Lighting level control of the office room. Technical implementation and daylight modelling of the system

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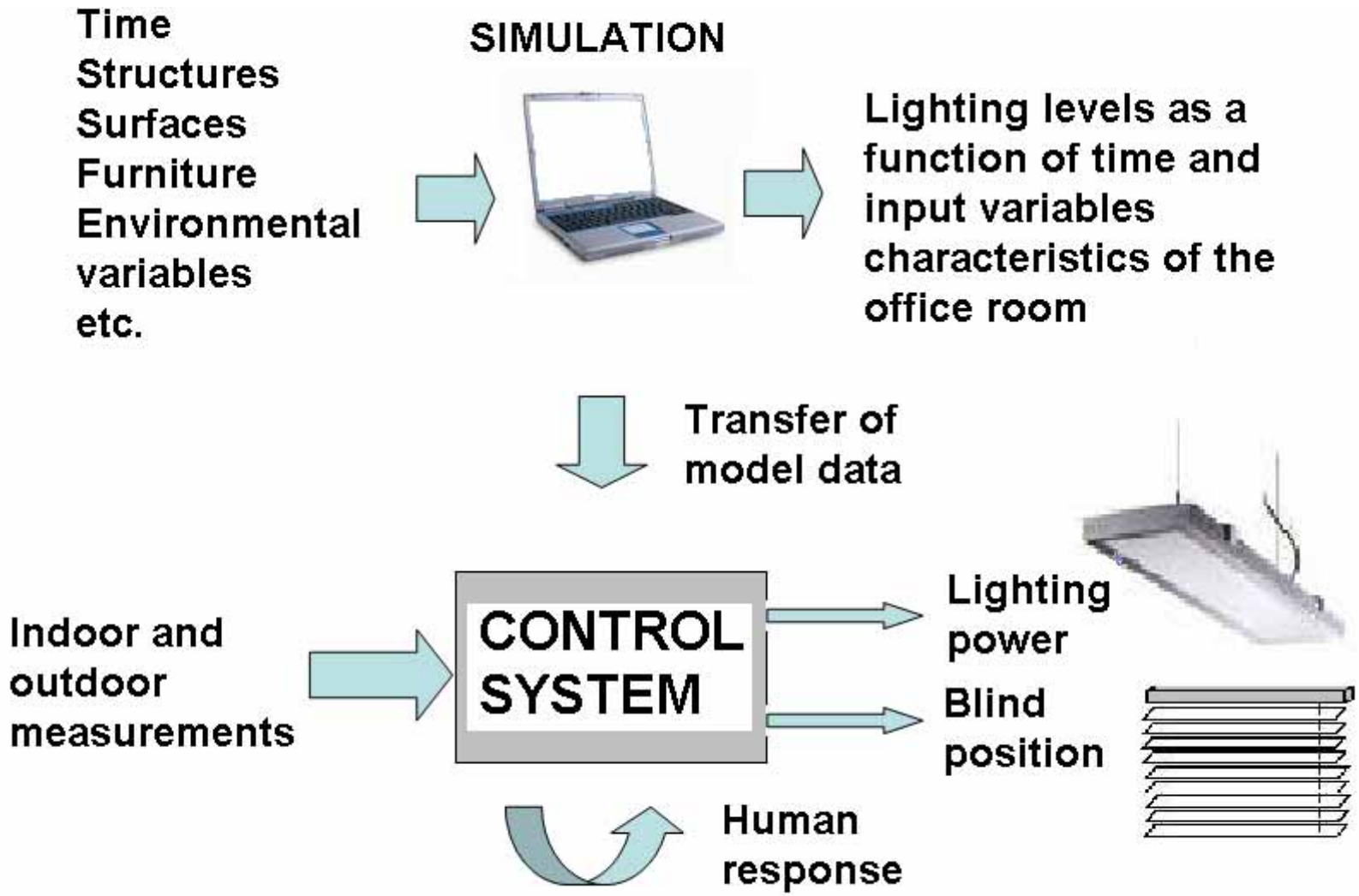
Objective

- To create a new approach for lighting level control of office rooms, which:
  - Guides the user to apply energy efficient but still satisfactory artificial lighting level
  - Creates uniform spatial lighting level distribution in the office room by benefitting natural outdoor lighting
  - Extends lamp lifes of the controlled system
  - Avoids excessive instrumentation and measurements in its final implementation
  - Benefits new IC-technology in control

