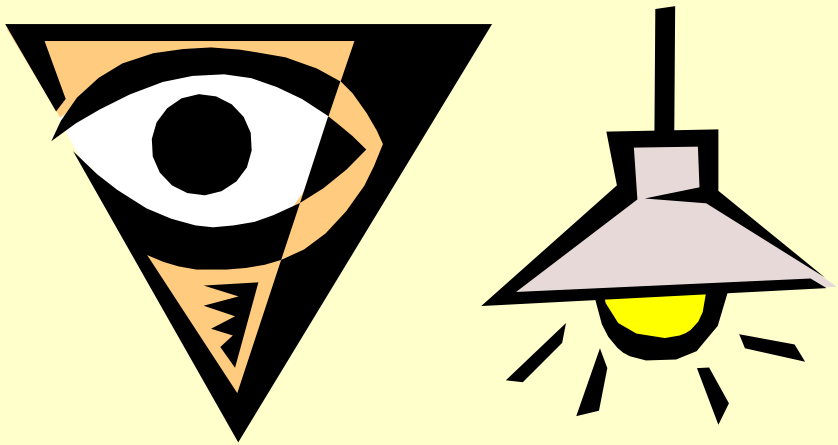
SBS5312 Lighting Technology

http://ibse.hk/SBS5312/



Computer-aided Lighting Design

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Sep 2017

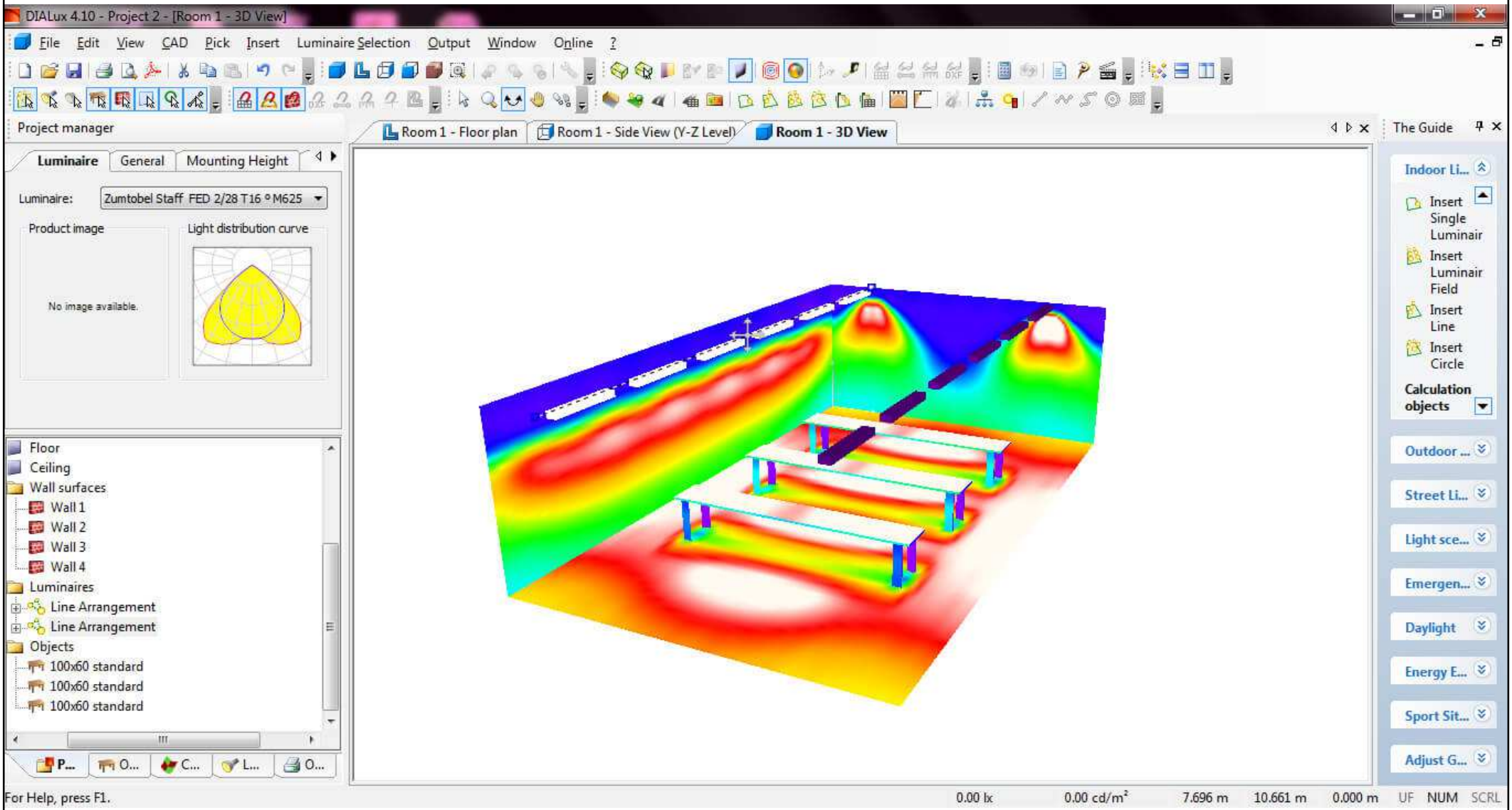
Contents

- Computer-aided Design
- Practical Examples
- Lighting Software
- Lighting Simulation
- Online Tools

Computer-aided Design

- Many of the lighting calculations can be carried out using a computer software, spreadsheet or online tools
- Common software for lighting designers:
  - 1. Manufacturers' programmes, normally linked to detailed databases of their own equipment
  - 2. General design programmes without links to any particular lighting manufacturer
  - 3. Advanced programmes, often linked with visualisation techniques

Lighting calculations and simulation with DIALux 4.10



(Further information: DIALux http://www.dial.de/)

Lighting calculations and analysis using ADELINE and Radiance

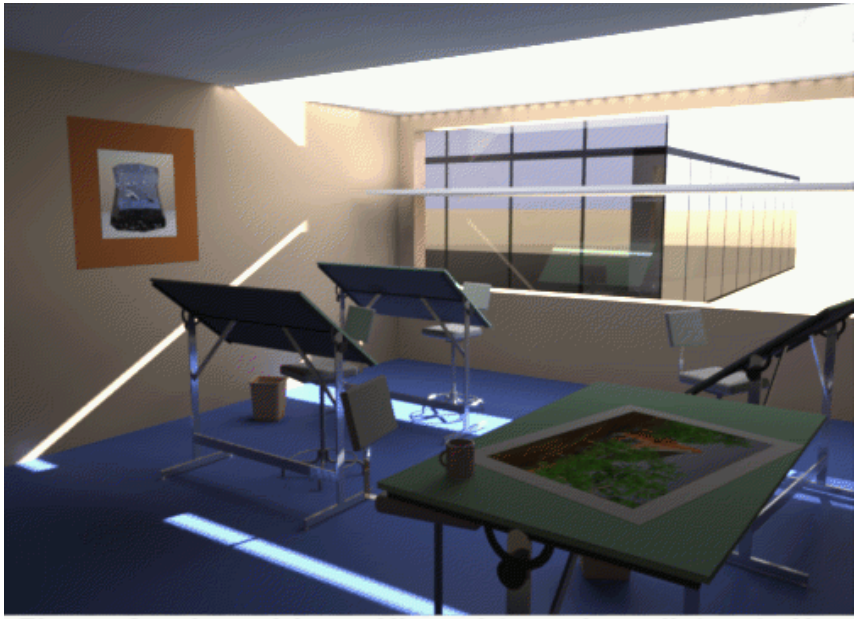


Figure 9a. A drafting office with a mirror light shelf slicing the window and redirecting light upwards.

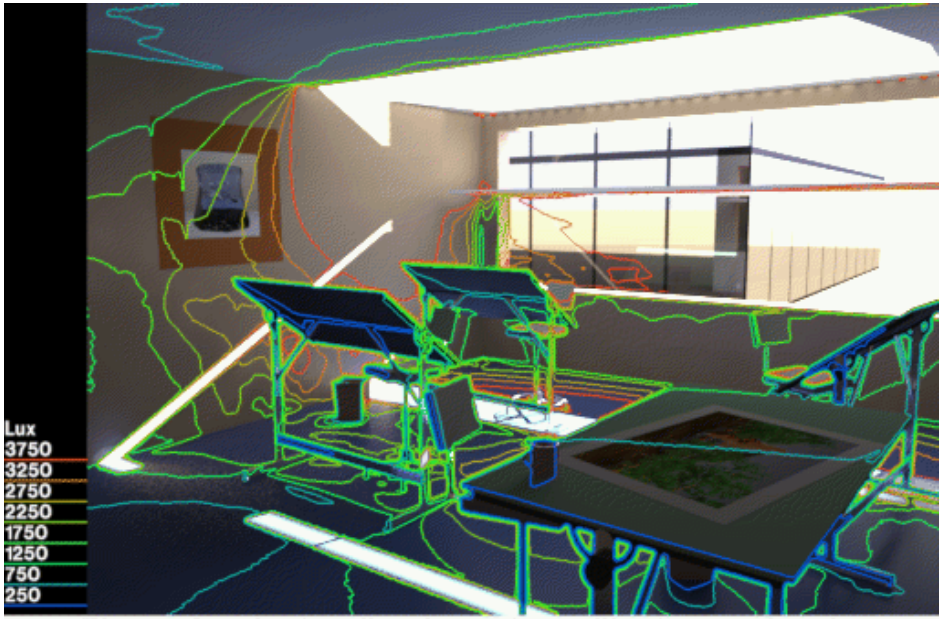


Figure 9c. A visualization of the illuminance levels on the room surfaces in the drafting office.

(Source: http://radsite.lbl.gov/radiance/refer/)

Lighting simulation using Radiance (real vs. simulated)

Figure I-1. Real vs. Radiance simulations of conference room and bathroom.

(Source: http://radsite.lbl.gov/radiance/refer/)

Computer-aided Design

- Lighting designers often use computer software as a design tool to complement and contribute to the design process to:
  - Perform simple calculations
  - Assist in space analysis or lighting layout
  - Provide the client with a photo-realistic rendering
- Remark:
  - When applying the computer tools, the designer must understand the calculation results and how they inform the lighting design project

