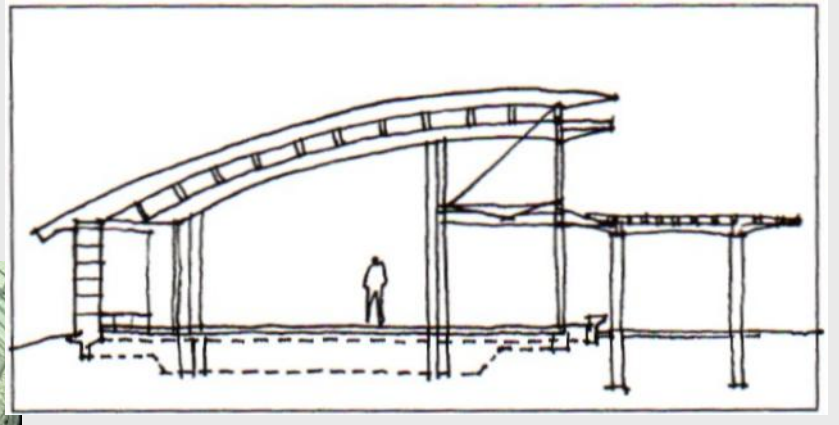
DAYLIGHT

Toplighting Strategies

M. Kroelinger

ABS 731 Spring 2006



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Outline

- Characteristics
- Skylights
- Sawtooth
- Roof Monitors
- Lightwells
- Atria & Lightcourts
- Summary; Q&A

Toplighting Characteristics

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- Of minimal use in tall buildings because you can distribute only a couple of floors.
- Freedom to place “source” where desired.
- Can achieve uniform illumination if needed.
- Solutions have to be different for each building type & location.
- Bring daylight in from above to obtain deeper penetration into space.

Toplighting Characteristics

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- Optimizing relationship between lighting & HVAC under wide daily & seasonal variations in sunlight a problem.
- Direct sunlight can be a plus or a minus.
- Can be oriented to sky vault or to horizon, depending on strategy.
- Can distribute daylight over a greater horizontal area than sidelighting.
- Better than sidelighting under overcast skies

Atrium of Center for British Art & Studies, Louis Kahn, New Haven, Connecticut

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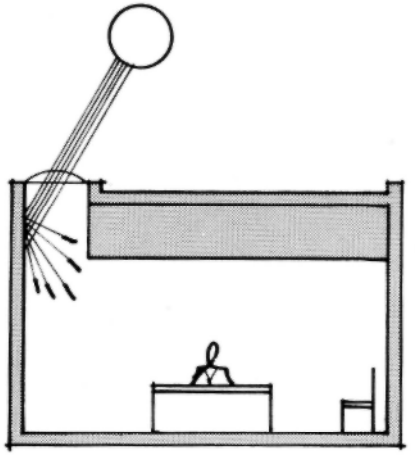
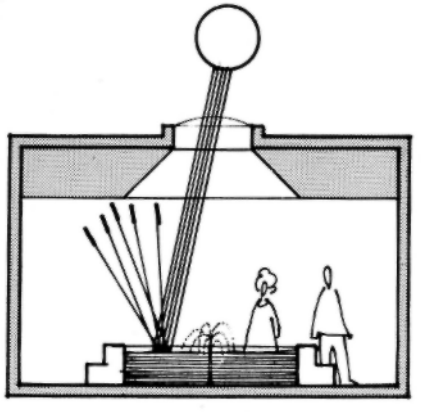
Skylights

- Provide a relatively uniform level of illuminance.
- Used to illuminate horizontal work planes.
- Excellent for general illuminance & for lighting 3D artwork or objects.
- Can introduce considerable heat gain in summer.



7–13. Locate skylight to illuminate walls.



7–14. Reflecting pools, sculptures, or polished floors can be used to redirect sunlight to the ceiling.

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Skylights

- Need to understand differing effects of clear vs. translucent glazing.
- Splaying the skylight opening can increase horizontal distribution.
- Available in standard & custom sizes from many manufacturers.
- Sound choice for high security & windowless spaces.

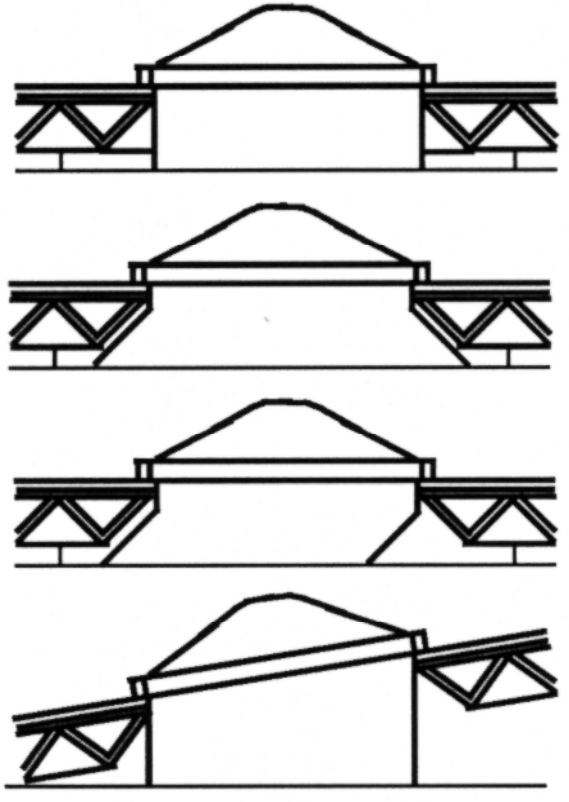

Fig. 64: Types of light wells for skylights (adapted from AAMA, 1987).

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Skylights

- Basic shapes:
  - Flat
  - Bubble
  - Dormer
  - Pyramid
  - Ridge
- Can be combined with internal modifiers to re-direct light which can reduce contrast & glare.

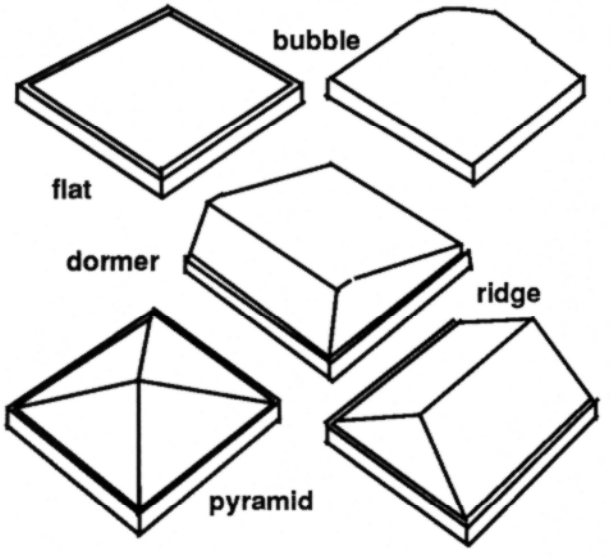


Fig. 63: Basic skylight shapes (adapted from AAMA, 1987).