The approach

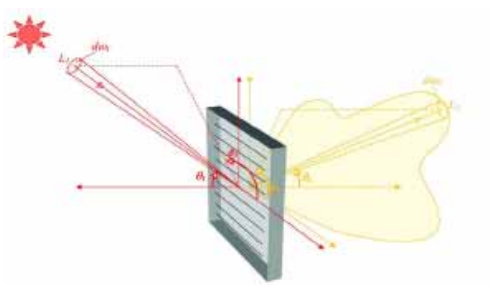
- Spatial lighting requirements of the office room are simulated by a computer program
- All the information concerning structures, surfaces, furniture, working places, environmental variables etc. are included
- The simulation will be done many times by varying indoor and outdoor environmental conditions and including seasonal variations
- The output data is applied in lighting level and blind position control together with indoor and outdoor environmental measurements
- Possibility for human feedback included

Overview of the system

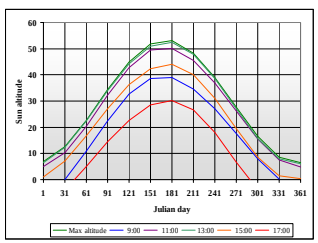


Daylight simulation

Sun position, weather, intensity



Blind model



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Geometry, orientation,materials

Room model

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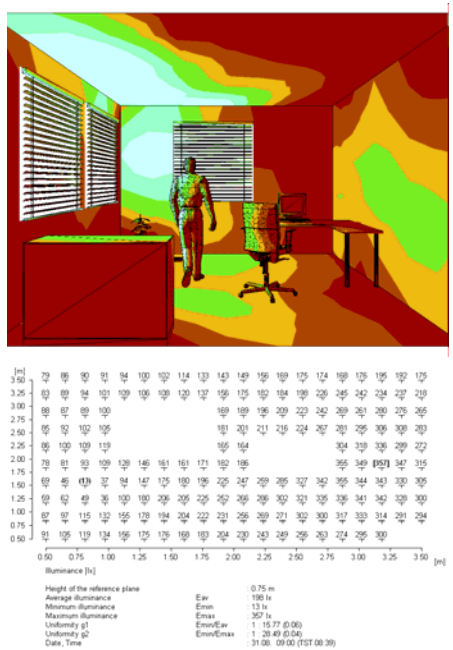


Daylight calculations

- Precalculated scenes
- Real-time control

TKK ”Light House”

Daylight laboratory ”Light Cube”

PV-panels on south facade

DALI-lighting system

Daylight measurement

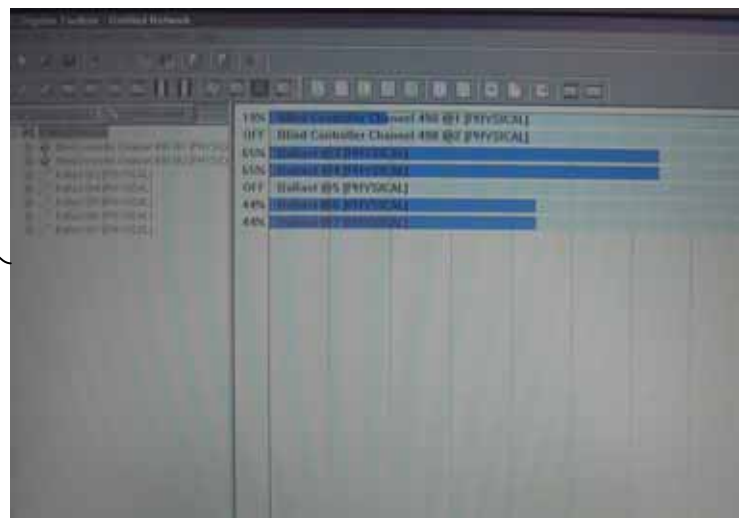
DALI-control system

Motorized venetian blinds

Blind control unit

DALI-bus

Luminaires with Dali-ballasts



Digidim Toolbox software

Data Logging

Sensors

- Outdoor illuminance:

