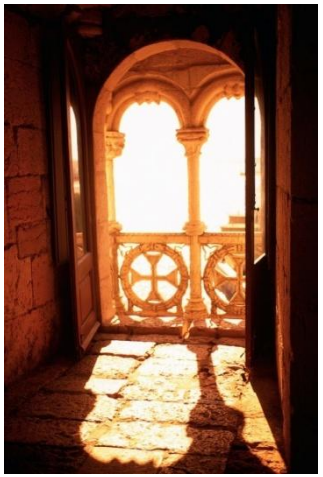
ADVANCES IN DAYLIGHT SIMULATION

A joint event by the CIBSE Building Simulation Group and the CIBSE Daylight Group

Why is Daylight design the Cinderella of Building Modelling

David Mooney Regional Associate PB

People like natural light



Is this your workplace

Are you wasting 10% of your electricity

Are your lights on during daylight hours?

Lights on Blinds Down= Bad Design

PARSONS BRINCKERHOFF

Presentation Content

1. Why daylight modelling is increasingly important
2. Project Constraints.
3. What Tools do we need for Daylight Modelling.
4. What and when Sunlight Modelling is Important.
5. Sunlight and Daylight Products.
6. Integrating Lighting Control Design with Daylight Modelling.
7. Case Studies.
8. Conclusions.

Why daylight modelling is increasingly important

Why is daylight modelling important

- Energy consumption.
- Statutory/regulatory change.
- Benchmarking.
- Quality of Internal environment
- User satisfaction and wellbeing

The Headlines

- Electric Lighting currently consumes 19% of current total global electricity

  = 1.9 Gt of CO_2/yr.

- If current energy efficiency polices do not change will increase to

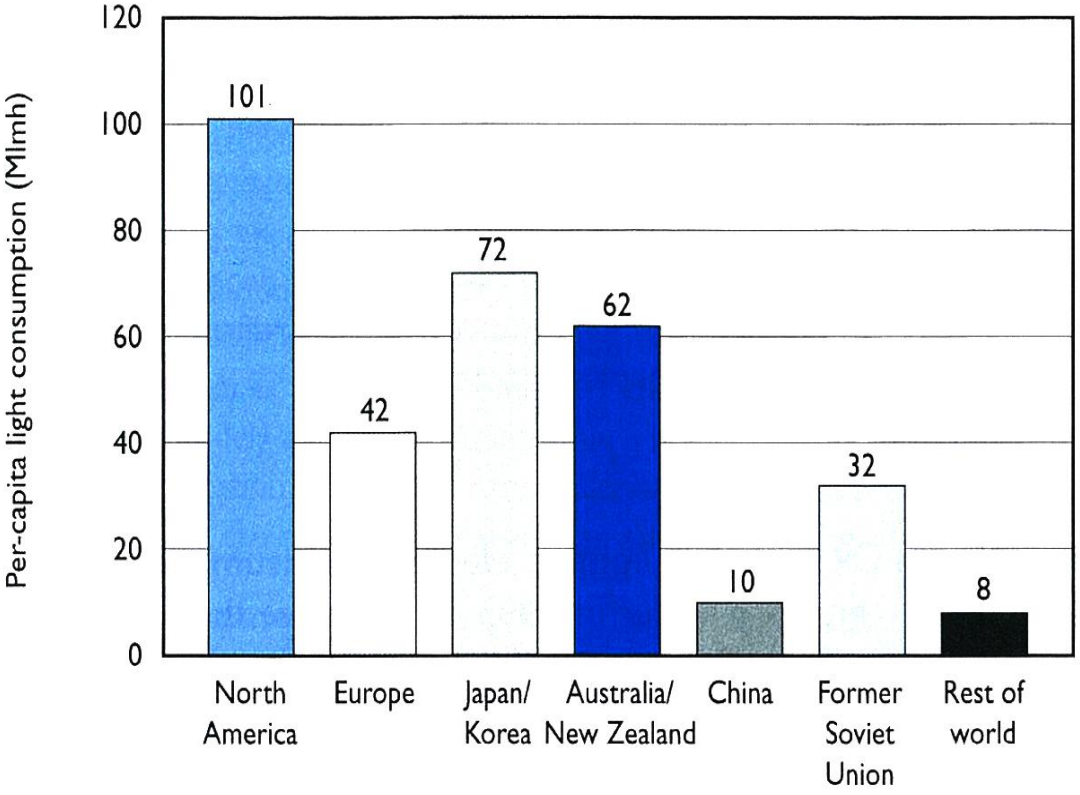
  = 3 Gt of CO_2/yr by 2030

IEA/OECD Lights Labours Lost 2006

There is no viable alternative to electric lighting during darkness hours that meets current design standards.

