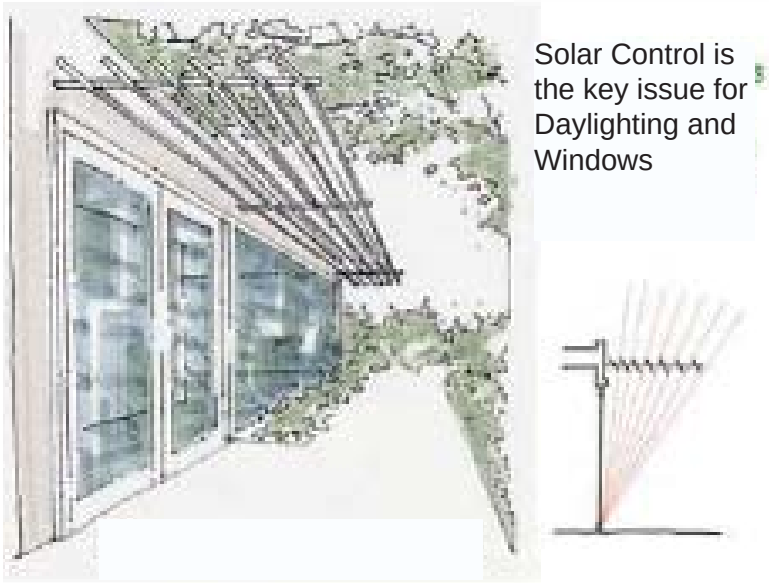
The three fundamental design issues in daylighting design are:

1. Glare Control
2. Sun Control
3. Variation Control

[Week 6] Daylighting in Architecture



Solar Control is the key issue for Daylighting and Windows

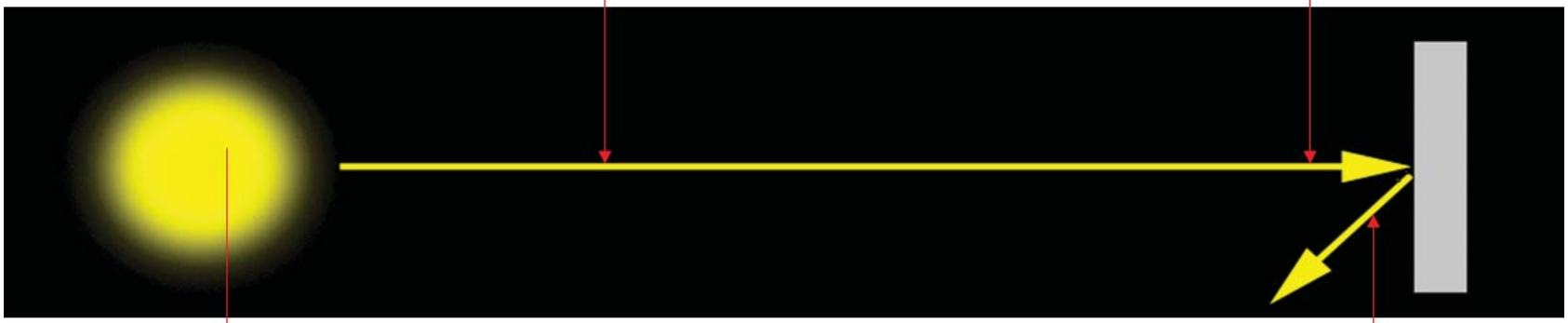
Know your sun angles!

Luminous flux
Unit: **Lumen [lm]**

- Perceived power of light
- Sensitivity of the eye by weighting the power at each wavelength

The higher the luminous flux, the higher the Illuminance on surfaces per unit area.
Unit: **Lux [lx]**

- Measure of the intensity of the incident light



Light is emitted by a source with a certain intensity.
Unit: **Candela [cd]**

- Power emitted by a light source in a particular direction
- **A common candle emits light with a luminous intensity of roughly one candela**

Reflectance of light depending on surface structure: luminance
Unit: **Candela/m^2 [cd/m^2]**

- Used to characterize emission or reflection from flat, diffuse surfaces
- Indicates how much power will be perceived by an eye looking at the surface from a particular angle of view

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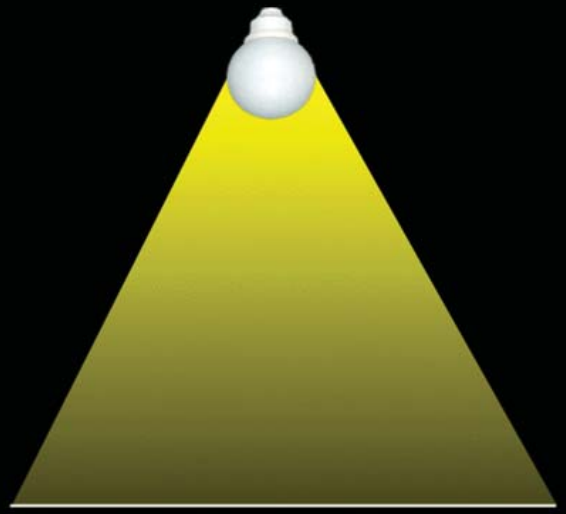
- From lm to lux
  - 100 W bulb
    - Assume 3,000 lm in a $10m^2$ room
    - no distribution losses



