2009

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Lighting/Electrical

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Science Building-Phase 1

Buffalo State College-Buffalo, NY

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Proposal

Table of Contents

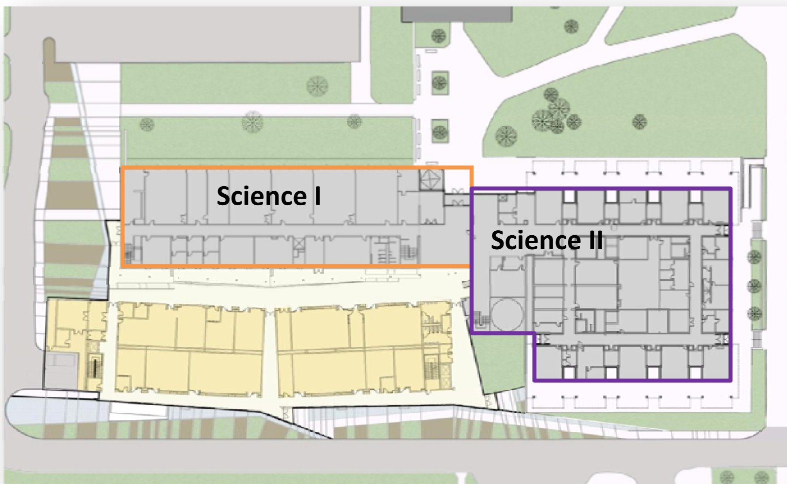
Executive Summary

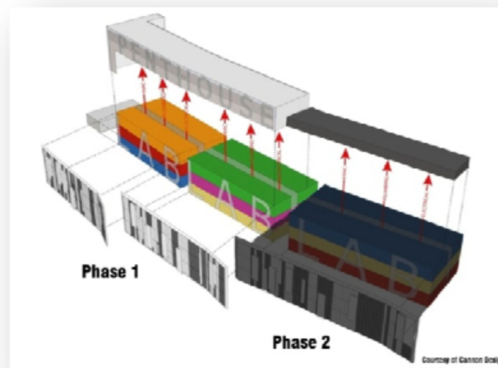
The proposed thesis will include an analysis of the existing electrical distribution system, a motor controller center design, protective device coordination (combined with an SKM study), and four new lighting design solutions for several spaces within the New Science Building at Buffalo State College. In addition to the material focused on lighting and electrical systems, four breadths will be undertaken to study and analyze daylighting, building enclosures, mechanical systems, and LED luminaires.

The breadths of daylighting, building enclosures, and mechanical systems were chosen because of their interaction and influence upon the other. All studies will share similar components in the investigation of performance and proposed alternatives based on efficiency and cost-benefit analysis. A proposed schedule of work is included at the end of the document.

Background

The New Science Building – Phase 1 at Buffalo State College is a 96,000 ft^2 addition to the existing Science I & II building on the Buffalo, NY campus. It is the first phase in a two-phase project which will eventually involve the demolition/reconstruction of the Science II wing and the renovation of the Science I wing. Upon completion, of both phases, the 224,000 ft^2 complex will house the natural science departments and their associated research and teaching labs, storage for sensitive/hazardous materials, a vivarium, and planetarium. The addition will connect to the existing Science I wing's western façade by means of a long, narrow atrium. Interior corridors branch from the central atrium to serve classrooms, labs, and faculty offices which is illustrated in Figure 1 below.





Figures 1,2 – Phase 1 Addition Layout and Perspective

The overall concept for the design of the addition was to expose and utilize the principles of the natural sciences housed within the building while creating a space that fosters collaboration and education. Consequently the architectural style employs lines and shapes that are influenced by the structured, proportions of the Fibonacci sequence, patterns of genetics, geological layers and forms, and biological circulation. Due to the spaces within the building, proper MEP design and integration was very important to the design of the project. Phase 1 construction includes the addition of a new service entrance and substation which will eventually provide power to the entire complex.

Lighting Depth

Problem:

Buffalo State College has commissioned this project to be a state-of-the-art research and educational facility that should attract visitors and prospective students. In upholding its context and definition, the lighting design should provide a functional and interesting environment. Analysis conducted in Technical reports I and II yielded a focus on four spaces to be redesigned with emphasis on flexibility, user control, and experience in addition to standards and recommendations of ASHRAE 90.1 and the IESNA Handbook. The four spaces to be redesigned are the Genetics Teaching Lab (Room 306), the Director's Office (Room 319A), the atrium, and the western façade.

Proposed Solution:

The **Genetics Teaching Lab** functions as a laboratory workspace as well as a lecture space. Therefore, the lighting design will provide clear and even illumination across the task planes. Additionally, it will be flexible in the availability of different scenes or multilevel switching to provide varied luminance levels for different tasks such as lecturing, note-taking, and experimentation (at the microscopic level). Luminaires for the space will consider viewing angles, visual tasks involving VDTs, and glare in terms of options for type and optical pieces.

Revisions to the existing design will include the use of sections for more effective graphics.