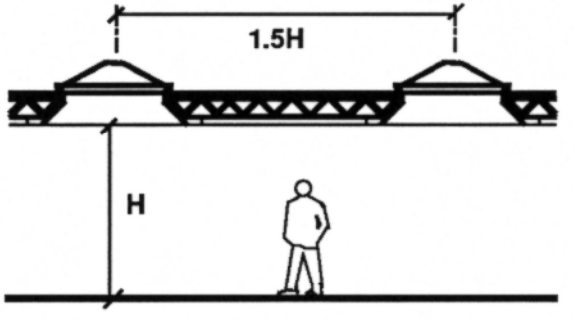
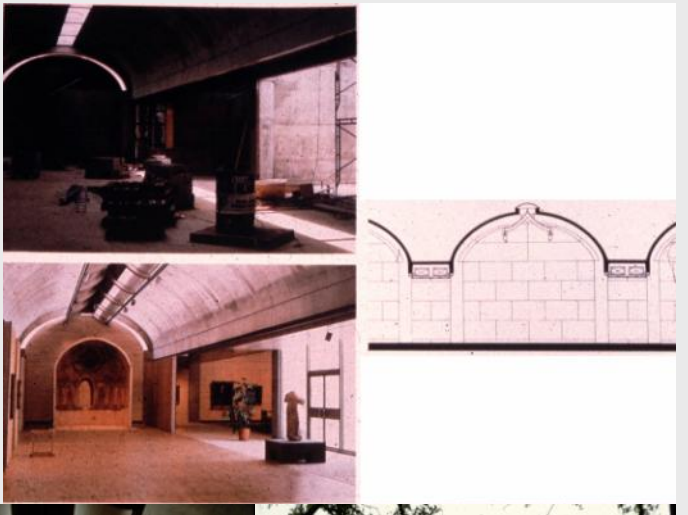


Fig. 65: Rule-of-thumb spacing for skylights (adapted from AAMA, 1987).

Case Study: Kimbell Art Museum

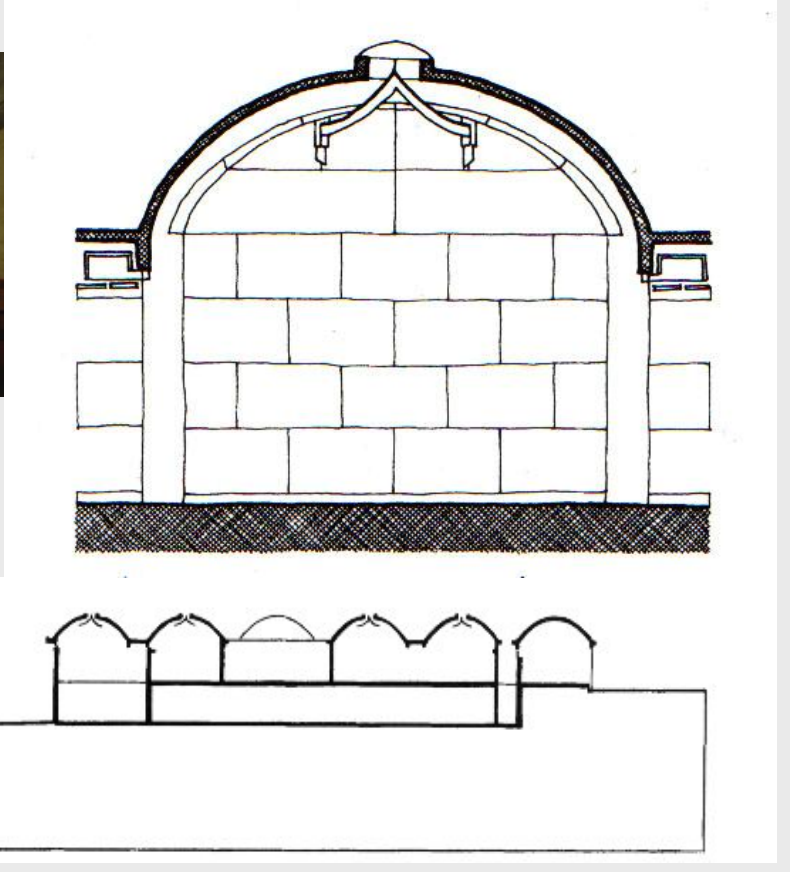
DAYLIGHT

- Fort Worth, Texas, USA
- Louis I. Kahn, Architect
- Reflected light across concrete vaults
- Internal reflector suspended below ceiling.
- Much use of bounced light.
- Courts for borrowed light.
- Changing of seasons
- Linear form



Case Study: Kimbell Art Museum

DAYLIGHT



Case Study: High Museum of Art

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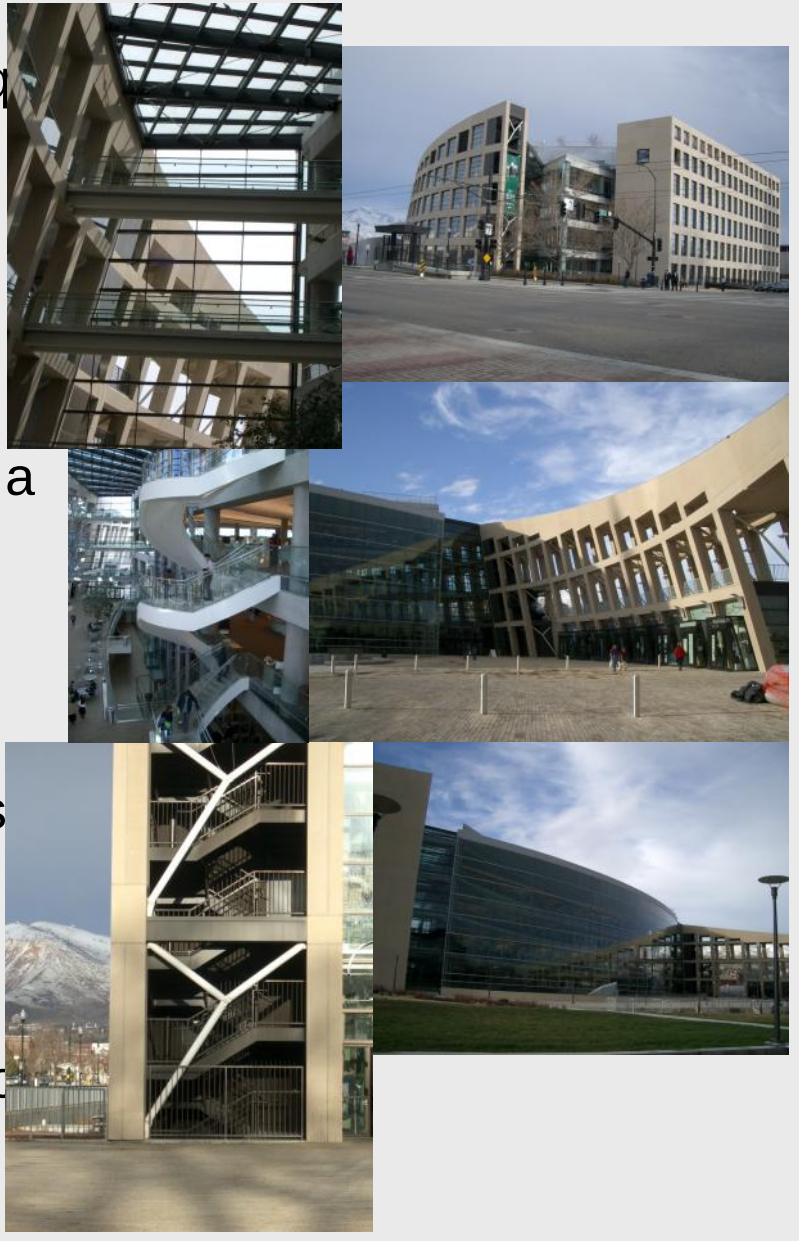
Case Study: Salt Lake City Public Library