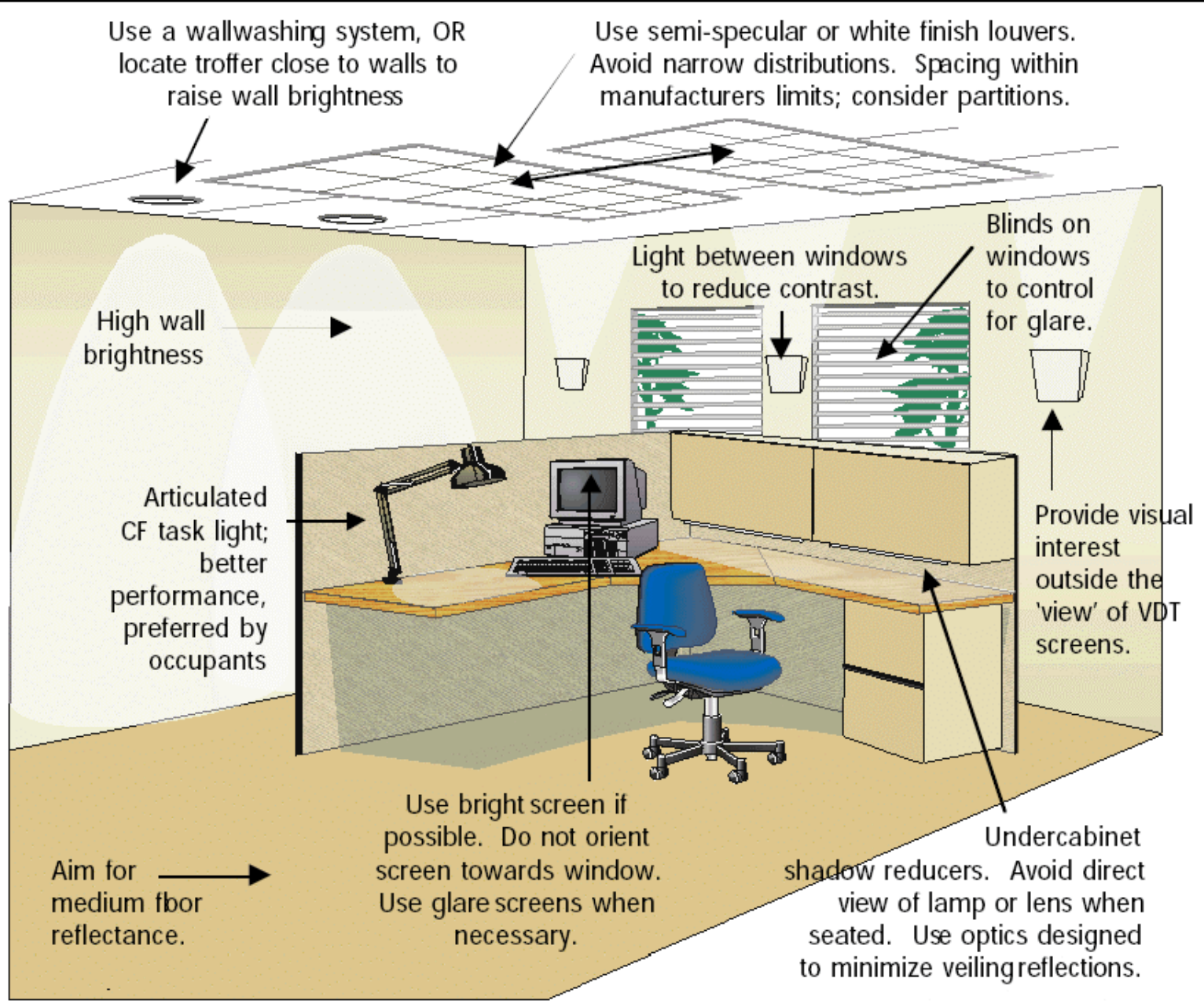
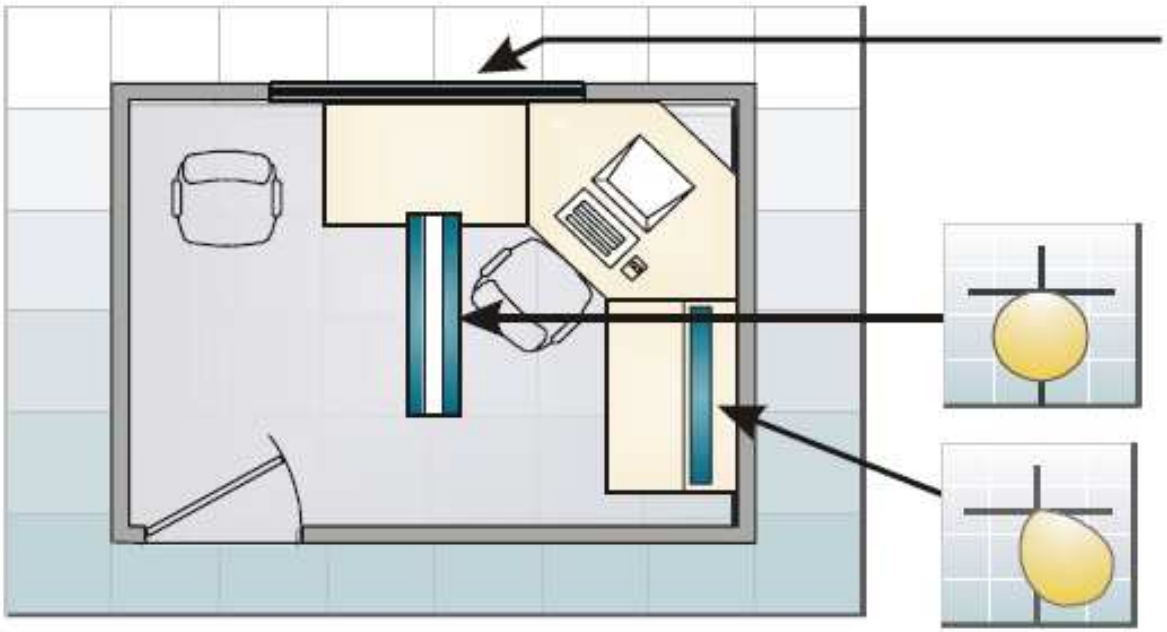


Figure 1. Graphic showing Lighting Quality Recommendations for Open Plan Spaces. The contribution of the IESNA Quality of the Visual Environment Committee is gratefully acknowledged.

(Source: *Federal Lighting Guide*, USDOE, June 1998)

Practical Examples

- 1. Private office and small work rooms
  - With a window for admitting daylight
  - General lighting (on ceiling): recessed indirect luminaire, two F32 T8 lamps
  - Task light: under cabinet, one F25 T8 lamp
  - Analyse light distribution at daytime & nighttime
- 2. Open office plan areas
  - Gray-scale rendering: daytime, daylight + electric light; evaluate the design & control strategies



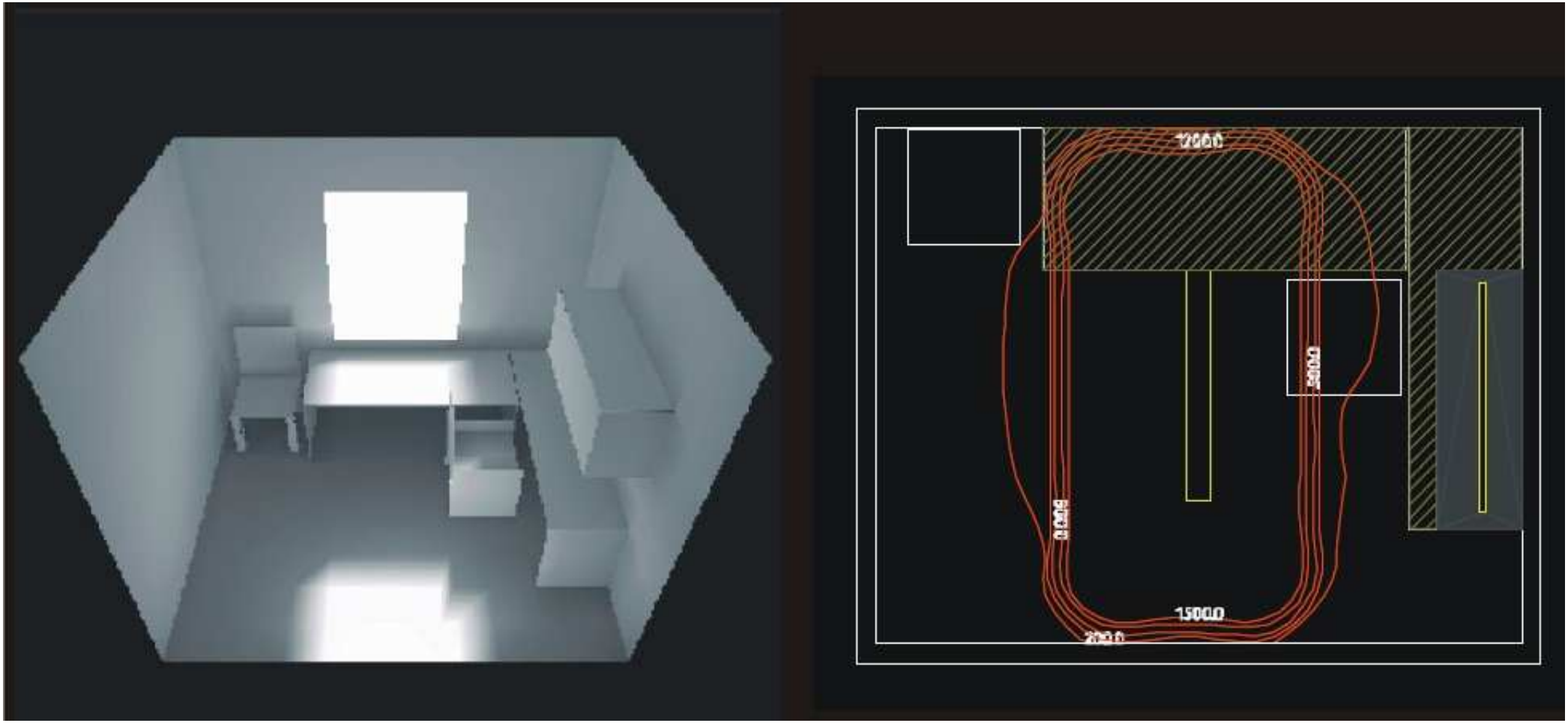
Daylight, from window with horizontal blinds, provides sufficient ambient light in space for part of the day and controls direct glare by directing direct beam sunlight upwards towards ceiling.

Recessed "indirect" basket luminaire produces direct light using two F32 T8 lamps and NLO/EE ballast. Dimming electronic ballasts allow for user and automatic photosensor control of light levels.

Under-cabinet task light, with one F25T8 lamp and RLO/EE ballast allows high illumination levels at task surface. User control or occupancy sensor.

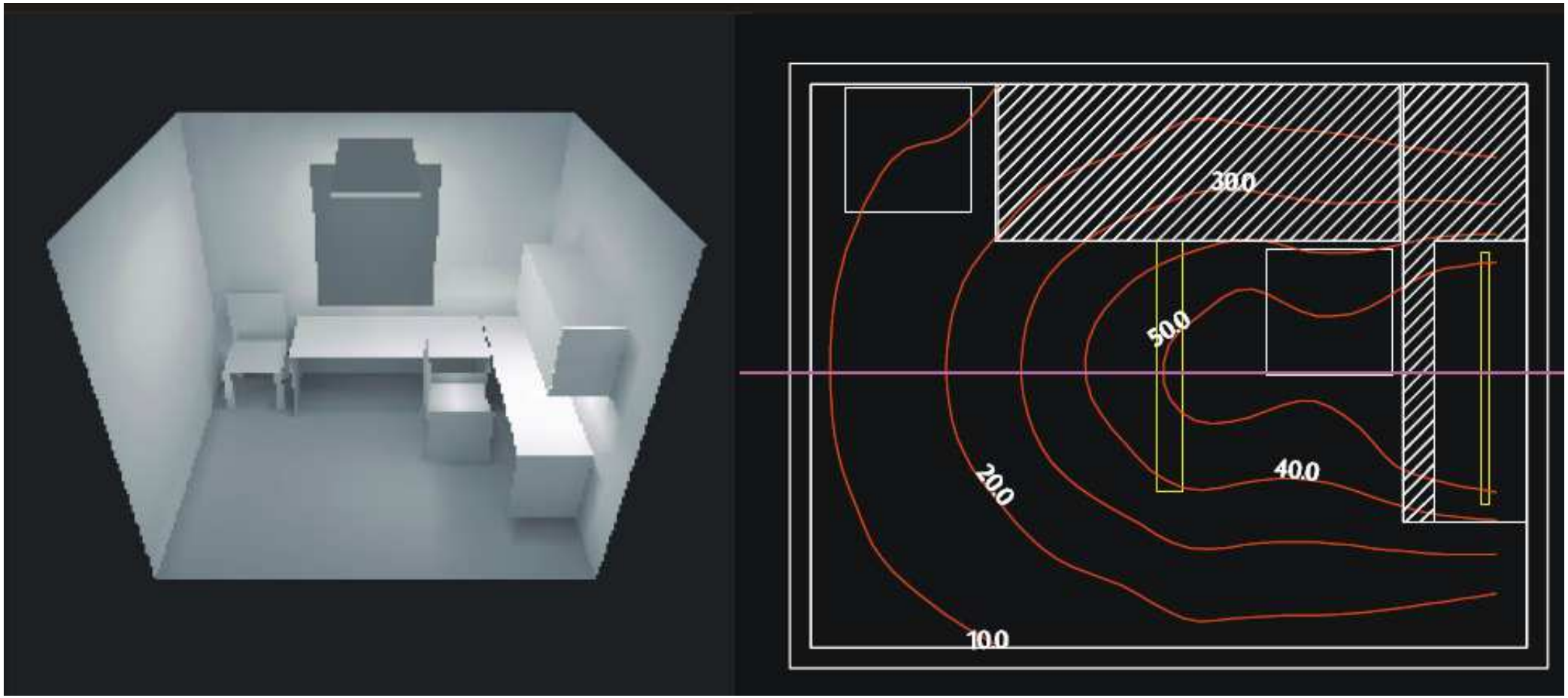
Example of lighting design (private office)