Illuminance =

- → 3,000 lm / 10 m^2 = 300 Lux

Daylight

max. illuminance (sunny day)	80,000 – 100,000 lux
max. illuminance (cloudy day)	5,000 – 10,000 lux
min. illumination at a work desk	300 - 500 lux

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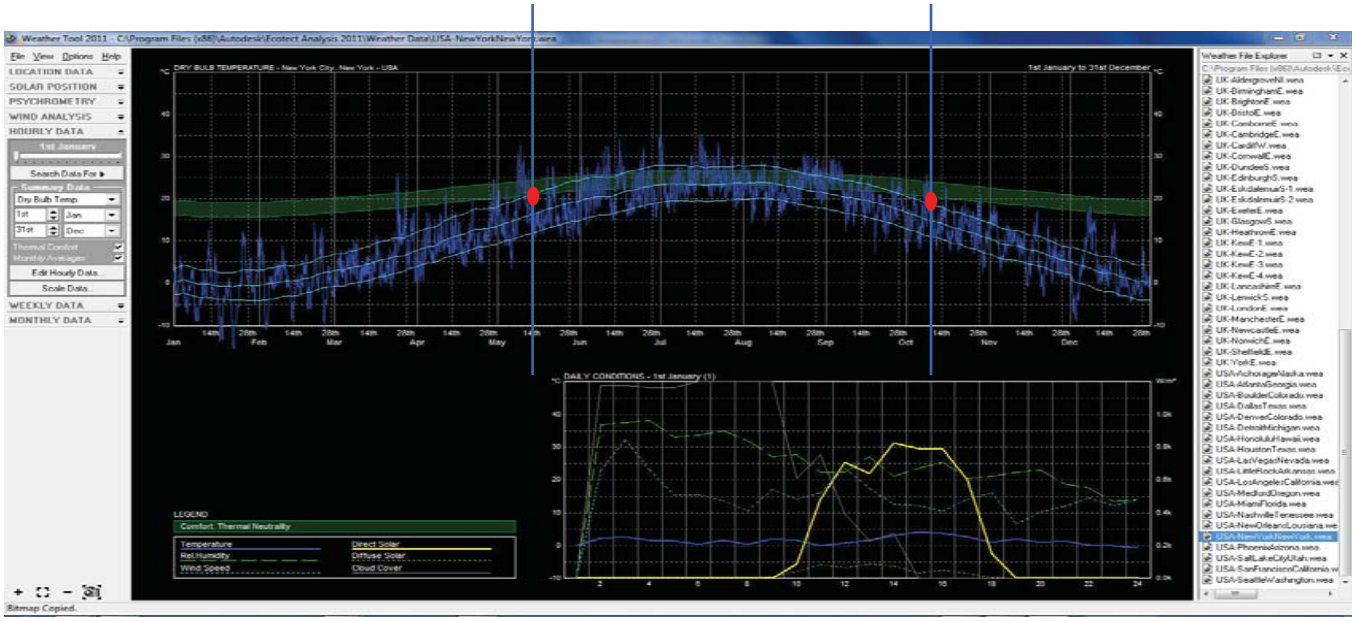
Solar Radiation -- Radiant energy emitted by the sun, especially electromagnetic energy. Radiation from the sun sustains life on earth and determines climate.

Irradiance = Power of electromagnetic radiation per unit area (radiative flux) incident on a surface. Radiant emittance or radiant exitance is power per unit area radiated by a surface. (SI units are watts per square meter (W/m2).

[Week 6] Daylighting in Architecture



Dry Bulb Temperature for New York City and Thermal Comfort:

Graph is used to determine dates employed for Solor Irradience

ENERGY

- Artificial lighting accounts for up to 50% of the energy used in offices (30-40 kWh/m²a)
- Between 30-50% savings can be easily achieved
- 60-70% savings are possible in some cases
- Replacement of artificial lighting by daylight reduces internal gains through higher illuminance efficiency
- Daylight is the most efficient way of using solar energy

Illumination efficiency	
daylight	100 - 110 lm/W
standard light bulb	20 - 30 lm/W
fluorescent tube	60 - ~100 lm/W
metal halide	~100 lm/W

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[Week 6] Daylighting in Architecture

- Benefits
  - Free, natural light
  - Healthy environment
  - No wasted energy
  - Heat Gain
  - Lower industrial waste

- Problems
  - Too much light
  - Heat Gain
  - Glare
  - UV

[Parametric Computation, Fabrication and Material Properties]

DAYLIGHTING AND VIEWS:

