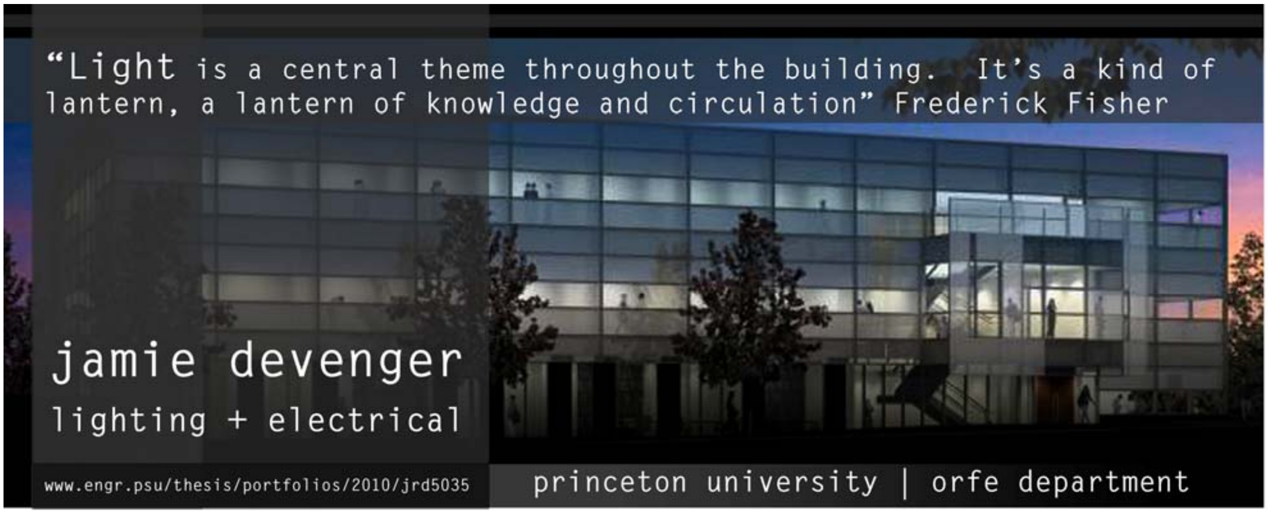

Thesis Proposal
Sherrerd Hall, Princeton University, NJ

Faculty Consultants: Ted Dannerth and Richard Mistrick
15 December 2009

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Jamie Devenger
Lighting/Electrical Option
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Lighting Consultant: Richard Mistrick

Sherrerd Hall | Princeton University

December 15, 2009

Executive Summary

This proposal details the work to be completed in the Spring of 2010. It presents a description of the redesign of several systems present in Sherrerd Hall, a campus building at Princeton University. Included are explanations of two depth and two breadth topics, with additional areas of focus related to the Master of Architectural Engineering degree and to the Schreyer Honors College. This document does not conclude that there are actual problems with the existing systems; rather, potential solutions and redesigns are presented that may provide interesting alternatives or greater optimization of systems.

The lighting depth presents new design concepts in five building spaces: the exterior façade at the main entrance, the central building core with lobby/atrium/stair, an open work space, a graduate bullpen, and a lecture hall. The new design aims to create an aesthetically dynamic and comfortable atmosphere that is tailored to the needs of the occupants. The space should also be functional, with light levels that meet those specified by the IESNA. The designs must also meet all power density requirements presented in ASHRAE 90.1.

The electrical depth includes a redesign of the branch circuit distribution for the five spaces to be re-illuminated. A protective device coordination study and short circuit analysis will also be conducted. The redesign of the HVAC system based on curtainwall modifications will lead to changes in design loads. The selection of distribution equipment and protective devices for this redesigned portion of the system will be necessary. An investigation into the economic and performance impacts of changing the entire electrical feeder system from copper to aluminum will also be completed.

The mechanical and structural breadths will be developed in conjunction with the extensive daylighting study in spaces adjacent to the curtainwall system and the large atrium skylight. The mechanical breadth will cover the effect of varying panel types within the curtainwall system and reconfiguring the large skylight over the atrium. The adjusted thermal gains and losses will be estimated and used to inform redesigns to the HVAC system. The structural breadth will include a redesign of the roof framing system to accommodate for the reconfiguration and sizing of the skylight spanning the building core atrium.

[Background Information] Sherrerd Hall

Sherrerd Hall is a 4 level, 47,000 square foot campus building located at Princeton University. This campus building houses two departments, the Department of Operations Research and Financial Engineering as well as the Center for Information and Technology Policy. Sherrerd Hall will thus provide effective bridging of two conventionally distinct disciplines, the social sciences and engineering. The building is complete and occupied, and the construction dates were from February 2007 to July 2008.

A main feature of the architecture is an expansive curtainwall system comprised of both transparent glass panels with ceramic frit patterns applied and opaque and translucent spandrel panels. The purpose of this unique building envelope is to allow ample daylight penetration and to promote the concept of transparency between distinct disciplines, as well as to reflect the surroundings during the day and to enhance the sense that the building dissolves into the surrounding campus.

