Thesis Proposal:

Lighting & Electrical Option

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with advisors: Leslie Beahm & Shawn Good
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University of Maryland: Prince Frederick Hall

Executive Summary

My thesis studies for the spring will consist of four main studies: lighting, electrical, architectural, and mechanical. The lighting and electrical studies will form the basis for my depth work. I will integrate my two breadths with my lighting and electrical studies for a cohesive report. These two breadths are architectural and mechanical evaluations.

The lighting design portion of my thesis will focus on four spaces: the entry plaza, the lobby, a seminar room, and a typical dormitory suite. For my lighting design, I will focus on applying the concept of discovery to each space in an appropriate way. The entry plaza's lighting is important to help visitors discover the building via wayfinding and guidance. In the lobby, discovery is applied strictly in the sense of wayfinding. By juxtaposing varying lighting techniques, I call attention to the difference between public and private spaces. The seminar room emphasizes educational discovery, and therefore, the uses a clean, layered approach. Finally, the most private of the four spaces, the dormitory suite, applies discovery in the sense of social discovery.

My electrical studies of the building will consist of two parts. The first part of my work involves a feasibility study and a cost analysis for distributing transformers throughout the building. This is different from the current design where fewer, large transformers are located on the basement level. Additionally, to gain a better understanding of building safety design, my second study will be to complete a short circuit analysis of a typical branch circuit.

Both breadth studies, architecture and mechanical are connected. My architectural study will analyze different ways to control daylight and solar gains that enter the building. I intend to do this by optimizing the articulation of the facade. This means potentially interrupting the architectural form of the building. So I will also study the current architecture, and produce renderings of my intended changes. I will use my mechanical breadth to quantify the improved energy performance from the solar shading.

These four main areas of study will be completed during the spring semester of 2014. They will be compiled into a comprehensive final report for April 9, 2014, by 5:00 PM. And condensed for final presentations, scheduled to begin on April 14, 2014.

Table of Contents

Introduction

Prince Frederick Hall is a new building located on the University of Maryland campus. This building contains spaces that represent a gradient of public to private. Programming for the building provisions space for academic rooms on the ground and first floors of the building. The second through seventh floors, along with part of the first floor, are used for student housing. A combination of single rooms, double-occupancy rooms, and suites provide housing for a little over 450 students.

Integration within the University of Maryland is achieved through the use of similar materials found throughout campus. Materials used on the facade can be summarized into three main categories: brick, stone, and metal. The university's red brick dominates the most surface area. The first floor of the building is wrapped in a limestone-colored finish. Metal is also used on the facade, integrated within the curtain walls.

Sustainability is also an important factor for Prince Frederick Hall. The building is planned to achieve LEED Gold certification. Its design increases heating and cooling performance, water systems efficiency, and recycling of construction debris. Other green features, such as : low-emitting materials, bike racks, and recycling facilities are also found throughout the building.

Building Statistics

General Data

building name: Prince Frederick Hall
location & site: University of Maryland
occupancy & function: University Housing
size: 185,522 GSF
number of stories: 7 floors + ground floor
construction dates: May 2012-August 2014
project cost: $66.8 million
delivery method: design-build

Project Team

owner: University of Maryland
architect: WDG Architecture, PLLC
general contractor: Clark Construction
structural engineer: Cagley & Associate, Inc.
mep & fire protection: WFT Engineering, Inc.
civil engineer: Site Resources Inc.
landscape architect: Parker Rodriguez Inc.

