The Depth and Breadth Design Proposal for the Lord Stirling Community School describes the investigation and intended design for the Spring 2005 completion of AE Senior Thesis. The Depth proposal outlines redesign issues in the buildings lighting and electrical systems that have been determined with respect to IESNA, ASHRAE 90.1, and NEC 2002 criteria. Heavy emphasis has been placed on design criteria pertaining to proper illuminance levels, aesthetics, and quality of the visual environment. The areas of focus for redesign are the main entry way and parking lot, the entrance vestibule, main corridor, cafeteria, media center and adjacent computer lab, downstairs corridor, kindergarten classroom, and auditorium. The main focus of the lighting redesign is introduction of daylight, efficient light sources, providing a ‘clean’ design with regards to ceiling plane, and creating an environment of openness, relaxation, and alertness. The electrical system will be reconfigured to accommodate with lighting redesign. As part of a holistic approach to the redesign of the school, the Breadth proposal encompasses changes in the structural and mechanical systems of the school. To accommodate the introduction of daylight into the cafeteria, corridor, and media center, the roof system will need to be redesigned and reconfigured for skylights. To improve the quality of the environment, Indoor Air Quality issues will be investigated and suggested for implementation. The methods that will be used to complete the above redesigns are outlined in the “Task and Tools” sections and a timeline has been provided to show a schedule of completion.
Background Information

Lord Stirling Community School is a kindergarten through eighth grade public school in the heart of New Brunswick. Constructed in 2002, the school was the beginning of a city-wide improvement program spearheaded by the New Brunswick Development Corporation. At 98,000 square feet, LSCS is not a large school, but common standards, but it still hosts over 500 students a day during the school year. During construction, great care and concern was implemented in the appearance of the school in the neighborhood. As a key figure in the community, the school symbolizes a new beginning for the city. Architecturally, the school is designed for functionalism. Spaces flow in a straightforward manner. Wide corridors provide easy access and flow throughout the day. A southward facing orientation for the cafeteria provides the students with pleasant views during lunch breaks. The upper and lower levels are tied together through a large, open stair case located in the main north-south corridor in the building. The lower level is home to the kindergarten, 1st, and 2nd grade classrooms, the art studios, music classrooms, and the auditorium. Entrances are located on both levels, with the main on the south side of the upper level and a secondary entrance downstairs on the building's north side.

Introduction

The intention of my thesis redesign is a holistic improvement of the quality of the school’s environment. Through the introduction of daylight and sky views throughout the day, the visual quality will be improved for the students and faculty members. Implementation of sky-lighting and top-daylight wall washing will require extensive redesign of the structural systems. To improve indoor air quality is the mission of the mechanical redesign which will deal with topics such as adequate fresh air distribution, humidity control, air filtration, and the feasibility of energy recovery ventilation equipment.
Lighting Depth Proposal

The challenges presented in lighting design are manifest not in adherence to IESNA design criteria and ASHRAE standards alone, but in the successful integration of those standards with aesthetics, human needs, and visual quality. The spaces selected for my lighting design encompass the variety of tasks found in most modern elementary schools. The exterior redesign encompasses the main façade, main parking lot, and entrance portico. The interior redesign follows the pattern of a walk through the building, beginning with the vestibule entrance and continuing to the cafeteria. From the cafeteria the next space is the media center and its adjacent computer lab. From there, the design travels through the main corridor down the main steps to the lower corridor. From the lower level, the design moves to the kindergarten classroom and finishes in the auditorium.

The Problems

The overall problems throughout the building are a lack of continuity and flow, and a feeling of being closed off from the outside. In general, there is a lack of connection to the world outside which effects the psyche of both students and staff in a negative way. Lack of flow is major concern in certain areas, such as the corridors, the media center, and the cafeteria, the current lighting layouts feel too chaotic and do not harmonize with the flow of the space, the lines of the architecture, or the function of the room. The lack of daylight is another issue to be addressed. Studies have shown daylight as well as views of the sky to have greatly improved the quality of the environment as well as the psyche of the occupants. Along with lack of daylight, the illuminance levels are another problem. Though the illuminance levels throughout the space comply with IESNA standards, they seem too low for stimulating learning and keeping children alert by suppressing melatonin levels throughout the day. With regards to inadequate lighting, the auditorium provides another problem for this redesign due to its extremely dim and cave-like appearance. Another space with improper lighting is the computer lab with harsh veiling reflections that disrupt the use of computers.
Lighting Depth Proposal (Continued)

The Solutions

Detailed descriptions of intended lighting solutions can be found in the Thesis Schematic Design Proposal.

