaire layouts. Work on electrical depth for each of the four spaces redesign.
02/15 - 02/21	Complete branch circuit redesign, short circuit calculations.
02/22 - 02/28	Complete research on acoustics in auditorium space. Focus on the completion of the second lighting space with fixture selection, calculations and layout.
03/01 - 03/07	Complete entire electrical breadth study and depth studies.
03/08 - 03/14	**Spring Break**
03/15 - 03/21	Complete Daylighting Studies renderings.
03/22 - 03/28	Complete all lighting renderings.
03/29 - 04/04	Finalize thesis repot and prepare for submission. Work on thesis presentation PowerPoint
04/05 – 04/11	Submit final summary report
04/12 – 04/18	**Thesis Presentations**