AE 481W
Senior Thesis

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Lighting/Electrical Option
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REVISED THESIS PROPOSAL

SMC Campus Center
Baltimore, MD

Updated: 1/11/2011

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Executive Summary

The following proposal includes the work to be completed in the Spring 2011 semester for AE482. It presents a description for the redesign of several building system components in the SMC Campus Center, a student union building for the University of Maryland, Baltimore campus. Included are brief narratives of two depth and two breadth topics, with an additional area of study related to the MAE requirements.

The lighting depth includes the redesign of four different building spaces: the north façade, the main lobby, a classroom, and the natatorium. The new designs are to improve functionality and aesthetics, while providing adequate light levels to meet the various needs of each space. The designs must also meet lighting power density requirements documented in ASHRAE 90.1-2007.

The electrical depth includes the redesign of the branch circuit distribution for the four spaces presented in the lighting depth. A protective device coordination study and short circuit analysis will also be conducted. Completion of two other studies, the comparative analysis between MC cable vs. conduit and wires for feeders and a comprehensive SKM software analysis will be documented for the building.

The mechanical and structural breadths will be developed to calculate the possibility of energy savings by using solar hot water collectors and energy blankets in the natatorium. The mechanical breadth involves calculations to determine the amount of hot water required and how many solar collectors will be necessary to offset some of the existing heating requirements from the steam system. The structural breadth includes a redesign of the roofing system to accommodate the added load from the solar hot water collectors.

Background

The Southern Management Corporation (SMC) Campus Center is a 110,000 square foot multifunctional facility for the University of Maryland, Baltimore campus. It is connected to the Health Sciences Library, the School of Nursing building, and the Pratt Street Parking Garage.

Located on the site of the previous Student Union Building, the SMC Campus Center is a modern student-centered facility that significantly improves student life at UMB through expanded programming and enhancement of the urban campus environment. The fundamental goals of the Campus Center are to increase interaction between students and faculty from the various UMB schools and to develop an interactive campus community.

The exterior of the Campus Center, which consists of synthetic stone veneer, face brick, and precast concrete, is respectful to the materials and aesthetics of the adjacent buildings, while maintaining a unique, easily recognizable identity. The Campus Center provides openness to Lombard Street and adjoins the surrounding courtyard and plaza areas. The interior is designed to encourage health and wellness, house student organizations and services, provide recreation and relaxation, and offer exceptional food and dining venues.

The four main spaces to be studied as part of the thesis are the north building facade, the main lobby, an interior classroom, and the natatorium. These spaces are discussed further in the proposal below. The following graphics provide supplementary information about the four spaces.