(Source: Advanced Lighting Guidelines 2001)



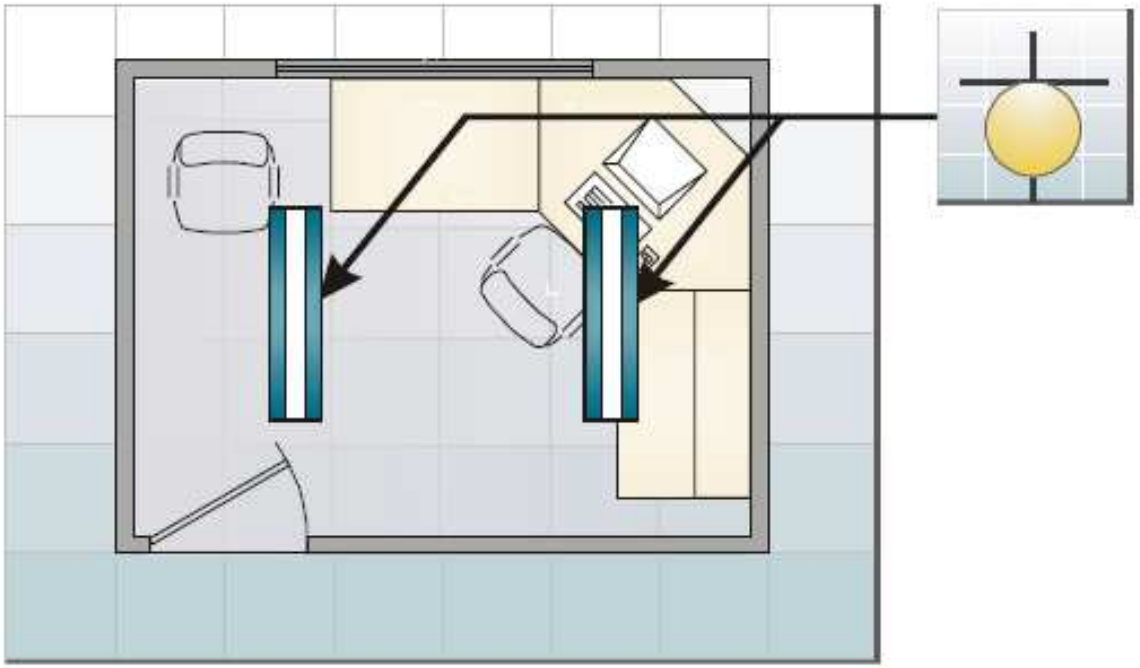
Daylighting distribution, private office at daytime

(Source: Advanced Lighting Guidelines 2001)



Electric lighting distribution, private office at night

(Source: Advanced Lighting Guidelines 2001)



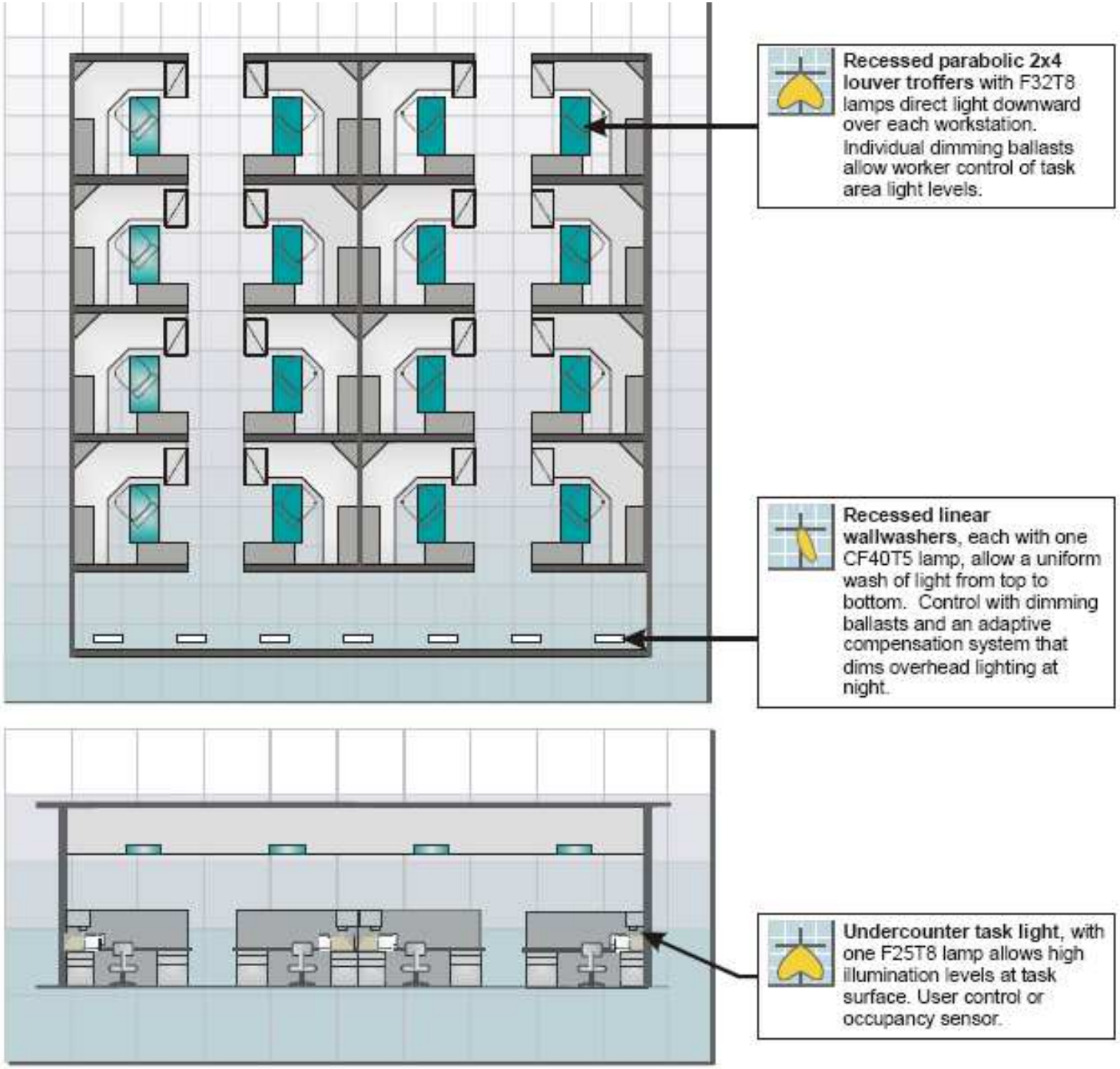
Alternate design using two recessed "indirect" basket luminaires, spaced about 6' apart, each with a single F32 T8 lamp and wired in tandem to a single NLO/EE ballast, distributes light more evenly over entire area but costs more.

Example of lighting design (private office) – alternate design

(Source: Advanced Lighting Guidelines 2001)

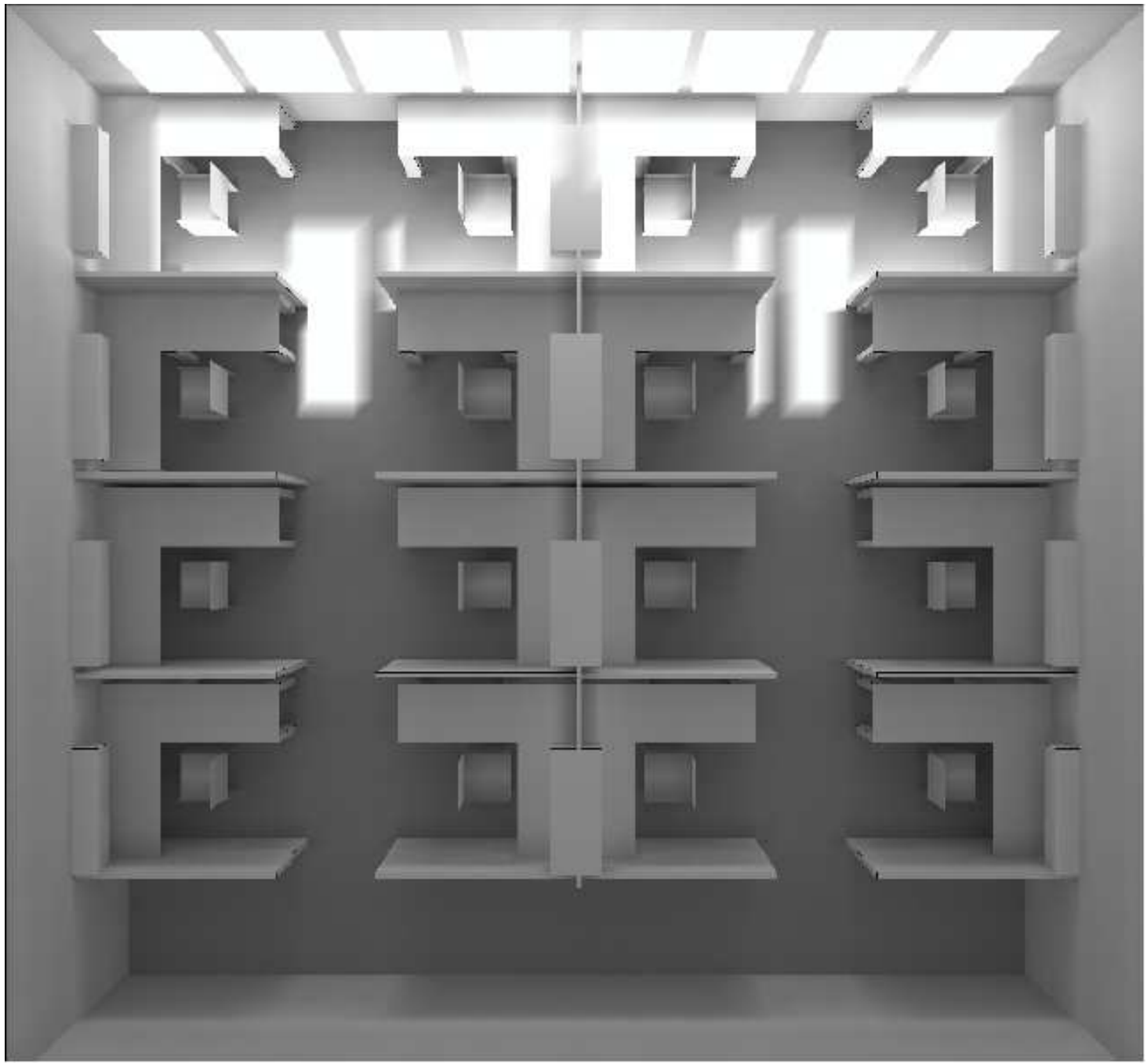
Example of lighting design (open plan office)

