Daylighting for sustainability

- Energy savings
  - electric lighting

- Transport and industry: 70%
- Buildings: 30%
- Lighting: 15 to 40% of building consumption
Daylighting for sustainability

- Energy savings
  - electric lighting
  - solar gains management
Daylighting for sustainability

- Energy savings
- Visual comfort
  - visual performance
  - color rendering
  - aesthetical effects
Daylighting for sustainability

- Energy savings
- Visual comfort
- Connection to outside
  - view
  - biological needs
Daylighting for sustainability

- Energy savings
- Visual comfort
- Connection to outside
- Productivity
Daylight as a design factor

Three aims when using natural light
- Collect
- Transport
- Distribute
Daylight as a design factor

- Three aims when using natural light
  - Collection
Daylight as a design factor

- Three aims when using natural light
  - Collection

Image by MIT OCW.
Daylight as a design factor

- Three aims when using natural light
  - Collection

Image by MIT OCW.
Daylight as a design factor

- Three aims when using natural light
  - Collection
  - Transport

Image by MIT OCW.
Daylight as a design factor

- Three aims when using natural light
  - Collection
  - Transport
Daylight as a design factor

Three aims when using natural light
- Collection
- Transport
- Distribution
Daylight as a design factor

- Main parameters in daylight availability
  - Climate and weather
Daylight as a design factor

- Main parameters in daylight availability
  - Climate and weather
  - Sun course (latitude, time/date)
Daylight as a design factor

- Main parameters in daylight availability
  - Climate and weather
  - Sun course (latitude, time/date)
  - Sun and sky access
    - orientation, mask, design of opening
Daylight Factor

- \( \text{DF} = \left( \frac{E_{\text{point}}}{E_{\text{outside horizontal}}} \right) \times 100\% \)
- only for an overcast sky!

Image by MIT OCW.
Daylight Factor

- **DF** = \( \frac{E_{\text{point}}}{E_{\text{outside horizontal}}} \) * 100%
  
- only for an overcast sky!

- below 1% → dark, only suitable for storage areas
- 1% to 2% → low illumination, suitable for circulation areas
- 2% to 4% → moderate, for living spaces
- 4% to 7% → medium, for office work
- 7% to 12% → high, for precision tasks
- over 12% → very high, for exceptional light requirements
(Emerging) dynamic daylighting metrics

- **Daylight Autonomy (DA)**
  - percentage of working hours when a minimum work plane illuminance is maintained by daylight alone

- **Useful Daylight Illuminance (UDI)**
  - divides working hours into either < 100 lux, 100 to 2000 lux (Useful Daylight Illuminance) or > 2000 lux

- **CHPS criteria**
  - continuous DA >40%, >60% and >80% (resp. 1, 2 and 3 credits) for 60% of work plane
Daylight as a design factor

What do we want to do?
- maximize daylighting, but avoid glare
- maximize solar gains in winter
- protection from solar gains in the summer and fall
Daylight as a design factor

How do we do it?

- siting and orientation
  - Mount Angel Library and Seinäjoki Library by A. Alto

Photographs and floor plans removed due to copyright restrictions.
Daylight as a design factor

- How do we do it?
  - siting and orientation
  - sizing and positioning
    - openings and room depth
      - Sahara West Library and Museum by Meyer et al.
      - N.-D. du Haut by Le Corbusier
      - Exeter Library by Kahn
Daylight as a design factor

How do we do it?

- siting and orientation
- sizing and positioning
  - Atrium
  - Genzyme HQ by Behnisch & Behnisch
Daylight as a design factor

How do we do it?
- siting and orientation
- sizing and positioning
- solar protections
  - fixed
  - mobile
  - orientation

30° maximise gains in winter
70° total protection in summer

maximise gains in winter
protection in summer
Daylight as a design factor

How do we do it?
- siting and orientation
- sizing and positioning
- solar protections
- glazing selection

Image by MIT OCW.
Daylight as a design factor

- How do we do it?
  - siting and orientation
  - sizing and positioning
  - solar protections
  - glazing selection
  - framing
Daylight as a design factor

- How do we do it?
  - siting and orientation
  - sizing and positioning
  - solar protections (fixed / mobile)
  - glazing selection
  - framing
  - indoor surface colors
Daylight as a design factor

How do we do it?
- siting and orientation
- sizing and positioning
- solar protections (fixed / mobile)
- glazing selection
- framing
- indoor surface colors
- advanced systems / materials

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Designing with Natural Light

- Reading assignment from Textbook:
  - “Introduction to Architectural Science” by Szokolay: § 2.3 - 2.4

- Additional readings relevant to lecture topics:
  - "Heating Cooling Lighting" by Lechner: Chaps 9 + 13