  - Global horizontal and vertical south

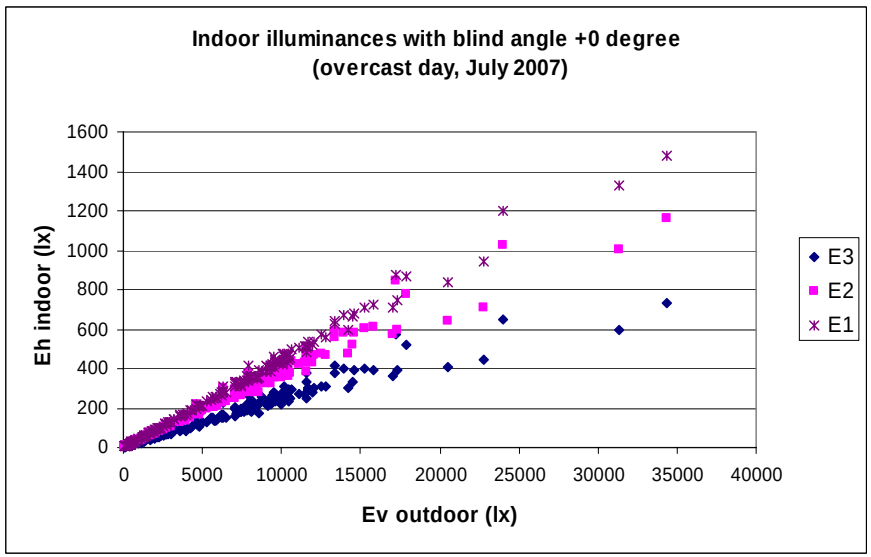
  Indoor illuminances:

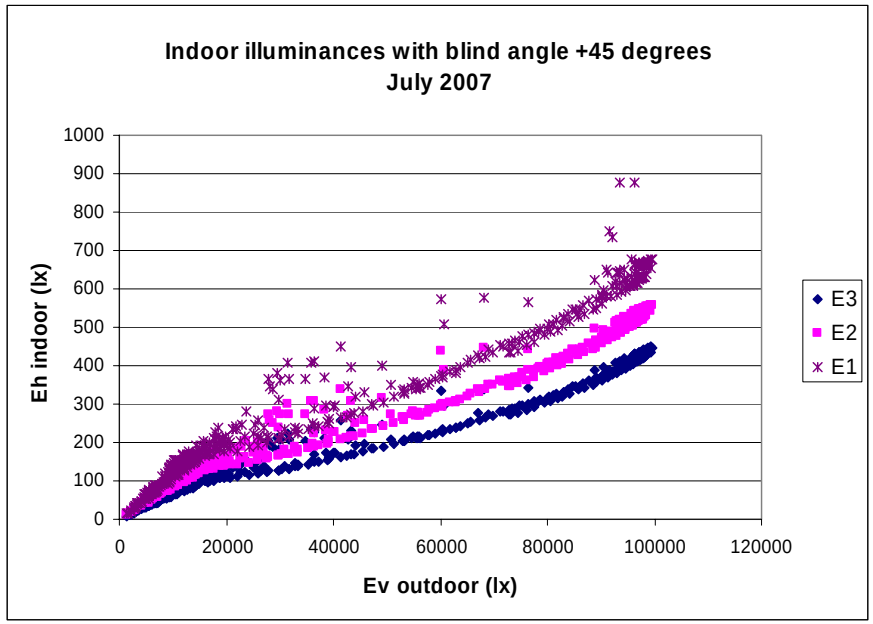
  - 3 horizontal sensors at workplane (1m, 2m and 3m from window)
  - 1 vertical sensor at eye height
- Average window luminance
- PV-panel output

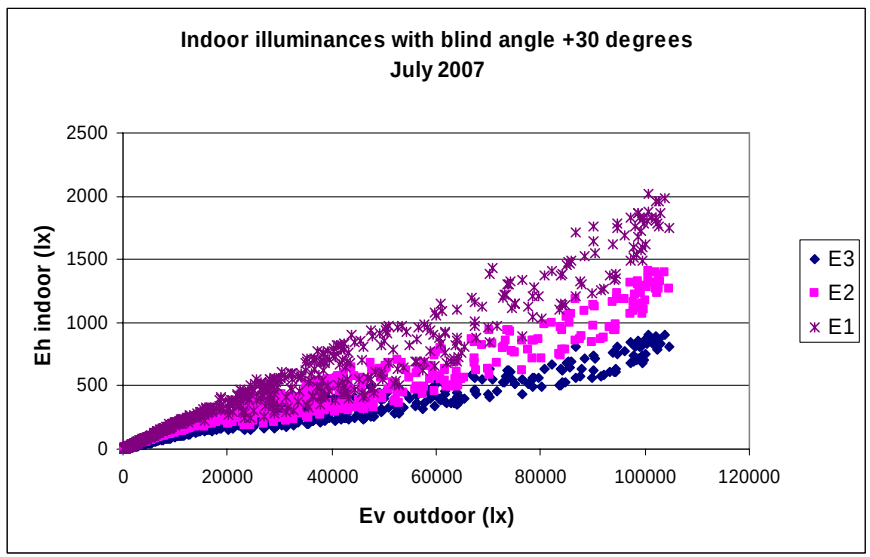
Recording interval 5 min

Measurement series in all seasons

Daylight measurements







- Effect of blind angle on indoor illuminances
- Examples: +0, +30 and +45 degrees