There is a central atrium core spanned by a skylight that also allows the penetration of natural light. Other spaces adjacent to this atrium are separated by partially transparent materials to enhance the sense of collaboration throughout.

The five main spaces that are to be studied as pasrt of the thesis are the atrium core and stair, the building façade at the main approach, an open work space, a graduate bullpen, and a lecture hall. These spaces are detailed further in the in proposal below. The following plans provide additional information about the five spaces.

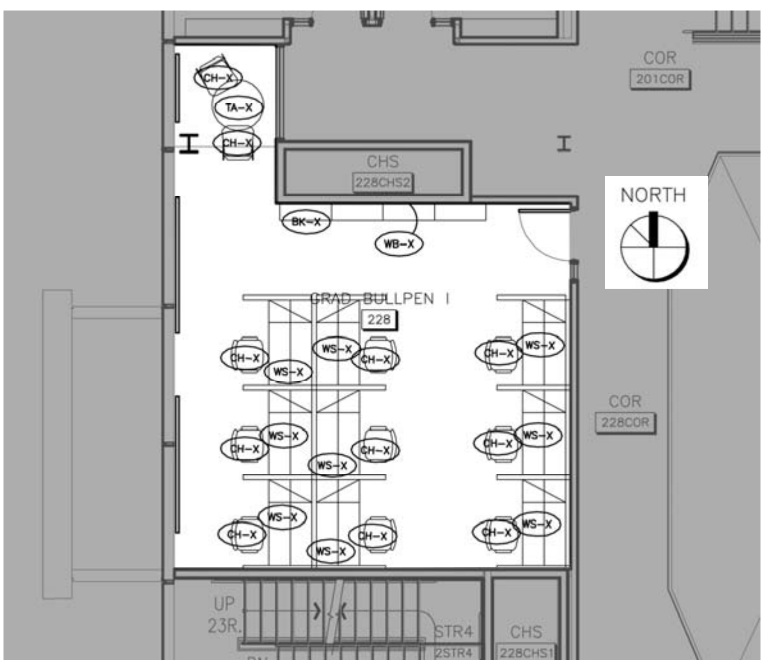

Figure 1: Plan View of Graduate Bullpen I

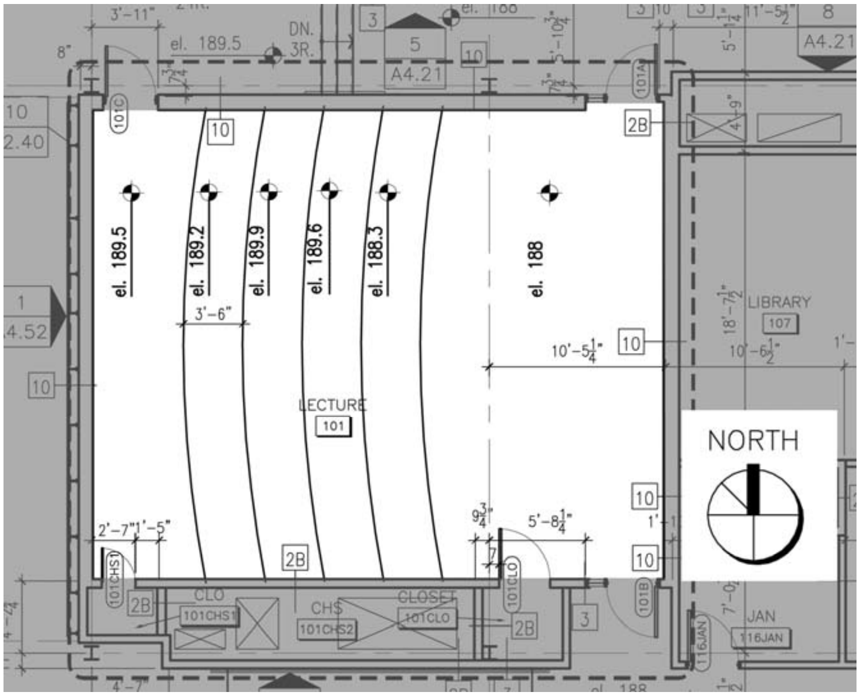

Figure 2: Plan View of Lecture Hall

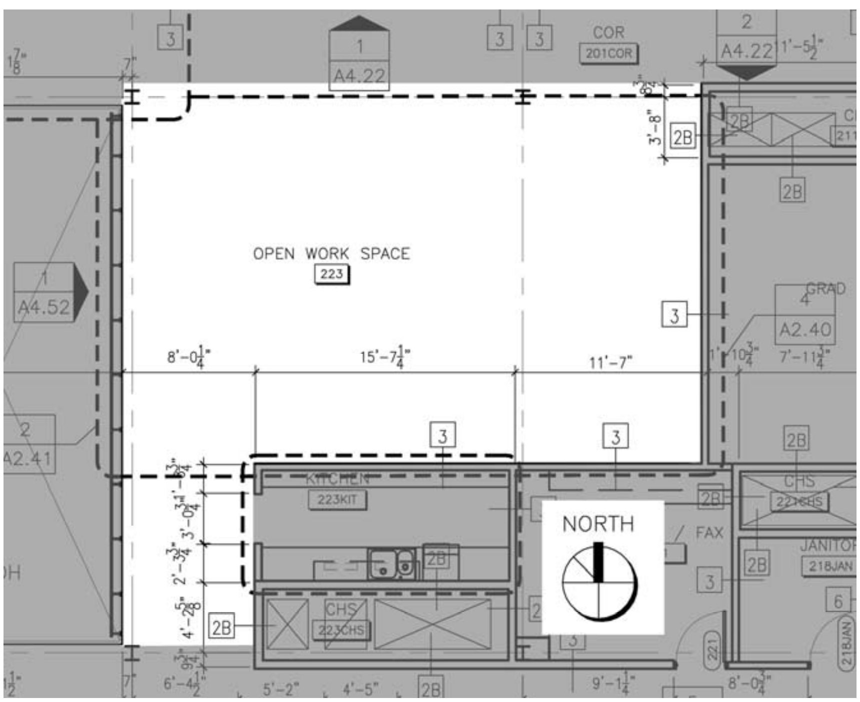

Figure 3: Plan View of Open Work Space

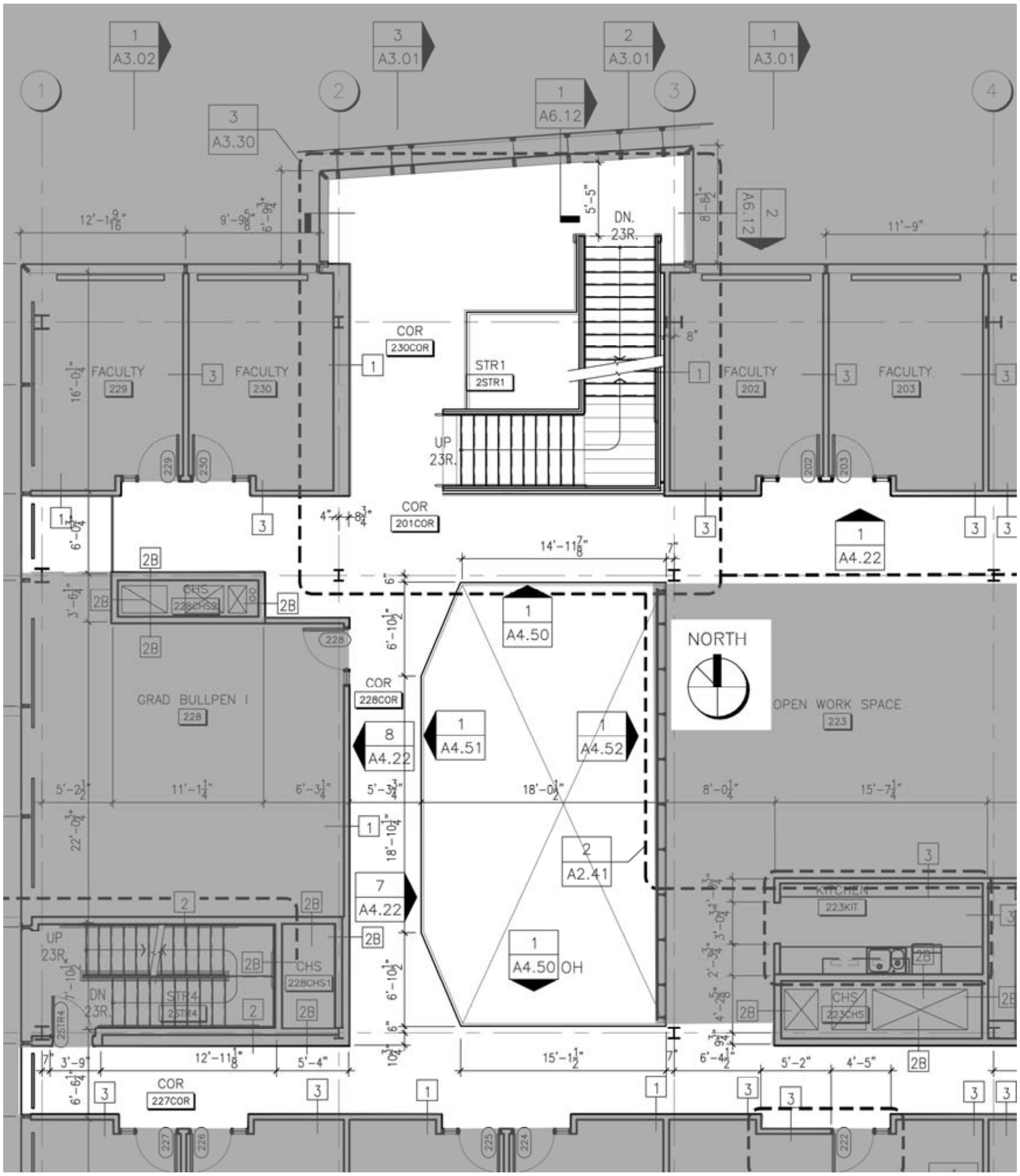

Figure 4: Plan View of Lobby/Atrium/Stair

Figure 5: Rendering of Architect's Vision for Façade at Main Approach

Figure 6: Daytime Image of Façade at Main Approach

[Lighting Depth]