Energy consumption 1

Figure OR.1 **Estimated per-capita consumption of electric light* in 2005**



* Source-lumens.
Abbreviation: Mlmh = megalumen-hours.

Regulations, Standards and Guides

Regulations

- European workplace directive - *Access to daylight required*
- Building Regulations - *No minimum daylight standards*

Standards

- BS 8206-2 2008 Code of Practice for daylighting.
- BREEAM 2008 *(four points only !!!!!)*
- Building Bulletin 87 Guidelines for environmental design in schools
- Lighting design for schools Building Bulletin 90
- Designing schools for the future Building Bulletin 95
- CIBSE LG2 Lighting for Healthcare buildings

Guides

- CIBSE SLL Daylighting and window design LG10 1999
- BRE Designing buildings for daylight.
- BRE Designing with innovative daylighting

Benchmarking

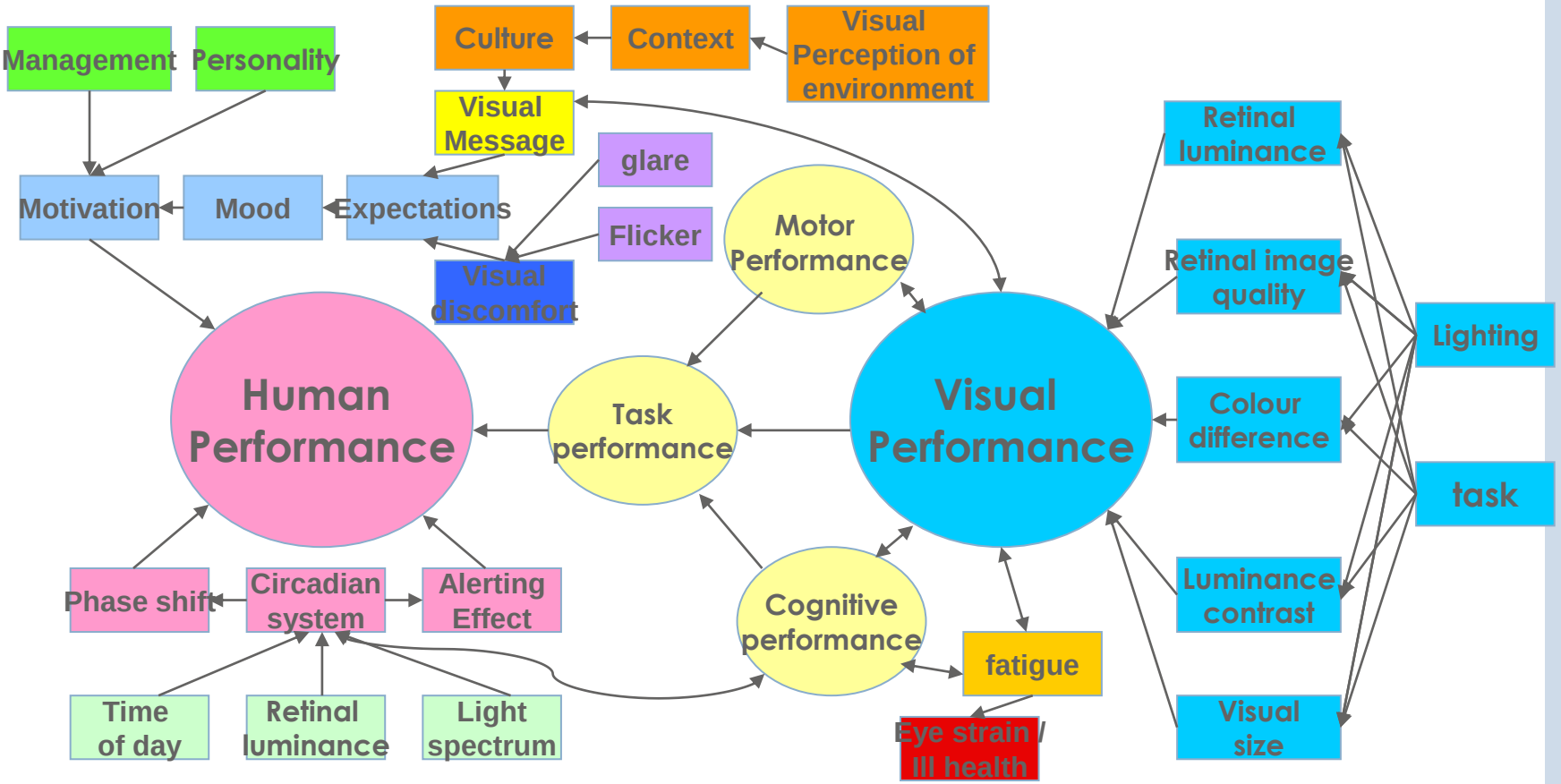
BREEAM 2008

- HEA 1 Daylighting 1pt= 2%av 1pt Multi St 3%av Uo 0.4 single st 4% av Uo 0.4
- HEA 6 Lighting zones and controls 1pt.
- HEA 2 View to outside 1pt
- HEA 3 Glare 1pt

LEED

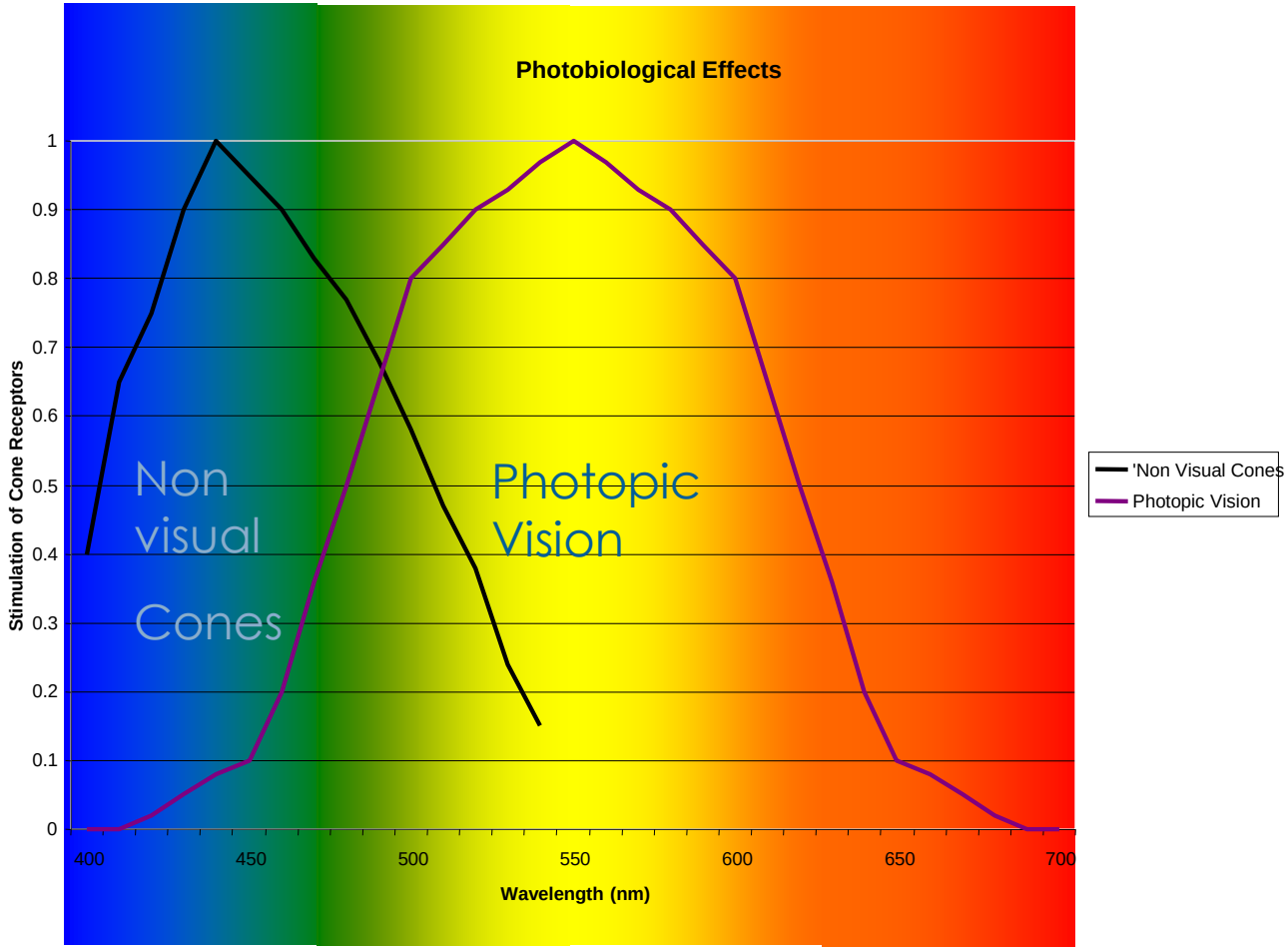
- Credit 8.1 Daylight and views—Daylight, 1 point
- Credit 8.2 Daylight and views—Views, 1 point