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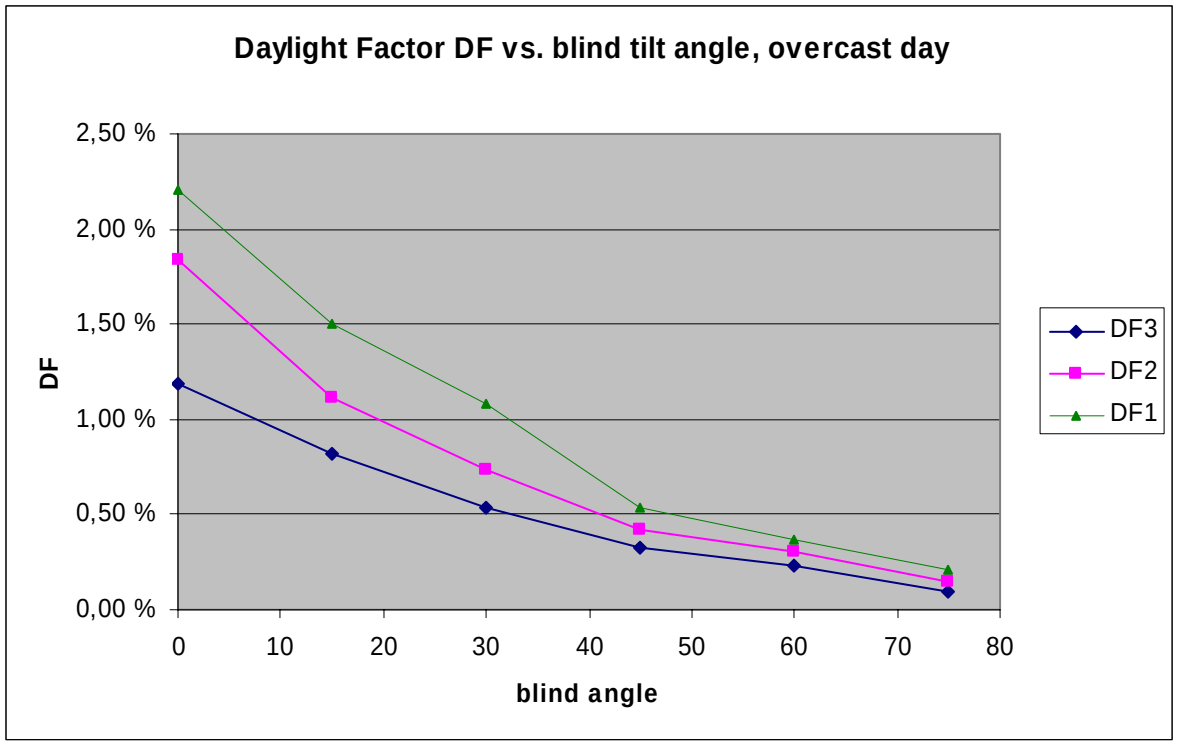
Daylight measurement