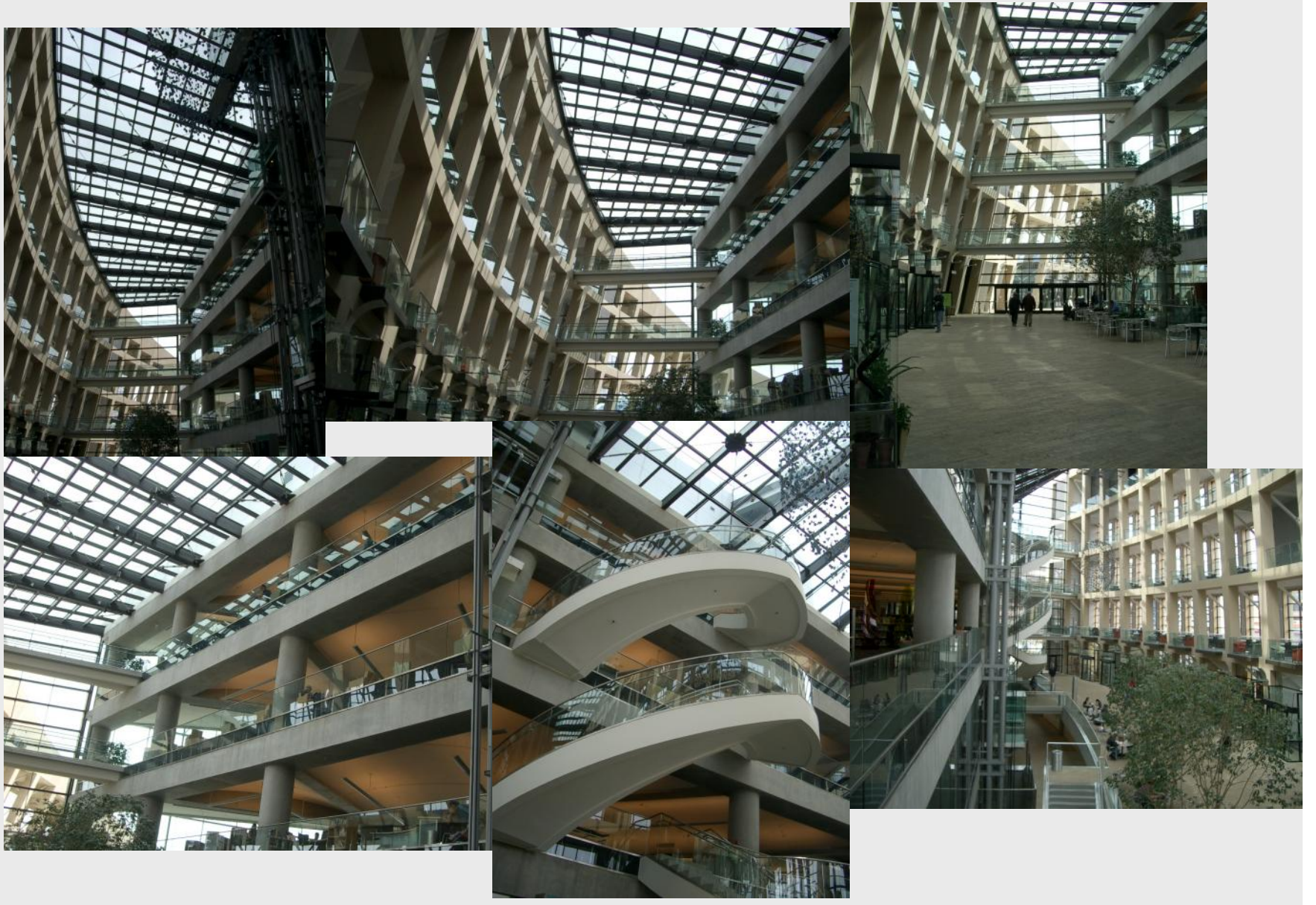
DAYLIGHT

- Salt Lake City, UT, USA; 225,000 sq ft.; 1999-2003.
- Moshe Safdie, Architect with VCBO Architecture, Associate Architects
- Five-story, triangular-shaped main building.
- Houses the stacks, an adjacent rectangular administration facility, & a glass-enclosed Urban Room and public piazza.
- Urban Room open to views of the surrounding Wasatch mountain range.
- Crescent-shaped wall allows visitors to ascend & access a public roof garden.
- At night the glass facade, lit from within, is reflected in a crescent-shaped reflecting pool extending into the outdoor space.



Salt Lake City Public Library

DAYLIGHT



Salt Lake City Public Library

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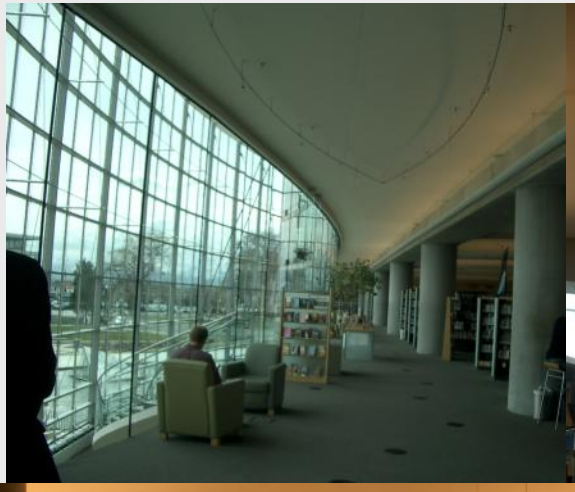

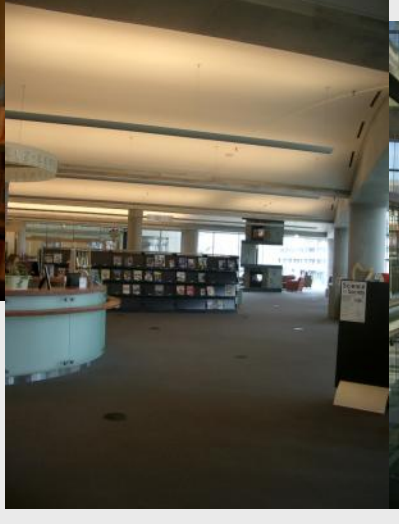

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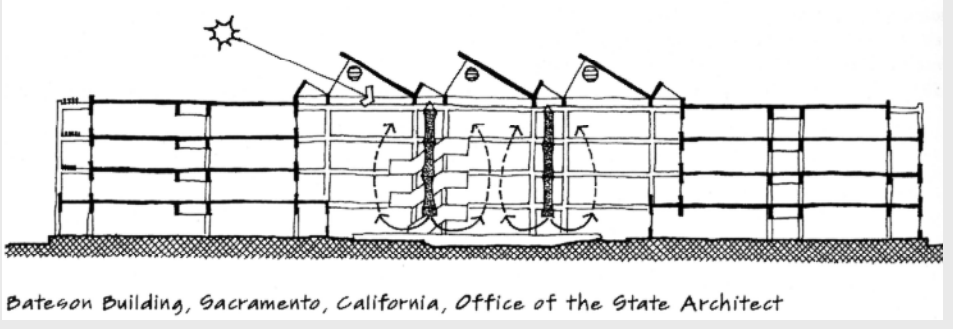
Sawtooth

- Common design strategy for industrial plants during late 19th & early 20th centuries because uniform illuminance possible.
- Can function well with low ceiling heights.
- Sawtooth aperture very complex due to infinite number of design variations.



Bateson Building, Sacramento, California, Office of the State Architect

DAYLIGHT

Sawtooth

- Single & multiple aperture designs do not function in a similar way.
- End aperture differ from center conditions due to sky characteristics & aperture design.
- Pattern of illuminance depends on sky type.
- Three apertures in series required to achieve good pattern of light.

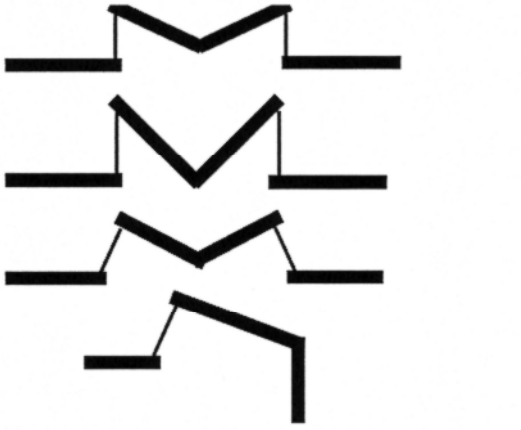


Fig. 71: Typical sawtooth configurations.

