

Daylighting Museums Guide

Integrated Design Lab, Bozeman, MT
Prepared by Chris Hancock, Shelby Hinchliff, and Justina Hohmann
October 6, 2009



Integrated Design Lab

Tom Wood, AIA

Operated by Montana State University

Bozeman, MT

406-994-4934

twood@montana.edu

www.idlbozeman.com



The work of the Integrated Design Lab-Bozeman is supported by the Northwest Energy Efficiency Alliance and NorthWestern Energy.

Table of Contents

Introduction	3
Why Daylight?	4
How to Daylight a Museum	5
Rules of Thumb	6
Generic Sections for Daylighting a Gallery	7
Lighting Art and Artifacts	8
<u>Examples and Case Studies</u>	
Art Institute of Chicago, Modern Wing	10
Audrey Jones Beck Building, MFA	9
Beyeler Foundation Museum—case study	13
Gulf Coast Museum of Art	11
High Museum of Art: Atlanta—case study	14
Kimbell Art Museum	3
MASS MoCA	4
Musée Archeologique	9
Museu de Serralves	12
National Gallery of Canada—case study	15
North Carolina Pottery Center	5

Integrated Design Lab, Bozeman, MT

Introduction

In the push towards sustainability and green design, daylighting is becoming critical to energy efficient design. In most situations daylight can be easily incorporated into building designs, however museum designs provide a special challenge. Unlike most building situations, where direct sunlight can occasionally grace a surface, museums require that the UV exposure from direct sunlight be completely controlled in order to protect the integrity of the art and artifacts on display. The following guide created by the Integrated Design Lab – Bozeman will highlight the specific issues associated with daylighting museums, provide you with some basic rules of thumb for museum lighting, and show you some successful examples of daylight galleries. For further information, please see IESNA *Museum and Art Gallery Lighting: A Recommended Practice* (RP-30-96).

Kimbell Art Museum

Fort Worth, Texas Louis Kahn



<https://www.kimbellart.org/MuseumInfo/Architecture/Tour-Building.aspx>

“So this is a kind of invention that comes out of the desire to have natural light. Because it is the light the painter used to paint his painting. And artificial light is a static light . . . where natural light is a light of mood . . . the painting must reveal itself in different aspects if the moods of light are included in its viewing, in its seeing. I think that’s the nature, really, of a place where you see paintings.” —Louis Kahn, *Light is the Theme*.

Why Daylight?

- While the daylighting of museums poses a unique and complex design problem, it is a surmountable challenge. Many design teams have successfully incorporated daylight into galleries while simultaneously accommodating the particular needs of the artifacts on display. In fact, daylight provides better color rendering than electric lights, meaning that artifacts can be observed more closely to their actual resemblance.
- Daylighting additionally provides energy savings for the museum by minimizing the amount of electric lighting required during the day to illuminate the museum. Over a period of time, these savings can help pay back the potential additional cost of construction from daylighting.
- Finally, daylighting improves the quality of experience of the visitor by providing a connection to the outside and showing the passage of time as the light changes throughout the day. The Illuminating Engineering Society of North America (IESNA) lighting guide entitled *Museum and Art Gallery Lighting: A Recommended Practice* comments that:
 Effective daylighting can provide psychological and economic benefits. Psychologically, daylight is ever-changing and a constant source of visual interest. Although daylight is generally more expensive to control than electrical light, energy costs can be substantially reduced if daylight's use is well-planned. Poorly conceived use of daylight can result in high construction and energy costs, glare increased noise, condensation, leakage, and, most importantly, artifact degradation. (p. 34)

MASS MoCA

North Adams, Massachusetts Bruner / Cott



Polidori, Robert. "MASS MoCA." Photograph. Trulove, James Grayson. *Designing the New Museum: Building a Destination*. Gloucester: Rockport, 2000, 29.