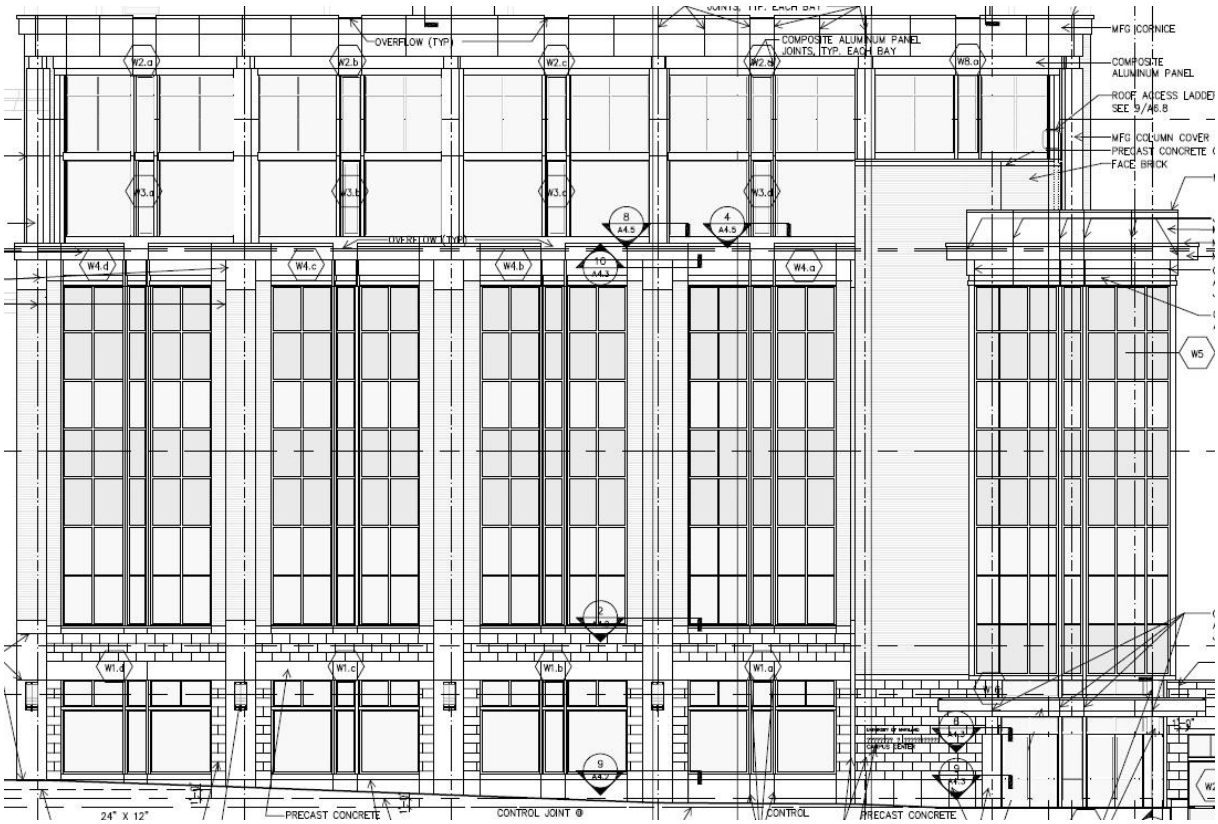


Figure 1: North Facade Elevation

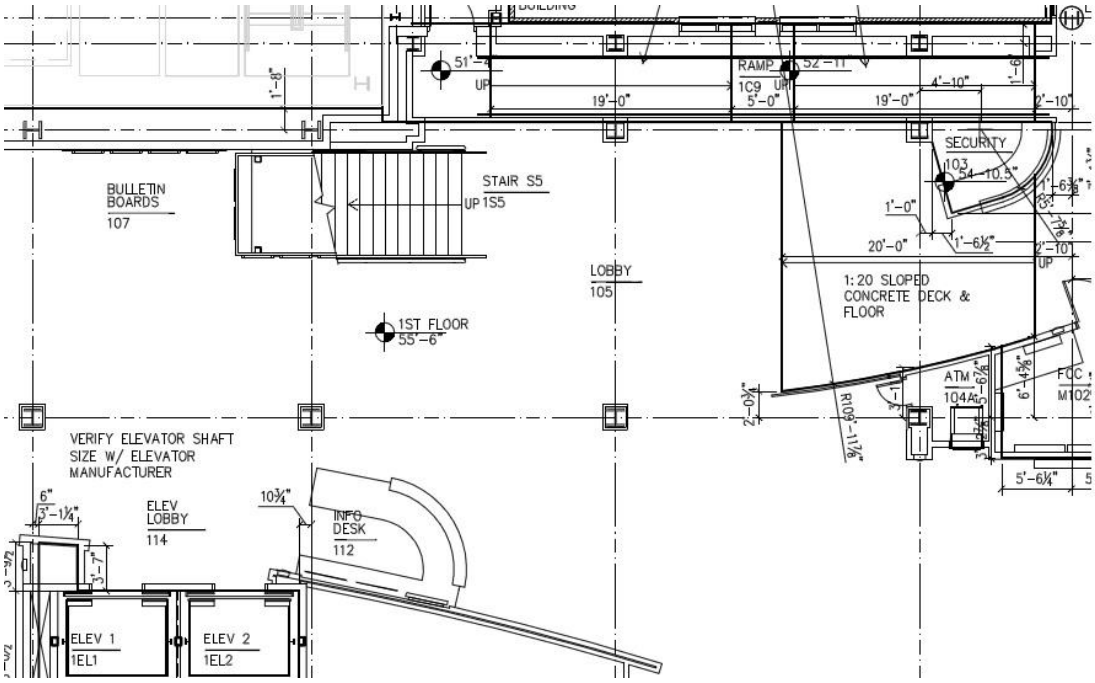


Figure 2: Main Lobby First Floor Plan

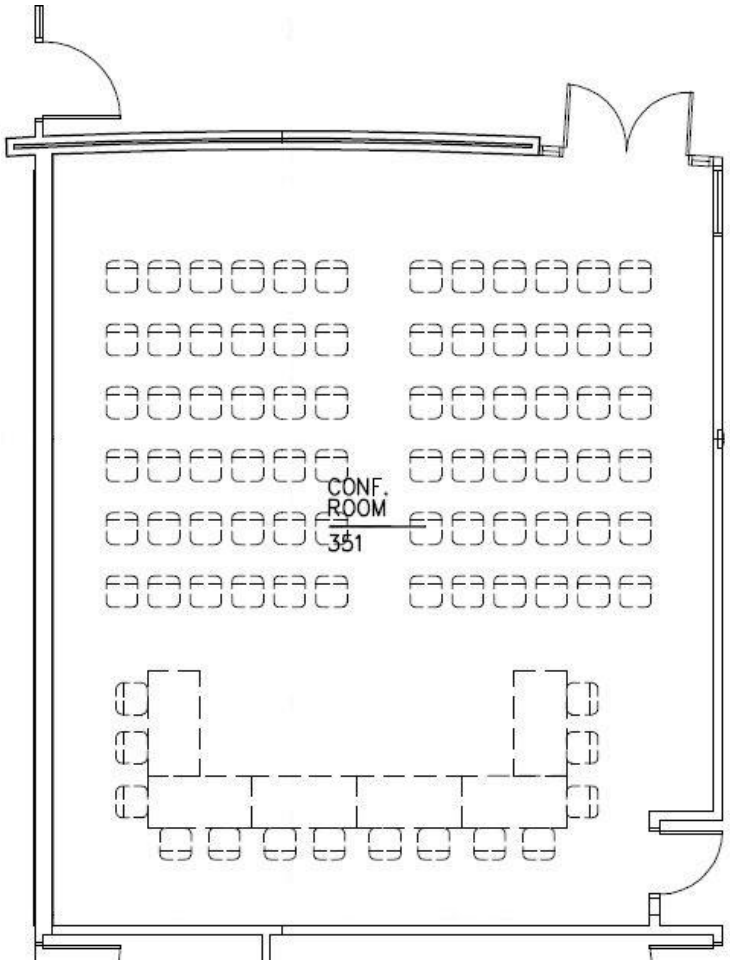


Figure 3: Classroom Floor Plan

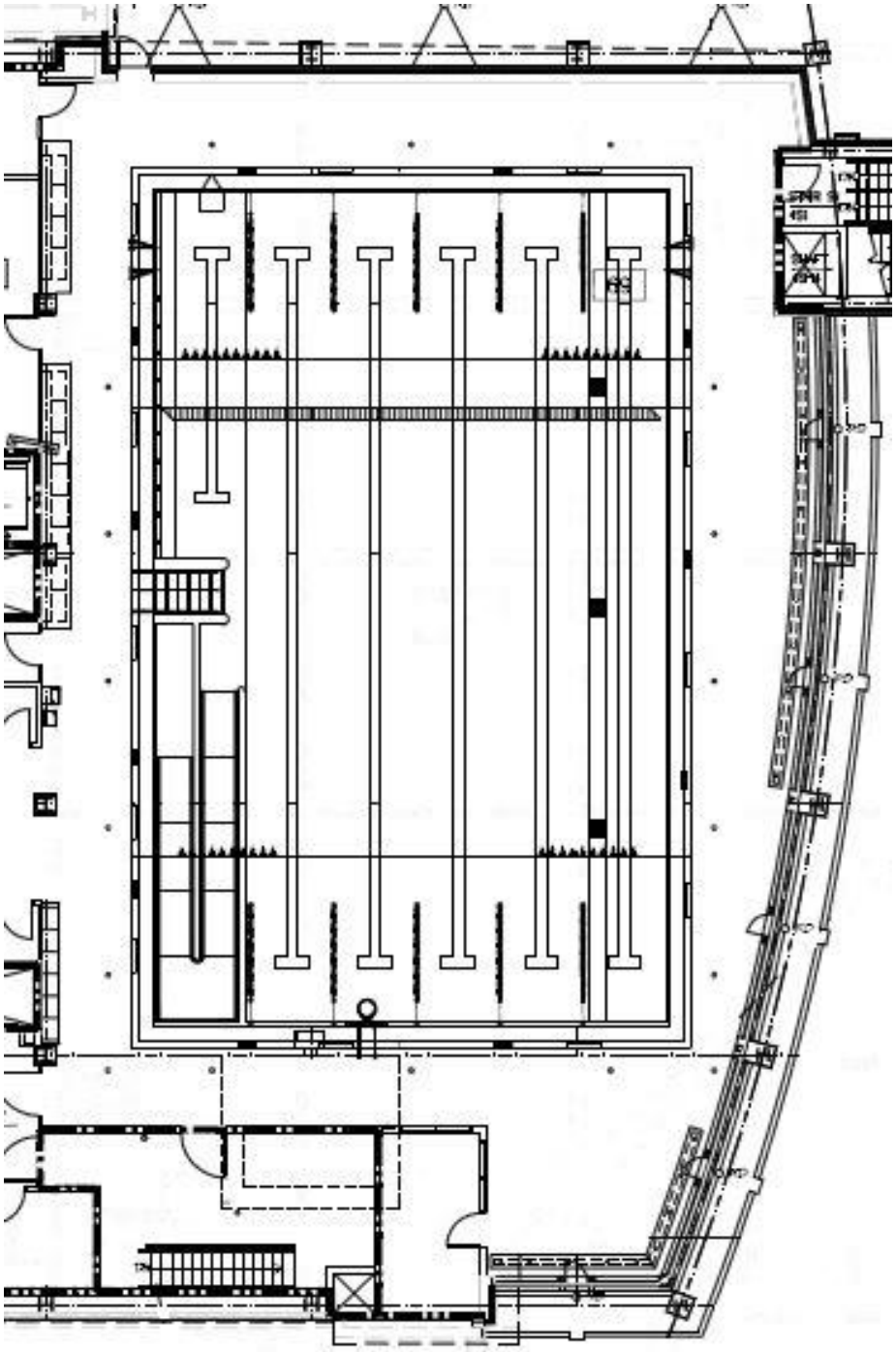


Figure 4: Natatorium Floor Plan

Lighting Depth

Problem

The lighting depth to be completed during the Spring 2011 semester includes the lighting re-design of four various spaces: the north facade, the main lobby, an interior classroom, and the natatorium. For each space, all lighting equipment, controls, and other equipment will be designed through design development and construction document phases. The schematic design phase was completed per Technical Report 3 requirements during the Fall 2010 semester with a formal presentation to a panel of professional lighting designers on December 8, 2010. The comments from the presentation are included in this proposal. Various computer software programs will be used to conduct calculations and presentation graphics during the Spring 2011 semester, including AutoCAD, AGi32, and 3D Studio Max, and Daysim.

