announcements 6/5/08

Final Exam Alternate Time:

Wednesday, 6/11
4:30 - 6:20
Smith (SMI) 304

Final Exam Assigned Time:

Friday, 6/13
4:30 - 6:20
Gowan 201

Daylighting Design Tips

Tips for Daylighting with Windows
http://windows.lbl.gov/pub/designguide/designguide.html

TIPS FOR DAYLIGHTING

The Integrated Approach
Daylight Design Resources

Daylight Design Variations Book
http://sts.bwk.tue.nl/daylight/varbook/index.htm

Physical Models and Daylighting

Why use physical models?
How to build daylighting models
How to test daylighting models
Why use physical models?

Light requires no correction for changes in scale: A scaled model behaves exactly as a full size building does.

Easy to construct while providing valuable insight into the quality of a space.

Proof of Concept

By modeling an existing space in detail, we can prove that daylighting models behave exactly the same as a full size building.
Proof of Concept

parametric analysis
Proof of Concept

Proof of Concept
Proof of Concept
Student Study Models

Daylighting Study Models

Surface materials are approximated

Quick model construction allows for multiple variations to be tested

Good for both qualitative and quantitative studies
Exploring Daylight Models:

Real Sky Studies

**Advantages:**
Best for **Qualitative** Analysis
- Full Spectrum Light - good color
- Dynamic lighting conditions
- Both clear sky and overcast sky conditions - and everything in between

How to build physical models
How to build physical models

Scale 3/4” = 1’

Wall thickness

Light leaks

Materials
• Why cardboard and paper?
• Tape?
• The window glazing?
• Translucent materials?

Daylighting Tools – Sky Simulator

Replicates an overcast sky
(diffuse daylight)

Primarily used for
quantitative studies

Measures the amount of
daylight hitting a specific part
of an interior space

This is then compared to the
amount of daylight available
(daylight factor)
Exploring Daylight Models

**Sky Simulator**

**Sky Dome Simulator**

**Mirror Box**

**Advantages:** Best for *Quantitative* Analysis

- Consistent, reproducible conditions for parametric studies
- Simulation of uniform overcast sky conditions only

**Openings**
Li - Cor light meter

Quantitative Analysis of Daylight Models

Use Daylight Factor:

- Light at Points Inside
- Light Available Outside Window

1 footcandle ~ 10 lux

isolux plans
daylight sections
daylight factor graphs

Daylighting Tools – Heliodon

Models direct beam (sunlight) penetration and shading

Models different locations, times of day and year

Not an accurate tool for studying daylighting
Four goals for designing with daylight

1. Use as much daylight as possible to replace electric lighting; bring it deeply into the space.

2. Provide adequate illumination levels for the given tasks and purpose of the space.

3. Avoid creating visual discomfort.

4. Consider light as formgiver of architecture; make use of all the visual and experiential qualities of daylight possible.
Goal Two: 
Provide adequate illumination levels

Dining 5 - 10 fc 
Reading 30 - 50 fc 
Conferring 20 - 50 fc 
CRT screens 5 - 10 fc 

from the IES Lighting Ready Reference

Daylight Factor
MEEB Table 14.2, pg. 593

\[ DF = \frac{\text{indoor illumination from daylight}}{\text{outdoor illumination at window plane}} \times 100\% \]

Recommended Daylight Factors

<table>
<thead>
<tr>
<th>TASK</th>
<th>DF</th>
</tr>
</thead>
<tbody>
<tr>
<td>Ordinary seeing tasks, such as reading, filing, and easy office work</td>
<td>1.5 - 2.5%</td>
</tr>
<tr>
<td>Moderately difficult tasks, such as prolonged reading and normal machine tool work</td>
<td>2.5 - 4.0%</td>
</tr>
<tr>
<td>Difficult, prolonged tasks, such as drafting, proofreading poor copy, fine machine work, and fine inspection</td>
<td>4.0 - 8.0%</td>
</tr>
</tbody>
</table>
Rule of Thumb for adequate illumination

For daylighting, the room depth (distance from the window wall) should be less than 2.5 times the height of the window head to maintain a minimum level of illumination and an even distribution of light.

