Rebecca Ho
Lighting/Electrical
AE Faculty Consultant: Dr. Moeck
Bahen Centre for Information Technology
Toronto, Ontario, Canada
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University of Toronto
Bahen Centre for
Information Technology

Lighting Existing Conditions and Design Criteria Report

EXECUTIVE SUMMARY

The Lighting Existing Conditions and Design Criteria Report will examine the existing lighting conditions in the Bahen Centre for Information Technology (in general and explicitly for the four redesign-spaces) and compare it with respect to IESNA lighting design standards and ASHRAE Standard 90.1, 1999 power consumption standards. This report will also examine other factors affecting the lighting design of the building. These factors include architectural elements such as wall surfaces, reflectances, daylighting, and location of furnishing in each of those spaces.

This report concluded that the lighting existing lighting condition in the Gallery space is appropriate for its use. However, the lighting for the Lecture Hall and Meeting Room can be improved because the current incandescent fixtures in those spaces are not the most efficient and fitting for the use and function of the space. As for the outdoor back courtyard at the Bahen Centre, currently insufficient information is available to determine whether or not the existing lighting condition would be the most appropriate and aesthetically pleasing for the space. Further contact with the water feature designer will be needed to determine the best lighting design for this space.

This report will include information on lighting fixtures (fixture cut-sheets) and part of the architectural plan showing the four spaces chosen for redesigning.

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The Bahen Centre for Information Technology, constructed for the University of Toronto, is a technological and architectural masterpiece designed for the use in education and facility of the Engineering and Information Technology disciplines. The architecture of this building is modern and therefore the lighting design will also compliment the same theme. This report will describe the existing lighting conditions in the building, specifically in the four spaces that will be used for redesigning. It will examine whether or not the existing lighting conditions satisfy the appropriate design criteria (IESNA) for the space, and comply with energy standards (ASHRAE/IESNA Standard 90.1, 1999). This report will also discuss factors of the building that affects the design of each lighting system, such as materials used, surface reflectance, and etc.

Part 1a - Existing Lighting Conditions

In General:

The Bahen Centre for Information Technology uses a few different types of lighting throughout the 8-story high building. In general, corridors located on the ground floor of the building uses a compact fluorescent suspended cylinder luminaire through out (*Figure 1*). These fixtures were custom made by in Toronto, Canada, to match the architect's requests. Corridors throughout the rest of the building were lit by a combination of custom made indirect fluorescent fixture suspended on the ceiling and recessed asymmetric luminaires mounted on the walls (*Figure 2 & 3*).


Figure 1


Figure 2


Figure 3

From the second floor to the eighth floor, the Bahen Centre consists of mainly lecture halls, computer labs, and offices. Lecture hall lighting consists of mainly incandescent recessed MR16 fixtures (*Figure 4*). Lighting in the computer labs are mainly suspended fluorescent semi-direct fixtures. These fluorescent fixtures are suspended between the acoustic ceiling panels, which are suspended from the concrete ceiling (*Figure 5*). The similar type of lighting is used in the offices, except they are usually 4 foot long fixtures instead of continuous fixtures.

Figure 4 – MR16 fixture

Figure 5 - Computer labs

Figure 6 – Lecture Halls

Lecture Hall #1210:

Room #1210 is an 85-seat lecture hall with a stepped floor (9 steps or rows). A long continuous desk and chairs are arranged in rows that range from 8 to 10 seats per row. A lecturer's desk, computer, and blackboard are arranged at the front of the room (*Figure 6*). Lighting used in this space are type **VA1** - adjustable recessed incandescent downlight fixtures, with MR16, 50 watts quartz halogen lamps. Forty-one of these fixtures are laid out evenly throughout the room, aiming at the long continuous desks below it. Fourteen of the similar fixture **VA2** (with specular black Alzak cone instead) were used to light the walkway isle in the center of the classroom. To light the front of the room, type **FF1** - recessed 1'x 4' asymmetric chalkboard wall wash fixture - was used to light the verticals of the chalkboard and the front of the room. This fixture utilizes two 32 watts T8 fluorescent lamp with integral electronic ballast.