Wellbeing 1

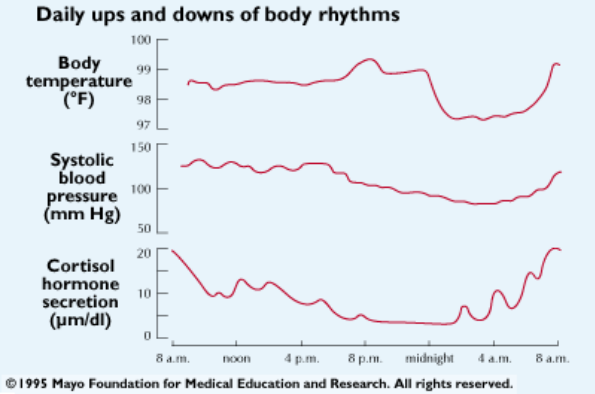

Management
Personality
Culture
Context
Visual Perception of environment
Visual Message
glare
Flicker
Motivation
Mood
Expectations
Visual discomfort
Motor Performance
Human Performance
Task performance
Visual Performance
Retinal luminance
Retinal image quality
Colour difference
Luminance contrast
Visual size
Lighting
task
Phase shift
Circadian system
Alerting Effect
Cognitive performance
fatigue
Eye strain / Ill health
Time of day
Retinal luminance
Light spectrum

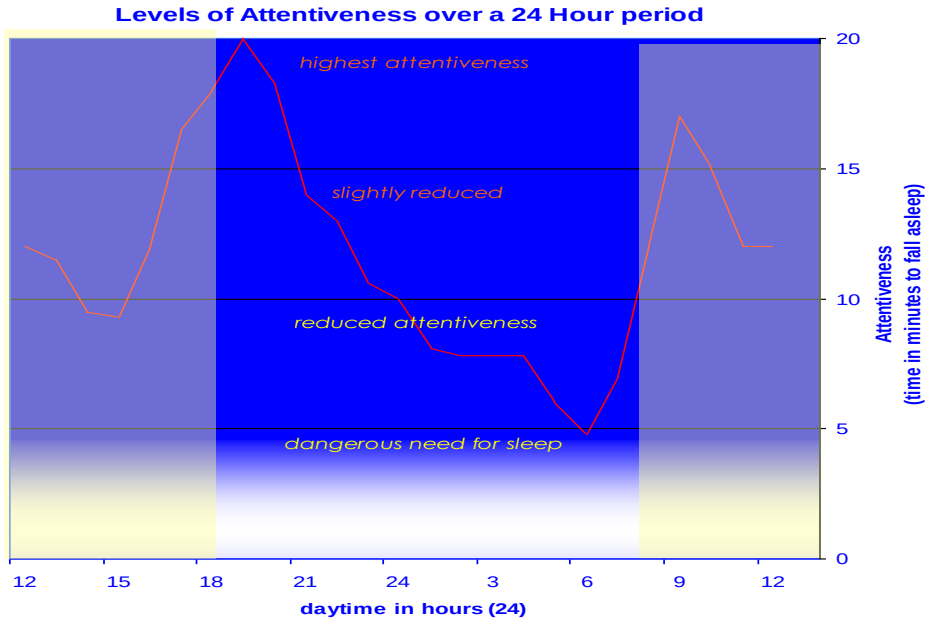
”