The SMC Campus Center's existing lighting is effective yet plain. Many of the same light sources and luminaires are used throughout the entire building with recommended light levels met or exceeded in most spaces. Recessed linear fluorescent and compact fluorescent sources dominate the majority of lighting needs in the Campus Center. The existing solutions are generally sufficient for the intended uses of the spaces, but do not entirely enhance the architecture or meet power density requirements. Many of the ceilings throughout the building are cluttered with different lighting equipment, which can be distracting as occupants travel from space to space.

Spaces such as the main lobby and natatorium will require a lighting system integrated with daylighting controls. These spaces provide a positive connection to the outdoors, but currently have minimal or no controls to respond to daylight. Further daylighting considerations are discussed in this proposal. Also, lighting power densities must meet ASHRAE 90.1-2007 requirements.

Solution

Due to the multifunctional nature of the SMC Campus Center, the lighting design will be individually personalized to the tasks and aesthetics of each space. However, a few overall design goals will be implemented in all lighting designs. The Campus Center is a modern facility in the heart of an historic campus. The interior is comprised of unique architectural styles, which must be accentuated with contemporary lighting equipment.

The building is constructed between three other structures, and therefore should promote interdisciplinary interaction between students, faculty, staff, and the various UMB schools, while enhancing the quality of life for students by providing a richer educational environment. The lighting must be interactive and flexible for the various tasks that occur within multifunctional spaces. Dimming or switching capability and careful placement of light will be essential to successfully create moods and meet the various needs of the spaces.