Daylight Rule-of-Thumb

2.5 x H Rule

MEEB Fig. 14.21, pg. 594

The portion of a space that can be considered “daylit” is the area located 2.5 times the height of the window head above the workplane, from the window into the room.
Sidelighting

Rule-of-thumb

MEEB Table 14.4, pg. 595

\[
DF_w = 0.2 \left( \frac{\text{window area}}{\text{floor area}} \right)
\]

\[
DF_{mv} = 0.1 \left( \frac{\text{window area}}{\text{floor area}} \right)
\]

Toplighting

Rule-of-thumb

MEEB Table 14.4, pg. 595

Vertical monitors:

\[
DF_w = 0.2 \left( \frac{\text{skylight glazing area}}{\text{floor area}} \right)
\]

North-facing sawtooth:

\[
DF_w = 0.33 \left( \frac{\text{skylight glazing area}}{\text{floor area}} \right)
\]

Horizontal skylights:

\[
DF_w = 0.5 \left( \frac{\text{skylight glazing area}}{\text{floor area}} \right)
\]

Maximum penetration of usable daylight:

\[2.5H\]
Skylights: Light Distribution

Effective daylight distribution ~ 1 times the floor to ceiling height in each direction from the skylight

Goal Three: Avoid Visual Discomfort

- Insufficient light
- Shadows or patterns
- Veiling reflections
- Contrast glare
shadows / patterns

reduce contrast glare

Discomfort Glare
- 3:1 for Task to Surround (10:1 max.)
- 20:1 for window to adjacent surfaces
contrast levels • luminance ratios

Task to adjacent surfaces  1:3
Task to surfaces within a 30 degree cone of vision  1:10
Anywhere in the room  1:40

Disability Glare

• Reduce puddles and splashes of light
• Minimize veiling reflections
Veiling Reflections

Minimize light that is too directional
Reducing Glare

- *light* window frames
- wall washing
- windows on two sides of a room
- thick or splayed window frames
- clerestory windows
- lightshelves
- indirect daylighting

*light window frames*
wall washing
windows on two sides

windows on two sides + wall washing
thick or splayed frames

[Images of windows with thick or splayed frames]

thick or splayed frames

[Images of a schematic and a photograph of a library interior with thick or splayed frames]

[Images of window frames labeled 'Thick Wall Spring' and 'Thin Wall Spring']
clerestory windows

- reduce glare by blocking view of the bright sky
- wash ceiling with daylight
- create a more even distribution of daylight
- if extended outside past the window, they act as shading devices – brise soleil – blocking glare-causing direct sunlight

lightshelves

- reduce glare by blocking view of the bright sky
- wash ceiling with daylight
- create a more even distribution of daylight
- if extended outside past the window, they act as shading devices – brise soleil – blocking glare-causing direct sunlight
Light shelves rarely produce higher illuminance levels away from the window; however, they often improve the quality of illumination and perceived lighting levels by providing more even daylighting and reducing glare for room occupants.

Emerald Peoples Utility District Building Eugene, Oregon

John Reynolds and G.Z. Brown
Clackamas High School

indirect daylighting

• borrowed daylight
• reflected daylight
• daylighting fixtures
• effective skylights
borrowed daylight

reflected daylight
reflected daylight

Rubio Avenue Studio, Tucson, Arizona

Rick Joy Architects
reflectivity of materials

<table>
<thead>
<tr>
<th>Material</th>
<th>Reflectance</th>
</tr>
</thead>
<tbody>
<tr>
<td>Flat black paint</td>
<td>.05</td>
</tr>
<tr>
<td>Brown concrete</td>
<td>.15</td>
</tr>
<tr>
<td>Red bricks</td>
<td>.30</td>
</tr>
<tr>
<td>Uncolored concrete</td>
<td>.35</td>
</tr>
<tr>
<td>White semi-gloss paint</td>
<td>.70</td>
</tr>
<tr>
<td>Polished aluminum reflector</td>
<td>.88</td>
</tr>
</tbody>
</table>

(from SWL, pp. 218-219)

daylighting fixtures

*Architectural elements in combination with windows or skylights that reflect, diffuse, distribute or otherwise control how daylight enters a space.*
daylighting fixtures

Institute of Technology, Otaniemi, Finland

Alvar Aalto
Skylights must be deep enough to minimize direct beam radiation (sunlight) from entering the space.

Skylights can also double as electric lighting fixtures at night.
Goal Four: Architectural Spacemaking

Daylight can be used as an architectural element as fundamental as structure, material or form.

Daylight is dynamic, changing the perception of a space throughout the day and year.

daylight as highlight
leading daylighting

Alvar Aalto • Seinajoki Town Hall

Daylight can be used to highlight certain paths or ways of moving through a space.

rhythmic daylighting

[Images of rhythmic daylighting]
material textures revealed by daylight

material textures revealed by daylight
dynamic daylighting
Church of the Light, Osaka, Japan

Tadao Ando
Myyrmäki Church, Finland

Juha Leiviskä