Problem

Sherrerd Hall's existing lighting system is effective and simple in that it employs many of the same sources and luminaires all throughout the building and adequate light levels are provided in all spaces. Recessed linear fluorescent and compact fluorescent sources are most common throughout the building. The central building core atrium, an architectural feature in the building, is illuminated almost entirely by small aperture compact fluorescent downlights. Ceramic metal halide spotlights are the only element in this space accenting a feature, the cherry wood panel wall. Additionally, suspended linear fluorescent lighting is provided in the open work spaces. This solution is sufficient for most of the intended uses of the spaces but does not consider the central architectural goal of promoting transparency, collaboration, and a sense of excitement and movement. Additionally, increasing the uniformity of illumination in some spaces will allow for greater ease of task performance.

The five spaces to be redesigned are: the exterior façade at the main entrance, the central building core with lobby/atrium/stair, an open work space, a graduate bullpen, and a lecture hall. The lighting redesign for the building will consider the single unifying concept of collaboration enhanced by transparency which will be manifested in the lighting design in each individual space.

The building enclosure consists of an expansive curtainwall system comprised of transparent glass panels with ceramic fritting as well as translucent and transparent spandrel panels. As part of a daylighting study, recommendations for the reconfiguration of this curtainwall wall system will be presented. This proposed portion of the report is discussed further below. However, in considering the implementation of quality daylighting in all peripheral spaces, the electric lighting must be coordinated with the daylighting via control systems to allow for energy savings. Currently no control systems have been applied to respond to daylighting. At the same time, the power density of the building must be kept to a minimum in order to exceed ASHRAE 90.1 requirements in keeping with Princeton's goal to design buildings that theoretically achieve LEED Certification.

Solution

Sherrerd Hall is metaphorically a bridge housing two departments that promote collaboration across conventionally distinct disciplines. Thus, the main goal for the lighting should be to enhance the sense of transparency and movement throughout the building to promote collaboration, interaction, and cross-pollination. The architect has employed a number of unique materials and finishes to the building to enhance this sense of transparency, and light should be applied in such a way that there is effective interaction between surfaces and light. The design must enhance the architect's philosophy that "a building is an assemblage of use, material, and light."

Building Façade at Main Entrance

The façade lighting is the most visible feature of this building at night, and presenting a good first impression at the approach is critical. The main concept for the façade is to implement lighting in adjacent spaces that produces a nighttime aesthetic similar to the one presented in the architect's rendering (Figure 5). The building should glow uniformly along the façade, with alternating areas of frosted and transparent surfaces to create visual interest. No lighting should actually be applied directly to the façade from the inside or the outside. Rather, the building should exhibit a muted glow that appears to come from deeper within. This aesthetic will likely be achieved by grazing the walls opposite the façade and switching off all other lighting components in the spaces. The luminance levels of these walls dictate how bright the façade will appear to approaching students, faculty, and visitors. The wall luminance must be the same in all spaces along to façade to prevent inconsistent lighting of the façade that would lead to nonuniformity and visual clutter. The ideal configuration for providing the desired look of glow on the wall is either a recessed wall slot solution where the wall is grazed with light or a wall washing solution where a surface mounted luminaire is set back several feet from the wall and aimed at the surface. Both solutions will be considered as the design progresses. Additionally recessed lighting solutions must be avoided in the spaces adjacent to the north façade recessed luminaires do not provide adequate light to the top of adjacent walls, and dark areas appear on the wall near the ceiling. This effect is often seen with recessed downlights that produce a scallop pattern on adjacent surfaces. Controls must be implemented such that other luminaires in the spaces that are not in use after hours may be turned off via a time clock. The wall lighting is really the only element of the space required to illuminate the façade at night.

Lobby/Atrium/Stair

The lobby and atrium with the adjacent open staircase is the central hub of the building that promotes interaction through vertical bridging and transparency. The skylight over this atrium allows daylight to penetrate the building core. Students, faculty, and visitors enter the building through this space, and the corridors and stair adjacent to the atrium serve as primary circulation paths in the building. The architecture should be enhanced with light to create drama and excitement that energizes the space. Three main concepts have been considered for the lighting of this space: transparency, energy and movement, and expansion. These three concepts will be studied further, and the final solution will likely employ a combination of all three.

The perforated cherry wood feature wall in the atrium adjacent to the open work spaces and the open corridors that look out onto the atrium allow students and faculty in one part of the building to share a connection with occupants in another area. The lighting design should reinforce these architectural objectives. In the open work spaces, the painted gypsum wall board surfaces opposite the perforated feature wall should be illuminated uniformly to allow for an inner glow that can be seen from the atrium. Lighting the opposite surface in the space while dimming other ambient lighting also places occupants slightly in silhouette, a concept that may be interesting for entertaining functions.