Meeting Room #4287:

Room #4287 is a circular meeting room located in the center of the grand staircase within the building atrium. The lighting used in this room is the same as in Lecture Hall #1210 (Type **VA1**- adjustable recessed incandescent downlight fixtures, with MR16, 50 watts

quartz halogen lamps). The luminaires are arranged in a radiating pattern throughout the circular room. There are a total of 31 of these fixtures installed in the room.

Gallery #1134:

The gallery is located on the ground floor on the east side of the Bahen Centre, overlooking St. George Street. The gallery is essentially a corridor connect the St. George Street entrance to the vestibule and entrance north of it. The lighting fixture used in this space is Type **CP1** – a custom designed suspended cylinder hung on a pendant stem (*Figure 7*). These cylindrical luminaires are hung in pairs throughout the gallery. The housing of the fixture consists of a white opal acrylic cylinder with a clear acrylic trans-reflector. This luminaire uses a 42 watts compact fluorescent triple tube T4 lamp.

Figure 7- Gallery

Figure 8- Water Feature

Outdoor Courtyard:

The lighting in the Back Courtyard was designed to incorporate the main water feature in the space. The water feature (Figure 8) was designed by fountain designer Richard Van Seters from Canada. Lighting in this area consists of luminaire Type **ML1** – recessed louvered steplight with a 50 watts metal halide lamp. These fixtures are to be mounted on architectural bench surrounding the central area of the courtyard. In order to highlight the water feature, a side lit fiber optic cable (fixture Type **MZ2**) was used along the edge of the slender water troughs.

**Note: lighting data for the outdoor courtyard is not the most updated. Lighting for that space has been redesigned, and request for updated information is currently in progress.*

Part 1b - Existing Lighting Hardware

Ballasts:

For fixtures used in the Bahen Centre, the specification states that electronic ballasts must be used for all fluorescent fixtures. Specifically, electronic rapid start ballasts are to be used for both T8 and compact fluorescent fixtures. These ballasts should have a total harmonic distortion (THD) that does not exceed 10%. They should operate at a frequency of 20 kHz or greater and operate without visible flicker. It also states that it should have a power factor of at least 0.99 lagging. And most importantly, all ballasts should be CSA approved and UL listed (Class P).

All metal halide and high pressure sodium ballasts used in the Bahen Centre should be epoxy encapsulated with a minimum power factor of 0.95 lagging at 95% rated lumens. The specification states that all ballasts should be auto transformer type with constant wattage. Ballast crest factor shall be a maximum of 1.8. Minimum starting temperature for metal halide and high pressure sodium ballasts should be -29 degrees C at 90% line voltage and -34 degrees C at 90% line voltage respectively.

Lamps:

Requirements were set for lamps specified for the Bahen Centre for Information Technology:

- Metal halide lamps should have a color temperature of 3500° K with a CRI of 70.
- Fluorescent T8 lamps should have a color temperature of 3500°K with a CRI of 85.
- Fluorescent T12 lamps shall have a color temperature of 3500°K with a CRI of 62.
- High pressure sodium lamps should have a color temperature of 2100°K with chromaticity co-ordinates of x = 0.512 and y = 0.42.

Luminaires:

The luminaires used in the 4 redesigning spaces are listed below with a brief description:

- **VA1** – 50W MR16 NFL, recessed adjustable downlight with polished anodized aluminum; for drywall installation.
- **VA2** – 50W MR16 NFL, recessed adjustable downlight with specular black Alzak; for wood installation.
- **FF1** – Recessed 1'x 4' asymmetric chalkboard wall washer; 2 lamp T8; drywall installation.

- **CP1** – Compact Fluorescent downlight in acrylic cylinder for suspended mounting.
- **ML1** - recessed louvered steplight ; 50 watts metal halide lamp
- **MZ2** - side lit fiber optic cable with CSA/U.L Listing for wet location; light source should use 150 watts metal halide lamp.

Daylight:

Daylight played a very important role in lighting design for the Bahen Centre for Information Technology. Multiple parts of this building is consists of large panes of windows or skylights, especially in the 8-story high atrium of the building where the enormous skylight brings daylight deep into the building (*Figure 9*). Meeting rooms located in the core of the grand spiral stair case receive sunlight from the atrium due to the fact that the walls of the meeting rooms are constructed of sand-blasted glass panels (*Figure 10*).