(Source: Advanced Lighting Guidelines 2001)



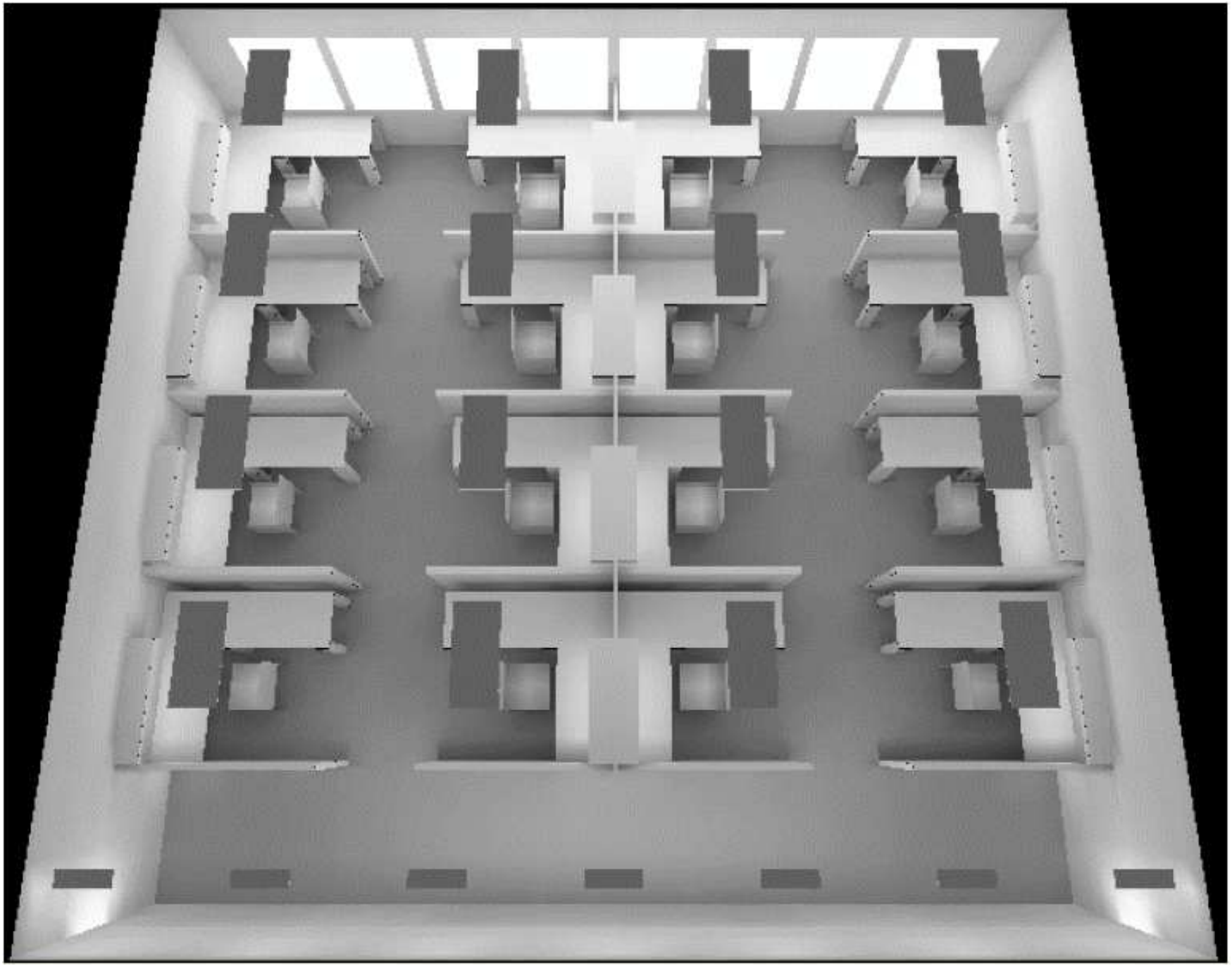
Lighting design for open plan office

(Source: Advanced Lighting Guidelines 2001)



Gray scale rendering, open plan office (daytime)

(Source: Advanced Lighting Guidelines 2001)



Gray scale rendering, open plan office (daylight + electric light)

(Source: Advanced Lighting Guidelines 2001)

Lighting Strategies: Open Office 1

Strategy	Performance	Issues
Electric Lighting: (16) Parabolic 2x4 troffers with two F32T8 lamps, 48 W each. Task lighting using (16) undercabinet 25-W lights. Circulation areas illuminated by (7) wallwashers with CF40T5 lamps, 38 W each.	Using non-dimming, efficient electronic reduced light output (RLO) ballasts BF = 0.74–0.78, the LPD = 0.93 W/ft². The connected load is 1,418 W.	Assumes 2,700 hrs/yr use = 2.6 kWh/f2 per year, annual energy cost is about $0.25/ft² for lighting plus an amount for HVAC up to about $0.08/ft². Task lighting may be T-8, T-5, or T-2.
Minimal control: Separate manual switching near window areas. Local zone override switches or overhead occupancy sensors. "Sweep" system automatic shutoff at night.	Daylit zone switching can reduce lighting power by 50% in the space if used.	The suggested 2,700 hour annual use assumes motion sensing. Manual daylight control has been shown to be predictable, but savings will be modest.
Good control: Manual controls with automatic shutoff. Automatic daylight dimming for luminaires near windows.	The connected load will rise slightly because dimming ballasts tend to be 1.00 BF. The new connected load with all dimming ballasts will be 1,716 W, LPD = 1.12 W/ft²	Automatic balancing of light levels near windows when daylighting is abundant. With daylight zone dimming only, energy reduction will be about 25% annually compared to not dimming. Annual energy is estimated at about 0.65 (2,700 hours x 1.12 W) = 1.96 kWh per year per ft²
Optimal control: Manual controls with zone adaptive dimming and automatic shutoff on all troffers. Individual remote dimming control of overhead luminaires. Occupancy sensor for task lights, plug strip control in each workstation	As above.	Progressive, multi-zone daylight dimming allows dimming of interior zone some portion of the time. Approximate energy reduction will be about 42% annually. Annual energy is estimated at about 0.50 (2,700 hours x 1.12 W) = 1.96 kWh per year per ft² Including plug strip controls, the impact is estimated at 40% for 22% of the lighting load, making the total energy savings about 50% annually compared to the base design.

Lighting Software

- Lighting Calculator, Excel spreadsheet (for checking compliance with National Construction Code in Australia)
  - http://www.abcb.gov.au/Resources/Tools-Calculators/Lighting-Calculator

TRY IT YOUR SELF!

Lighting Software

- Typical lighting software in the market:
  - AGi32 (from Lighting Analysts)
    - http://www.agi32.com/
  - Calculux (from Philips Lighting)
    - http://www.lighting.philips.cz/podpora/podpora-vyrobku/calculux
  - DIALux http://www.dial.de/
  - Relux http://relux.com
  - Visual Lighting http://www.visual-3d.com/

Lighting Software

- Selected examples for study:
  - Calculux (from Philips Lighting)
    - “Calculux Indoor”: indoor lighting
    - “Calculux Area”: outdoor lighting
  - DIALux
    - Professional lighting software
    - For calculating lighting layout
    - Perform simple rendering
  - Visual Lighting (from Lightolier)
    - Basic and Professional versions
    - Simple lighting design & modelling

CLX

DIALux

VISUAL

Lighting Software

- Calculux (from Philips Lighting)
  - Download at:
    - http://www.lighting.philips.cz/podpora/podpora-vyrobku/calculux
  - Calculux Indoor, version 5.0: indoor lighting
    - Video: video tuto calculux (9:53)
      - http://www.youtube.com/watch?v=muh8A68-Q2A
  - Calculux Area, version 5.0/6.6 : outdoor lighting
    - Video: Calculux demonstration (2:06)
      - http://www.youtube.com/watch?v=Am14Rs7ZXIM

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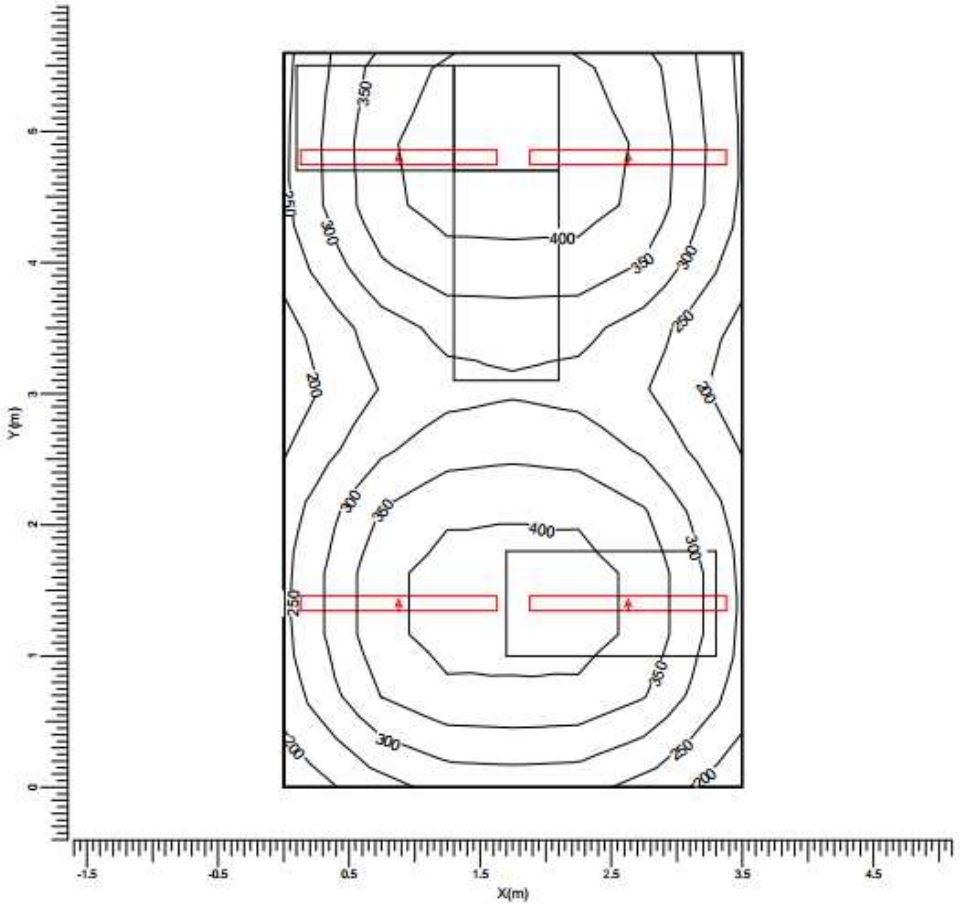
Lighting design analysis report using Calculux Indoor

3.2 Working Plane: Iso Contour

General Lighting

Grid : Working Plane at Z = 0.80 m
Calculation : Surface Illuminance (lux)
Result Type : Total