In the evening, the stair becomes a glowing transition space that creates an interesting focal point in the adjacent quadrangle. Due to the fact that the entire façade is glass, no light should actually be applied to the façade. Rather, the glow from within the spaces simulates an illuminated façade. The vertical surfaces parallel to the façade should be illuminated uniformly. Uniformly illuminating these walls also allows passerby on Shapiro Walk to clearly discern occupants moving throughout the stair. The energy of the space is thus communicated to the exterior.

The space also features a decorative element, a light sculpture that ascends through the full height of the stair. The light sculpture is a central feature. The luminaires in this space cannot detract from this element. Ideally, lighting should be concealed in the stair such that occupants see only the light and not the source.

Graduate Bullpen I

The graduate bullpen is used as an open office and workspace for graduate students. Therefore, appropriate lighting for tasks is the most important consideration in this space. Direct glare that reduces occupant comfort and interferes with visibility must be prevented. Occupants in the space are primarily reading and writing, so visibility is essential to performance of critical tasks. The selection of luminaires must consider glare, and indirect pendants will likely be recommended with the design. Direct and reflected glare may also come from the windows. Therefore, this criterion directly relates to daylighting integration. The location of furnishings with respect to the windows has a tremendous impact on the glare potential of the daylighting system, and the desks are to be reoriented to a position perpendicular to the windows, rather than parallel.

The light distribution on the desks should be highly uniform to accommodate the tasks of reading and writing. Patterns of light on the task plane in this space would be highly distracting. To allow for appropriate lighting at each desk and individual occupant control, task lighting will be considered to supplement an indirect general ambient lighting scheme. Additionally, the vertical illuminance must be uniform on the marker board where students may be sharing information during discussions, so a wash of light should be provided on this surface.

A task-ambient lighting scheme will not only allow for minimized glare and greater uniformity at the desks. This solution will also allow for greater balance of room surface luminances. Compared with the current recessed lighting scheme in the space, the ceiling luminance should be higher and thus reduce excessive contrast.

Lecture Hall

The lighting in this space should most importantly consider focal points. The instructor and the chalkboard at the front of the space are the focal points during lectures, unless the screen is down and the projector is in use. The lighting design should provide higher light levels at these locations than at the surroundings to draw occupant attention. The light distribution on the chalk board should be highly uniform to accommodate the task of reading. Patterns of light on the chalk board would be highly distracting to students who are attempting to take notes. The horizontal light distribution on the instructors table should also be highly uniform; the instructor could be presenting objects and information on this surface that all students must be able to discern clearly.

Light levels also must be uniform on the desks where students take notes, and the location of luminaires in the new design will be informed by the location of the furnishings.

The design will also provide flexibility of lighting control. Different light levels are required for different tasks in the space. The instructor may be teaching via verbal communication, in which case the lighting over the instructor should be emphasized compared to the other lighting elements in the space. The instructor may be instructing with the aid of the chalkboard; in this case, the lighting for this vertical element should be emphasized. Variability of light levels on the surfaces of the desks is desirable. If the instructor uses the projector and screen for presentations, ambient light levels in the space and light on the desks needs to be reduced so that the projected image appears with adequate contrast. When the chalk board is in use, the ambient light levels in the space do not need to be reduced as much.

Open Work Space

The open work space serves two varying functions: a classroom and work space during the day and an entertaining space at night. Due to its multi-use nature, the open work space will be studied with respect to psychological impressions. The two Flynn impressions that are considered for the space are public versus relaxation. The public impression relates to classes, lectures, and more formal group meetings. An impression of relaxation is desired when the space is used for entertaining, or even when students are relaxing after classes. The lighting design must be flexible here to allow for a change in mood from class time to formal entertaining.

The space is frequently used for entertaining in the evening. The public impression that is applicable during lectures does not apply for this function. The lighting solution for entertaining varies greatly from the lighting solution for classroom spaces. The design should evoke the impression of relaxation. In order to create this impression, luminances in the space should be lower than those used for the classroom setting and nonuniform. The luminance should be highest at the periphery; however, peripheral lighting must not be uniform throughout the space. Therefore, a single wall in the space is selected for accenting with light. The plan east wall may be illuminated with spotlights (where artwork or signage may be applied). The luminance of the spots on this wall must be higher than other luminances in the space, but the general light level for this scene is low. The opposite plan west wall is the perforated cherry wood feature wall that is adjacent to the atrium. If the plan east wall is at a relatively higher luminance than other surfaces in the space, the feature wall may appear to glow to a viewer standing in the atrium. If light levels are higher in the atrium, interesting shadow patters from the perforations will create pools of light on the floor. This element enhances the sense of transparency.

Luminaires in the center of the space that provide highly uniform light during lectures must be dimmed considerably. In order for guests to relax, they should not feel as though they are under spotlights at the center of the space. To enhance the periphery and the sense of nonuniformity, sconces may be added along the opposite corridor wall. The corridor is at the periphery of the workspace, so the lighting for this corridor has an effect on the impression in the open work space. An indirect lighting solution that accents the corridor wall is favorable for contributing to the sense of relaxation in the open work space.