Integrated Design Lab, Bozeman, MT

How to Daylight a Museum

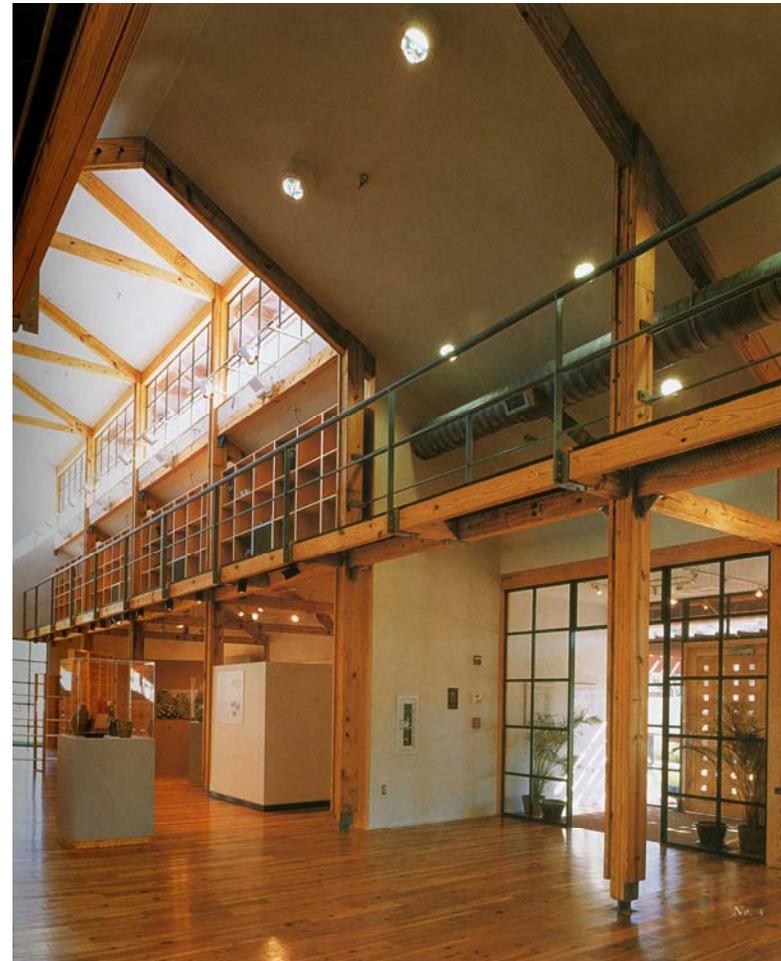
Generally, there are some basic principles to follow and aspects to consider when daylighting a museum. The following list should help get you started:

- Direct sunlight should be avoided completely in display spaces.
- UV exposure should be limited using UV filters. These filters can be built into the glazing and should be specified appropriately.
- A range of components should be considered:
 - side lighting (view windows),
 - top lighting (clerestories and skylights),
 - shading systems (interior and exterior),
 - sensors (light and occupancy), etc.
- There are 3 ways to bring daylight into a space:
 - Side lighting—windows, etc.
 - Top lighting—skylights, light wells, etc.
 - Reflected light technique—clerestories, lightshelves, etc.

North Carolina Pottery Center

Seagrove, North Carolina

Frank Harmon



West, James. "North Carolina Pottery Center." Photograph. Trulove, James Grayson. *Designing the New Museum: Building a Destination*. Gloucester: Rockport, 2000, 103.

Rules of Thumb

The following rules of thumb from the IESNA *Museum and Art Gallery Lighting: A Recommended Practice* (p. 33) will help you in designing for daylighting in museums:

- Exhibit luminance should be no more than five times the luminance of the surrounding area (5:1).
- The visitor should spend from five to eight minutes in transitional areas.
- Window walls should face north in the northern hemisphere.
- Glazing should eliminate all wavelengths below 400 nm.
- Illuminances within a space should remain within the guidelines outlined in the **Table 3.1** [see table to the right]. This could result with glazing transmittance of less than five percent of the visible and solar energy.

TABLE 3.1
Recommended Total Exposure Limits in Terms of Illuminance Hours Per Year to Limit Light Damage to Susceptible Museum and Art Gallery Artifacts

Note: All ultraviolet radiation (400 nm and below) should be eliminated.