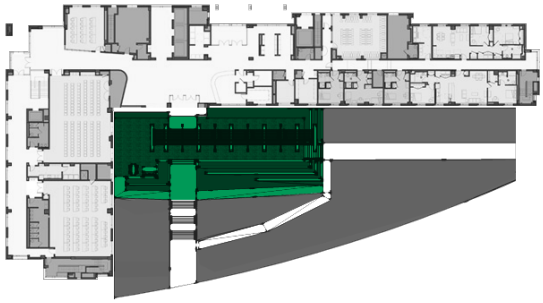
Lighting Overview

Lighting Concept

This building's composition represents a gradient of public to private spaces. But the one binding factor across this variation is that the primary function of every space is to provide a good learning environment. I have summarized this idea into the singular concept of **DISCOVERY**. Through this concept I am able to express the building's function in multiple ways. Discovery is important in that occupants must literally be able to navigate through the building to discover new spaces. This concept can also be applied in sense that the lighting must provide an effective learning environment. In each of my four spaces, I am able to apply discovery in different ways appropriate to the space: the outdoor plaza, the lobby, a seminar room, and a typical dormitory suite.

Entry Plaza

The most public of the four spaces is the entry plaza. It is located on the south side of the building, and functions as both a circulation space and a social space with seating. There are two ways I want to apply the concept of discovery to this space:



Welcoming Entrance

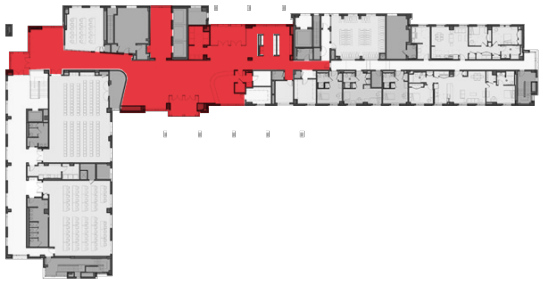
I want to use this opportunity to provide a welcoming entrance to help visitors discover the building at night. This will also increase safety around the building after dark. The main doors into the building are glass that will allow light from the lobby to clearly illuminate the entrance. Therefore lighting is integrated into the stairs and lining the walkway to help direct visitors to the entrance.

Social Gathering

The architect has provided some seating areas on the plaza, and I want to reinforce this with my design. For my design, I'm proposing the addition of a bench along the side of the plaza. This allows me to integrate lighting into some much needed seating to the space. Social discovery is also reinforced by lighting the seating under the trellis. This area is lit with grazing strips of light that highlight the architectural form of the trellis.

Lobby

This space can be accessed from three different entrances, on the north, south, and west sides. It serves as the main circulation to the academic spaces on the west side of the building. Located within the lobby is a front desk, elevator lobby for building residents, seating, and resident mailboxes. My goals for this space are as follows:



Augment Wayfinding

With so many different spaces served by his irregularly shaped lobby, it is important to help visually differentiate these areas. This will aid in visitors' discovery of the building.

Highlight Architecture

With so many other strictly functional spaces in the building, I also want to take the time in the lobby to celebrate the architecture as much as possible. Additionally, this will create a good impression on visitors of the building.

Juxtapose Public & Private

Discovery, in this space, is applied in the sense of wayfinding. I've used contrasting lighting techniques in different areas to reinforce the difference between public and private.

Welcoming Entrance

The most effective way to accomplish this is to ensure bright, uniform light levels throughout the space. Also accomplishing my first three criteria will provide a more welcoming entrance for the building.

Seminar Room

The next space on the road to discovery is a seminar room located on the first floor of the building. The design for this space utilizes several different types of lighting to provide a functional and flexible outcome. In this case, providing a space free from distraction makes discovery accessible to students through their education.

Functional Environment

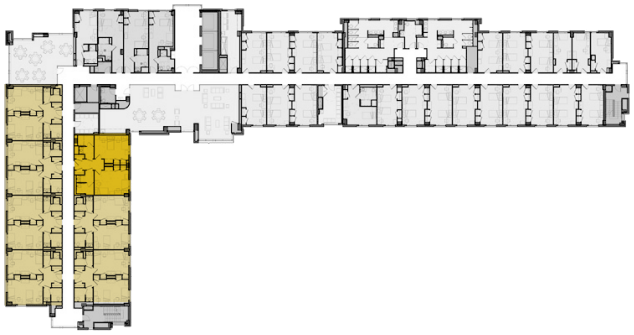
To ensure a productive learning environment, and enhance discovery, this space is functionally driven. My design, therefore, focuses on achieving IES Handbook recommendations for illumination and uniformity. As a university building I will also assume that the primary user is under 25 years old. Additionally, I have increased the perceived brightness of the space by lighting the peripheral walls.