Wellbeing 2


Photobiological Effects
Stimulation of Cone Receptors
1
0.9
0.8
0.7
0.6
0.5
0.4
0.3
0.2
0.1
0
400
450
500
550
600
650
700
Wavelength (nm)
Non visual Cones
Photopic Vision
'Non Visual Cones
Photopic Vision

Wellbeing 3





Non visual

Cones

midday

midday

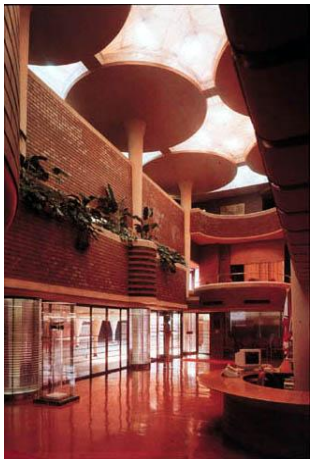
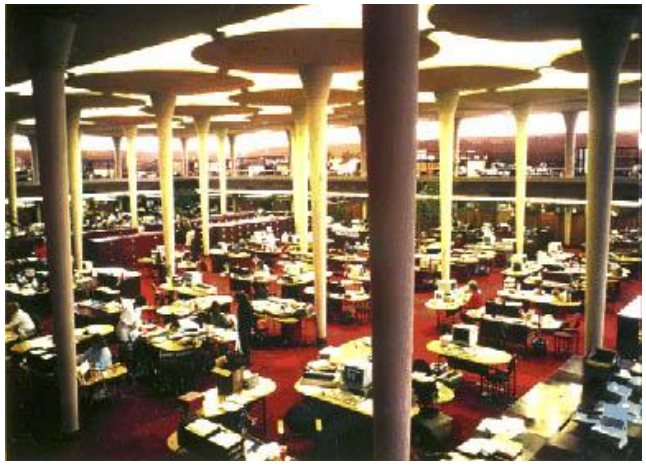
Project Constraints.

Who is responsible for daylight design

- Architect
- Electrical engineer
- Mechanical engineer
- Environmental Specialist
- Lighting Designer/Specialist
- Lighting Supplier

