16.0
LIGHTING

"Thin floor plates allow light into the building from both sides. This is very different from a typical Vancouver office building where you have light in one side and a core on the other. It allowed us to maximize daylight and natural ventilation while working with the structural capacity of glulam structure."

– Z Smith, Architect, Perkins+Will

LESSONS LEARNED

Design tenants spaces early

Consider impacts and alternative for shading options

Coordinate structural design and daylighting

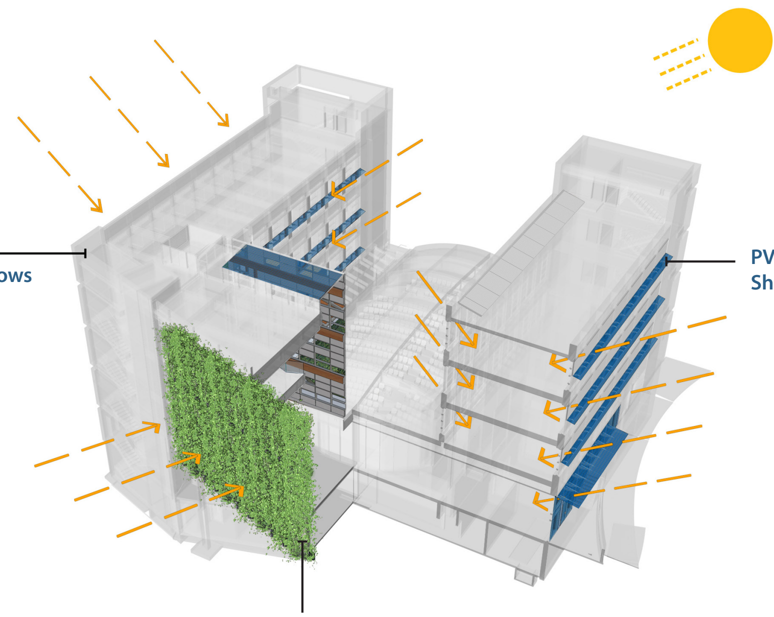

Image 16.1 Daylighting Diagram

16.1 System Overview

One of the original goals of the CIRS project was to create a building that was 100 per cent daylit. The building orientation and programming directly reflect the site's daylight opportunities and the varied lighting needs throughout the building. The structural system permits a large amount of glazing in the façades and allows windows to be located as high as possible, which in turn allows a deeper penetration of daylight into the interior spaces. Building elements, such as the solar shades, the spandrel panels in the glazing system and the living wall are designed to control glare and heat gain.

The daylighting strategy is supplemented by a variety of artificial lighting strategies, depending on the use and illumination needs of the space. In regularly inhabited spaces, artificial lights have both daylighting dimming sensors and motion sensors, limiting unnecessary use. Distinct spaces have specialized lighting controls, allowing inhabitants to adjust the level of illumination minimizing the use of artificial lighting. Efficient fixtures were chosen to further reduce lighting loads and building energy consumption.

1.0 Executive Summary
2.0 Project Background & Overview
3.0 Vision & Leadership
4.0 Goals & Targets
5.0 Partnerships
6.0 Research
7.0 Building Design
8.0 Design Process
9.0 Structural System & Wood
10.0 Building Materials
11.0 Energy Systems
12.0 Rainwater System
13.0 Reclaimed Water System
14.0 Landscape & Site
15.0 Living Roof & Living Wall
16.0 Lighting
16.1 Overview
16.2 Description
16.3 Campus Context
16.4 Goals & Targets
16.5 Benefits
16.6 Challenges
16.7 Lessons Learned
17.0 Ventilation
18.0 Building Rating Systems
FUTURE SECTIONS TO BE ADDED:
19.0 Monitoring & Measurement
20.0 Construction
21.0 Commissioning & Performance Testing
22.0 Inhabitants vs. Occupants
23.0 Community (food...)
24.0 Operations & Maintenance
25.0 Continual Evaluations

AGENTS

Architects: Perkins + Will

Electrical/Mechanical Engineers: Stantec

16.2 System Description

CIRS is designed to harvest natural daylight in all interior spaces and aims to use no artificial lighting during daylight hours in all occupied spaces. Different passive strategies are employed in different spaces, including shading strategies to reduce glare and heat gain. The effectiveness of the original design was compromised somewhat during the development of the project. The exterior blinds were removed due to cost constraints and user needs required significant interior partitions. The change increased the use of artificial lighting, but excellent daylighting is still maintained.