Summary of proposed solutions:

Solutions to the daylighting problems will be solved by introducing daylight to the cafeteria, main corridor, and media center.

- **Cafeteria:** Skylight Wells and extension of current clear story windows to run the entire length of the wall
- **Corridor:** Diffuse top daylight wall wash along the eastern wall with clear or slightly diffuse skylights above the main staircase
- **Media Center:** Diffuse Skylight

Solutions to the electric lighting:

- **Exterior:** Provide more appealing façade lighting and area lighting
- **Vestibule:** Create a flow from exterior to interior
- **Cafeteria:** Remove Chaos with introduction of skylight wells and supplemental up lighting inside the wells and downlighting
- **Corridor:** Remove chaos and improve flow by introducing daylight patterns from skylight over the stair case and creating daylight wall washer on east wall. Supplemental electric light will be provided with linear wall washers on the west wall and inside the daylight wall washer for evening hours.
- **Media Center:** Provide a lighting scheme that highlights the various functions in the space
- **Computer Lab:** Provide an indirect lighting system that complies with IES recommended 1:4 luminance ratios
- **Lower Level Corridor:** Create a flow from the upstairs daylight to the lower level with indirect lighting that mimics skylight. Wall washing will provide supplemental lighting and remove chaos from the ceiling plane.
Lighting Depth Proposal (Continued)

Solutions to the electric lighting (Continued)

- **Kindergarten classroom**: Provide electronically controlled shading devices, delineated functions of the space, and provide a more stimulating lighting system that complies with IES VDT screen usage.
- **Auditorium**: Bring light up to the ceiling to remove cave-like feeling. Send light to the highly reflective upper walls. Experiment with changing floor and lower wall reflectance while implementing the same lighting solutions.

Solution Methods

All design will conform, at a minimum, to guidelines set forth in the IESNA Handbook, 9th edition, and levels of control and allowable power densities outlined in ASHRAE 90.1. Analysis of the lighting design will be completed once all luminaries, ballasts, and lamp selections have been finalized and exact locations determined. Daylight analysis will begin with determination of glazing materials, placement, and aperture size and depth has been determined. Electrical analysis will be completed with AGI32 and daylight analysis shall be completed with Radiance. A reflectance study will be completed in the auditorium with two lighting scenarios being implemented in the providing the same illumination but varying the reflectance of the rooms materials.
Tasks and Goals

I. Fixture Selection
   a. Fixtures will be selected according to performance data provided from manufacturers that satisfy the design requirements for selected spaces
   b. Lamp type and wattage to be selected on limitations set forth by ASHRAE90.1 and desired illuminance levels
   c. Ballasts to be selected on the basis of type of control required per situation

II. Luminaire Location and Testing
   a. Location of fixtures and spacing to be determined according to design requirements and manufacturer’s spacing criteria
Lighting Depth Proposal (Continued)

Tasks and Goals (Continued)

III. Daylight Design
   a. Glazing selection will be based on diffusing, transmitting, and tint characteristics supplied from calculations and manufacturer’s data
   b. Systems will be sized according to preliminary SkyCalc and AGI32 analysis in accordance with desired illuminance levels

IV. Software Modeling
   a. Models built in AutoCAD 2005
   b. Models will be imported to AGI32 and Radiance for rendering
Electrical Depth Proposal

Due to extensive lighting depth redesign, the electrical depth section will consist of redesigning the Lord Stirling Community School’s electrical system to accommodate the new designs. After consultation with my electrical advisor, it was determined that due to the building’s small size and uncomplicated electrical distribution system, redesign of the current layout would not provide significant advantages.

The Problems

The proposed lighting re-design will impact the existing electrical power distribution system. With the integration of daylight in the building’s cafeteria, media center, and main corridor, with efficient lighting systems a decrease in the electrical lighting load is expected. Further work described in the mechanical breadth section will discuss the investigation of daylight integration’s impact on the current HVAC system and if an increase will be necessary. Therefore, the completion of the mechanical breadth work will indicate if increased cooling or heating will impact the mechanical loads on the electrical distribution system.