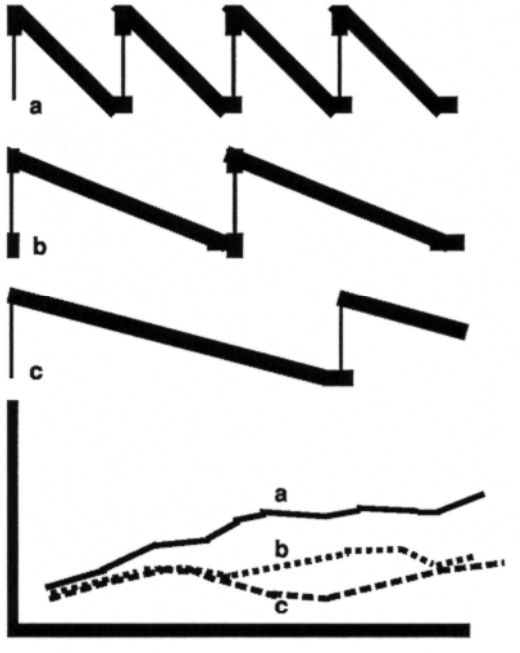
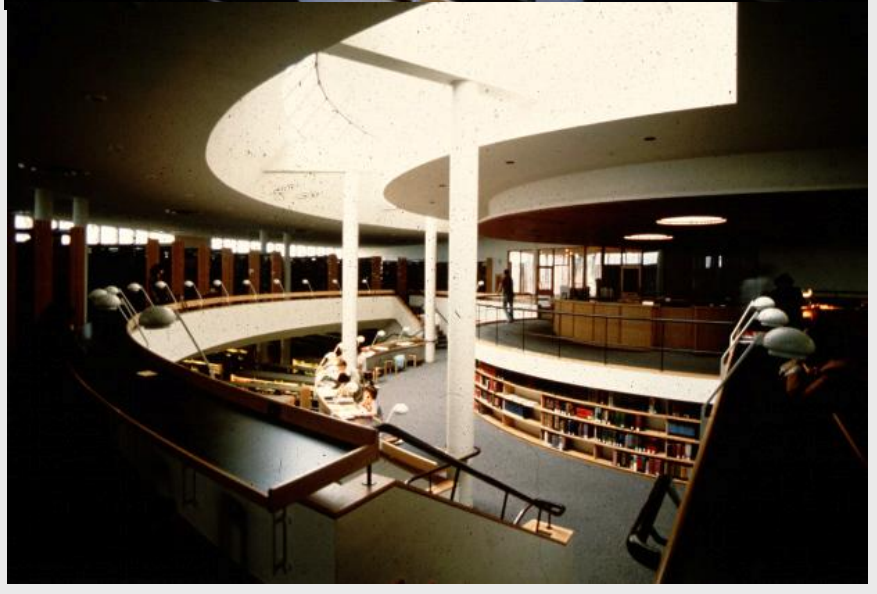


Fig. 72: Sawtooth performance under overcast sky conditions (adapted from Robbins, 1986).

Case Study: Mt: Angel Abby Library

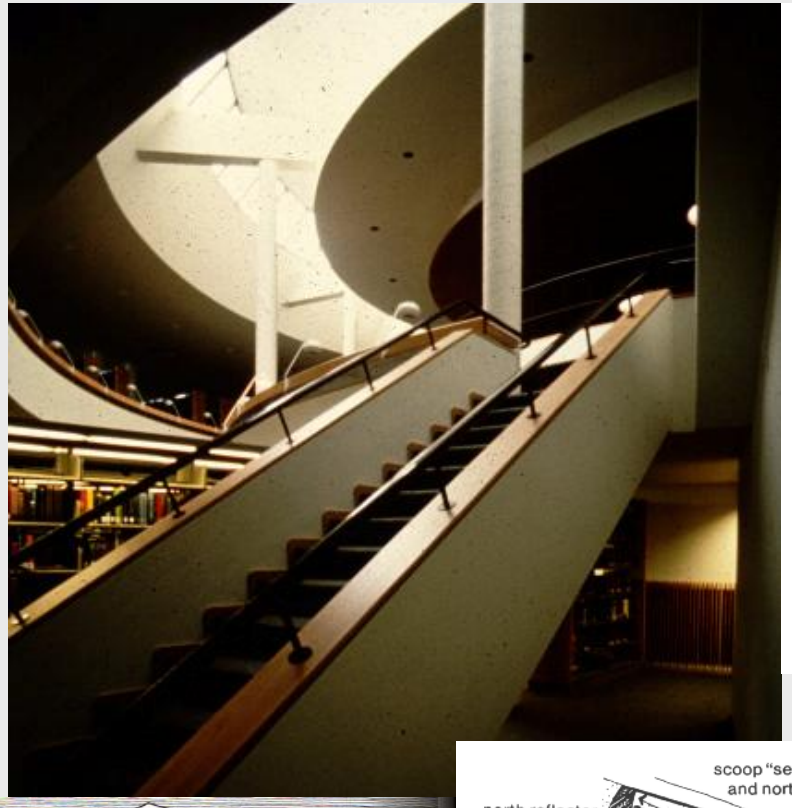
DAYLIGHT

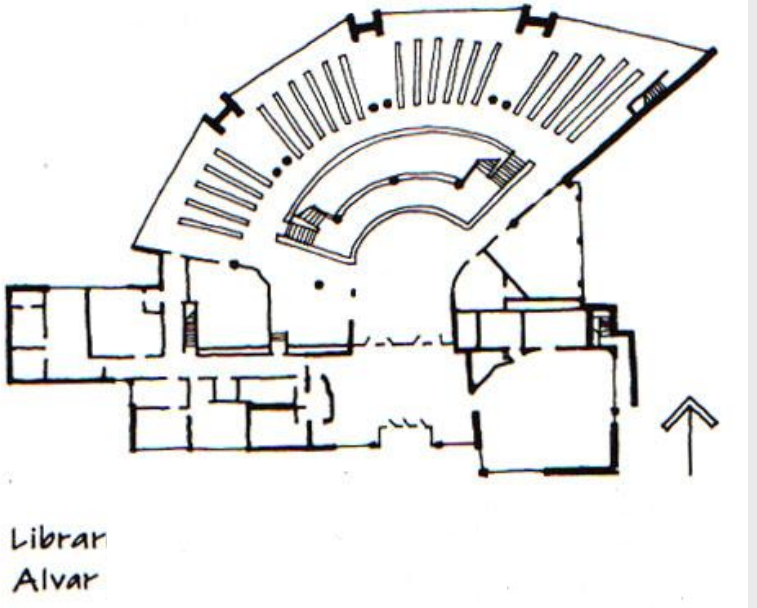
- Oregon, USA
- Alvar Aalto, Architect
- Spaces divided into two groups with varying lighting needs
  - Reading (high levels)
  - Book storage (lower levels)
- Reading areas along perimeter wall & under sun scoops.
- Books between reading areas, further from pools of light.
- Centric, linear form