North Facade

The north façade is the most noticeable feature of the Campus Center exterior. A large walkway lined with planters and benches joins the courtyard and plaza areas of the surrounding buildings. The architecture is respectful to the adjacent structures, while maintaining a unique identity.

The proposed lighting design must provide safety for occupants walking past the building and accentuate the façade architecture and materials. The main entrance requires adequate lighting to make it easy to find. Other specific elements of the façade will be highlighted to draw focus and create visual interest. A grazing technique will be implemented to illuminate the concrete natatorium structure. Decorative lights will provide the walkway lighting leading to the main entrance, while strip lighting will be used to highlight the planters and benches.

Main Lobby

The two-story main lobby is the first space occupants will encounter in the Campus Center. It is very welcoming and colorful and leads occupants to a dining facility, the information desk, student lounges, or up the stairs to the second level. The main feature includes a curved ceiling and concourse.

The lighting design must present a positive first impression, provide visual guidance to the main circulation paths, and emphasize prominent architectural elements like the curved concourse. The information desk has decorative features such as glass panels, televisions, and the UMB logo. These will be backlit to create visual appeal and general lighting will also be provided for staff members to perform their tasks. The remaining illumination for the open lobby will come from the high ceiling. The curvature will be accentuated with cove lighting, while downlighting will provide necessary light levels to the lobby floor. The cove lighting will be color changing to create various moods depending on major activities occurring within the Campus Center. Minimal west facing glazing will provide some direct sunlight into the lobby during afternoon hours, which should be acceptable.

Classroom

The interior classroom is a large, dynamic gathering space for learning, presentations, and conference meetings. The front of the room features a whiteboard, podium, and recessed projector screen. The desks are not permanent and can be placed in a variety of configurations depending on the current task in the space.

The lighting must be flexible to meet the needs of the various applications and accent the main design features to create focal points within the space. The podium and whiteboard will have dedicated equipment, while general ambient light will be provided by volumetric linear fluorescents. This will reflect light to the walls creating a spacious impression. During presentations, perimeter lighting will be dimmed or switched off to create a more closed feeling.

Natatorium

The natatorium is a major part of recreation space that covers two levels of the Campus Center. It is exposed to the curved north glazing façade, features a 25 meter, five lane lap pool, and has an exposed truss system. The natatorium is used for recreation and intramural swimming events.

The proposed lighting design must be integrated with daylighting controls, consider direct and reflected glare on the water, and provide flexible light levels for the different swim activities. Safety is important along the pool deck, and strong chemicals and high humidity will demand corrosive resistant lighting equipment listed for wet locations. An indirect/direct solution will be considered for the natatorium with metal halide light sources.

MAE Focus: Daylighting

Constructed between three existing structures, the SMC Campus Center is not presented with the best opportunity for daylight integration. The south facing portion of the building faces an unpopulated street with minimal glazing apertures. The north facade, facing Lombard Street, consists of significant glazing throughout all floors of the building, providing daylight to common areas such as dining facilities, student offices, and the natatorium. The top level natatorium will be studied for an improved daylighting design.

Currently, no control strategies are present in the natatorium to respond to daylight levels. All existing lighting equipment remains on during operating hours. The mechanical penthouse on the roof is set back from the natatorium, which makes utilizing skylights over the natatorium a possibility. A shading study using AGi32 or Ecotect will be conducted to determine the amount of hours the natatorium roof will be shaded by the mechanical penthouse. This will conclude if skylights are a good choice for the space.

Following the shading study, an overall analysis will be conducted for the daylight contribution from the north facing facade (and potentially from skylights). Depending on the results of the shading study, a skylight layout will be determined to maximize daylight throughout the natatorium. North glazing materials will be selected to consider thermal gains, views to the exterior, and overall performance to maximize energy savings.

From the daylighting analysis, it will be determined how much of the space should be controlled (dimmed or switched) to provide the required light levels in the space and maximize energy savings. This will provide comfort to the swimmers and reduce the energy loads of the space. Daysim daylighting software will be used to complete the study and establish photosensor placement and calibration and calculate the proposed energy savings based on the controls. Thermal losses or gains will also be considered, as well as any new equipment that accommodates a dimming or switching system.