Image 16.2 Lighting Diagram for the Office Blocks

Office Blocks

The office spaces are situated in two blocks with narrow floor plates, only ten meters wide. Windows on the long façades are oriented north and south. The structural moment frame is designed to allow for large expanses of glazing in the exterior walls, with windows extending close to the underside of the floor plate. These high windows allow daylight to penetrate deeper into the interior space. Fixed exterior solar shades are mounted at a height of two meters to provide shading for work surfaces and a mounting surface for photovoltaic cells. The original operable exterior blinds were replaced by interior window blinds. This solutions still provides shading while controlling glare and solar heat gain.

The design criteria for illumination levels in the original open plan office space was 300 lux (30 foot-candles), with task lighting installed where necessary. A series of reflective surfaces, 1830 x 1830 mm (6x6 foot) flat panels of acoustic tiles called reflective clouds, are mounted to the underside of the ceiling. The reflective clouds reflect and disperse the light throughout the space, reducing glare and eliminating distracting shadows. Two T5 fluorescent lighting fixtures projecting upwards are mounted below each surface.

As programming was confirmed, the lighting strategy was modified to accommodate specific tenant needs. The installation of interior partitioning to create private offices, though glazed, has reduced the amount of daylight available to the space, and changed the artificial lighting strategy. Each closed office has one T5 high output fluorescent lighting fixture, projecting upwards to a reflective cloud. The current fixtures are brighter than the ones in the old design and require more energy to operate. The overall illumination level is 205 lux (19 foot-candles) and task lighting will likely be required.

Modern Green Development Auditorium

Daylighting in the Modern Green Development Auditorium is provided by two skylights running the length of the theatre above the aisles on either side of the seating area. The light from these skylights washes the side walls of the theatre, creating diffused light in the space. The projection area at the front is recessed and dark so that lectures and presentations can occur while maintaining visibility in the seating area. Automated blackout curtains are provided for occasions were absolute darkness is required.

The general artificial lighting in the Auditorium is a combination of diffused fluorescent strip and recessed luminaires, with recessed light fixtures along the side walls. These are wired to allow a wide variety of lighting configurations, both at the front of the theatre and throughout the seating area. The switch program is operated by UBC Classroom Services to provide different standard settings corresponding to different types of expected presentations and events, which can be changed or specialized at any time.

Atrium

Controlling glare and heat gain is most challenging on the western façade of a building. The atrium and social spaces at CIRS are located against the western side of the building. The atrium forms an open space spanning all the floors of the building and is topped by a large skylight that is shaded by photovoltaic cells. The space experiences fluctuating temperatures and light levels. Randomly patterned spandrel panels in the glazing and the planting on the exterior living wall provide shading and limit the glare and heat gainfrom sunlight. The living wall, a three-story screen of vines, will provide variable shading throughout the year, allowing more light in during the dark winter months and less during the bright summer ones.

There are multiple artificial lighting schemes in the atrium. General lighting, in the form of recessed luminaires, is provided on each floor and controlled by one illumination level sensor for the entire atrium. The stairs are lit by linear lighting fluorescent fixtures. A display wall is lit by special LED lights. Three feature light fixtures are hung in the middle of the atrium.

Service Spaces

The service spaces in the building have artificial lighting designed to meet building code. In spaces with varying levels of use, the washrooms for example, the lights have motion sensors. The exit stairs of the building are daylit with supplemental artificial lighting. Budget constraints required a single circuit design in stairwells so all artificial lighting is either on or off. The lower, darker stairwell areas near the basement require higher levels of illumination than the higher, brighter areas, resulting in some unnecessary artificial light.

Modelling

Both physical models and computer modeling programs were used to test the lighting strategies for CIRS. Various combinations of glazing and shading devices were compared, and interior light levels were measured for optimum illumination. The modeled energy consumption for lighting is 15.7 kilowatt hours per meter squared per year (kWh/m2/yr), 56 per cent less than the reference case at 36 kilowatt hours per meter squared per year (kWh/m2/yr).