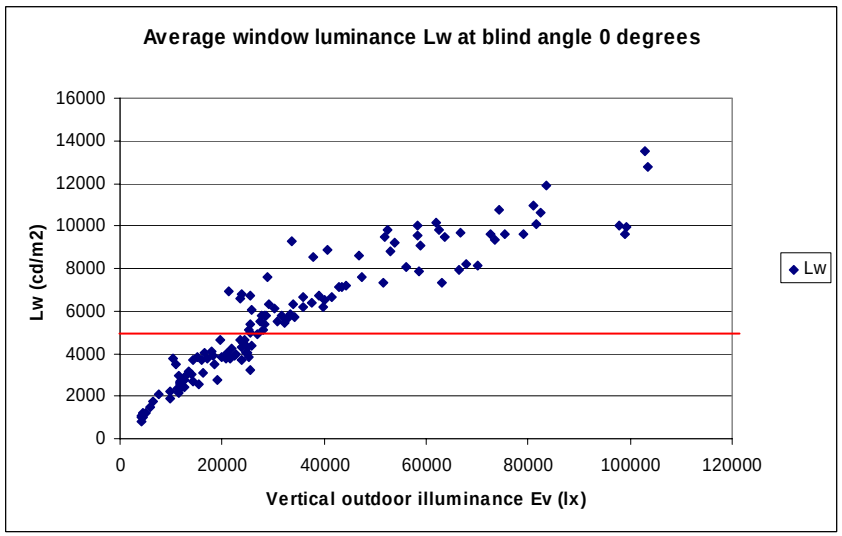


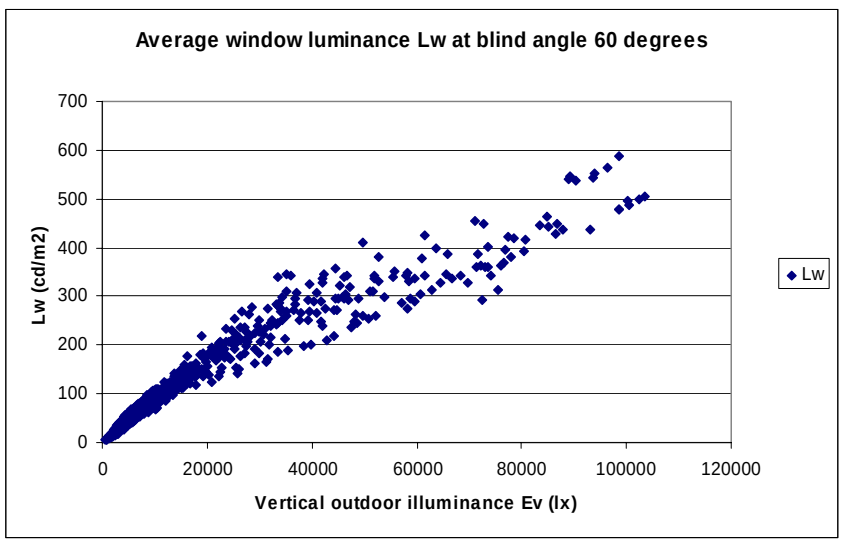
Distance from window:

DF1 = 1 m
DF2 = 2 m
DF3 = 3 m

DF = Eh in / Eh out

Window luminance vs. vertical outdoor illuminance





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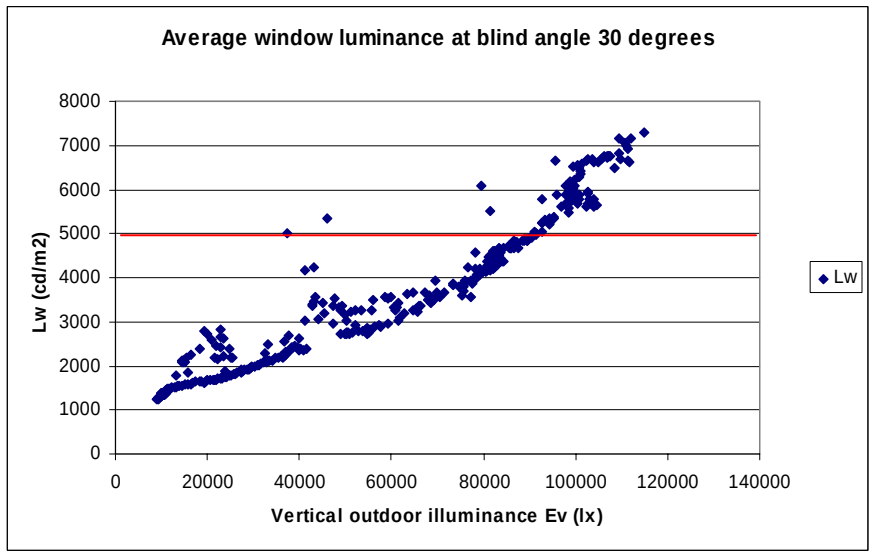

= 5000 cd/m^2 (glare limit)

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Technical implementation

- A demonstration system will be installed in the office rooms of TKK Lighting laboratory
- The system will be interfaced to the daylight measurement and photovoltaic system of the building
- The lamps and venetian blinds are controlled through Dali-bus using Digidim-Toolbox user interface
- The ultimate goal is to save the model in an serial flash memory-IC and create control system for each room with minimum measurements and instrumentation.