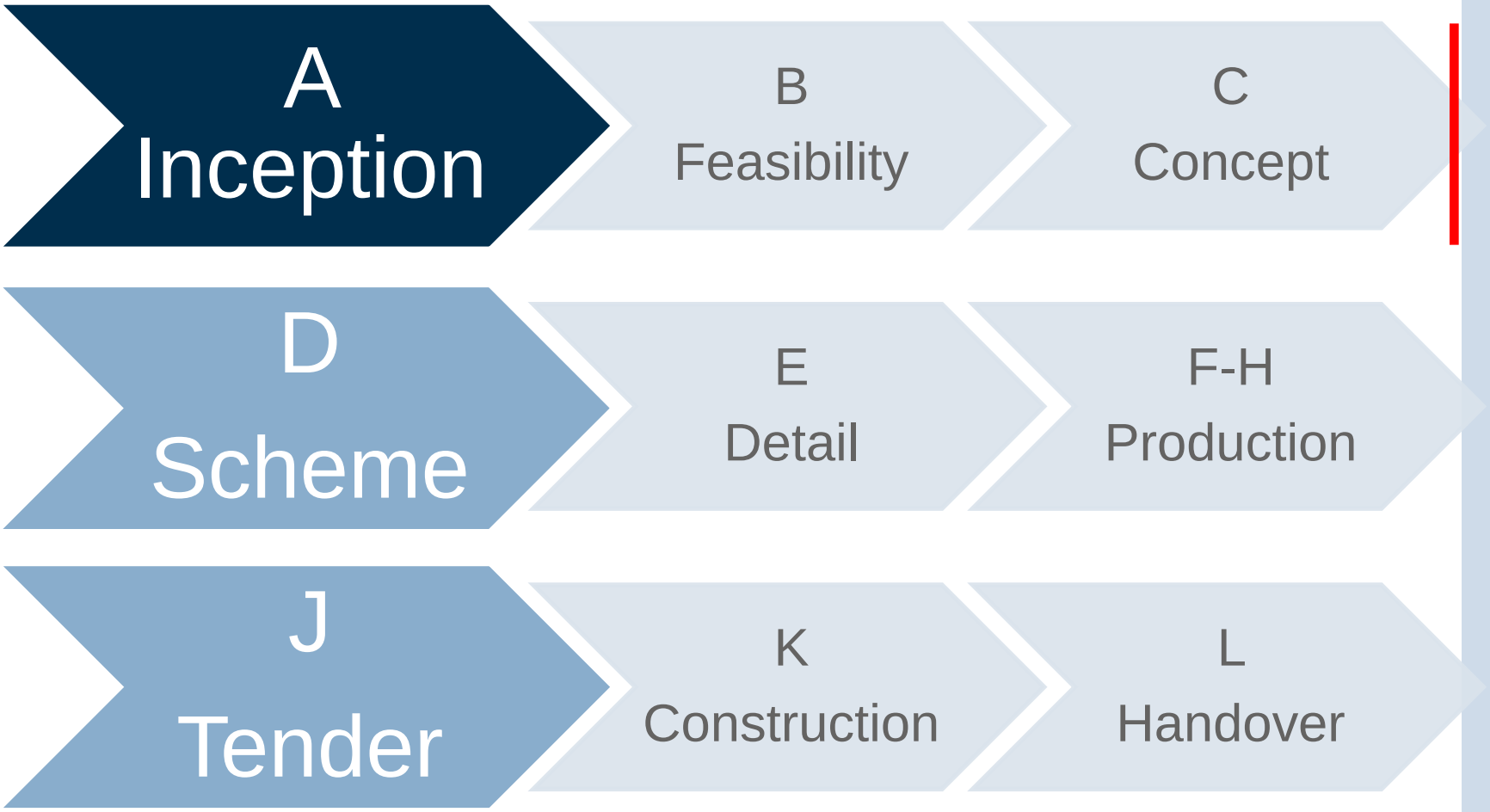
Daylit architecture





When does Daylight Design Happen



What Tools do we need for Daylight Modelling

Modelling Tools

- Physical Modelling
- Computer Modelling
- Manual Modelling

Physical Modelling

- Build a scale model of the building or section of the building.
- Use external daylight to simulate conditions
- Use Artificial skies

Computer Modelling

Hybrid post Ray Tracing and Radiosity packages

- Dialux
- Relux
- AGI 32
- Lumen Designer
- Revit
- 3D Studio Max

Backward Ray Tracing packages

- Radiance
- Superlite
- Adeline

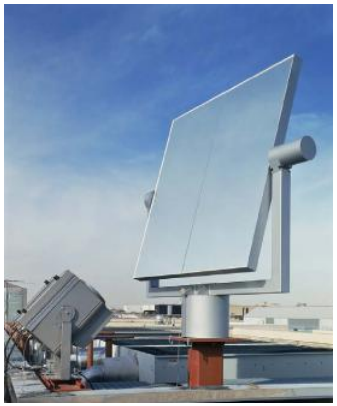
What and when Sunlight Modelling is Important.

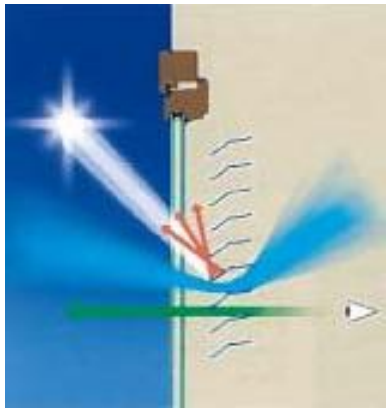
Sunlight Modelling 1

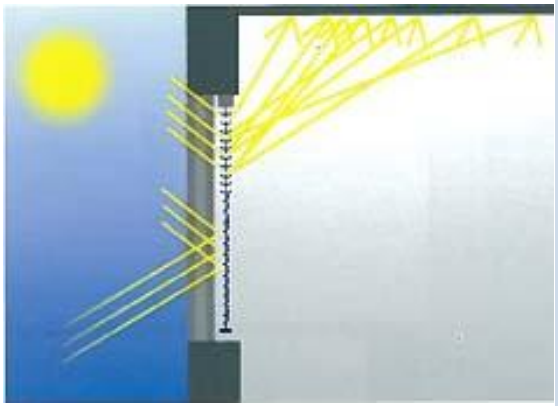
- We need to consider shading.
- We need to look at sun patches and the dynamic quality of daylight in the space.