PROCESS

Design process:

A dedicated daylighting charrette and the subsequent integrated design process developed complementary passive and artificial lighting strategies.

Construction:

Passive design elements and artificial lighting systems were installed as part of the construction of the base building.

Commissioning:

Operations:

Inhabitants can control daylight in their spaces through operable shades and artificial lighting through highly specific switching. Motion and illumination levels sensors, as part of the building monitoring system, limit unnecessary use.

COSTS

Costs will be added in a future update

16.3 Campus Context

UBC Campus Plan

The UBC Campus Plan places a strong emphasis on lighting, mainly in the campus public realm context, in addition to individual buildings. It is hoped that the implementation of the UBC lighting Strategy for the campus, will stimulate improved lighting across the campus, consistent with the University's identified needs.
The desire for improved daylighting is directly related to UBC's integrated approach to energy planning, whereby new projects are required to incorporate strategies that reduce energy demand and carbon emissions. Specialised lighting strategies can contribute towards these sustainability goals such as the passive daylighting design and automated light-level fixtures installed at CIRS.

UBC Campus Plan, Part 2

UBC Design Guidelines

The UBC Design Guidelines provide direction on daylighting to encourage the sustainable design of new buildings on campus. Passive lighting design strategies are strongly emphasized, including maximizing daylighting for interior occupied spaces, while addressing glare, heat gain and insulation.

Windows are expected to provide a connection between the inhabitants of the building and campus community; providing views and incoming daylight, while creating an open transparent presence on campus.

UBC Design Guidelines, Part 3, 2.3.5 Architectural Expression (p14-16) and 2.3.10 Sustainability Best Practice in Design (p 18-20), 3.1 Campus Core District (p.45-47)

Buildings on campus are expected to consider the appropriate glazing response according to façade orientation. The Design Guidelines suggest that east and west elevations should minimize un-shaded windows, particularly the west elevation which contributes to significant undesirable afternoon and evening solar gain. These considerations pertain to reduced lighting needs and the associated carbon and energy savings.

UBC Design Guidelines, Part 3, 2.3.10 (b i)

Furthermore, the UBC Design Guidelines encourage reduced energy need by specifying that buildings with extensive glazing on any given façade are to consider strategies such as high performance glazing, shading devices or buffer spaces.

UBC Design Guidelines, Part 3, 2.3.10 (b ii)

The UBC Design Guidelines also make recommendations for reducing exterior light pollution. Lighting must follow best practices by limiting illumination at night, considering maintenance, durability and reliability, and anticipating future technology improvements where possible.

UBC Design Guidelines, 2.5.2 (d) pg 32

16.4 Goals and Targets

Table 16.1 lists the project goals and targets specifically related to the lighting strategies. For a complete list of all the goals and targets for CIRS, refer to Section 4.0 Goals & Targets.

Category	Goals	Targets
5 - SUPPLY SYSTEMS	Supply all building energy requirements from on-site sustainable and renewable energy sources.	Direct energy consumption target: Meet and exceed the best achieved to date for comparable uses (< 75kWh/m2/yr. overall, 15 kWh/m2/yr. for heating)
	Achieve net positive energy performance.	Reduce energy loads.
	Be greenhouse gas emission neutral.	
6 –ENERGY REDUCTION	Design CIRS to be as simple and passive as possible.	
7 - ENERGY REDUCTION LIGHTING	CIRS will integrate daylight systems that provide 100 per cent of the illumination required through the building during the day to minimize lighting power consumption at other times.	Maximize lighting power density (LPD).
14- DAYLIGHTING	CIRS workspaces will be 100 per cent daylit and provide connection to the natural world through views.	
17 - COMFORT & CONTROL	Provide local control over comfort conditions to adapt to individual differences and differing inhabitations.	

Table 16.1 Goals and Targets for the CIRS lighting system.

RATING SYSTEMS

The lighting strategies used in CIRS contributed to the achievement of LEED credits and Living Building Challenge petals, as listed below. For more information on the ratings systems and CIRS refer to Section 19.0 Rating Systems.