Flexible Controls

Since this is a multi-use classroom, I'm also going to provide flexibility in the controls of the room. This means my design incorporates several layers of lighting, to accommodate multiple scenes. Calculations will be conducted to determine lighting levels at these different schemes, and I will adjust lighting fixtures and locations to optimize each scene.

Dormitory Suite

This space consists of 2 bedrooms for 4 occupants; it also contains a vestibule and 2 bath areas. I've chosen to apply discovery to this space in the sense of social discovery; this isn't, after all, a totally private space. A shared dorm room, isn't going to express itself the same way that a bedroom or hotel room would. In the life of busy college students, a dorm room is more like to a social office space. It needs to have sturdy, function work light. A bright ceiling will help reduce the heaviness of the concrete surfaces. A focal point can create a more casual atmosphere for social life. Ideally, though, all of these pieces will be applied in layers, the goal being to reduce the institutional feel of this utilitarian space.



Flexibility
Due to the high concentration of people living in this space, I want to provide comfort in the form of controllability. This means not simply using a 2x2 troffer, like every other dorm room, but instead using layers of light that can be adjusted accordingly.

Power Reduction
On a more practical side, I also want to stay 10% under the ASHRAE requirements for a space of this type. Since there are 42 duplications of this suite throughout the building, small savings per space will have a large effect.

Designer Comments
The following comments are a summary from my presentation of Tech Report 3, Version 2 at Lutron.

Lee Brandt
Overall
- rendering technique and graphics are good

Entry Plaza
- grazing is not the correct term
- will need more light on stairs
- add pole mounted lighting
- need higher lighting for on faces

Lobby
- distinguish where occupants will move vs sit
- lighting design doesn't affect wayfinding that much, focus on other criteria

Dormitory Suite
- good thoughts on dorm room
- think about how I will power the desk lighting (receptacles?)
- consider using a wall mounted fixture to light the ceiling
- I won't be able to get 10% under ASHRAE
- don't worry about task lighting, focus on vestibule, bathroom, mirror, etc
- find surface fixture that illuminates on 3 sides
- try to use only 2 fixtures

Lee Waldron
Entry Plaza
- light columns or cantilever, not both
- need to indicate where entry is better, light wall nearby

Lobby
- relate the functions to arrow diagram
- use square symbol for square lights on poche diagram

- prefered SD 1 and 2 (over 3, which I prefered)

Seminar Room
- fixture image doesn't match SD sketch
- dir/indir will be more uneven than as rendered

Dormitory Suite
- need to identify entrance better
- add uplight to trellis

Electrical Overview

Medium voltage is provided to the building from the university's grid. Two 3000 kVA transformers, outside the building, provide 480/277V to Switchgear#1 and Switchgear#2 in the main electrical room. Power is transformed to 208Y-120V for receptacles and interior lighting. Switchgear#1 is primarily for equipment, and Switchgear#2 is primarily for lighting and power in occupied spaces. Distribution to the residential floors and mechanical pumps occurs through four switchboards.

Distribution throughout the building is at 208Y-120V. Two transformers each feed a 1600A switchboard. These feed to the upper floors, where power is delivered through two main risers. All conductors in the building are copper.

A 350kW natural gas generator is mounted on the roof. This provides power to required emergency loads, but a few loads are on the generator that are not required, such as the telecom/data racks.

Transformer Study

Power to the main dormitory floors is transformed in the basement by transformers T-5 and T-6 to 208Y-120V. Each of these transformers is 500kVA. I'd will complete a feasibility study on distributing 480V to the upper floors and then transforming the power down at each floor's electrical closet. I will also complete a cost analysis based on changes to: equipment costs, wire sizes, and electrical room space.