Figure 9- Daylight from atrium

Figure 10 – Meeting room #4287

The gallery space located near the St. George entrance also receives a large amount of sunlight during the day, since one entire side of the gallery (corridor) consists of large panes of glass looking through to the sidewalk of St. George Street.

Part 1c- Architectural Elements

Glass:

The walls of Meeting room # 4287 are almost completely constructed of cast glass panels supported by aluminum frames. The appearance of this glass is greenish in color, and has a sandblasted texture to it. Transmittance information for this material is important because it will allow us to determine the amount of light entering through the glass panels. However, specific transmittance of this glass material is currently not available because the panels were custom made. For the purpose of this exercise, an assumption will be made for this glass material: sandblasted glass with a transmittance of 70% to 85%. This same type of glass is also used alone one entire side of the Gallery that is shared with the 160 seat Auditorium (Room 1130). The other side of the Gallery is enclosed by clear glass, where an assumption of transmittance = 90% will be made for now since actual transmittance level information is not available.

Reflectances:

Reflectance values in the four redesign-spaces should be carefully considered. The reflectance values of the surface material used in the room will affect on how much light will be reflected back, which will in the end affect the lighting design as a whole. Each of the three indoor spaces has very different interior surfaces. In Meeting room #4287 and Gallery, majority of the surfaces are made of glass panels; in Lecture Hall #1210, much of the walls are decorated with mahogany wood details designed by the architect (*Figure 11*). This will dramatically affect the amount of light reflected back into the room from the dark surfaces. Unfortunately the actual reflectance value of the wood material is not available, therefore an assumption of reflectance = 15% will be used for now.

Figure 11 – Mahogany wood detail in Lecture Hall #1210

Part 2 - Design Criteria

Suggested Illuminance Levels and Design Criteria:

According to the IESNA Lighting Design Guide in the IESNA Handbook, different illuminance level and criteria are suggested for spaces with for functions. These values are not a minimum requirement but rather a suggested guide to lighting those spaces. From IESNA, it is suggested that for corridors of educational facilities to have a minimum illuminance value of at least 10 fc. This suggestion fits in to the design criteria for the Gallery space in the Bahen Centre. For such a space, the guide suggests that color appearance and daylight integration to be very important. This is because the corridor is a space where people pass by each other constantly. Color rendition of faces must be considered in order to avoid making a corridor seem like a cold dark tunnel. It also suggests that lighting the point of interest as an important design factor. This design criteria is crucial due to the fact that the corridor is a transportation routes for people throughout the building, where with the correct lighting, it will lead the people to their destinations.

The design criteria for Lecture Halls #1210 are related to those given for the task of general reading. The IESNA states that for reading ball point written tasks (for students taking notes in class), it is recommended that there should be a minimum of 30 fc illuminated on the task. Issues such as shadows and uniformity are of medium importance. However, reflected glare issues should be considered heavily because it can affect one's ability to read their tasks in the lecture room, especially for prolong periods of time. This issue may be magnified due to the fact that the Lecture Halls are lit with incandescent MR16 fixtures, which can cause spottiness and excess glare on the tasks. The same criteria can also be applied to the Meeting Room #4287, which has a similar function as the Lecture Hall and uses the same incandescent lighting fixture. However, vertical illuminance will be more important in this space since vertical visual displays (charts, projector screens, etc) are often utilized in this type of meeting space. Also, facial appearance is an important design criterion in the meeting space. People spend a lot of time interacting in this space, therefore lighting the face properly will be a high priority for this space.

Power Allowance:

According to ASHRAE/IESNA Standard 90.1, 1999, different spaces with their purposes and tasks are given a power allowance. Listed below is the range of power allowed in the four spaces used for redesigning (from IESNA Space by Space Method Table 9-B, and Outdoor Space Table 9-C). Each list will also state the importance of these values how these numbers relate to each of the four spaces.

- Conference, meeting, multipurpose: 1.5W/ft^2
    - Sufficient lighting is important for this space in order to provide good illuminance to the task and correct color rendering of the occupants face.