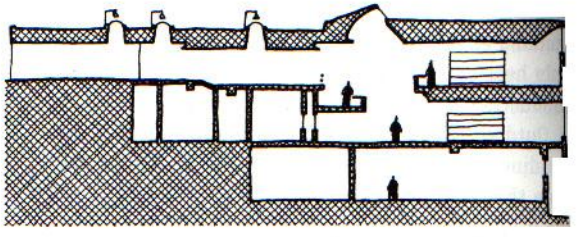


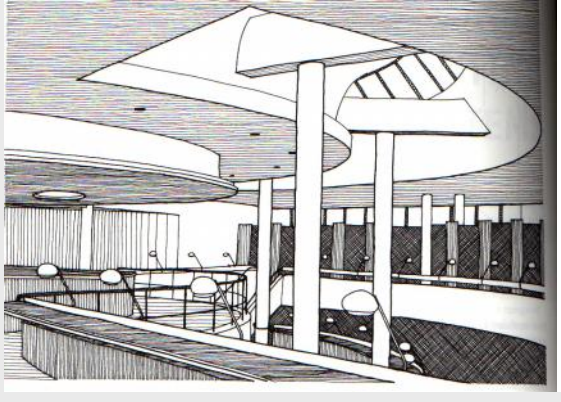
Case Study: Mt: Angel Abby Library

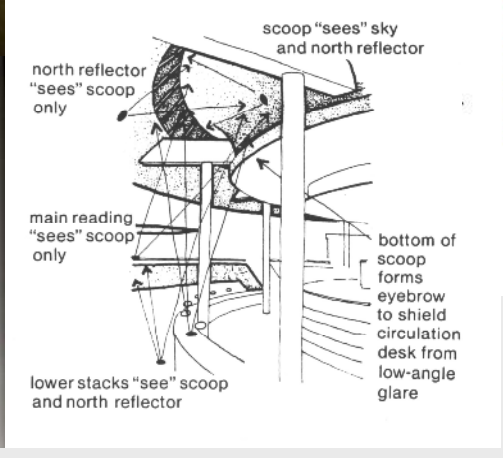
DAYLIGHT











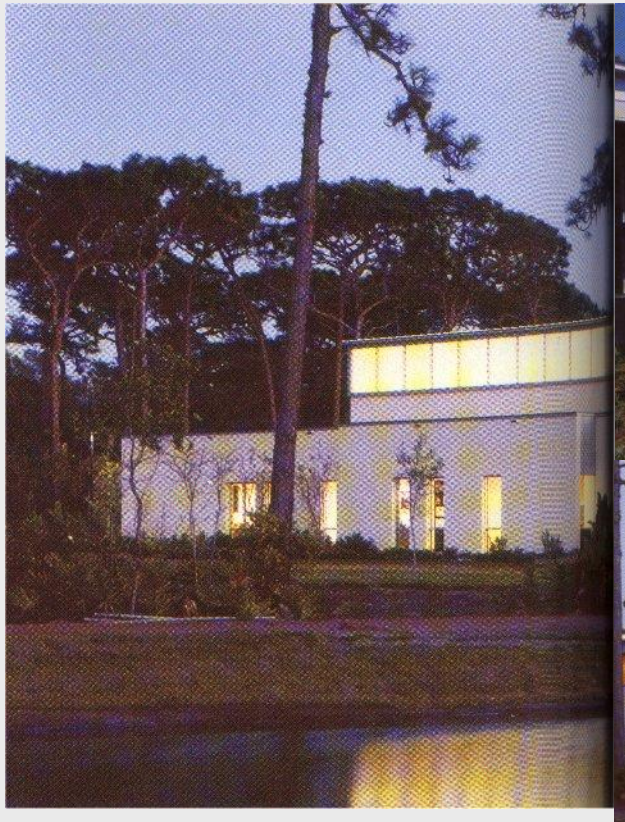
Case Study:Tampa Art Center

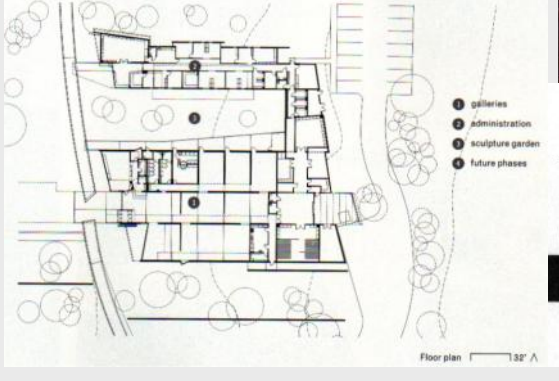
DAYLIGHT

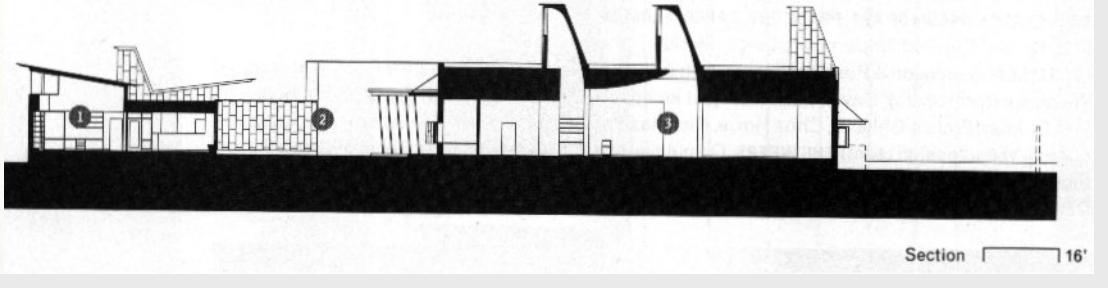
- Largo, Florida, USA.
- Thompson & Rose, Architects, Cambridge, MA
- Museum & administration building.
- Sawtooth monitors for top lighting.
- Galleries are sky lighted.
- Canopy overhang to block direct sun and bounce diffuse light in clerestories.
- Linear, clustered form

Case Study:Tampa Art Center

DAYLIGHT







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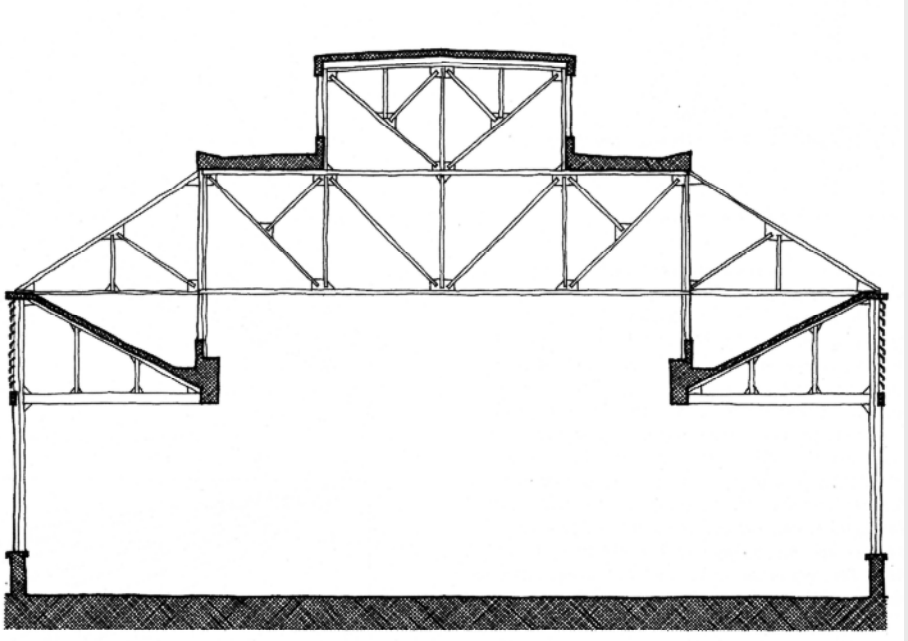
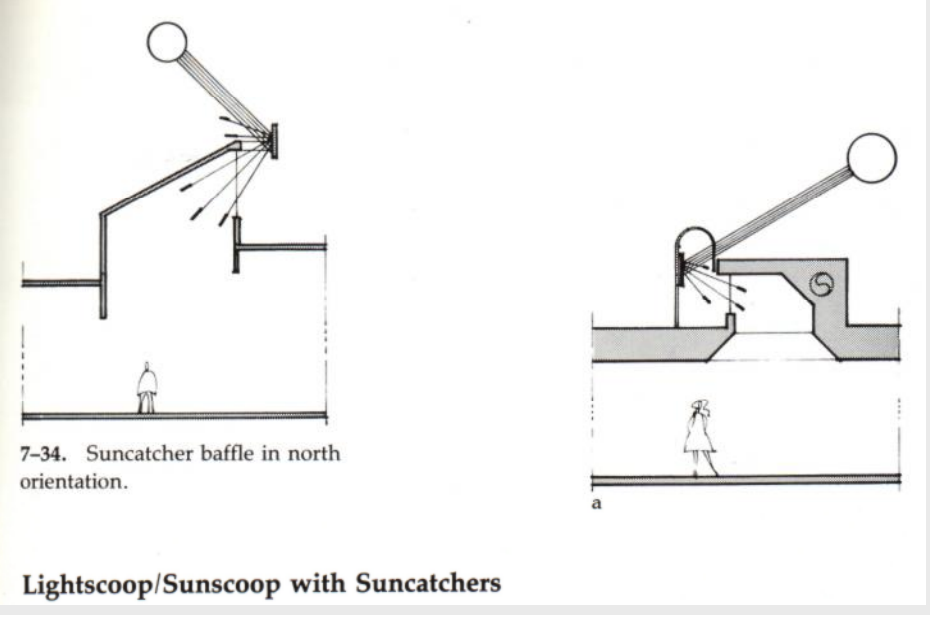
Roof Monitors

- Utilize vertical or steeply sloped glazing above ceiling line.
- Light scoops face north.
- Sun scoops face south.
- Sun scoops, without modifiers, not appropriate for hot, arid climates.