Types of Materials	Maximum Illuminance (Neither value should be exceeded)	Lux-Hours/Yr
Highly susceptible displayed materials: textiles, cotton, natural fibers, furs, silk, writing inks, paper documents, lace, fugitive dyes, watercolors, wool, some minerals.	50 lux	50,000
		<i>Note:</i> Approximately (50 lux) × (8 hours per day) × (125 days per year). Different levels (higher or lower) and/or different periods of display (4 hours for 250 days) may be appropriate, depending upon material. If in doubt, consult a conservator.
Moderately susceptible displayed materials: textiles with stable dyes, oil paintings, wood finishes, leather, some plastics.	200 lux	480,000
		<i>Note:</i> Approximately (200 lux) × (8 hours per day) × (300 days per year). Lower levels may be appropriate, depending upon material. If in doubt, consult a conservator.
Least susceptible displayed materials: metal, stone, glass, ceramic, most minerals.	Dependent upon exhibition situation.	

IESNA *Museum and Art Gallery Lighting: A Recommended Practice*, p.14.

Generic Sections for Daylighting a Gallery

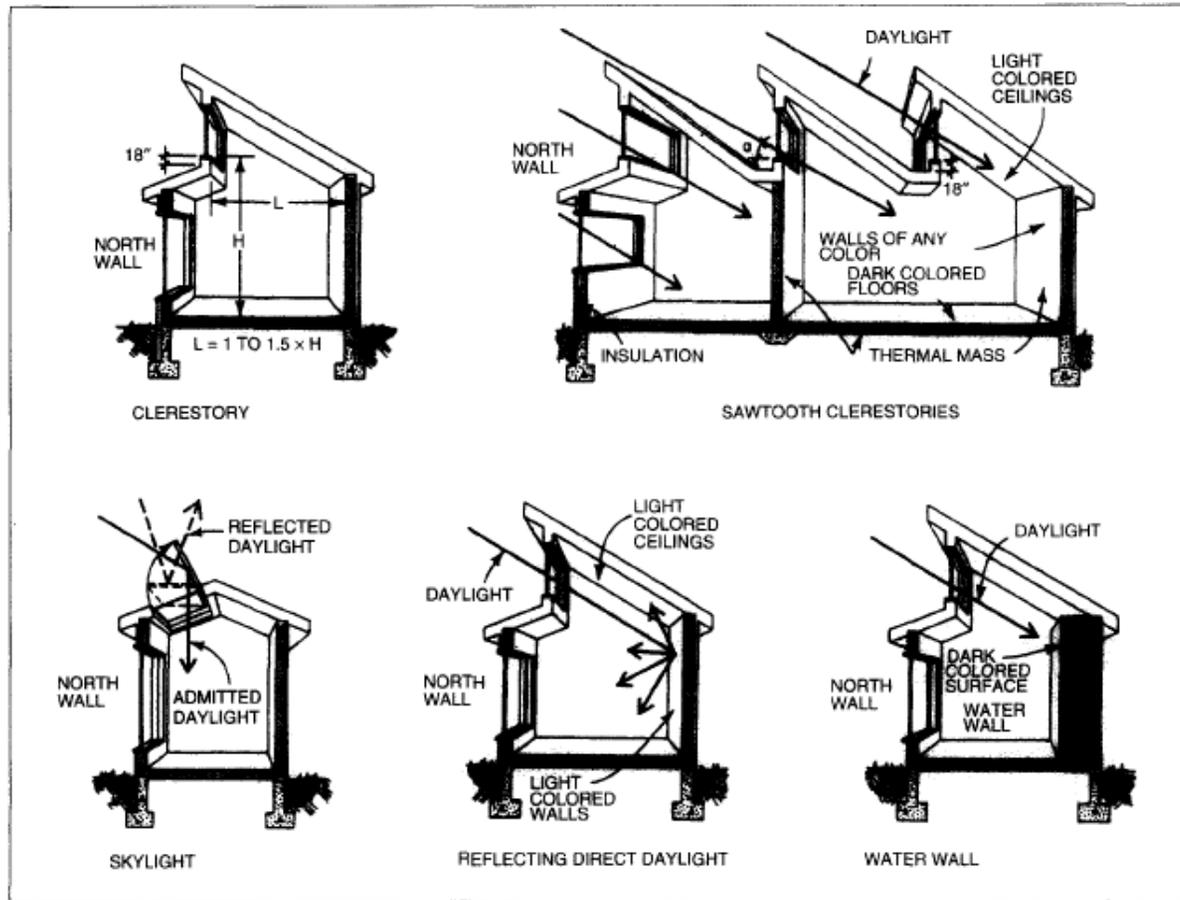


Figure 5.1. Multiple architectural design alternatives for admitting daylight into a museum environment. (Based on: *Architectural Graphic Standards, Eighth Edition*, Hoke, John Ray, Jr., NY, 1988, The American Institute of Architects. Reprinted by John Wiley & Sons, Inc., New York, NY. p. 721.)