Lutron Comments (12/8/10)

A schematic design presentation was held at Lutron on December 8, 2010 to a panel of three professional lighting designers. Design and presentation feedback was provided and the comments are summarized below.

Sandra Stashik

- Discussed architecture, linked exterior photos well
- Concepts, ideas, and showing fixture locations (well thought out integration)
- Lobby - decorative pendants block logo, logo could also use front light, good to look at sources for correct application (induction for high, hard to reach areas), discussed the problem, developed a solution, and checked the work
- Classroom - watch light on screen, liked spacious vs. closure
- Natatorium - check light levels on water and deck, liked pros and cons of each scheme (leads owner to best solution), careful with skylights which can also cause glare for swimmer, overall well thought out, clear, and nice

Shawn Good

- Header matched top of the actual building, works well
- Overall, most comprehensive - sketched, criteria, etc.
- Sketches - facade light sketch works, but progressively got more technical like AutoCAD, prefers had sketches, but be consistent
- Information Desk - "vertical has a lot going on," lighting may have made a bigger problem, do not overdue it
- Ceiling progression from inspiration to final outcome showed thought, main concern of no hierarchy for guidance (all light levels the same) or clear path
- Classroom - again, hierarchy of space for spaciousness (focus more light to front)
- Natatorium - pros and cons excellent, liked example images but they don't show cons, make sure images work both ways with ideas, HVAC will question skylights
- Overall good

Charles Stone

- Teaching type style - can sometimes work with client
- Agree with other comments about lobby - too many ideas
- Excellent images for psychological impression, but make bigger
- Be careful with type fonts
- Classroom sketches cut out, substitute application slides - easier to understand ("we've all seen a typical classroom, but here is what I'm going for...")
- Natatorium - what's your favorite? What about lightpipe? Go back past code in NEC Handbook, lays out rules over water and deck, suggest an option to client
- Very good, new style

Electrical Depth

Branch Circuit Distribution

The branch circuit distribution will be redesigned for each of the four spaces to be re-lighted as part of the lighting depth discussed earlier in this proposal.

North Facade (Building facade and main entrance)

The north facade is respectful to the campus aesthetic but features a more modern approach with sufficient glass, synthetic stone veneer, face brick, and concrete. Currently, only four custom linear fluorescent sconces are present on the lower stone structure with more linear fluorescents under the main entry canopy. The new design will highlight more of the facade, specifically uplighting the natatorium concrete structure, and also accent some of the planters and benches in front of the building.

Main Lobby (Inside main entrance)

The two-story main lobby is large circulation space guiding occupants where they need to go in the Campus Center. It has many architectural features including colorful materials and a curved ceiling and concourse. Decorative sconces are present on all columns, while most general illumination comes from the ceiling's compact fluorescent downlights and large, 8'x8' custom compact fluorescent pendants. The proposed design will accentuate the curved ceiling with a decorative cove element and downlights over the open area of the lobby.

Classroom (3rd floor)

The interior classroom space provides a variety of seating configurations for typical learning environments or conference meetings. It is pretty plain and features a whiteboard, projection screen, and podium at the front of the room. The current lighting is all 3-lamp linear fluorescents that provide illuminance values that far exceed IESNA recommendations. The new design will be much more energy efficient, provide more variety of luminaires, and be controllable for the variety of activities.

Natatorium (4th-5th floor)

The natatorium is a major part of the recreation space in the building and is generally used for fitness swimming and intramural events. The main features are the five lane lap pool and the curved north facing glazing facade. Indirect luminaires with metal halide lamps are currently ceiling suspended around the pool deck. The proposed solution will involve a indirect/direct solution to provide more light on the pool deck for safety purposes. Daylight integration will also be a key design factor for the natatorium as discussed previously in this proposal.

Protective Device Coordination Study and Short Circuit Analysis

A protective device coordination study that addresses a single-path through the distribution system will be applied to the SMC Campus Center. The path extends from the utility to the main substation to panel LDP461. The coordination of protective devices for the redesigned system components along this path will be provided and short circuit calculations will also be included.

Electrical Depth Topic 1 - MC Cable vs. Conduit and Wires

A comparison study will be performed to determine whether changing the existing feeders from conduit and wires to MC cable would be advantageous. The problem addressed is the fact that construction was on an extremely tight budget, making the all-in-one assembly of MC cable a more cost effective and installation reducing solution. I will analyze existing feeders according to RS Means costs for materials and installation to make a comparison to determine if the change is a good idea for the building.