Short Circuit Analysis

I will select a typical branch circuit, and conduct a short circuit analysis on one branch of my building's single line diagram. This will enhance my understanding of short circuit safety, and allow me to determine what type of protection is already in place for this building.

Breadth 1: Mechanical

Daylighting is important to both occupant comfort and energy use within a building. Prince Frederick Hall offers a few unique aspects that make an interesting case study for reduction of mechanical loads through daylight control. First is that the building is oriented perfectly along the four cardinal directions. Secondly the current facade is not articulated to control daylight and solar gains, and this would allow for a baseline study. A redesign of the facade will be completed to optimize solar shading in areas that will produce the largest impact: an east and west facing dormitory suite, and a north and south facing dormitory room. Research will first be done to determine the most effective ways to control daylighting in these spaces. Based on that research, calculations will be used to quantify the difference between the redesign and the existing design, in terms of reduced mechanical loads. Reducing the load on the HVAC systems means that these can be downsized.

Breadth 2: Architectural

By adjusting the facade to optimize daylight within the building, the look of the building will also change. To protect its architectural form, this second breadth will be used to study the changes made during the daylighting study. The daylighting control systems will be integrated within the building's architecture for a design that compliments the University of Maryland campus. The final design will be communicated with a series of renderings to illustrate difference between existing conditions and final design.

Tasks and Tools

My final designs will be developed and communicated in the following manner:

3D Modeling

Throughout my depths and breadths, I will need accurate 3D models of my spaces to produce calculations and renderings. The majority of my models will be created in Revit, based on 2D pdf plans of the building. I have already created Google SketchUp models of parts of this building.

Illuminance Calculations

After selecting luminaires to achieve my lighting schematic design, I will use AGi32 to calculate the light levels and uniformity within each of my re-designed spaces. As needed, I will reassess my fixture selection for an optimized design.

Lighting Renderings

Schematic design renderings have already been created using Photoshop and Google SketchUp. Based on the outcome of my AGi32 calculations, I will create artistic representations of each re-designed space. For my final renderings, I will use my Revit model to render the lighting in 3DS Max.