Lighting Art and Artifacts

Beyond lighting general circulation and gallery spaces, the art and artifacts of museums also require certain amounts and types of light. The following points should help guide you in lighting exhibits appropriately:

- When appropriately lighting an exhibit, it is important to consider not just the quantity but also the quality of the light used. In regards to color, it is important to light objects so that they bear "original appearance." Daylight assists with this because of its full color spectrum. Artificial lighting must be designed in such a way so as to incorporate this full spectrum, but this is much harder to do. See the figures to the right for details.
- Avoid lighting scenarios in the ultraviolet or infrared spectrum. All ultraviolet radiation can be filtered by selecting glazing with the appropriate specifications.
- The IESNA *Museum and Art Gallery Lighting: A Recommended Practice* suggests that:
 - "The artifact should be visible when on display. There is no point causing a little damage (with insufficient light) for no purpose (the artifact cannot be seen)." (p.1)
 - "The institution must decide how much light damage in how much time is acceptable, i.e., what lifetime is desirable." (p.1)
 - "The institution must acknowledge the sensitivity of each artifact, or group of artifacts, as accurately as possible." (p.1)

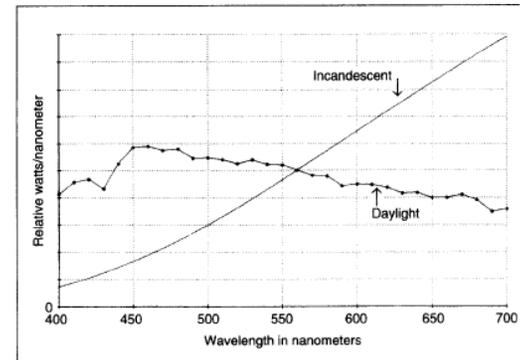


Figure 2.4. The Spectral Power Distribution (SPD) curves for an incandescent lamp (2856 K) and average daylight. All spectral colors are present in the incandescent lamp's SPD; however, compared to the SPD for average daylight, the incandescent lamp's output is weaker in the blue and stronger in the red. (Courtesy of: Dr. William A. Thornton, Prime-Color, Inc., Cranford, NJ)

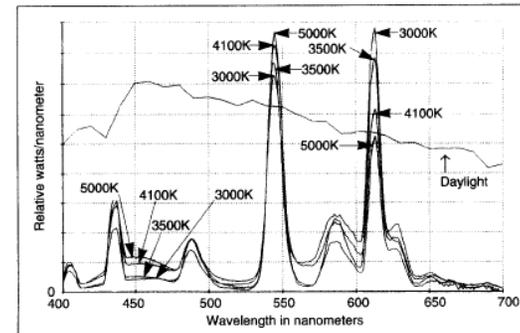


Figure 2.5. The Spectral Power Distribution (SPD) curves for four different tri-band fluorescent lamps (3000 K, 3500 K, 4100 K, 5000 K) and average daylight. (Courtesy of: Dr. William A. Thornton, Prime-Color, Inc., Cranford, NJ)

IESNA *Museum and Art Gallery Lighting: A Recommended Practice*, p. 8

Integrated Design Lab, Bozeman, MT

Audrey Jones Beck Building, MFA

Houston, Texas

Jose Rafael Moneo, Architect



Barnes, Richard. "Audrey Jones Beck Building, MFA." Photograph. Trulove, James Grayson. *Designing the New Museum: Building a Destination*. Gloucester: Rockport, 2000, 56, 57.