Electrical Depth Topic 2 - Comprehensive SKM Software Analysis

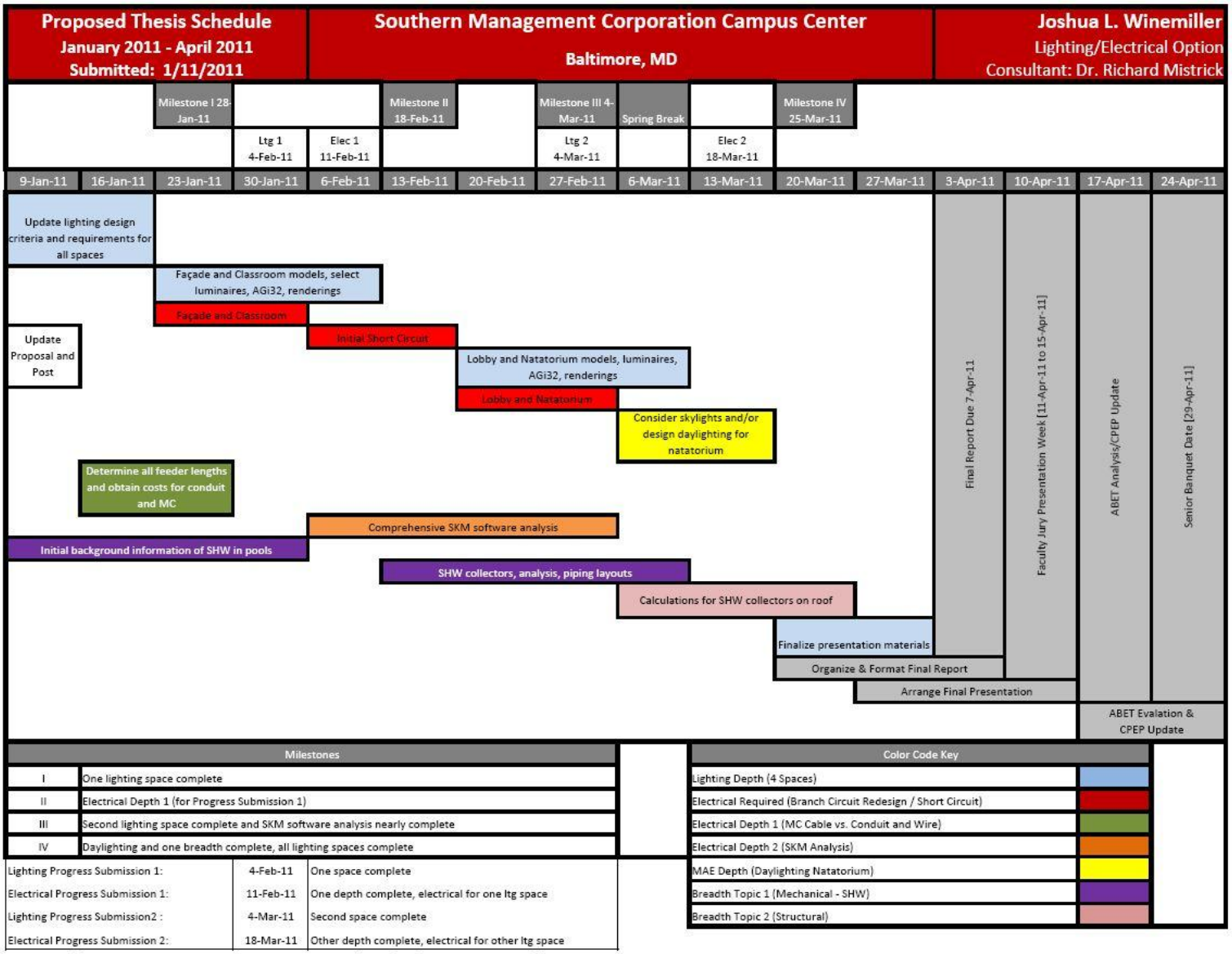
A complete analysis will be performed for the entire electrical distribution system. Using SKM software, a comprehensive short circuit analysis, coordination study, and arc fault study will be conducted and presented in clear, easy to follow tables. The tables will be generated in spreadsheet format to include the listing for each piece of equipment by tag and description, the actual AIC rating and short circuit current from SKM, and the arc fault level with required protective clothing and gear.