Electrical Calculations

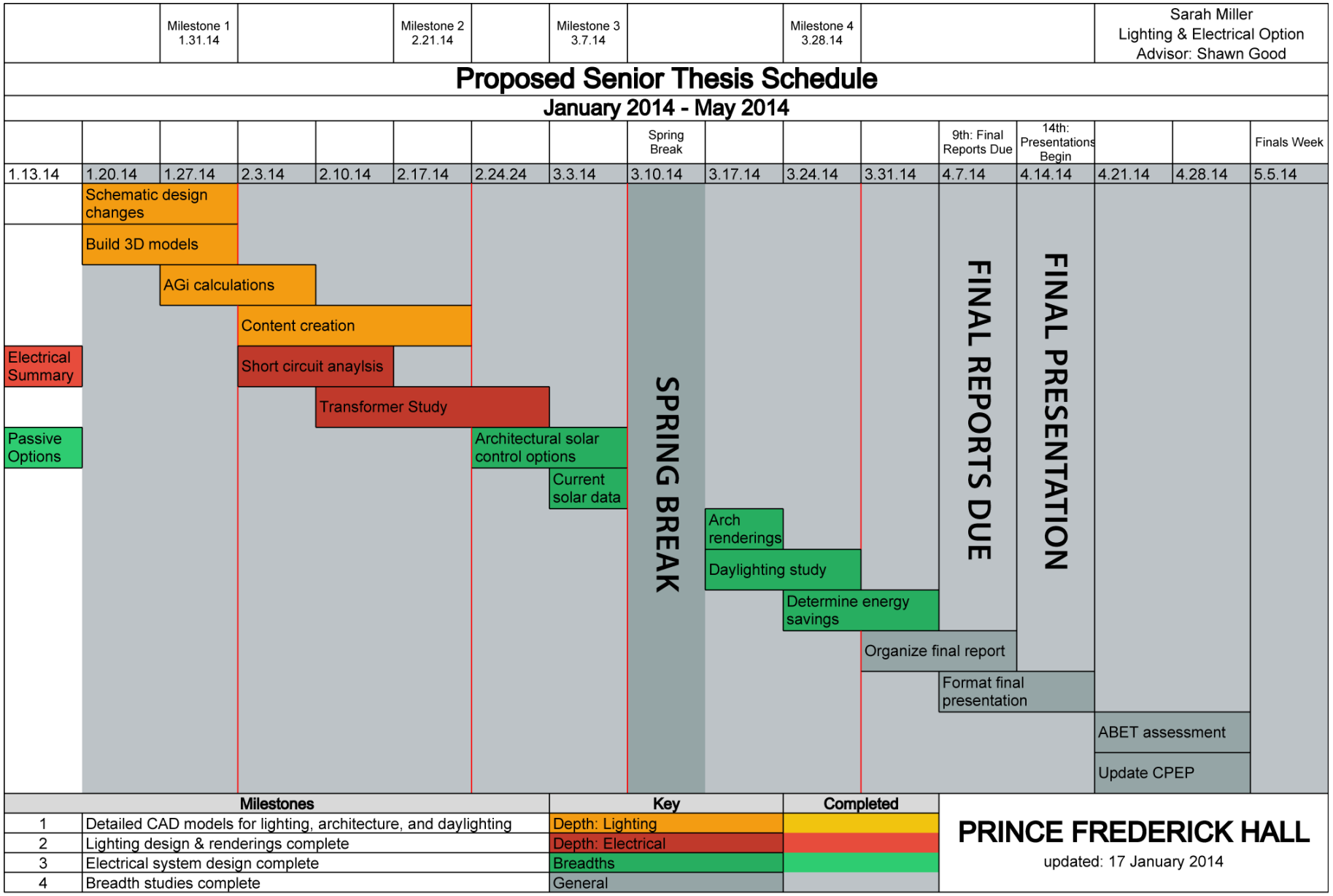
My electrical calculations will consist of standard methods and methods provided by the 2011 NEC.

Daylighting Studies

My initial daylighting studies will be conducted using Google SketchUp. After I have a list of potential daylighting solutions, I will take models of each space into AGi32 to calculate the results.

Architectural Renderings

Using the Revit model I created for lighting and daylight studies, I will make necessary changes for architectural improvement. My final renderings will be completed in 3DS Max, to ensure cohesion with my lighting renderings.


Milestone 1 1.31.14
Milestone 2 2.21.14
Milestone 3 3.7.14
Milestone 4 3.28.14
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Proposed Senior Thesis Schedule
January 2014 - May 2014
Spring Break
9th: Final Reports Due
14th: Presentations Begin
Finals Week
1.13.14
1.20.14
1.27.14
2.3.14
2.10.14
2.17.14
2.24.24
3.3.14
3.10.14
3.17.14
3.24.14
3.31.14
4.7.14
4.14.14
4.21.14
4.28.14
5.5.14
Schematic design changes
Build 3D models
AGi calculations
Content creation
Electrical Summary
Short circuit anaylsis
Transformer Study
Passive Options
Architectural solar control options
Current solar data
SPRING BREAK
Arch renderings
Daylighting study
Determine energy savings
Organize final report
FINAL REPORTS DUE
FINAL PRESENTATION
Format final presentation
ABET assessment
Update CPEP
Milestones
1 Detailed CAD models for lighting, architecture, and daylighting
2 Lighting design & renderings complete
3 Electrical system design complete
4 Breadth studies complete
Key
Depth: Lighting
Depth: Electrical
Breadths
General
Completed
PRINCE FREDERICK HALL
updated: 17 January 2014