Musee Archeologique

Saint-Romain-En-Gal/Vienne, France

Chaix+ Morel



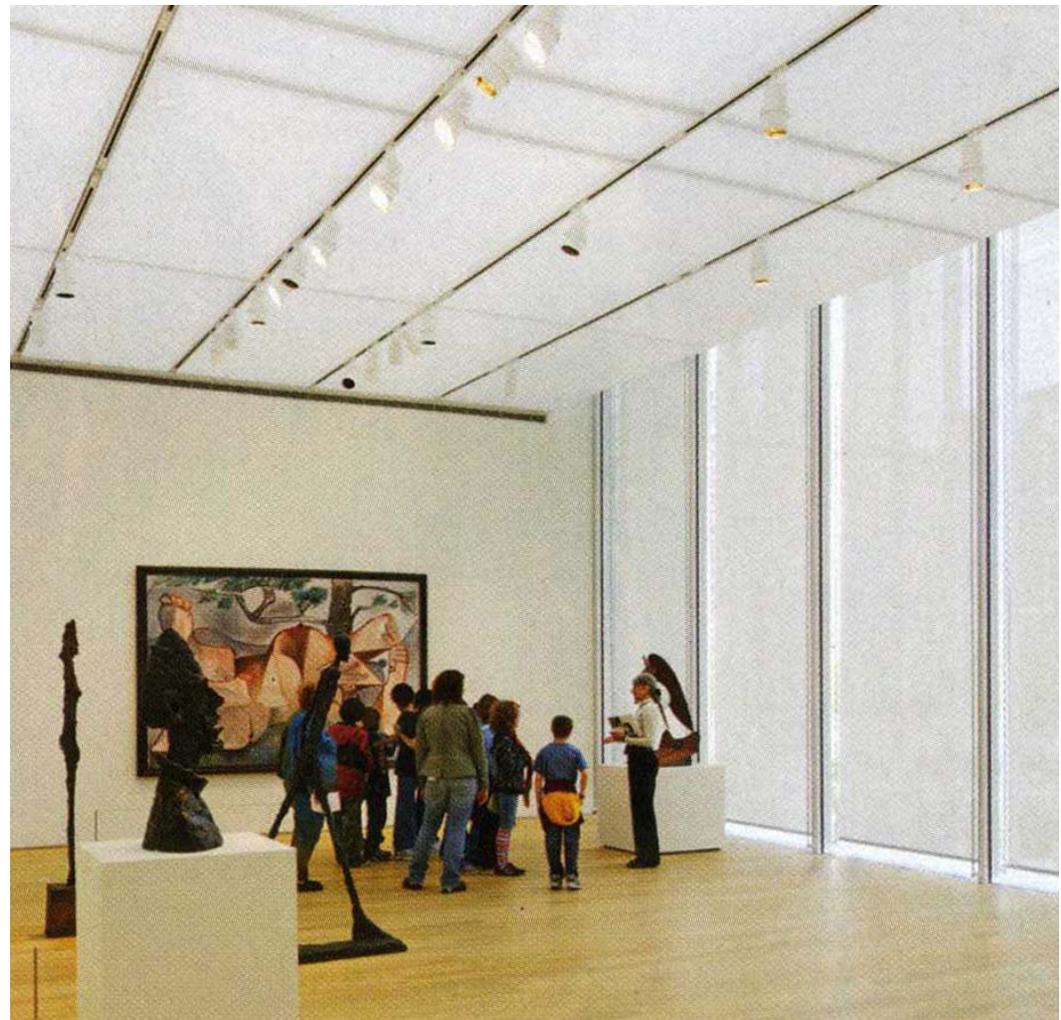
Christian Richters Photograph. "Musee Archeologique." Photograph. Trulove, James Grayson. *Designing the New Museum: Building a Destination*. Gloucester: Rockport, 2000, 152.

Integrated Design Lab, Bozeman, MT

Art Institute of Chicago, Modern Wing

Chicago, Illinois

Renzo Piano Building Workshop



Lehoux, Nic. "The Art Institute of Chicago's Modern Wing." Photographs. Minutillo, Josephine. "The Art Institute of Chicago, Illinois." *Architectural Record* August (2009): 55, 58, 59.