The Solutions

To either increase or decrease the electrical power distribution system in response to finalized lighting depth work and mechanical breadth work. Electrical solutions will consist of and not limited to, the resizing of feeders, overcurrent protection devices, or transformers. Integrated panelboard layouts for all distribution systems affected by redesigned lighting systems.

Thesis Proposal
Lord Stirling Community School
Nehal M. Youssef
Lighting-Electrical Option
Faculty Consultant: Professor Martin Moeck
Electrical Depth Proposal (Continued)

Solution Methods

All solutions will conform, at a minimum, to requirements set forth in NEC 2002. All additional loads will be incorporated into the building’s distribution system with changes made according to need. Panelboard layouts will be provided for all areas affected by lighting and/or mechanical redesign. Analysis of at least one major piece of mechanical equipment motor control panelboard and its associated feeder will be conducted with all calculations and descriptions documented in a clear and concise fashion. A protective device coordination study addressing a single path through the distribution system will be completed showing the coordination of newly integrated protection devices, along with a short circuit current analysis. All manufacturers’ data for newly integrated equipment will be provided.

Tasks and Goals

I. After completion of Lighting Depth work and Mechanical Breadth work, begin calculation of building loads.
   a. Identify different building loads (lighting, power, mechanical) and consider demand factors set forth in NEC 2002

II. Size panelboards (Annex D of NEC 2002)
   a. Separate panels for lighting, mechanical, and power distribution
   b. Size main distribution panel
   c. Size overcurrent protection devices for all panels
   d. Distribute loads onto individual circuits, achieving as balanced a loading of phases as possible

III. Size circuits
   a. Conductors sized using Article 310 of NEC 2002
   b. Conduit sized using Annex C of NEC 2002

IV. Performance analysis
   a. Compare differences between newly integrated system and original
**Breadth Proposal**

**Mechanical**

The Mechanical Breadth analysis will begin with an analysis of fresh air flow rates per student and per square foot within the facility and if the values correspond with ASHRAE standard 62. The remainder of the analysis will consist of inspecting the current HVAC system’s ability to deal with common indoor air quality issues that plague most public schools. Such issues as humidity control and outdoor air pollution filtration will be investigated and suggestions for improvement will be researched and recommended. Professor Friehaut will be consulting with me on this portion of analysis. A brief analysis of heat gain will determine if needed adjustments to the HVAC system will be necessary.

**Structural**

Due to the implementation of large skylights and skylight wells, the Structural Breadth redesign will deal with supporting extensive openings in the roof. The current roofing system is primarily reinforced concrete beams. My redesign will consist of analyzing the newly imposed loads and resizing the support members accordingly. The new skylight over the main corridor staircase will require the specification of new connections as well due to a new configuration for the skylights.
Proposed Schedule of Events

Spring 2005 Semester

January 10 - January 16
- Lutron Presentation
- Review of Proposal
- Finalize design development
- Visit Professor Friehaut to pick up reading material for Mechanical Breadth work

January 17 – January 23
- Finalize fixture selection
- Begin Building 3D Models of all spaces
- Run SkyCalc to determine skylight well depth and placement in cafeteria

January 24 – January 30
- Select material properties for clear skylight at main stair and diffuse in hallway and media center
- Complete AutoCAD 3D Models
- Import to AGI and set up models for calculations
- Import daylit area models to radiance

January 31 – February 6
- Begin Mechanical breadth analysis of air flow rates
- Begin Electrical Breadth Work - Calculate redesigned area’s design loads

February 7 – February 13
- Resize panelboards
- Create new panelboard layouts and size conductors, conduits, and overcurrent protection

February 14 – February 20
- Structural redesign work – resizing new supports for skylight additions

February 21 – February 27
- Run final electrical lighting renderings
- Run Radiance daylight analysis

February 28 – March 6
- Finalize all renderings and calculations

March 7 – March 13 – Spring Break

March 14 – March 20
- Create final electrical and lighting drawings
- Compile and format all manufacturer’s data on fixtures, lamps, ballasts, and skylight material

March 21 – March 27
- Write final thesis report

March 28 – April 3
- Create final thesis presentation

March 11 – March 17
- Present Thesis