The **Director's Office** is a roughly 600 ft^2 unit comprised of two private offices for reception and for the director of the Great Lakes Center. Schematic design for the spaces included a focus on psychological impressions as well as aesthetics. The design will incorporate several different scenes to account for day-to-day tasks as well as meetings/conferences and should promote a relaxed mood. Revisions to the existing schematic design will include a specification of sources and position to promote a relaxed scene and revised hand-drawn sketches.

Three different schematic designs were generated for the **Atrium** in the third technical report, and the final design will be a combination of different characteristics from each. It will highlight architectural features and direct people through the circulation space by means of luminance ratios. Also, the spacious ground floor will be lit to levels in spaces in order to facilitate studying or face-to-face meetings. The revised design will include stronger graphics for a night-time rendering and a clear representation of the daylight integration.

Lighting for the western **façade** will emphasize the idea of viewing the departments within by accentuating the interior glow. The colorfully painted walls of the western corridor are visible from the exterior, and to complement the shapes and colors, the projecting sections of the curtain wall will be highlighted with a blue light. Revised design graphics will emphasize contrast and spread/reflection of light on the surrounding.

Daylighting considerations will also be developed for the Atrium and the façade, but will be developed further in Breadth 1.

Solution Method:

The proposed lighting designs are to be studied in various programs, with graphical images produced electronically and by hand. Verification of proper lighting levels and power densities will be achieved through an AGI32 model, lumen method, or point calculations. All new equipment will be compiled in a luminaire schedule and illustrated in a reflected ceiling plan.

Tasks and Tools:

1. Finalize designs and layouts for the four spaces, one at a time throughout the semester.
    a. Document LLFs and calculated luminance levels from calculations.
2. Compile new equipment in a luminaire schedule.
3. Produce graphic images to properly convey lighting design and results, using a combination of sections, perspective, and plans from AGI32, photoshop, and hand-drawn renderings.

Electrical Depth

Problem:

Due to the redesign of the Genetics Teaching Lab (Room 306), the Director's Office (Room 319A), the atrium, and the western façade, new branch circuiting and switching is required. A protective device coordination study is required for the distribution system as well as analysis of potential areas for improvement in performance, economics, and/or efficiency.

Proposed Solution:

New load calculations will be conducted for the four spaces and any areas where the distribution system or loads are altered. A coordination study will be conducted from the service entrance to a specified distribution panel, with supporting short circuit current calculations and trip curves. The loads of the mechanical equipment will be analyzed for the design of a motor controller center, and finally the whole electrical distribution system will be analyzed with a comprehensive study in SKM software.

Solution Method:

All design considerations, calculations, and distribution equipment sizing will be in compliance with NEC 2008.

Tasks and Tools:

1. Calculate new loads for redesigned lighting layouts in the four spaces.
    a. Resize all distribution equipment associated with alterations according to NEC 2008.

2. Conduct protective device coordination study for path leading from service entrance to distribution panel. Follow NEC 2008 calculation guidelines and create trip curves. Make sizing adjustments as needed.
3. Analyze mechanical loads and design a major mechanical equipment motor control center. Size feeder according to NEC 2008 standards and create an isometric detail in AutoCAD.
4. Perform an analysis of the complete electrical distribution system in SKM software by performing short circuit analysis, coordination study, and arc fault study.
    a. Document each piece of equipment, its associated AIC rating, and available short circuit current in a spreadsheet.

Breadth One: Daylighting (MAE)

The design for the New Science Building incorporates daylighting by means of sidelighting and toplighting in the atrium, but there is no direct exposure of any working space to the outdoors. As such, there is minimal exposure of inhabitants to daylight and exterior views. Existing glazing is sporadic, partly due to the aesthetic design and partly due to the layout of the building and major equipment. An analysis will further study the existing daylighting systems and façade to determine where it performs well and where it can be improved.

Specifically, the efficiency of the specified skylights will be studied. It is possible that a skylight model with a rounded top and splayed well, when applied in a series of 13, could improve efficiency of light transmission into the space. A cost-benefit analysis will be conducted based on calculations and simulations conducted in Daysim and/or AGI32.

Breadth Two: Building Enclosures

The western, curtain wall façade of the New Science Building is perhaps its most defining element. As such, its aesthetic integrity should be respected but its performance can be enhanced. To dovetail with Breadth One, an analysis of the materials used in the building envelope will be conducted with simulations/calculations developed in the Heating Air and Moisture (HAM) Building Science Toolbox software program. Specifically, research will be conducted on the utilization of an alternative glazing material, such as spectrally selective low-e glass, in order to obtain lower values for the U-factor and solar heat gain coefficient (SHGC).

Breadth Three: Mechanical

The mechanical breadth will include a study of adjustments to the façade and their impacts on the mechanical loads. Additionally, there is the coordination that will be conducted with the electrical system for the motor controller center design.