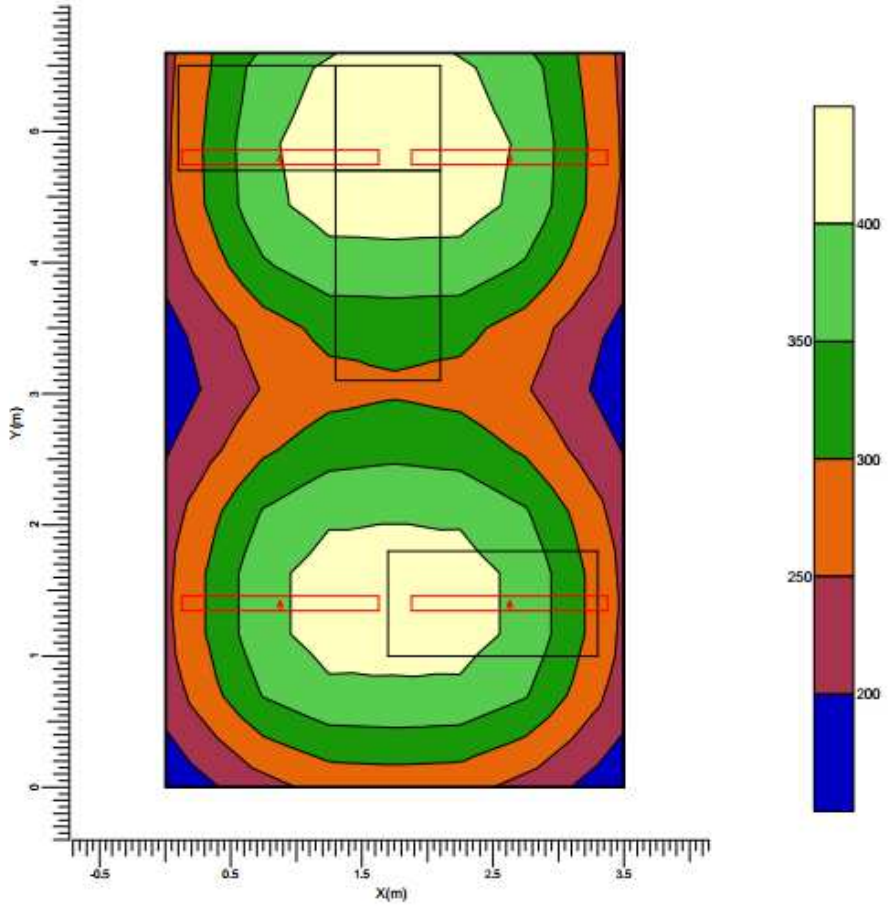
A : TBS 600/135 C7-60

Average	Min/Ave	Min/Max	Project maintenance factor	Scale
331	0.60	0.47	0.80	1:40

3.3 Working Plane: Filled Iso Contour

General Lighting

Grid : Working Plane at Z = 0.80 m
Calculation : Surface Illuminance (lux)
Result Type : Total



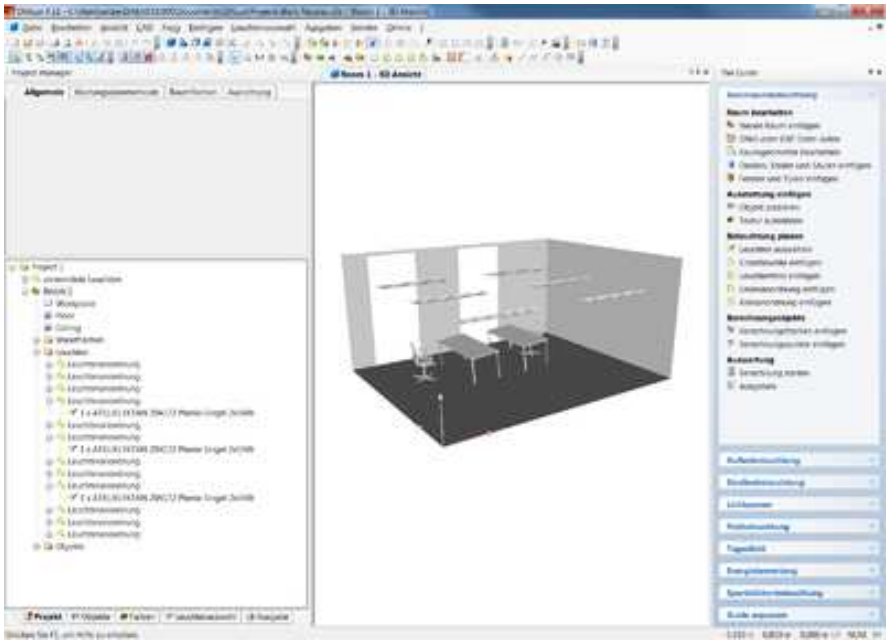
A : TBS 600/135 C7-60

Average	Min/Ave	Min/Max	Project maintenance factor	Scale
331	0.60	0.47	0.80	1:40

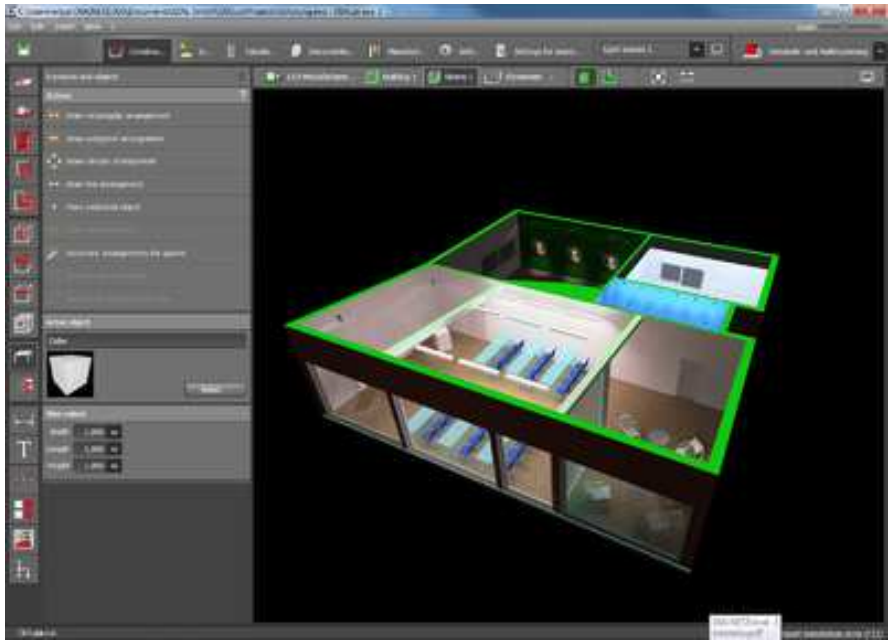
(Further information: DIALux http://www.dial.de/)

Lighting Software

- DIALux (http://www.dial.de/)
  - Learning resources:
    - DIALux Wiki (DIALux evo manual) http://en.wiki.dialux.com/
    - DIALux video tutorials http://www.youtube.com/user/TheDIALux

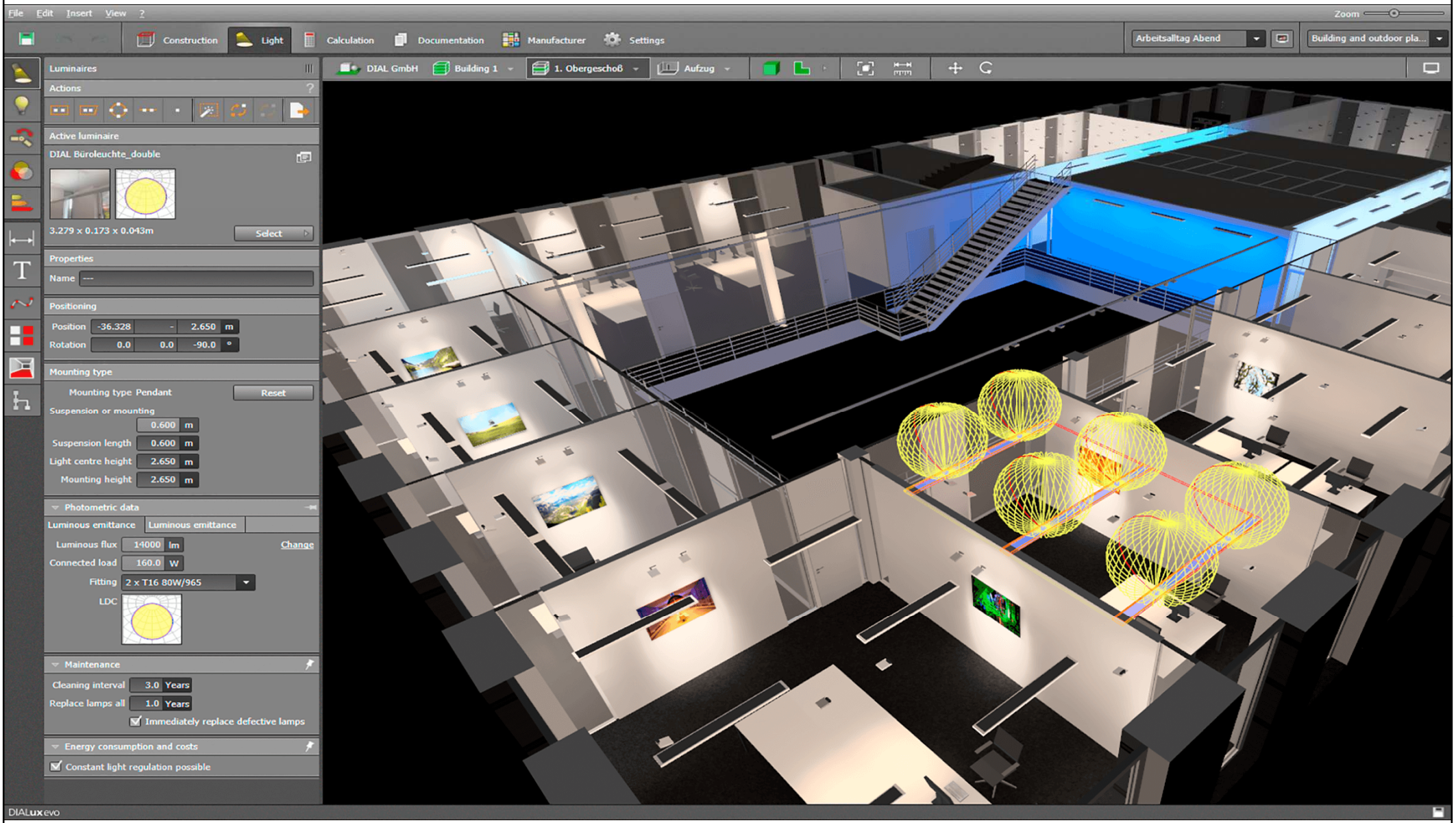


DIALux 4.13 (no more update)



DIALux evo (new successor)

Interface of DIALux evo



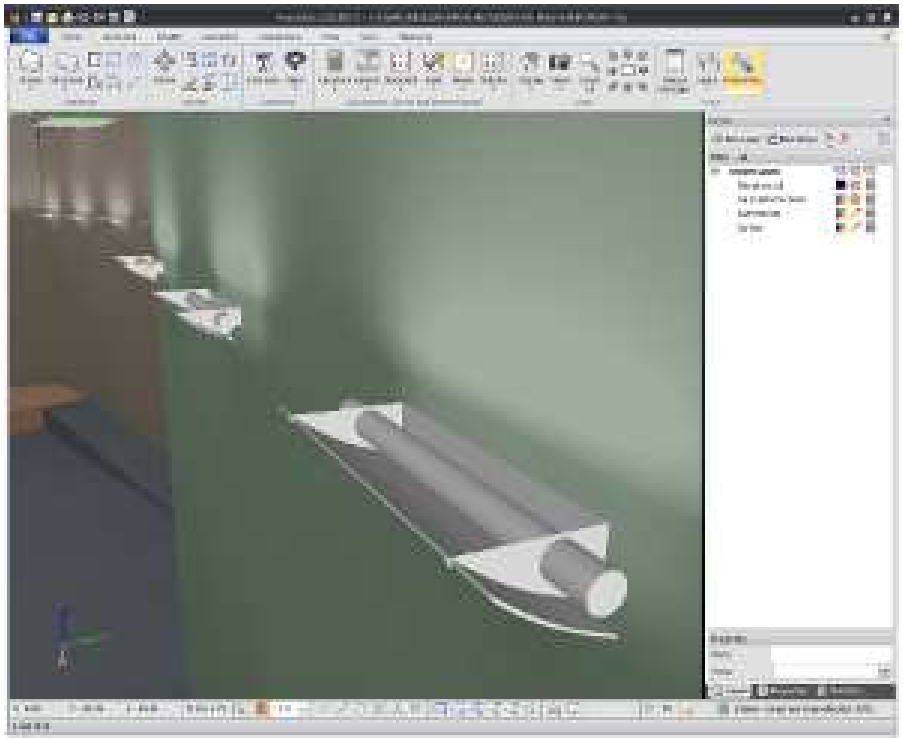
(More complicated; try it only if you have time.)