During the day, the room is often used for classes and group study sessions. These functions are considered to be public, and the lighting should reinforce the space function. To evoke a sense of public space, the lighting must be uniform throughout, with particularly high luminance on the tables over where the students are seated. A wall washing luminaire may also be desired for highlighting the chalkboard in the space, to increase the brightness over where the instructor is standing.

The lighting for this space must adjust to meet the demands of two very different functions. Flexibility is essential. Ideally, there should be preset lighting control scenes so that occupants can simply select the desired function and have the lighting respond to this demand. This flexibility demands that the final design allows for the integration of both a public and a relaxation impression.

MAE Focus: Daylighting

Daylighting integration and control is one of the driving factors in the lighting design for Sherrerd Hall. The building is entirely enclosed by a curtainwall system on all four façades. Fritted transparent panels and translucent panels allow daylight penetration, while opaque panels are applied where daylight penetration is undesirable. In several of the spaces, particularly spaces where the panel configuration leads to high contrast and diminished views, a reconfiguration of these panels could allow for a far more comfortable visual experience for the occupants. Additionally, the use of translucent panels should be minimized, where possible, because when illuminated with direct sun, these panels reach excessive luminance levels that create glare potential at the interior. A study of the current daylight penetration will inform panel reconfiguration. The reconfiguration of panels within the curtainwall system also needs to consider its implications for thermal gains or losses, and this study will be integrated with a mechanical breadth topic proposed below. Ultimately, this portion of the daylight study should culminate with a set of recommendations for panel configurations and material changes (if any).

There is also a large skylight that spans half of the atrium at the building core. The current configuration of this skylight leads to high contrast and harsh shadowing in the atrium. Reconsideration of the skylight configuration could greatly improve the aesthetics of the atrium, as well as the comfort of the occupants within this space. This portion of the study should culminate with recommendations for a revised skylight orientation and configuration, as well as images showing how the daylight penetration has changed based on this reconfiguration.

Controls that allow the electric lighting to respond to daylighting would also greatly enhance the design and allow for energy savings. The graduate bullpen has direct access to daylight and should be integrating daylight to provide comfort to the occupants and to reduce building energy loads. A study of photosensor placement, aiming, and calibration will be conducted using DAYSIM daylighting software, and the study should conclude with proposed energy savings from daylighting based on the daylighting controls. These daylight energy savings should, of course, be presented in conjunction with the estimated thermal losses or gains. New equipment that accommodates a daylight dimming or switching system must also be considered in this portion of the report.

Honors Focus: Daylighting in Perimeter Office Spaces

There are many perimeter office spaces in the building that are not within the scope of the other five spaces considered in the lighting design portion of the thesis. These spaces, however, have access to daylight and should be integrating daylight to provide comfort to the occupants and to reduce building energy loads. As part of an additional study to meet the requirements of the Schreyer Honors College thesis, a daylight study will be conducted in several of these offices (which are typically repeated all along each façade). This portion of the report will include an initial study of the daylight penetration with the current panel configurations for these spaces. Based on this study, reconfiguration of these panels will be recommended to improve occupant comfort. Shading systems will also be considered for reducing direct sunlight glare. Any proposed panel reconfigurations will be considered with respect to thermal gains and losses (as part of a mechanical breadth topic).

In addition to recommending panel reconfigurations, daylight responsive controls that will allow for energy savings (to balance out energy losses from thermal impacts) will also be considered for these spaces. The daylighting software DAYSIM will be used to determine appropriate photosensor location and orientation, as well as projected energy savings from this system. New equipment required to accommodate this daylight (likely dimming) system will also be provided in the summary report.

Lutron Comments

A schematic design presentation was given at Lutron on December 9, 2009, to a group of five lighting designers. Feedback on the design and presentation was provided, and a summary of the comments is provided below.

Lee Brandt

- The presentation was well organized.
- Since the façade lighting is on the interior, do you need some sort of control system to shut off the lights after the building is not occupied?
- Low level task lighting at the tables in the lobby/lounge are likely not feasible because they could be stolen or trashed. In general, students will locate and orient themselves where the light is.
- In the graduate bullpen, the silhouette graphics are too much. This is almost a scary graphic because the faces should be illuminated too.

Kari Nystrom

- Great renderings as impression of what the space would actually be.
- Too many architectural quotes in the presentation.

LukeTigue

- The essence of the architectural quotes should be distilled down to just two slides. From that point on, I should own all of the concepts as my own.
- For the façade lighting concept, lighting the ceiling on the second and third floors will have more of an impact than lighting the wall.
- The reorientation of the furniture in the graduate bullpen is a good idea.
- For the façade, it may be more effective to leave the trees in silhouette and to add light to the granite at the first level. The base of the building should appear more pronounced and provide a sense of "grounding" for the building.
- For the open work space where there are two separate impressions: these need to be designed so that with controls, either could work in the space. There should not be two completely separate designs.

