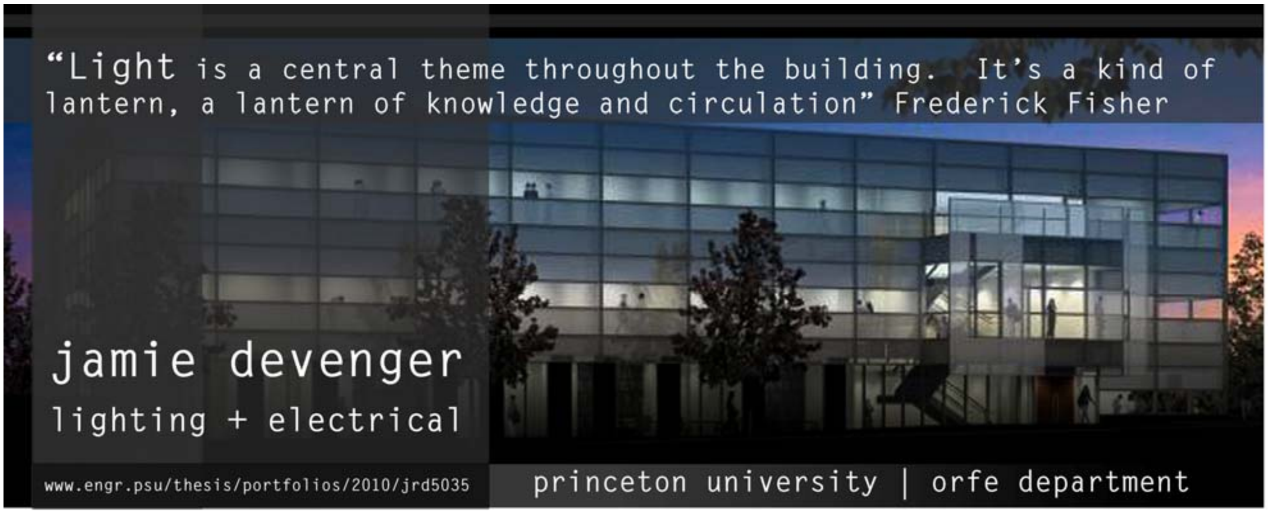

Thesis Proposal Breadth Topics
Sherrerd Hall, Princeton University, NJ

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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.

[Breadth 1] Mechanical Systems

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

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.

[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.