Natural Light in Design
Using simulation tools to explore realistic daylight-responsive solutions

Overview - Radiance
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## Overview - Radiance

<table>
<thead>
<tr>
<th>time slot</th>
<th>Content</th>
<th>instructor</th>
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</thead>
<tbody>
<tr>
<td>Mon 9.30</td>
<td>Welcome, class introduction, design project [teams formed next morning]</td>
<td>MA, all</td>
</tr>
<tr>
<td>Mon 10.00</td>
<td>General introduction to daylighting [benefits, history, some case studies]</td>
<td>MA</td>
</tr>
<tr>
<td>Mon 10.30</td>
<td>Introduction to Building Simulation [why simulations for architects, tools used in this course]</td>
<td>CR</td>
</tr>
<tr>
<td>Mon 11.00</td>
<td>coffee break</td>
<td></td>
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</table>
| Mon 11.15 | - Photometry [definition, measurement, typical values, DF definition (MA)  
            |   - Static Daylighting Metrics [context of LEED, selected results from NRC  
            |   - survey, DF & Solar Shading] (CR)                                        |
|           |   - Daylight factor calculations: protractor method, LEED spreadsheet     | MA, CR, all  |
|           |   method, sky models CIE and Perez (MA)                                   |
|           |   - Daylight factor simulation: design sky, split flux method in Ecotect (CR) |
|           |   ▪ Hands-on exercise: DF calculation in Ecotect (split flux) (CR)         |
|           |   ▪ Hands-on exercise: solar shading module in Ecotect (CR)               |
|           |   - Intro to Radiance (CR)                                               |
|           |   ▪ Hands-on exercise: Radiance visualizations (CR)                       |
|           |   ▪ Hands-on exercise: DF calculation in Ecotect (Radiance) (CR)          |
| Mon 13.00 | lunch [on your own]                                                      |              |
| Mon 14.00 | - Climate Data [kind of data and measurement, weather files, E+ weather  
            |   - data directory] (MA)                                                  | MA, CR, all  |
|           |   ▪ Hands-on exercise: weather tool in Ecotect (CR)                       |
|           |   - Overview on visual comfort [glare, contrast, requirements, health] (MA) |
|           |   - Dynamic Metrics & related tools (CR)                                  |
| Mon 15.45 | coffee break                                                             |              |
| Mon 16.00 | ▪ Hands-on exercise: Daysim exercise from tutorial interrupted by        | all          |
|           |   discussions on:                                                         |
|           |   - Short time steps dynamics                                             |
|           |   - Daylight Coefficients                                                |
|           |   - User Behavior Model                                                   |
|           |   - Daylight Autonomy Results                                             |
| Mon 17.00 | ▪ Hands-on exercise: students to repeat at DF, Solar Shading & DA analysis |
|           |   on their own                                                            | all          |
| Mon 17.30 | end of first day                                                          |              |
Objectives for this module

- Export to Radiance
- Radiance Algorithm
Advanced Radiance Visualizations IV
Some Facts on Radiance

Physically based backward raytracer – no fudge factors.

A wide variety of material properties and sky models.

Longish learning curve.

“Magic” lies in simulation parameters.

2004 Survey: >180 participants, 40 different tools, >50% of picks for Radiance based tools.
Backward vs. Forward Raytracing

forward raytracer

backward raytracer (Radiance)
Validation Radiance/ sky scanner data for a clear glazing with/without a lightshelf (Radiance materials: “plastic”, “metal”, “glass”)

Figure by MIT OCW.
Parameter Study Radiance: ab 0 to ab 8
Ecotect Demo – Export to Radiance

(1) define a camera view
(2) Ecotect lighting simulation
(3) Export to Radiance
(4) Visualization (ab 1 & sunny)
Export to Radiance Menu

Radiance Export

ECOTECT: Calculation Wizard...

| radianc analysis | STEP 8 OF 8 (SUMMARY) |

Output Options:
- Run in RadianceCP
- D:\mp\D10vrad
- Scaling Factor: 0.001

- Use DDS 8.3 filenames
- Save separate zone files
- Run in minimised window
- View images when done
- Pause on completion

- Generate Point Data
- Current 2D analysis grid
- Current 3D analysis grid
- Objects tagged as shaded
- Currently selected objects

Include Material Definitions:
- Check for Material,rad files
- Check for Zone.rad files

Sky Definition:
- Sunny with sun
- Use ECOTECT design sky
- Use ECOTECT sun angles

RIF File:
- Include camera views
- Use current model view
- Indirect reflections: 2

Type: Luminance (cd/m2)

Model Detail: MEDIUM

Light Variability: MEDIUM

Image Size: 640 x 480

Image Quality: MEDIUM

Use Wizard: Always skip this wizard.
Export to Radiance Menu

Radiance Control Panel

```
14 0
16 5 0.898 0.898 0.898 0.00000 0.00000
16 18 void plastic Brick TimberFrame
19 0
20 0
21 5 0.898 0.898 0.898 0.00000 0.00000
22 23 void glass SingleGlazed_TimberFrame
24 0
25 0
27 3 0.787 0.848 0.848
28 29 void glass Camera_Normal
30 0
32 0
33 3 0.000 0.000 0.000
34 36 ConcLab OnGround polygon zone02.rad00000
```
# Sky definition.
!gensky 4 1 12.76 -c -a 45.500 -o -73.700 -m -75.000 -B 40.307263

skyfunc glow sky_mat
0 0 4 1 1 1 0

sky_mat source sky
0 0 4 0 0 1 180

skyfunc glow ground_glow
0 0 4 1 .8 .5 0

ground_glow source ground
0 0 4 0 0 -1 180

sky.rad
Gensky (sky description in Radiance)

Under Google type: Radiance – gensky

-s Sunny sky without sun. The sky distribution will correspond to a standard CIE clear day.

+\(s\) Sunny sky with sun. In addition to the sky distribution function, a source description of the sun is generated.

-c Cloudy sky. The sky distribution will correspond to a standard CIE overcast day.

-i Intermediate sky without sun. The sky will correspond to a standard CIE intermediate day.

+i Intermediate sky with sun. In addition to the sky distribution, a (somewhat subdued) sun is generated.

-u Uniform cloudy sky. The sky distribution will be completely uniform
Visualization – internal vs. external

**interior view**

**exterior view**

- *indirect*: 0
- *detail*: medium
- *variability*: medium
- *quality*: medium
Visualization – ab 0,1,2,3,

detail medium - variability medium - quality medium
Image Parameters

ab 5
Detail: low
Variability: low
Quality: low

ab 5
Detail: high
Variability: low
Quality: low
Image Parameters

ab 5
Detail: low
Variability: low
Quality: low

ab 5
Detail: low
Variability: high
Quality: low
Image Parameters

- ab 5
  - Detail: low
  - Variability: low
  - Quality: low

- ab 5
  - Detail: low
  - Variability: low
  - Quality: high
Image Parameters

ab 5
Detail: low
Variability: low
Quality: low

ab 5
Detail: high
Variability: high
Quality: high
Limitations of Radiance

Radiance will not necessarily `find` the sun.