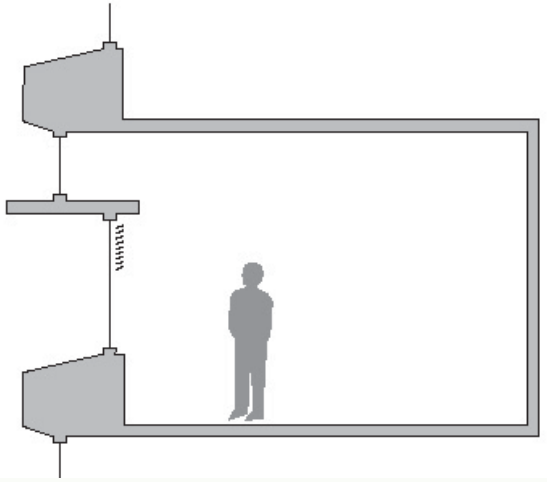
Strategies + Components

- Overall Strategies:
  - Design Well Lit Spaces
  - Design daylighting for the task, whether bright light, darkness or highly controllable lighting is required.
  - Assess daylighting needs and feasibility for each different portion of the building.
  - Install daylight-activated controls.

BUILDING ENVELOPE STRATEGIES

- Shape building for self shading. Building form can assist cooling and lighting by providing self shading through wings, balconies, deep reveals and arcades.

- Deep facades. A façade with some depth creates a buffer zone which can be used for shading elements.



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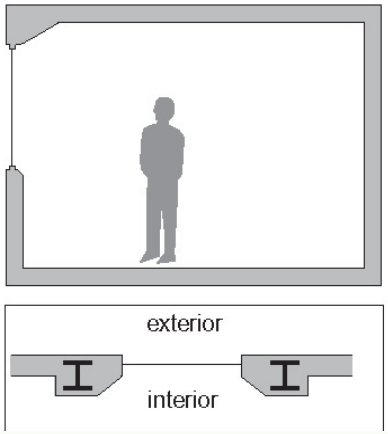
BUILDING ENVELOPE STRATEGIES

- Incorporate building envelope features that improve daylighting: deep reveals, splayed reveals, exterior fins, and rounded edges can soften light contrasts.



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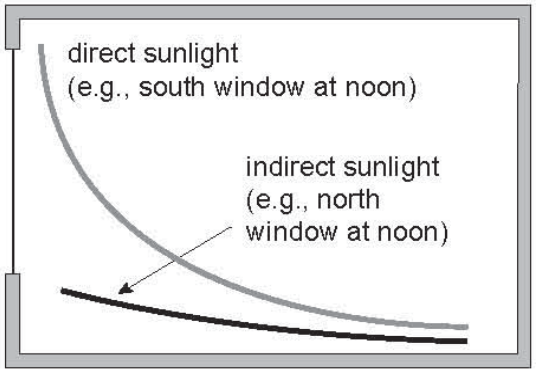
WINDOW STRATEGIES

- Incorporate shading elements within windows. Shading devices perform triple duty: keep out sun's heat, block uncomfortable direct sun, soften harsh daylight contrasts

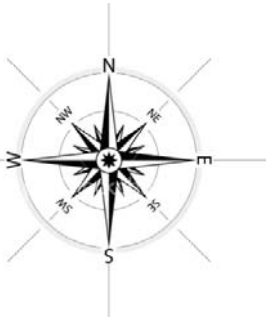


DAYLIGHTING AND VIEWS:

Orientation (in the Northern Hemisphere)

North: High quality consistent daylight with minimal heat gains, but thermal loss during heating conditions.

West: Shading is difficult, but critical for comfort and heat gain on both sides.

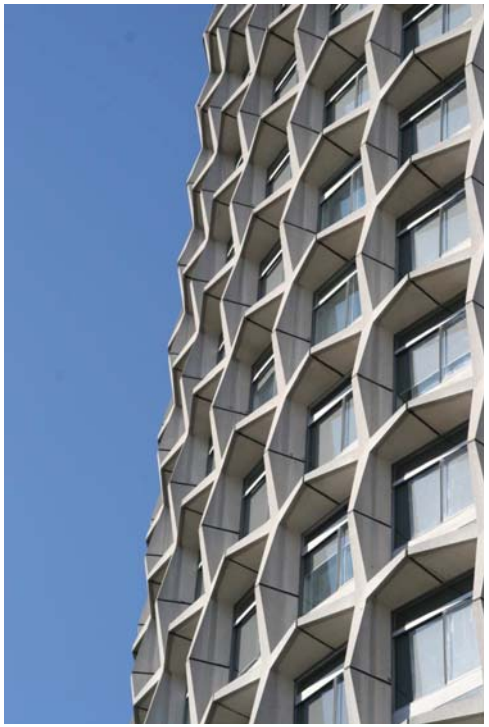


East: Shading is difficult, but critical for comfort and heat gain on both sides.

South: Good access to strong illumination. Shading is “easy”

*Generally windows facing **north** and **south** create the fewest lighting and heat gain/loss problems.*

[Week 6] Daylighting in Architecture



[Week 6] Daylighting in Architecture

[Week 6] Daylighting in Architecture

The Esplanade, Singapore

[Week 6] Daylighting in Architecture

•Menil collection (Houston)- Renzo Piano Architect

- Forms to optimize the relationship between sunlight and shading