LEED

Energy & Atmosphere credits:

- *Prerequisite 2 - Minimum Energy Performance*
- *1.1 – 1.5 - Optimize Energy Performance*

Indoor Environmental Quality Credits:

- *8.1 & 8.2 – Daylight & Views*

Living Building Challenge

7 – Net Zero Energy

8 – Civilized Environment

16_Human Scale & Humane Places

19 - Beauty & Spirit

RELATED SECTIONS:

3.0 Vision& Leadership

4.0 Goals & Targets

7.0 Building Design

8.0 Design Process

9.0 Structural System & Wood

17.0 Ventilation

18.0 Building Rating Systems

19.0 Monitoring & Measurement

20.0 Construction

16.5 Benefits

The lighting strategy at CIRS benefits the project in the following ways:

Improves Inhabitant Health

- Natural daylighting and views to the exterior provide a direct connection to the natural environment, which has been shown to improve the health and mood of inhabitants and increases productivity. Exposure to natural cycles of daylight is directly linked to improved sleep patterns which leads to increased energy levels, improves concentration and enhanced general wellness.

Increases Inhabitant Comfort

- Providing mechanisms for inhabitants to control the light levels (both daylight and artificial) of their personal space increases comfort while reducing energy loads across the building.

Creates Friendly Spaces

- Daylit spaces are perceived as more welcoming and comfortable than artificially lit spaces.

Reduces Energy Consumption and Cost

- Utilizing natural daylight and energy efficient fixtures can reduce the lighting load of a building, if the artificial lights are turned off or dimmed when sufficient levels of natural daylight are present in the space. Reduced lighting loads reduce the amount of energy consumed and carbon emitted, as well as the overall cost of electricity.

Provides Surfaces for Photovoltaic Cells

- The shading devices on the office windows and roof of the atrium provide an ideal surface for mounting photovoltaic cells.

Harvests Daylight

- Daylight dimming devices on fixtures reduces the use of artificial lights when they are not required, and helps take full advantage of the daylight in the building.

16.6 Challenges

The lighting strategy at CIRS was challenging for the project in the following ways:

Balancing Light Levels with Comfort

- Appropriate levels of shading are imperative to create comfortable interior environments that are conducive to working while still maintaining a friendly, welcoming building.

Designing Western Façades

- Controlling glare and heat gain is most challenging on the western side of any building, due to low sun angles that shift throughout the year. Programmatic spaces located on the west side of the building must be capable of handling a range of internal temperatures and light levels.

Providing Daylighting within Closed Offices

- Closed offices can create less than ideal lighting requirements. If the interior partitions area solid they limit the extent of daylighting in the interior spaces, if they are transparent, they may not provide adequate levels of privacy. Division of interior space necessitates increased amounts electrical lighting which raises the internal temperatures and further effects energy costs and environmental impacts.

High Cost of Effective Shading Systems

- Effective shading systems can represent significant costs. Interior blinds are less effective at controlling heat gain, and providing optimum light levels.

Accommodating Task Lighting

- Clear specifications must be provided for tenant supplied supplementary task lighting to ensure energy efficiency while still meeting required illumination levels for comfort and productivity.

Designing Appropriate Circuits

- Controlling lights on the same circuit in areas of varying daylight levels can be challenging. Artificial lights may become unnecessary in well-daylit areas or be insufficient in poorly daylit areas.

16.7 Lessons Learned

The experienced gained through the lighting strategy at CIRS provided valuable lessons to apply to future projects. Some of the key lessons are:

Design Tenants Spaces Early

- Understanding how tenants will actually use the space, especially the way in which the space will be subdivided, is critical in ensuring that both adequate lighting levels are provided and that the system will meet the energy targets for the building.

Consider Impacts and Alternative for Shading Options

- Removing certain components from the design of the building to reduce costs can have significant and potentially more costly implications on long term functionality and operations.

Coordinate Structural Design and Daylighting

- Emphasis on daylight considerations in structural design is key to a robust and innovative daylighting strategy.

16.8 Future Learning

Additional lessons learned over the operational life of the building will be added at periodic intervals

RESOURCES:

- *Diagrams links*
- *Drawings links*
- *Perkins + Will: www.perkinswill.ca*
- *Stantec: www.stantec.com*
- *UBC Campus Plan*
- *UBC Climate Action Plan: www.sustain.ubc.ca/climate-action*