Sandra Stashik

- The graphics are nice.
- The use of a laser pointer would make the presentation far more effective.
- Using "spill" light to illuminate Shapiro Walk is counterproductive in terms of reducing light trespass.
- Nice work on the stair detail; maybe consider developing this further.
- Be careful with the "chaotic movement" in the atrium scene; this tended to be too much.
- In the open work space with two impressions, how will the pendants look when they are turned off? May have missed the boat on public versus private in this space by using the pendants. There needs to be greater integration here.
- The reorientation of the workspace works well.
- How are you dealing with the cherry wood wall at the back of the lecture hall?
- In the atrium, lighting the railings enhances the perimeter of the space well, but look more deeply into how this will be done.
- Great concept of light transmission being reversible.
- Great daylighting study in the graduate bullpen.

Helen Diemer

- Very "handsome" graphics. The use of layering with the graphics is also effective for the façade renderings.
- Good use of metaphors.
- Are you trying to enhance the architect's vision of the façade?
- The concept of the "core anchoring" the building is a good idea.
- Using light to represent movement and energy is a good, effective technique, but in the central core, tame the movement down.
- With the open work space with two impressions, what about the pendants when they are turned off? Do you want both concepts to work in this space?
- The reorientation of the desks in the graduate bullpen is a good idea.
- Great analysis of daylight and glare in the graduate bullpen.

Solution Method

The comments provided by the industry professionals will aid in solidifying the final design concepts for each space. The lighting solutions will be completed using the aid of computer software calculations and lighting renderings. Final documentation of the solutions, which includes cut sheets, lighting plans, details, calculations, and photorealistic renderings of at least two of the spaces will be presented.

Tasks and Tools

1. *Update and Complete Schematic Lighting Design and Concepts*
Reconsider several design concepts and solidify the proposed lighting design with the use of comments from the panel of lighting designers present at the Lutron schematic design presentation.

2. *Model Spaces*
Use AutoCAD to accurately model all five selected spaces in three dimensions. These models are to be used for electric lighting calculations, daylighting calculations (where applicable), and rendering purposes.

3. *Analyze Impacts of Daylighting and Thermal Gains or Losses*
Use AGI32 to determine daylight penetration in each space. Determine necessary changes to glass curtainwall panels in the graduate bullpen, open stair, and perimeter offices. Also determine requisite changes to the skylight over the atrium. Model applicable spaces using DAYSIM daylighting software to determine the appropriate location and orientation for a photosensor to inform daylighting control. Also determine the most appropriate control algorithm for this system. Use the DAYSIM model to determine projected energy savings from daylighting.

Prepare simple spreadsheet calculations to estimate thermal impacts of reconfiguring the curtainwall panels. Also model the graduate bullpen and a typical office using some form of energy modeling software to determine whether thermal energy gains or losses are balanced by daylighting energy gains.

4. *Equipment Selection*
Choose all lighting hardware to fulfill all schematic design goals and criteria.

5. *Electric Lighting Calculations*
Use AGI32 to perform all calculations that ensure the lighting design provides illuminance levels specified by the IESNA. Verify power density for conformance with ASHRAE 90.1

6. *Final Renderings*
Apply accurate materials to create final renderings of each space using either AGI32 or 3D Studio Max.

7. *Documentation*
Properly document all design conclusions and solutions, including a fixture schedule, cut sheets, reflected ceiling plans, lighting plans, a daylighting report, and calculation summaries.

[Electrical Depth]

Overview

Sherrerd Hall's overall electrical system is a radial system with one point of service entrance at the plan southeast corner of the building on the sub-grade level. Primary service is provided to Princeton University by PSE&G, and the building is tied to the campus system and receives power through a 750kVA oil-filled transformer that steps down the voltage from 4.160kV to a 480Y/277V, 3P, 4W voltage system. Emergency power is provided via an existing area generator in an adjacent campus building.

A 1200A main switchboard provides power to all equipment loads. Power at 480V is distributed to each floor, with transformers at power panels at each level to step down to 208Y/120V, 3P, 4W for receptacles and other small equipment. All other loads are connected to the 480Y/277V voltage system.

Solution/Methods/Tasks and Tools

1. *Branch Circuit Distribution*

The four spaces to be redesigned are the exterior façade at the main entrance, the central building core with lobby/atrium/stair, an open work space, graduate bullpen I, and a lecture hall. There is currently no lighting dedicated particularly to the façade in the existing design, but linear fluorescent lighting will be considered as part of a new solution. The central core is used as a main circulation and gathering space, as well as the main entry point to the building. There lighting for this space is currently comprised almost entirely of recessed compact fluorescent downlights, but the proposed solution will also consider linear fluorescent lighting. The open work space is used for lectures and study sessions, as well as entertaining in the evening. Lighting in the current and proposed solutions consists of linear fluorescent sources; halogen spotlights may also be considered in the new design. The graduate bullpen is an open office space for graduate students; the lighting in both the existing and proposed solutions is entirely of linear fluorescent sources. The lecture hall currently employs linear fluorescent sources in conjunction with halogen spotlights, and the new design will likely only use linear fluorescent sources. In order to accommodate for the new lighting design, the branch circuit distribution will be redesigned. Modification to the panel board layout and resizing the feeders and electrical equipment is required as part of these changes.