Packard Forge Shop, Detroit, Michigan, Albert Kahn



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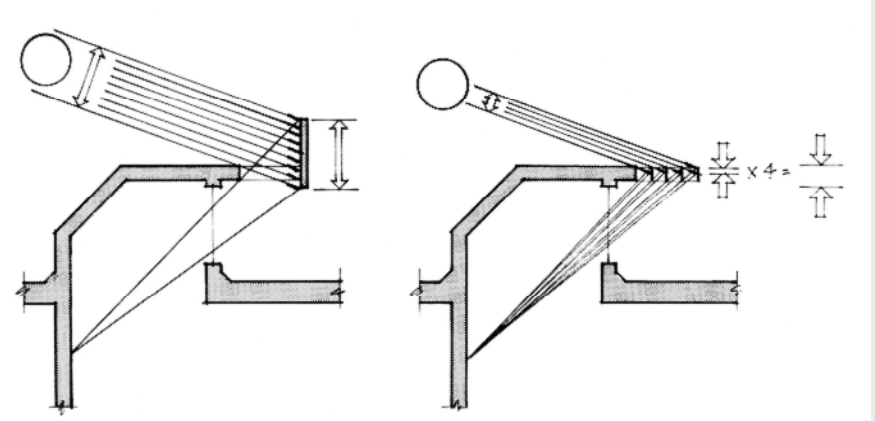
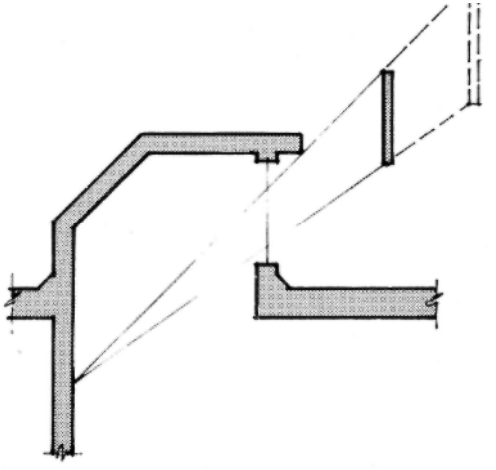
Roof Monitors

- Overhangs, translucent glass & baffles or heat-reflecting glass can be used to reduce heat gain & improve visual comfort.
- Light scoops use clear glazing to max. transmission.
- Roof surface contributes to ERC.



7–38. For a given surface area, one large louver is more efficient than several small ones both in capturing and redirecting sunlight.



7–37. The further away the suncatcher baffle is placed, the larger it must be for any point of the wall to ''see'' the same amount of sunlit surface.

DAYLIGHT

Roof Monitors

- Light scoops should not be used in cold climates, unless insulating glazing is used.
- Heat loss through a light scoop can be significant in cold climates.
- Light scoops provide most consistent level of illuminance with a min. of glare.

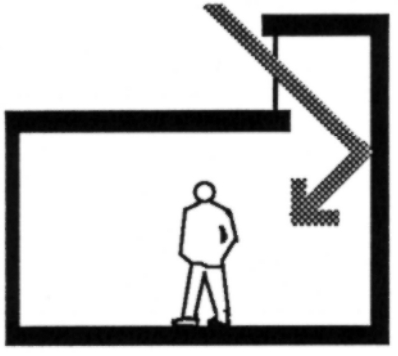


Fig. 68: The observer should not have direct view of a south-facing monitor.

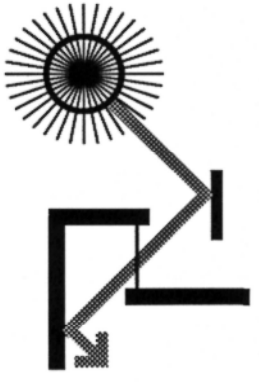
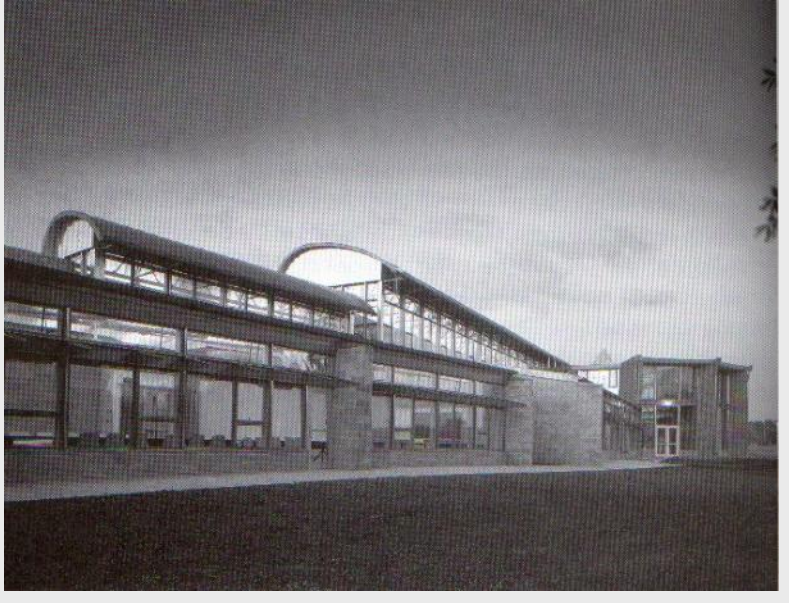


Fig. 69: Light scoops can re-distribute daylight from a south-facing reflector.