Breadth Topic 1 – Mechanical

The natatorium requires significant energy from the existing heating system to keep the pool water between 78°F and 81°F. Incorporating solar hot water collectors on the roof of the mechanical penthouse and an energy blanket to cover the pool at night will be investigated to help reduce energy costs to the University within a relatively short payback period. Existing energy use will hopefully be provided by the University for comparison with the new additions. A series of calculations will be conducted to determine the amount of hot water required, the required area of solar collectors, and how much solar radiation the collectors will be exposed to in the Baltimore area. A RETScreen model will be created to run an energy analysis based on the calculated parameters. Finally, a new piping layout will connect the new equipment to the existing system in the pool filter room along with sizing a hot water storage tank to be in the same room. An energy blanket can be utilized at night to retain heat and minimize evaporation, which saves energy from being used in the morning to re-heat the pool water.

Breadth Topic 2 – Structural

As a result of placing a series of solar hot water collectors on the mechanical penthouse, the layout of the structural support system will be affected. The collectors provide added dead load to the structure and will require a redesign of the support framing system. Additional structural members may also be required. The extent of the structural alterations will depend on the location of the proposed solar hot water collectors. Hand calculations will be used to determine the additional load from the collectors and to determine new support systems. The updated system and calculations used will be clearly documented as part of the final report.


Proposed Thesis Schedule
January 2011 - April 2011
Submitted: 1/11/2011
Southern Management Corporation Campus Center
Baltimore, MD
Joshua L. Winemiller
Lighting/Electrical Option
Consultant: Dr. Richard Mistrick
Milestone I 28-Jan-11
Milestone II 18-Feb-11
Milestone III 4-Mar-11
Spring Break
Milestone IV 25-Mar-11
Ltg 1 4-Feb-11
Elec 1 11-Feb-11
Ltg 2 4-Mar-11
Elec 2 18-Mar-11
9-Jan-11
16-Jan-11
23-Jan-11
30-Jan-11
6-Feb-11
13-Feb-11
20-Feb-11
27-Feb-11
6-Mar-11
13-Mar-11
20-Mar-11
27-Mar-11
3-Apr-11
10-Apr-11
17-Apr-11
24-Apr-11
Update lighting design criteria and requirements for all spaces
Façade and Classroom models, select luminaires, AGi32, renderings
Façade and Classroom
Update Proposal and Post
Initial Short Circuit
Lobby and Natatorium models, luminaires, AGi32, renderings
Lobby and Natatorium
Consider skylights and/or design daylighting for natatorium
Determine all feeder lengths and obtain costs for conduit and MC
Comprehensive SKM software analysis
Initial background information of SHW in pools
SHW collectors, analysis, piping layouts
Calculations for SHW collectors on roof
Finalize presentation materials
Organize & Format Final Report
Arrange Final Presentation
Final Report Due 7-Apr-11
Faculty Jury Presentation Week [11-Apr-11 to 15-Apr-11]
ABET Analysis/CPEP Update
Senior Banquet Date [29-Apr-11]
ABET Evalation & CPEP Update
Milestones
I One lighting space complete
II Electrical Depth 1 (for Progress Submission 1)
III Second lighting space complete and SKM software analysis nearly complete
IV Daylighting and one breadth complete, all lighting spaces complete
Lighting Progress Submission 1: 4-Feb-11 One space complete
Electrical Progress Submission 1: 11-Feb-11 One depth complete, electrical for one ltg space
Lighting Progress Submission2 : 4-Mar-11 Second space complete
Electrical Progress Submission 2: 18-Mar-11 Other depth complete, electrical for other ltg space
Color Code Key
Lighting Depth (4 Spaces)
Electrical Required (Branch Circuit Redesign / Short Circuit)
Electrical Depth 1 (MC Cable vs. Conduit and Wire)
Electrical Depth 2 (SKM Analysis)
MAE Depth (Daylighting Natatorium)
Breadth Topic 1 (Mechanical - SHW)
Breadth Topic 2 (Structural)