2. *Protective Device Coordination Study and Short Circuit Analysis*

A protective device coordination study that addresses a single-path through the distribution system will be implemented. The path extends from the utility to the main switchboard to panel LP-1. The coordination of protective devices for the redesigned system components along this path will be shown. Short circuit calculations will also be included.

3. *Redesign Equipment Supplying Power to HVAC System*

The modification of the curtainwall transparent and spandrel panels and the reconfiguration of the large skylight spanning the atrium core will affect the HVAC loads and thus the design of the existing HVAC equipment. The change in thermal gains and losses through the adjusted building enclosure will provide new design parameters. Additionally, the new mechanical system will require that electrical loads be added or modified. New distribution equipment, including the transformer and switchgear from one section of the building, and protective devices will be sized and selected to accommodate for these alterations. An Excel spreadsheet will be applied to organize and record all calculations.

4. *Perform a feasibility analysis for changing building feeders from copper to aluminum.*
An investigation into the economic and performance impacts of changing the entire electrical feeder system from copper to aluminum will be completed. A final recommendation will be presented and supported based on the results of this study. Hand calculations and computer software techniques will be utilized to determine the positive and negative effects of the change.

[Breadth 1] Mechanical Systems

Overview

The reconfiguration of panels within the curtainwall system may allow for energy savings from daylighting, but this redesign also needs to consider its implications for thermal gains or losses. Ideally, daylighting gains must outweigh thermal losses to make this redesign valuable. The modification of the curtainwall transparent and spandrel panels and the reconfiguration of the large skylight spanning the atrium core will affect the HVAC loads and thus the design of the existing HVAC equipment. The change in thermal gains and losses through the adjusted building enclosure will provide new design parameters and thus have a direct impact on the mechanical equipment required to condition the building. Preliminary hand calculations organized into a spreadsheet will be used to determine the energy lost or gained through these new features. A simple energy modeling software will also be used to determine the thermal gains or losses over a year. The final report will conclude whether the curtainwall reconfiguration is worthwhile in terms of the energy balance between daylighting and thermal gains and losses. A simple redesign of a section of the existing HVAC system will also be performed.

[Breadth 2] Structural Systems

Overview

As a result of the reconfiguration of the large skylight spanning the atrium core, the layout of the structural support system will be affected. The reconfigured skylight will require a redesign of the roof framing system that supports this skylight. Additional structural members may be required, and the structural layout will certainly change. The extent of the structural alterations depends on the extent of the modifications to the skylight, but an increase in size of this skylight by at least 25 percent is likely. Hand calculations will be used calculate the additional load from the reconfigured skylight and to determine relevant new support systems. The updated system and calculations used in its derivation will be clearly documented as part of the final report.

Preliminary Spring 2010 Schedule		
Week	Focus	Planned Activity
Winter Break	Lighting	Finish developing schematic design
		Model all five spaces in AutoCAD
		Import models into AGI32 and 3DS Max and apply materials
		Begin studying daylight penetration in offices and graduate bullpen
Jan 11-17	Lighting	Begin selecting sources/luminaires and organize cutsheets
		Import ies files into AGI32 and begin lighting calculations
Jan 18-24	Lighting	Continue running lighting calculations and making appropriate modifications
		Set up daylighting models in DAYSIM for typical offfice and graduate bullpen
	Electrical	Begin electrical depth study #1
Jan 25-31	Lighting	Continue working on lighting calculations and begin renderings
		Continue working on daylighting models in DAYSIM and documenting results
	Electrical	Complete electrical depth study #2
		Continue working on electrical depth study #1 based on updated lighting
Feb 1-7	Electrical	Begin electrical depth study of aluminum versus copper feeders
	Lighting	Continue working on lighting calculations
		Continue working on lighting renderings
		Continue working on documentation of daylighting studies
Feb 8-14	Lighting	Continue working on lighting renderings
		Finalize lighting calculations
		Finalize documentation of lighting hardware
		Finalize documentation of daylighting studies
	Electrial	Finish electrical depth study of aluminum versus copper feeders
Feb 15-21	Mechanical	Start mechanical breadth study
	Lighting	Continue working on lighting renderings
	Electrical	Begin electrical depth topic related to HVAC redesign
Feb 22-28	Electrical	Continue electrical depth topic related to HVAC redesign
	Lighting	Continue working on lighting renderings
	Mechanical	Finish mechanical breadth study
Mar 01-07	Structural	Start structural breadth study
	Lighting	Continue working on lighting renderings
	Electrical	Finish electrical depth topic related to HVAC redesign
Mar 08-14		SPRING BREAK
Mar 15-21	Lighting	Finalize lighting renderings
	Structural	Finish structural breadth study
	Electrical	Make any necessary updates to electrical depth work
Mar 22-28	General	Start preparing final presentation
		Start organizing and preparing final report
Mar 29-April 04	General	Finalize documentation (report)
		Organize all completed graphics into report
April 05	General	Powerpoint Presentation
April 07	General	Final Report Due
April 12-18	General	Final Presentations