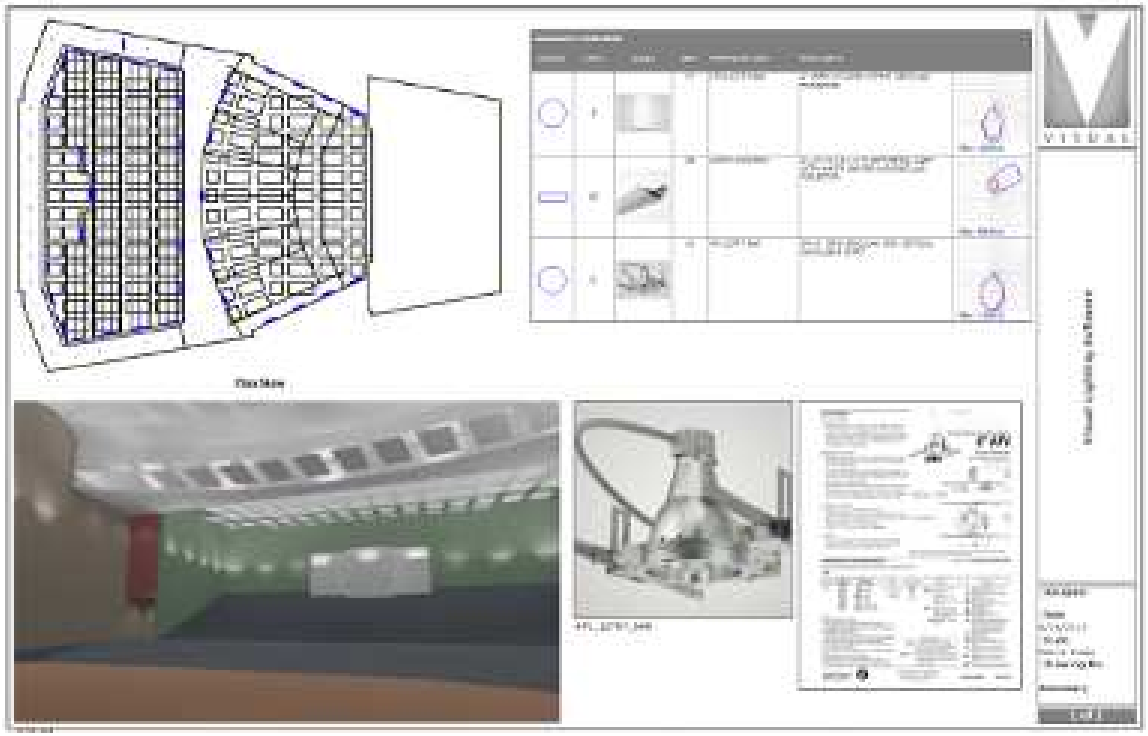
(Source: DIALux http://www.dial.de/)

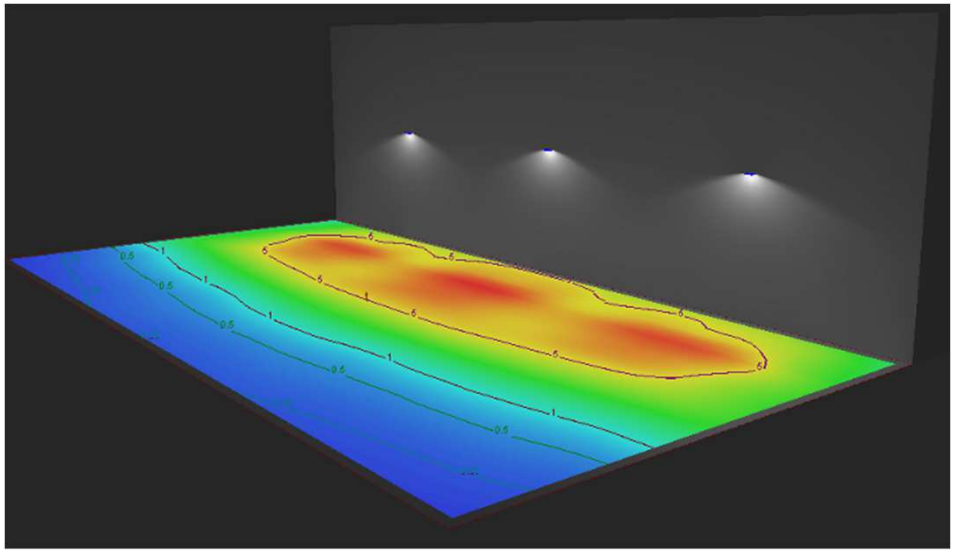
Lighting Software

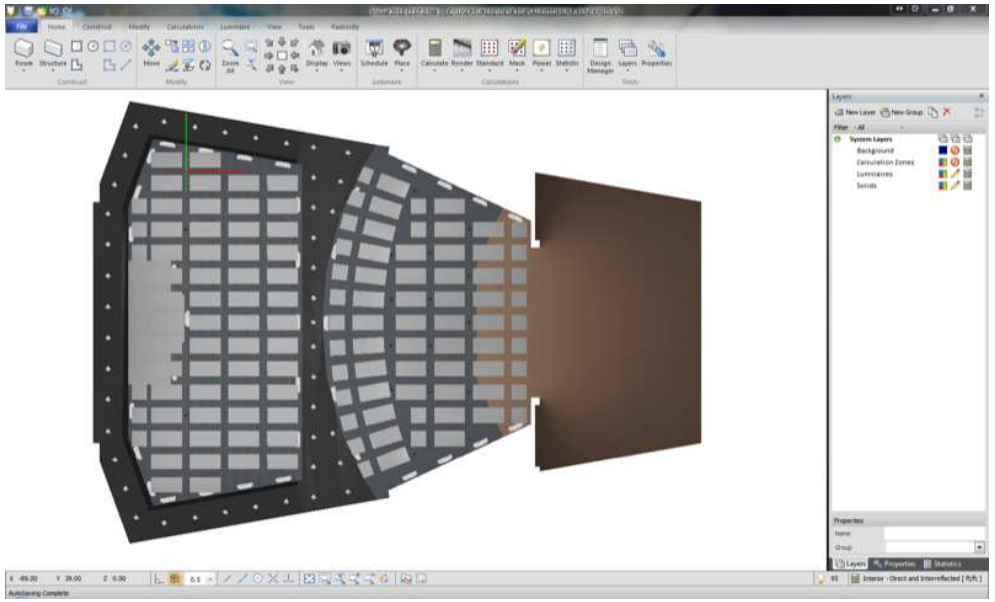
- Visual Lighting (http://www.visual-3d.com/)
  - Training Videos
    - http://www.visual-3d.com/support/trainingvideos/2012.aspx
  - Tutorial Projects
    - http://www.visual-3d.com/support/tutorials.aspx
  - Visual 2012 Documentation
    - http://www.visual-3d.com/support/documentation.aspx
  - Also has online “Design Tools”
    - http://www.visual-3d.com/software/designtools.aspx

Visual Lighting software (from Acuity Brands)









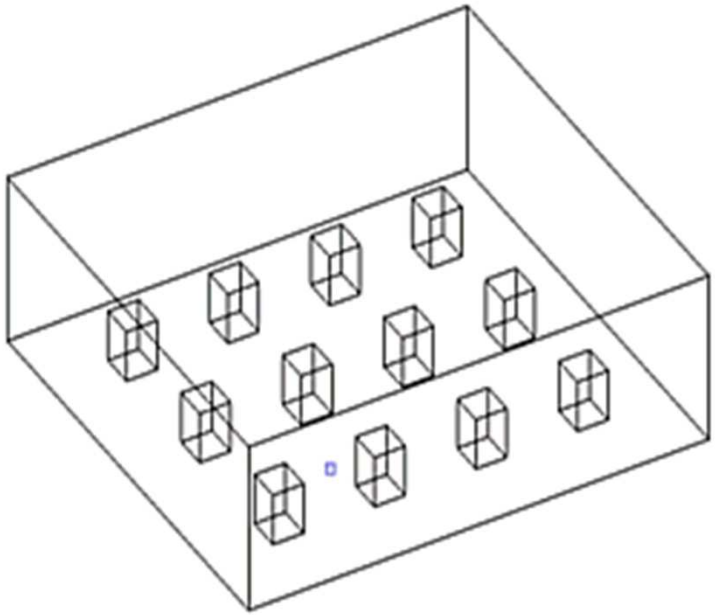
(Source: http://www.acuitybrands.com/resources/tools-and-documents/visual-lighting-software)

Lighting Software

- Other related software and analysis tools:
  - ADELINE (Advanced Day- and Electric Lighting Integrated New Environment)
    - http://www.iea-adeline.de/
  - DAYSIM (Radiance-based daylighting analysis software) http://daysim.ning.com/
  - Radiance http://radsite.lbl.gov/radiance/
    - http://www.radiance-online.org/
    - Synthetic imaging system (ray-tracing)
    - Analysis and visualization of lighting in design

Lighting Simulation

- Lighting simulation examples
  - http://iarc.uncg.edu/elight/learn/qualitative/la_sub/examples.html
  - Horizontal illuminance
  - Vertical illuminance
  - Isolux diagrams
  - Daylight factor
  - False color rendering

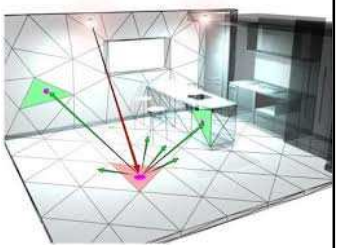


Lighting Simulation

- Lighting simulation software depends on two important components to produce accurate calculations:
  - The selected light sources
  - The surfaces within the model
- Two methods of calculation for lighting simulation or rendering:
  - 1. Radiosity 輻射度演算法
  - 2. Raytracing 光線追蹤

Lighting Simulation

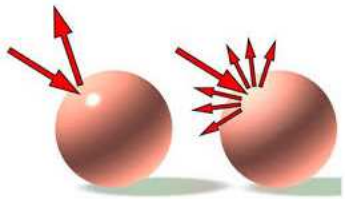
- Radiosity 輻射度演算法
  - Divides each surface into small pieces (patches)
  - Each patch is calculated individually for the amount of light that enters or leaves that surface
  - Solves the system of equations in the model by determining the quantity of light on each patch as a result of the total sum of all the patches
  - This method works well for all matte model surfaces (perfectly diffusing), and it cannot include translucent, transparent, and specular (shiny) surfaces



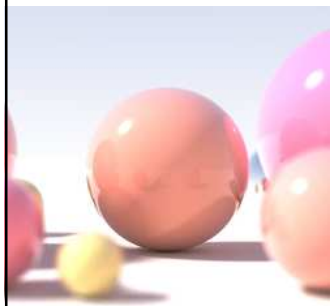
(See also: Radiosity Solution http://www.3dmax-tutorials.com/Radiosity_Solution.html)

Lighting Simulation

- Raytracing 光線追蹤
  - A point-specific lighting calculation process



  - Calculation rays are sent outward from a particular viewpoint and the program follows each ray as it hits and reflects off different surfaces and divides into more rays
  - This method works for all object types including transparent, translucent, and specular surfaces



    - Creates beautiful renderings and presentation-quality images (e.g. sparkle on specular materials)
    - View dependent and greater computational cost

Online Tools

- GE Lighting Toolkit (for simple estimating)
  - http://www.gelighting.com/LightingWeb/emea/resources/tools/
  - Cost of Waiting Estimator
  - Dimming System Watts Estimator
  - Luminaire Replacement Estimator
  - Lighting Layout Estimator
  - Simple Energy Estimator
  - Simple Life-Cycle Cost Estimator
  - Watts / m² Estimator

GE Lighting

TRY IT YOUR SELF!