Breadth Four: LED Luminaire Options (Honors)

This additional breadth will analyze the options for LED luminaire utilization within the building. Aside from emergency and sign lighting, there is one LED step light specified in the existing design. This study would propose a luminaire for ambient lighting within a classroom or lab space and analyze the benefits and disadvantages to specifying such a luminaire. Items for study and analysis include:

- Durability
- Lamp Life
- Maintenance
- Cost
- Performance (distribution, optics)
- Color rendering properties
- Matching CCTs with other luminaires in the building

ID		Task Name	Duration	Start	Finish	Predecessors
Week of January 10						
1		Office Lighting	18 days	Mon 1/11/10	Wed 2/3/10	
Week of January 17						
1		Office Lighting	18 days	Mon 1/11/10	Wed 2/3/10	
2		SKM Analysis	53 days	Wed 1/20/10	Fri 4/2/10	
3		Atrium Lighting	31 days	Wed 1/20/10	Wed 3/3/10	
Week of January 24						
1		Office Lighting	18 days	Mon 1/11/10	Wed 2/3/10	
2		SKM Analysis	53 days	Wed 1/20/10	Fri 4/2/10	
3		Atrium Lighting	31 days	Wed 1/20/10	Wed 3/3/10	
Week of January 31						
1		Office Lighting	18 days	Mon 1/11/10	Wed 2/3/10	
2		SKM Analysis	53 days	Wed 1/20/10	Fri 4/2/10	
3		Atrium Lighting	31 days	Wed 1/20/10	Wed 3/3/10	
8		Daylighting	35 days	Mon 2/1/10	Fri 3/19/10	
4		Office Lighting Circuiting	3 days	Wed 2/3/10	Fri 2/5/10	
5		Lab Lighting	19 days	Fri 2/5/10	Wed 3/3/10	
Week of February 7						
2		SKM Analysis	53 days	Wed 1/20/10	Fri 4/2/10	
3		Atrium Lighting	31 days	Wed 1/20/10	Wed 3/3/10	
8		Daylighting	35 days	Mon 2/1/10	Fri 3/19/10	
5		Lab Lighting	19 days	Fri 2/5/10	Wed 3/3/10	
Week of February 14						
2		SKM Analysis	53 days	Wed 1/20/10	Fri 4/2/10	
3		Atrium Lighting	31 days	Wed 1/20/10	Wed 3/3/10	
8		Daylighting	35 days	Mon 2/1/10	Fri 3/19/10	
5		Lab Lighting	19 days	Fri 2/5/10	Wed 3/3/10	
6		MCC	8 days	Wed 2/17/10	Fri 2/26/10	
Week of February 21						
2		SKM Analysis	53 days	Wed 1/20/10	Fri 4/2/10	
3		Atrium Lighting	31 days	Wed 1/20/10	Wed 3/3/10	
8		Daylighting	35 days	Mon 2/1/10	Fri 3/19/10	
5		Lab Lighting	19 days	Fri 2/5/10	Wed 3/3/10	
6		MCC	8 days	Wed 2/17/10	Fri 2/26/10	
7		Lab and Atrium Circuiting	8 days	Wed 2/24/10	Fri 3/5/10	
Week of February 28						
2		SKM Analysis	53 days	Wed 1/20/10	Fri 4/2/10	
3		Atrium Lighting	31 days	Wed 1/20/10	Wed 3/3/10	
8		Daylighting	35 days	Mon 2/1/10	Fri 3/19/10	
5		Lab Lighting	19 days	Fri 2/5/10	Wed 3/3/10	
7		Lab and Atrium Circuiting	8 days	Wed 2/24/10	Fri 3/5/10	
9		Building Enclosure	11 days	Mon 3/1/10	Mon 3/15/10	
11		Façade Lighting	20 days	Thu 3/4/10	Wed 3/31/10	
Week of March 7						
2		SKM Analysis	53 days	Wed 1/20/10	Fri 4/2/10	
8		Daylighting	35 days	Mon 2/1/10	Fri 3/19/10	

ID	ℹ	Task Name	Duration	Start	Finish	Predecessors
Week of March 7, continued						
9		Building Enclosure	11 days	Mon 3/1/10	Mon 3/15/10	
11		Façade Lighting	20 days	Thu 3/4/10	Wed 3/31/10	
Week of March 14						
2		SKM Analysis	53 days	Wed 1/20/10	Fri 4/2/10	
8		Daylighting	35 days	Mon 2/1/10	Fri 3/19/10	
9		Building Enclosure	11 days	Mon 3/1/10	Mon 3/15/10	
11		Façade Lighting	20 days	Thu 3/4/10	Wed 3/31/10	
10		LED Luminaire Study	15 days	Mon 3/15/10	Fri 4/2/10	
Week of March 21						
2		SKM Analysis	53 days	Wed 1/20/10	Fri 4/2/10	
11		Façade Lighting	20 days	Thu 3/4/10	Wed 3/31/10	
10		LED Luminaire Study	15 days	Mon 3/15/10	Fri 4/2/10	
12		Mechanical	9 days	Mon 3/22/10	Thu 4/1/10	
Week of March 28						
2		SKM Analysis	53 days	Wed 1/20/10	Fri 4/2/10	
11		Façade Lighting	20 days	Thu 3/4/10	Wed 3/31/10	
10		LED Luminaire Study	15 days	Mon 3/15/10	Fri 4/2/10	
12		Mechanical	9 days	Mon 3/22/10	Thu 4/1/10	
13		Façade Circuiting	3 days	Wed 3/31/10	Fri 4/2/10	