Integrated Design Lab, Bozeman, MT

Gulf Coast Museum of Art

Clearwater, Florida Thompson and Rose

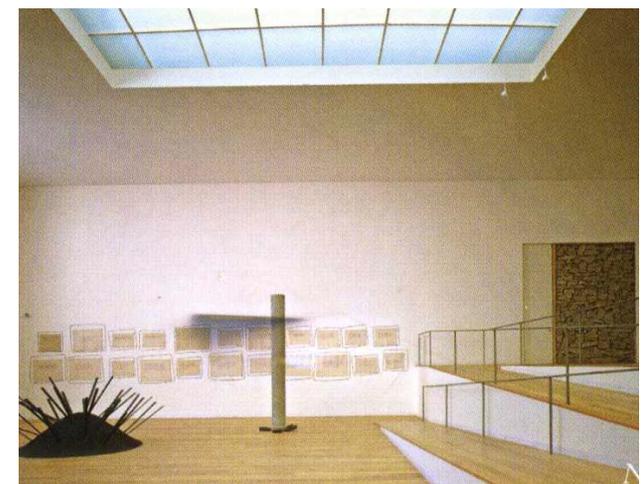


Choi, Chuck. "Gulf Coast Museum of Art." Photograph. Trulove, James Grayson. *Designing the New Museum: Building a Destination*. Gloucester: Rockport, 2000, 84, 85.

Integrated Design Lab, Bozeman, MT

Museu de Serralves

Oporto, Portugal Alvaro Siza, Architect

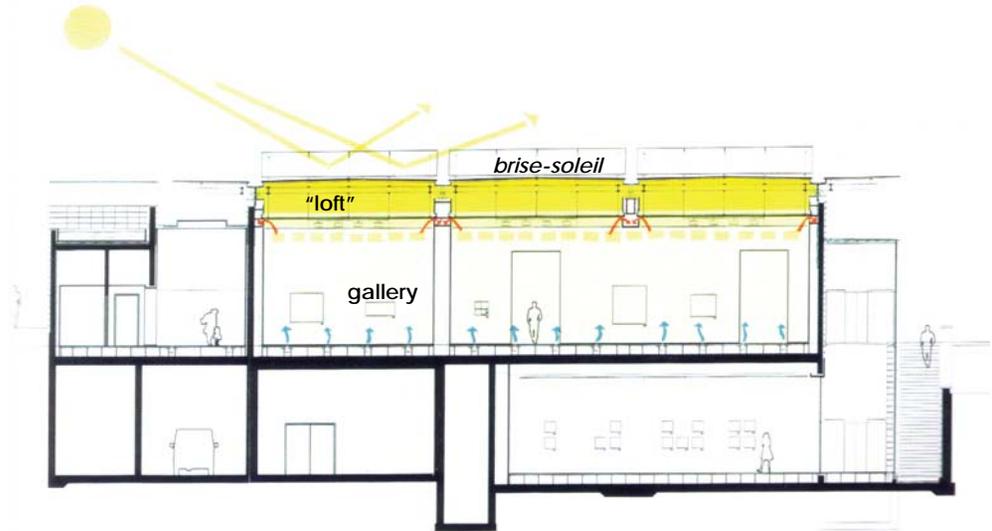


Christian Richters Fotograf. "Museu de Serralves." Photographs. Trulove, James Grayson. *Designing the New Museum: Building a Destination*. Gloucester: Rockport, 2000, 78, 79.