Sunlight and Daylight Products

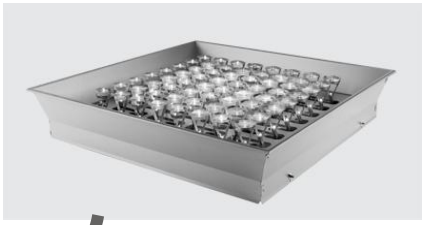
Sunlight and daylight products 1

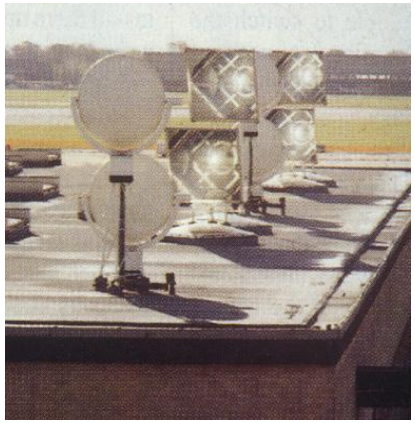






Sunlight and daylight products 2





Integrating Daylight with Electric Light

Lighting Integration 1

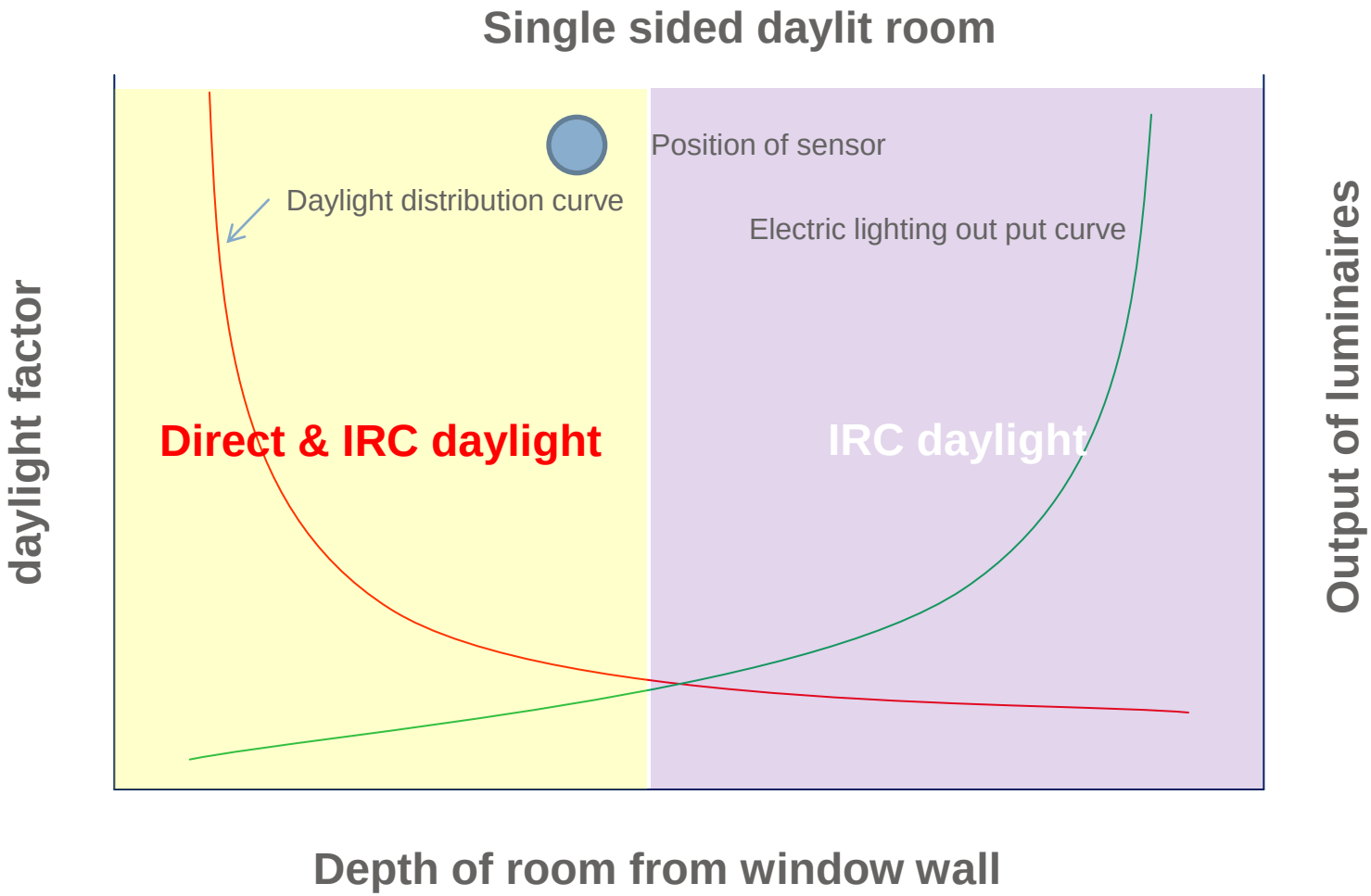
For successful daylight/electric lighting integration