- Classroom, lecture hall: 1.4 – 1.6 W/ft^2
    - Sufficient power is needed to provide lighting that is comfortable for the occupants yet still be bright enough for writing and reading tasks.

- Corridor: 0.5-1.6 W/ft^2
    - A smaller power allowance is given for this space because the task is simply walking, thus not requiring as much light compared to more detailed tasks.
    - Daylight in corridor spaces will help lower the amount of power needed to light the space during the day.

- Building entrance without canopy: 33W/linear foot of door width

Part 3 - Evaluation of existing lighting conditions

Evaluation of building (in general):

The use of mostly fluorescent and compact fluorescent fixtures throughout the building creates and opportunity for the building to save a tremendous amounts of power. Aesthetically, the fluorescent lighting provides the building with a modern, clean, high-tech feeling, which suits the purpose of this stylish information technology building. The use of simple shaped luminaires creates a lighting design that is functional yet does not take away too much attention from the architectural details of the building.

Evaluation of Gallery:

The lighting used in the Gallery (corridor) is very suitable as it is bright enough for the given task yet aesthetically pleasing to look at. The layout of the pairs of compact fluorescent fixtures creates a continuous line through the space, leading its occupants through the corridor space from one end to the other. The cylindrical fixture also creates a pleasing effect when viewed from the outside of the building during the night. It catches the attention of pedestrians walking by, yet not too prominent to become distracting.

Evaluation of Outdoor Courtyard:

Lighting of the outdoor courtyard space is acceptable because it provides the basic illuminance level suggested by the IESNA for an outdoor space. However, the lighting does not highlight the water feature enough to make it a center of attention. Without the dramatization of the outdoor space, it will just look like a dark space outside the building.

Evaluation of Lecture Hall#1210 and Meeting Room#4287:

Lecture Hall Lighting Power Consumption:
Room Area = 28.31ft x 45.93ft = 1300ft^2
Fixture type VA1: 55 x 50W = 2750W
Fixture type FF1: 3 x 68W = 204W
Total Lighting Power = 2954W
Power Density: 2954/1300= **2.27W/ft^2**

The lighting power density in the Lecture Hall #1210 is over ASHRAE/IESNA Standard 90.1, which suggests a maximum of 1.4 – 1.6W/ft^2. This is probably because incandescent fixtures are used in this space, and it takes many of them to illuminate the space to the desire illuminance level therefore consuming more power than for example, fluorescent fixtures, would. A similar problem will be experienced with Meeting Room #4287 because it uses the same type of light source in similar configuration.

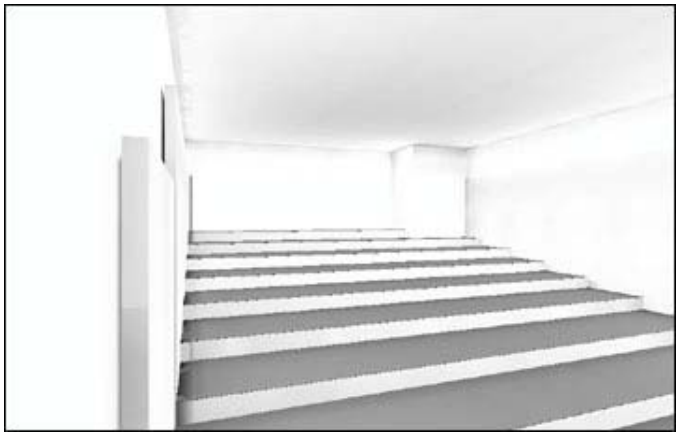

Figure 12 – Rendering of Lecture Hall Space using Luxicon

The lighting used in the Lecture Hall and Meeting Room may not be very appropriate for the use of this space in terms of visual appearance and uniformity. The use of that many incandescent MR16 fixtures in one space can create uneven lighting patterns, not to mention glare issues and extra heat gain. MR16 downlights installed at the given ceiling

height of the Lecture Hall and Meeting Room may not provide the amount of light needed to satisfy the IESNA's suggestion of at least 30fc on the task plane.