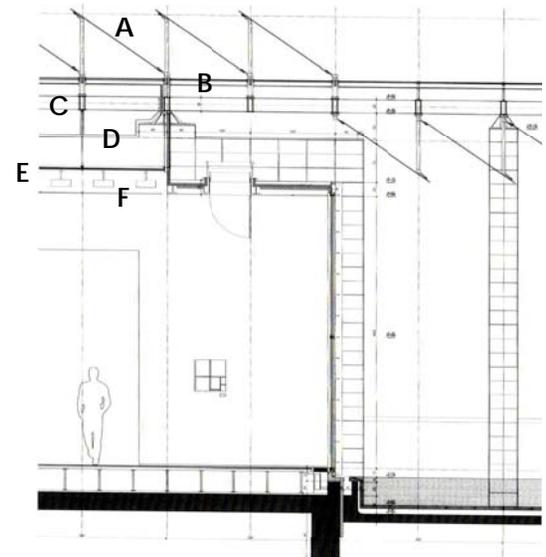
Integrated Design Lab, Bozeman, MT

Beyeler Foundation Museum

Basel, Switzerland Renzo Piano Building Workshop



- A** *brise-soleil*
fritted glass inclined and positioned to prevent direct sun penetration and maintain optimum admittance of diffused light
- B** weatherproof layer
double glazed skin with an ultraviolet filter that removes the parts of the electromagnetic spectrum most likely to damage the artwork
- C** computer motorized aluminum louvers that control light levels in each room
- D** "loft thermal buffer zone"
louver system lies in this zone between the ceiling and the roof, combined with brise-soleil prevents 98% of incident solar radiation from reaching the spaces below
- E** laminated glass ceiling
designed to support maintenance access to the louver motors and electric lights
- F** grid of perforated metal panels
incorporates a paper that diffuses the light once more and hides the "loft"



Integrated Design Lab, Bozeman, MT

High Museum of Art: Atlanta

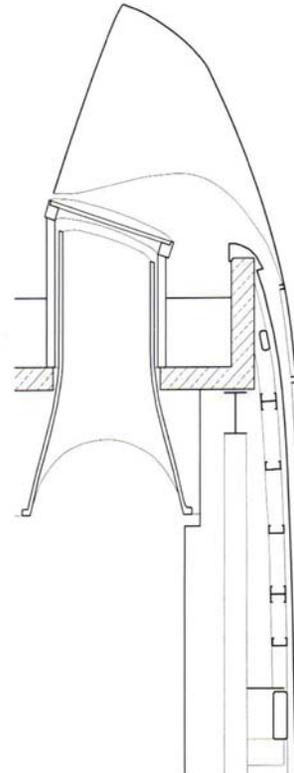
Atlanta, Georgia Renzo Piano Building Workshop



Aerial view of the 1000 skylights atop the High Museum of Art



Entrance to the addition of the High Museum with the rooftop "sails"



Section through one of the "sails" and skylight



Interior of a top floor gallery naturally lit by 1000 skylights

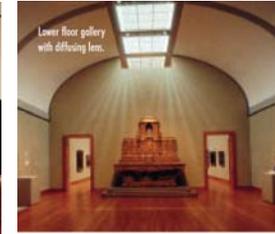
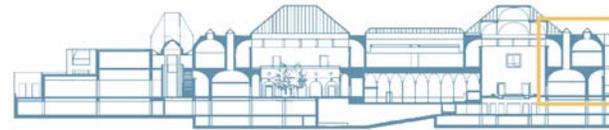
- The original High Museum of Art in Atlanta was designed by Richard Meier, this addition was designed by the Renzo Piano Building Workshop, and built in 2005.
- Rooftop "sails" funnel soft northern light into the galleries through cone shaped openings.
- Each mini skylight twists slightly to focus the light and diffuse it through the top floor galleries housing the museums permanent collection.

Integrated Design Lab, Bozeman, MT

National Gallery of Canada

Ottawa, Ontario 1988

Moshe Safdie



Daylighting Features of the National Gallery of Canada

- 1 **Skylights** In order to minimize heat loss, skylight consists of clear thermopane assembly with low E coating and width is limited to six feet
- 2 **Motorized Roller Blinds** Fabric roller blinds mounted on the inside of each skylight above the galleries are controlled automatically by a photosensor located in the skylight in order to maintain desired light levels
- 3 **Reflective Light Shaft** Six foot wide mirror-lined shafts extend 25' from the upper floor to the lower to propagate light to lower-level rooms
- 4 **Prismatic Diffuser Lens** Prismatic acrylic lens at ceiling level helps to diffuse daylight across the lower gallery
- 5 **Automated Blinds** In side galleries, daylight is brought in through a vertical clerestory with automated blinds mounted on the interior of the clerestory
- 6 **Fixed Louvers** Wide aluminum louvers, installed at a fixed pitch to prevent direct sunlight penetration, are mounted inside the clerestory of the side galleries
- 7 **Electric Lights** Most of the electric lights in the galleries are spotlights linked to a building management system where curators can decide when to turn the lights on or off, based on scheduling, season, time of day, and curatorial specifications