Case Study: Center for Energy & Environmental Education

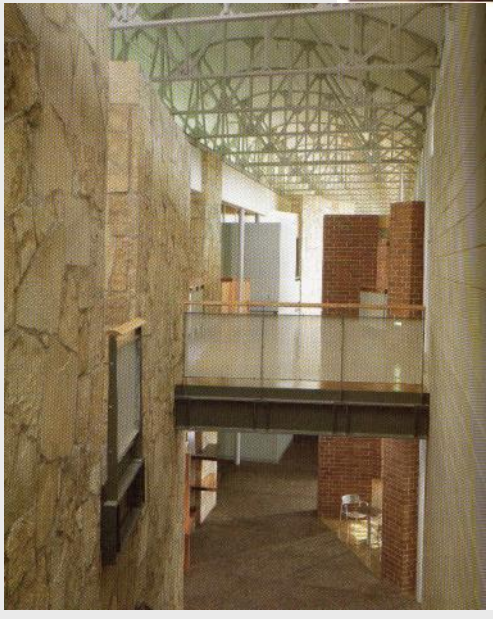
DAYLIGHT

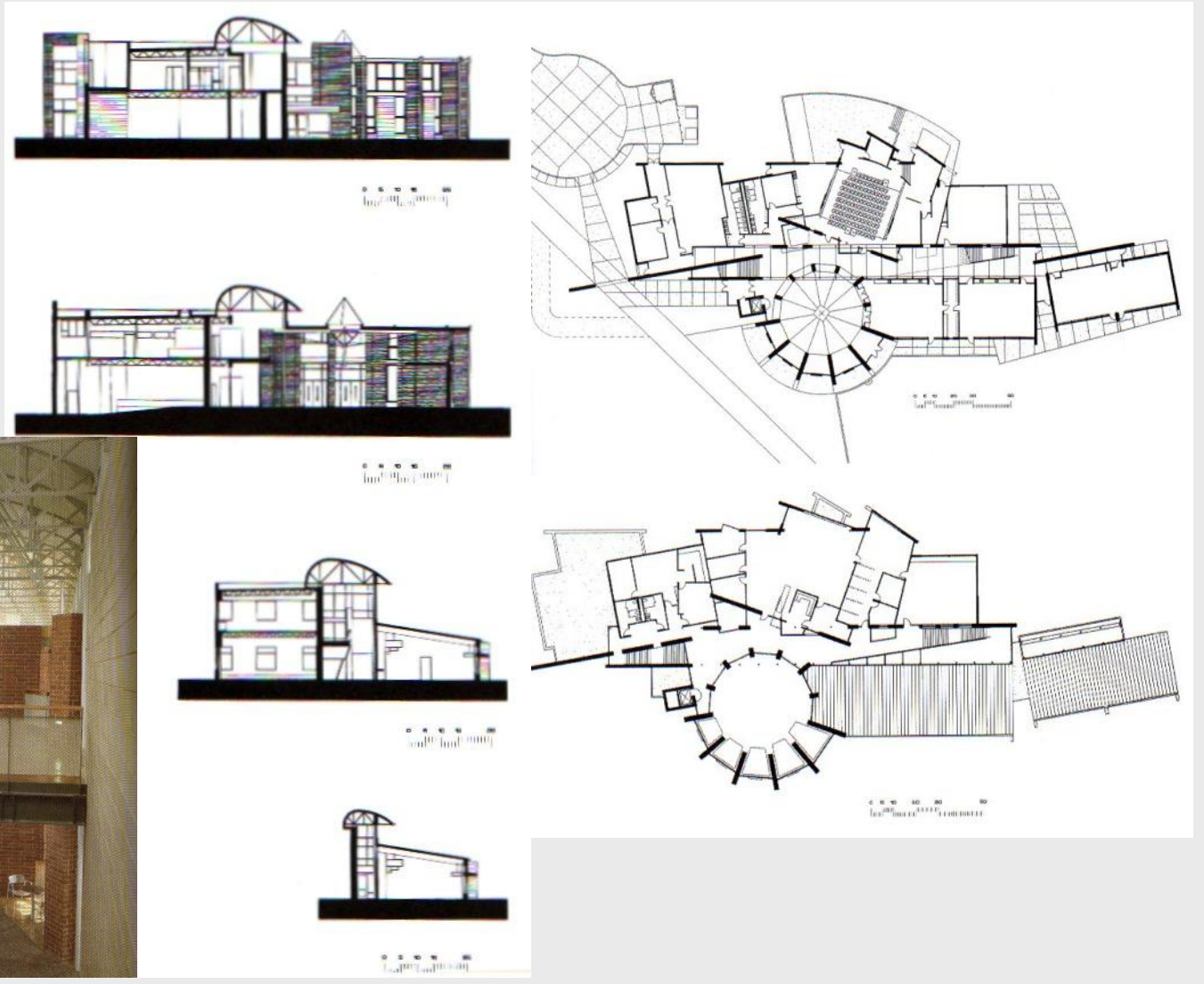
- University of Northern Iowa.
- Wells Woodson O'Niel, Architects with the Weidt Group, Energy & Environmental Consultants.
- Integrates architecture, ecological design & education.
- Primary goal was to maximize daylighting and reduce electrical energy consumption.
- Combination form



Case Study: Center for Energy & Environmental Education

DAYLIGHT





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Lightwells

- A vertical opening through one or more floors of a building.
- Designed to distribute daylight to adjacent spaces.
- Usually located adjacent to vertical circulation.
- Often do not provide view to outdoors.

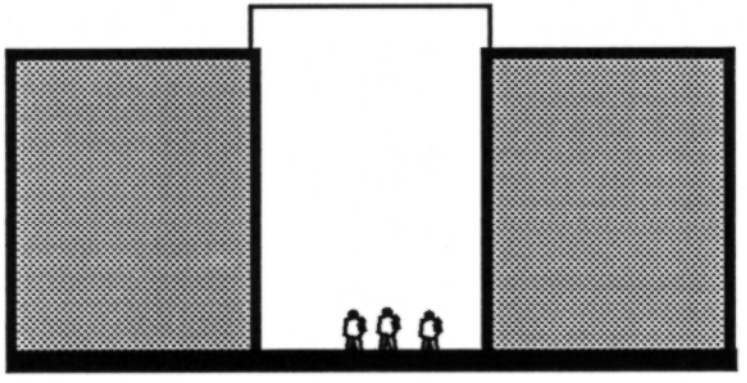


Fig. 75: Typical lightwell configuration.

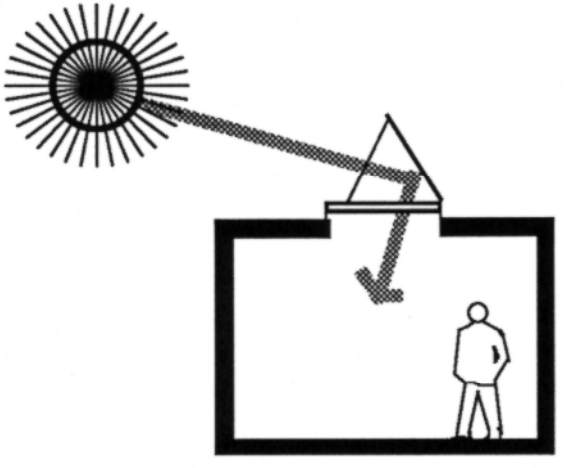
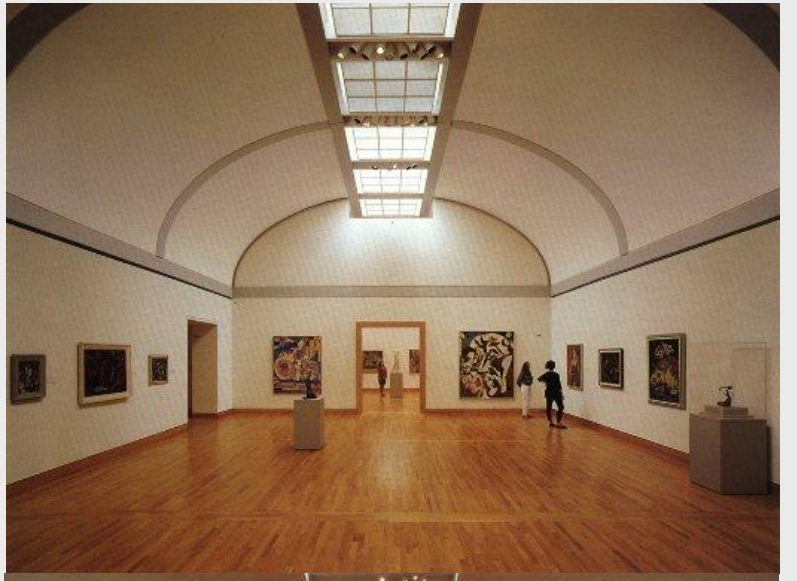


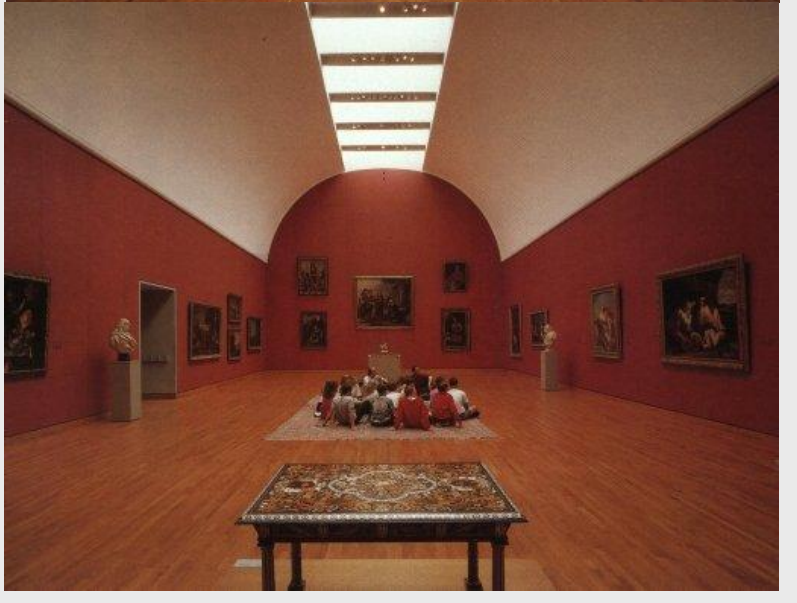
Fig. 76: Heliostat used for sun-tracking or beam daylighting.

