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!
[Week 6] Daylighting in Architecture

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/m² [cd/m²]**

- 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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[ Parametric Computation, Fabrication and Material Properties ]
• From lm to lux
  – 100 W bulb
  • Assume 3,000 lm in a 10m² room
  • no distribution losses

Illuminance =
• 3,000 lm / 10 m² = 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
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).
Dry Bulb Temperature for New York City and Thermal Comfort:

Graph is used to determine dates employed for Solar Irradiance
[Week 6] Daylighting in Architecture

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

<table>
<thead>
<tr>
<th>Illumination efficiency</th>
<th></th>
</tr>
</thead>
<tbody>
<tr>
<td>daylight</td>
<td>100 - 110 lm/W</td>
</tr>
<tr>
<td>standard light bulb</td>
<td>20 - 30 lm/W</td>
</tr>
<tr>
<td>fluorescent tube</td>
<td>60 - ~100 lm/W</td>
</tr>
<tr>
<td>metal halide</td>
<td>~100 lm/W</td>
</tr>
</tbody>
</table>
[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

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[ 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.
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

[Parametric Computation, Fabrication and Material Properties]
[Week 6] Daylighting in Architecture

[Parametric Computation, Fabrication and Material Properties]
[Week 6]  Daylighting in Architecture

The Esplanade, Singapore

[ Parametric Computation, Fabrication and Material Properties ]
Menil collection (Houston)- Renzo Piano Architect
  - Forms to optimize the relationship between sunlight and shading