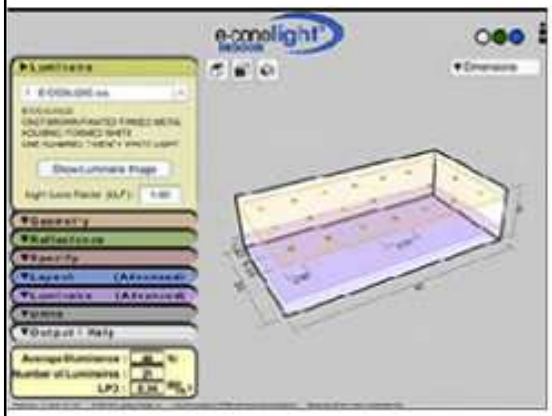
Online Tools

TRY IT YOUR SELF!

- Indoor & Outdoor Lighting layout Tools
  - http://www.e-conolight.com/resource_center/resources/lighting-layout-tool

INDOOR LIGHTING LAYOUT TOOL

- Model a fixture's light output in a custom-sized room
- Calculate the number & layout of fixtures needed to reach a target level of illumination
- Generate a clean, detailed & printable summary



STEP-BY-STEP GUIDES

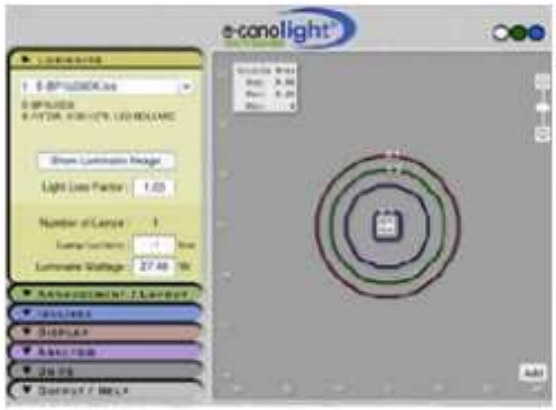
PRINTABLE >

VIDEO >

INDOOR CALCULATOR

OUTDOOR LIGHTING LAYOUT TOOL

- Model a fixture's light output based on mounting height, orientation, placement & tilt
- Create a photometric layout for the selected fixture
- Generate a clean, detailed & printable summary



STEP-BY-STEP GUIDES

PRINTABLE >

VIDEO >

OUTDOOR CALCULATOR

Online Tools

- The Visual Lighting Design Tools
  - http://www.visual-3d.com/software/designtools.aspx
  - A set of web based tools that allow users to analyze many common lighting scenarios and view photometric files
  - Can be used to quickly calculate scenarios with simple geometries
  - Complex lighting designs and geometries should be studied by professional software programs

TRY IT YOUR SELF!

Online Tools

- The Visual Lighting Design Tools
  - 1. Interior design tools
    - Interior Tool
    - Wallwash Tool
  - 2. Exterior design tools
    - Area Tool
    - Floodlight Tool
    - Template Tool
    - Roadway Tool
  - 3. Report tool
    - Photometric Tool
    - Economic Tool and Simple Economic Tool


Interior Tool


Roadway Tool

Photometric Tool


Floodlight Tool


Area Tool


Economic Tool


Wallwash Tool


Template Tool


Simple Economic Tool

Online Tools

- The Visual Lighting Design Tools
  - http://www.visual-3d.com/software/designtools.aspx
  - Learning the Interior Tool

    - Lighting Design Calculations by Using On-line Tools
      - http://www.electrical-knowhow.com/2013/01/lighting-design-calculations-by-using_16.html
    - Tutorial Video:
      - http://www.visual-3d.com/tools/interior/helpvideos/video.html
  - Learning the Area Tool

    - Tutorial Video:
      - http://www.visual-3d.com/tools/area/HelpVideos/Video.html

File Help Tools

Visual Interior Tool™

AcuityBrands.

Settings

Units: Meters - Lux

Room Dimensions

Length [X]	10	m
Width [Y]	8	m
Height [Z]	3.5	m
Workplane	1	m
Ceiling Type	2x2	

Room Reflectances

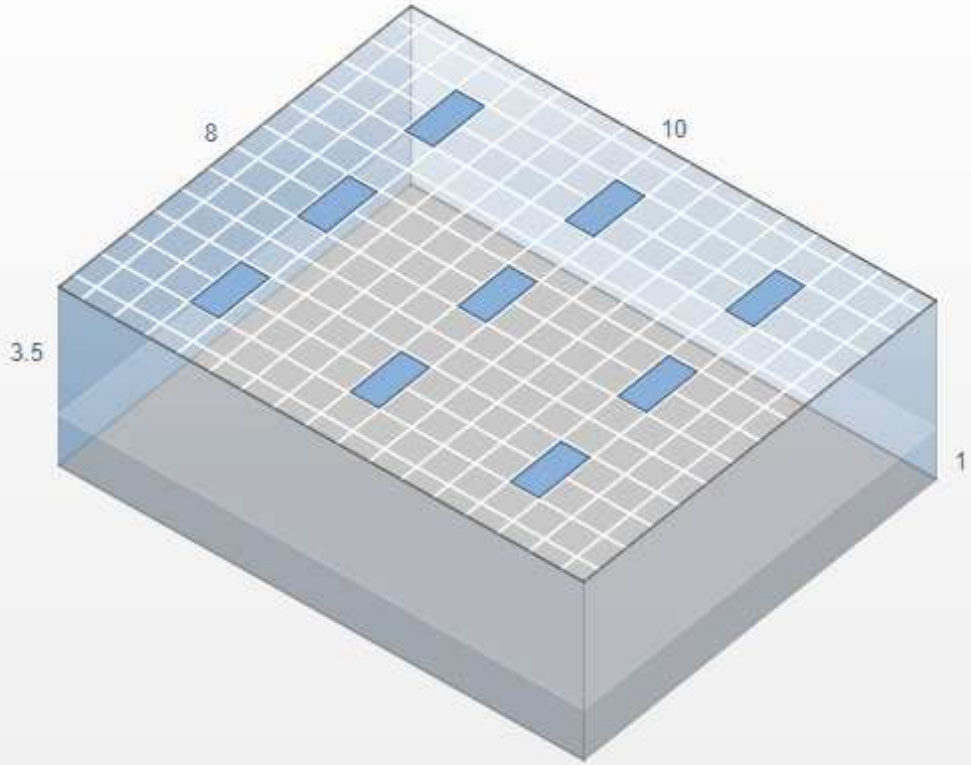
Ceiling	80	%
Walls	50	%
Floor	20	%

Criteria

Illuminance	500	lux
Power Density		W/m²
Quantity		

Constraints

Spacing X [SC=3.6]		m
Spacing Y [SC=3.1]		m
Rows		
Columns		



Calculation Results [A]

Illuminance	462 lux
Power Density	6.52 W/m²
Quantity	9

Spacing Results [A]

Spacing	3.05 x 2.44 m
Arrangement	3 x 3
Outside Spacing X	1.68 m
Outside Spacing Y	0.99 m

Display

Dimensions Room ☑ Layout ☐

Show Zonal Cavity Info [+]

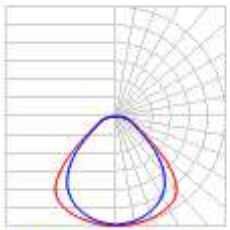
Project Information

A

Holophane

[A] - HT24 2 32 A12 GEB10IS

Light Loss Factor	1	Symbol Shape	Rectangular	Lamp Quantity	2
Suspension Length	0	Symbol Length	.54	Lumens Per Lamp	2850
Orientation	0	Symbol Width	1.15	Wattage	58



File Help Tools

Visual Area Tool ™

AcuityBrands.

Settings

Units: Meters - Lux

Precision: 0.00

Criteria

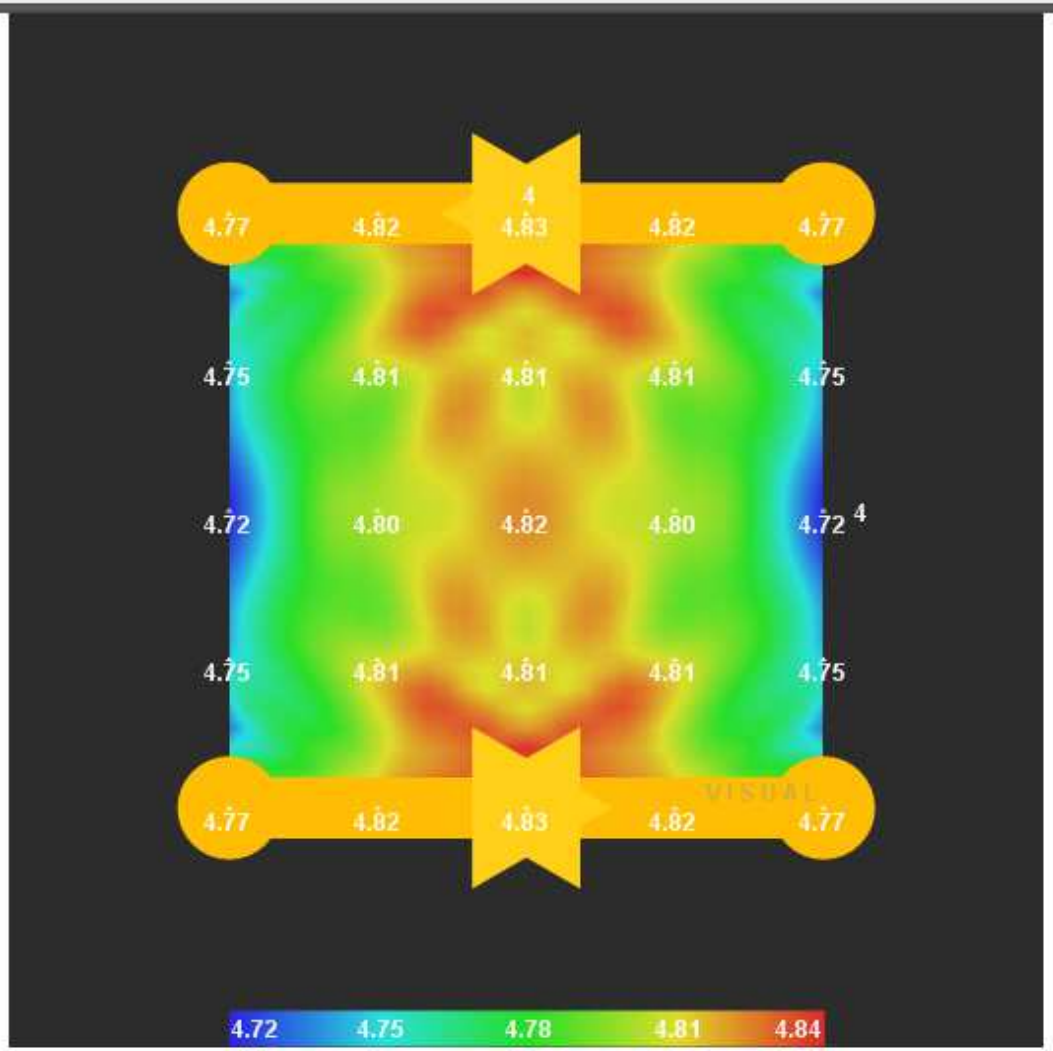
Minimum	10	lux
Average		lux
Max / Min		lux
Parking Lanes	60	m
Pole Arrangement		

