INTEGRATED DAY- AND ARTIFICIAL LIGHT

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PROJECT OVERVIEW

State of the art

Development of control

Development of a new adaptive daylighting system

System documentation, measurements

Evaluation with mock-up monitoring

Artificial lighting system

Bartenbach L’chtLabor

Zumtobel

TRIDONIC

FIBAG
relevant – and conflicting – criteria:

i. amount of daylight
   guide daylight into the depth of the building

ii. daylight distribution
    properly distribute daylight throughout
    the adjacent rooms

iii. thermal properties
     shade solar heat in summer,
     provide solar gains in winter

iv. glare protection
    provide visual comfort

v. view to the outside
   allow a good contact to the outside
patented daylighting system “Daytec lamella”:  

- highly specular material  
- concave shape  
- 2 types  
  - non-perforated  
  - 50% elliptically perforated with film  
    applied on back side  
- side-mounted
DAYLIGHTING SYSTEM

daylighting system “Daytec lamella”
thermal characterization

full angular dependent SHGCs from:
• SHGC measurement of selected angles
• simulation/measurement of direct-hemispherical transmission
• inter- and extrapolation for remaining angles based on transmission

angular dependent solar heat gain coefficients for perforated Daytec lamella inside a casement window
lighting characterization

BSDF of overall system from:
1. simulation of system BSDF with genBSDF
2. combination with casement window in WINDOW7

apply material BSDF to geometry

genBSDF (tensor tree BSDF)

gemBSDF (Klems basis)

highly specular aluminum, perforated, applied film
lighting characterization

BSDF of overall system from:
1. simulation of system BSDF with genBSDF
2. combination with casement window in WINDOW7

BSDF front transmission discretized in Klems patches for perforated Daytec lamella at 0° tilt angle for varying incident directions
approach

use a single sensor on the roof to control the daylighting system and the artificial lighting and account for the thermal behavior of the building.
CONTROL STRATEGY

approach

daylight sensor

$E_v$ on façade from sun / sky / ground; color temperature

system settings (tilt angles)
daylighting system
daylight coefficients

measurement points

workplane illuminance from daylight

dimming level; color temperature

artificial light

heating / cooling period

BMS/HVAC

control
simulation
adapted daylight coefficient approach

for each system position (tilt angle):
- 1 DC for sky (upper quarter-sphere)
- 1 DC for ground (lower quarter-sphere)
- 1387 DCs for sun (façade-based Cartesian grid 5°/5°)

→ 3-phase-DC method

- Klems BSDF for daylighting system
- Reinhart sky subdivision (2305)
monitored values

light
- luminances
- illuminances
- color temperature
- spectrum

thermal
- temperatures
- humidity
- wind speed
- heating / cooling loads
- U-value
- SHGC
illuminances

• from luxmeter
• from HDR (diffuse reference surfaces $\rightarrow E = L^*\pi/\rho$)

luminances

• from HDR ($\textit{pcomb, pvalue, total and psign are your friends =) }$)
example: july 26, 2013, 13:00 (all system parts closed)

measured illuminance on workplane: 238 lx (sensor); 235 lx / 209 lx (HDR)
measured illuminance in depth of room: 91 lx (sensor)
CURRENT AND FUTURE WORK

**bug fixing**

- under-estimation of illuminances
  - daylight sensor $\rightarrow$ vertical illuminance on façade?
  - vertical illuminance on façade $\rightarrow$ interior illuminances?

**further work**

- monitoring & evaluation
- generalization possibilities to arbitrary rooms (without Radiance simulation)?
Q & A

questions?

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