DAYLIGHT

Lightwells

- Glare not usually a problem when lightwells are tall & narrow.
- Thermal gain usually negligible if interior opening is glazed.
- Exterior opening usually glazed for moisture control.
- Can be used with sun-tracking or beam daylighting devices.





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Lightwells

- Canadian National Gallery, Ottawa
- Moshe Safdie, architect
- Opened in 1988
- Granite & glass is the home of Canada's art collection








DAYLIGHT

Atria and Lightcourts

- Atria are central areas that open to the sky in multi-story buildings.
- Often glazed to create a controlled environment.
- Amount of sunlight admitted must be balanced against heating & cooling needs.

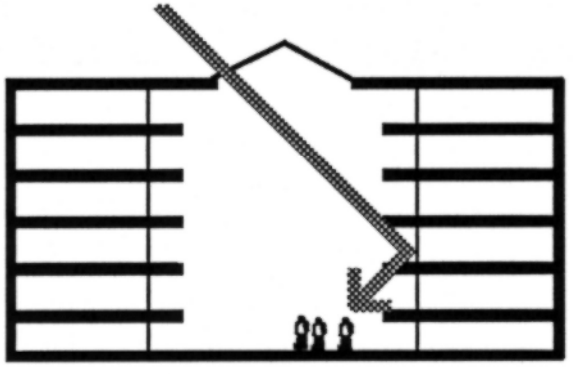

Fig. 62: Top lighting can provide deep penetration of daylight if properly designed.

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Atria and Lightcourts

- Varying geometries including:
  - Side wall perpendicular to floor
  - Splayed up or down.
- Performance depends on aspect ratio of atria:
  - Tall, narrow
  - Short, wide
- Shape should be determined, in part, based on lighting needs on horizontal vs. vertical surfaces.

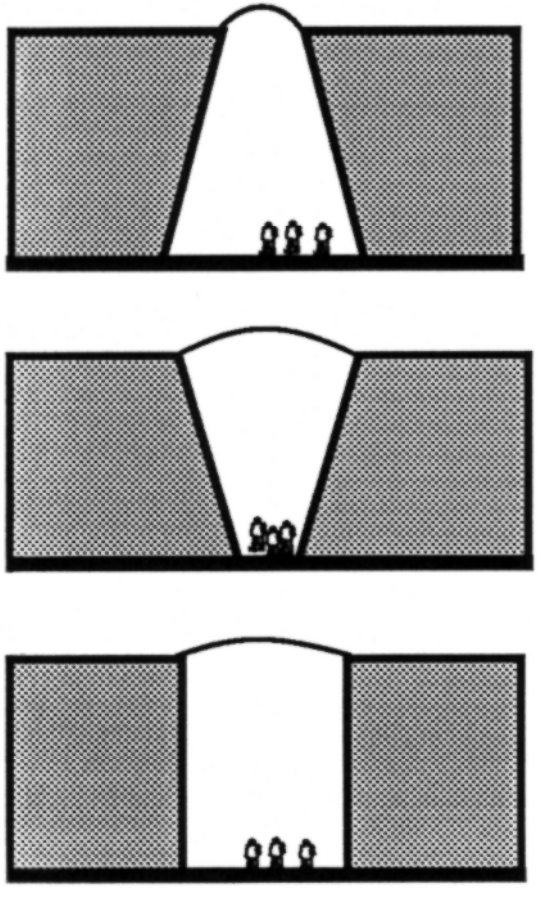
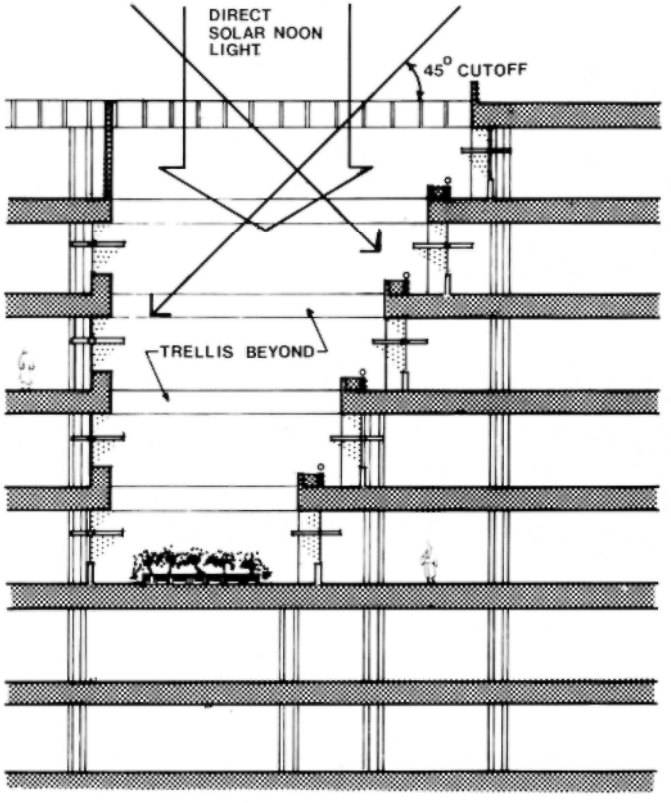


Fig. 74: Atria configurations.

Atria and Lightcourts

DAYLIGHT

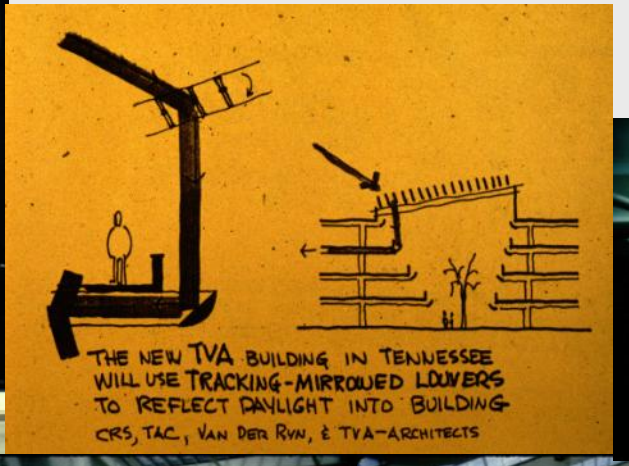
- Major concern – maintenance of trees & plants.
- Interior wall finishes & wall glazing characteristics will impact distribution.
- Ratios of 1:1 are best (depth to width).
- Vertical wall illuminance is usually less than 20% of exterior horizontal illuminance below 2 or 3 floors from opening.



8–29. Suncatcher trellises at the GSIS building (case study B3) are combined with lightshelves for a complete sunlighting system.

Case Study: TVA Building

DAYLIGHT



Case Study: Denver Airport

DAYLIGHT

Summary & Discussion

DAYLIGHT

“Architecture is the making of a room; an assembly of rooms. The light is the light of that room. Thoughts exchanged by one and another are not the same in one room as in another.” (Louis Kahn in Buttiker, Urs, Louis I. Kahn Light and Space, New York: Watson-Guptill Publications, 1994, p.178)