Constraints

Spacing X	4	m
Spacing Y	4	m

Calculation Points

Point Spacing X	1	m
Point Spacing Y	1	m



Spacing Results [A]

Spacing	4 x 4 m
Area Between Poles	16 m²
Wattage / Area	15.75 W/m²
Optional Spacing	

Calculation Results [A]

Minimum	4.72 lux
Average	4.79 lux
Maximum	4.83 lux
Max/ Min	1.02
Ave/ Min	1.01
Point Spacing	1.00 x 1.00 m
iterations	1
Points Calculated	986

Display

Points

[A]

0.1	lux
0.2	lux
0.5	lux
1	lux

View Grid Detail

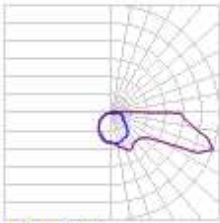
Project Information

A

Holophane

[A] - PK050HP00CXA

Configuration	Single	Light Loss Factor	1	Lamp Quantity	1
Mounting Height	20	Orientation	0	Lumens Per Lamp	4000
Support Length	.3	Tilt	0	Wattage	63



- 0° H
- Max Cd: 65° H

Open File Settings Tools

Visual Photometric Tool™

AcuityBrands.

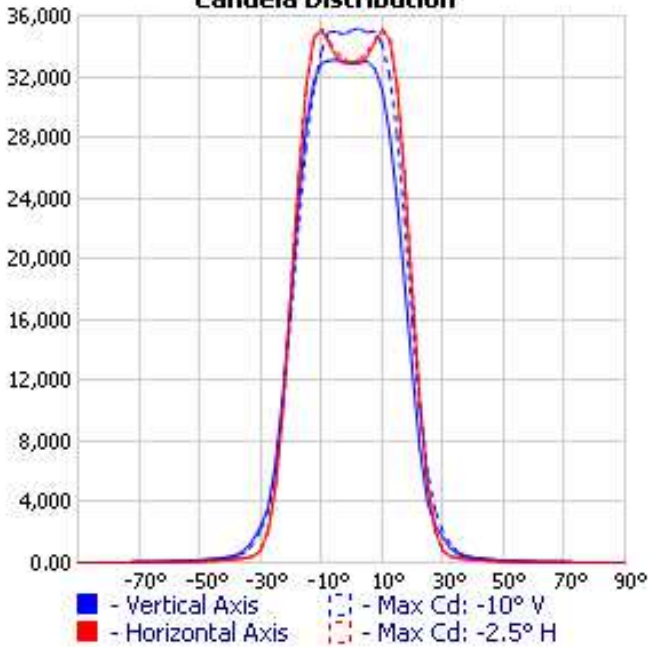
TEST #:	107267P22
TEST LAB:	SCALED PHOTOMETRY
TEST NOTES:	SCALED FROM ABSOLUTE TEST: 107267
TEST DATE:	4/11/2016
CATALOG:	HPFL 7 4K 07A 44
DESCRIPTION:	HAZARDOUS PREDATOR LARGE LED WITH 7 COBS, 4000K COLOR TEMPERATURE , 700MA DRIVE CURRENT , 4X4 DISTRIBUTION
SERIES:	PREDATOR HPFL LARGE LED
LAMP CATALOG:	C0B
LAMP:	LED
LAMP OUTPUT:	TOTAL LUMINAIRE LUMENS: 16852, ABSOLUTE PHOTOMETRY *
BALLAST / DRIVER:	LED DRIVER
INPUT WATTAGE:	185
LUMINOUS OPENING:	POINT
NEMA TYPE:	4 X 4
MAX CD:	35,189.3 AT HORIZONTAL: -10°, VERTICAL: -2.5°

HOLOPHANE

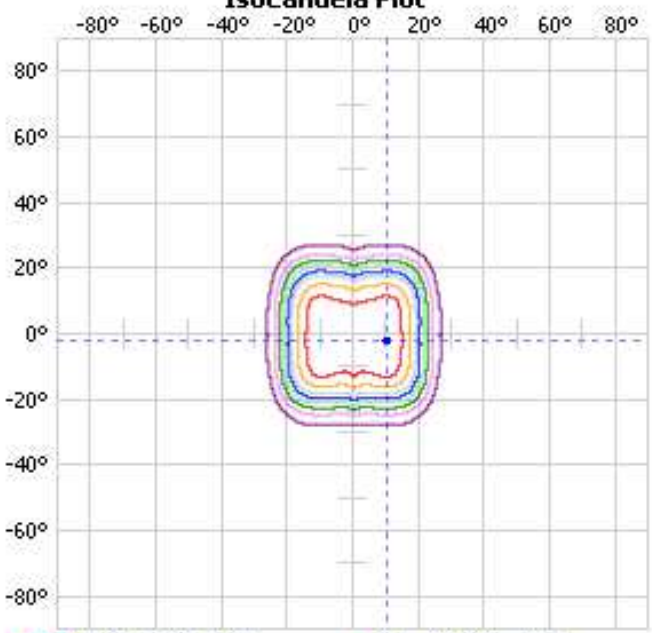
PRODUCT LINKS

IES LDT PDF RFA DWG

Candela Distribution



IsoCandela Plot



Cd: 31,670, 90%
Cd: 26,392, 75%
Cd: 21,114, 60%
Cd: 17,595, 50%
Cd: 14,076, 40%
Cd: 10,557, 30%
Cd: 7,038, 20%
Cd: 3,519, 10%
Point of Max Cd: 35,189.3

File Help Tools Design Spaces Luminaires Controls Results AcuityBrands

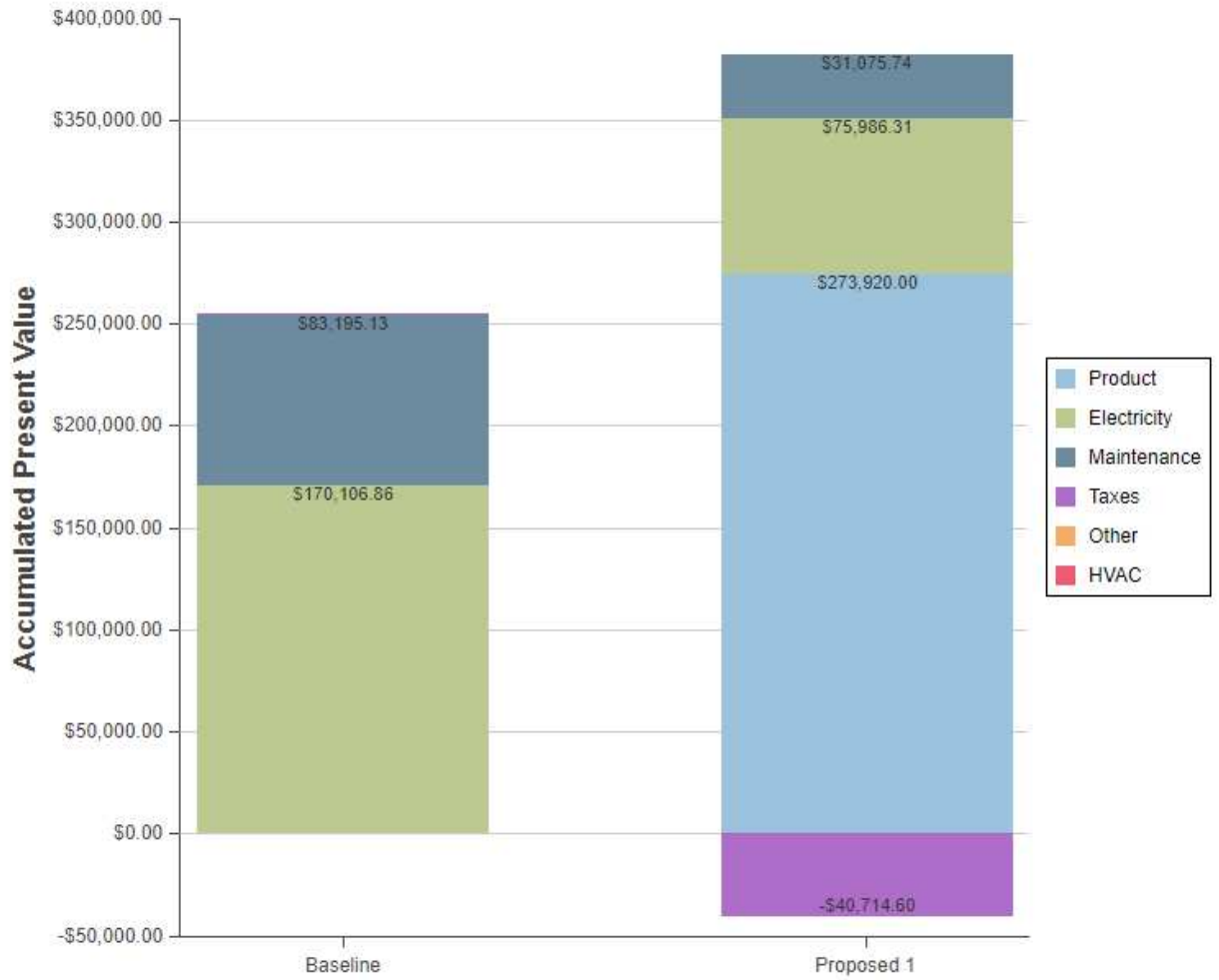
Assumptions

Life Cycle (years):	12
Discount Rate (%):	5
Electricity Rate (¢/kWh):	8
Electricity Escalation (%):	0
Reinvestment Rate (%):	0
Taxes	
Local Sales Tax (%):	6
Income Tax Rate (%):	30
Depreciation Years:	10

Summary results of the Economic Tool

Designs | Groups | Spaces | Annual Details | Luminaires | FV vs PV | Design Audit (5)

By Category | By Year



Design Summary

Category	Baseline	Proposed 1
Initial Cost	$0.00	$288,288.20
Ave. Operation Cost (FV)	$28,713.47/Year	$6,710.69/Year
Total Operation Cost (PV)	$254,494.74	$51,979.25
Life Cycle Cost	$254,494.74	$340,267.45
Net Present Value	--	($85,772.71)
Simple Payback	--	No Payback
Discounted Payback	--	No Payback
Internal Rate of Return	--	--

Analyze Calculate

Further Reading + Trying

- The Visual Lighting Design Tools
  - http://www.visual-3d.com/software/designtools.aspx
  - Interior http://www.visual-3d.com/tools/interior/
  - Area http://www.visual-3d.com/tools/area/
  - Photometric http://www.visual-3d.com/tools/photometricviewer/
  - Economic http://www.visual-3d.com/tools/economicpro/