- Appropriate luminaire and lamp packages
- Appropriate control systems
- Understanding the client's expectations and needs
- Understanding the client's occupation patterns
- Correct commissioning of the systems
- Respecting the users.

Appropriate lamp and luminaire packages

- We need dimmable sources
- We need digital control gear technologies
- We need luminaires with appropriate optical distributions.
- We need luminaires that can still maintain their lit form through a range of luminances.

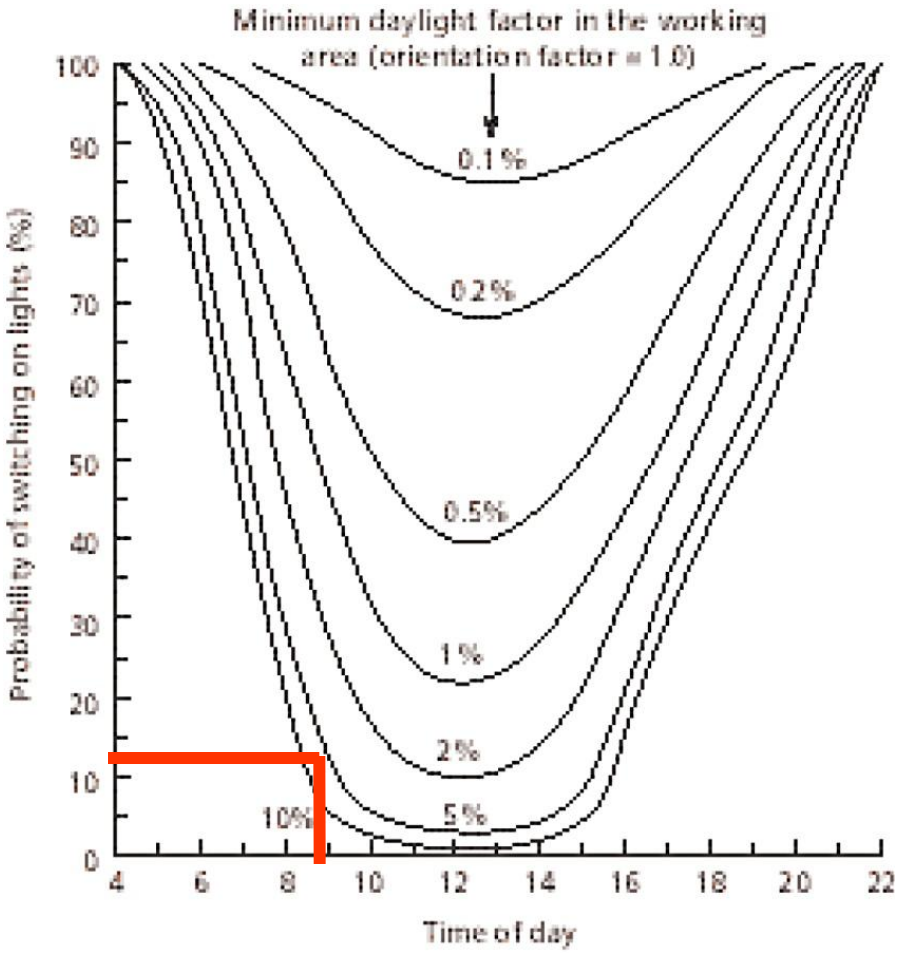
Typical daylight penetration diagram



Appropriate Control Systems

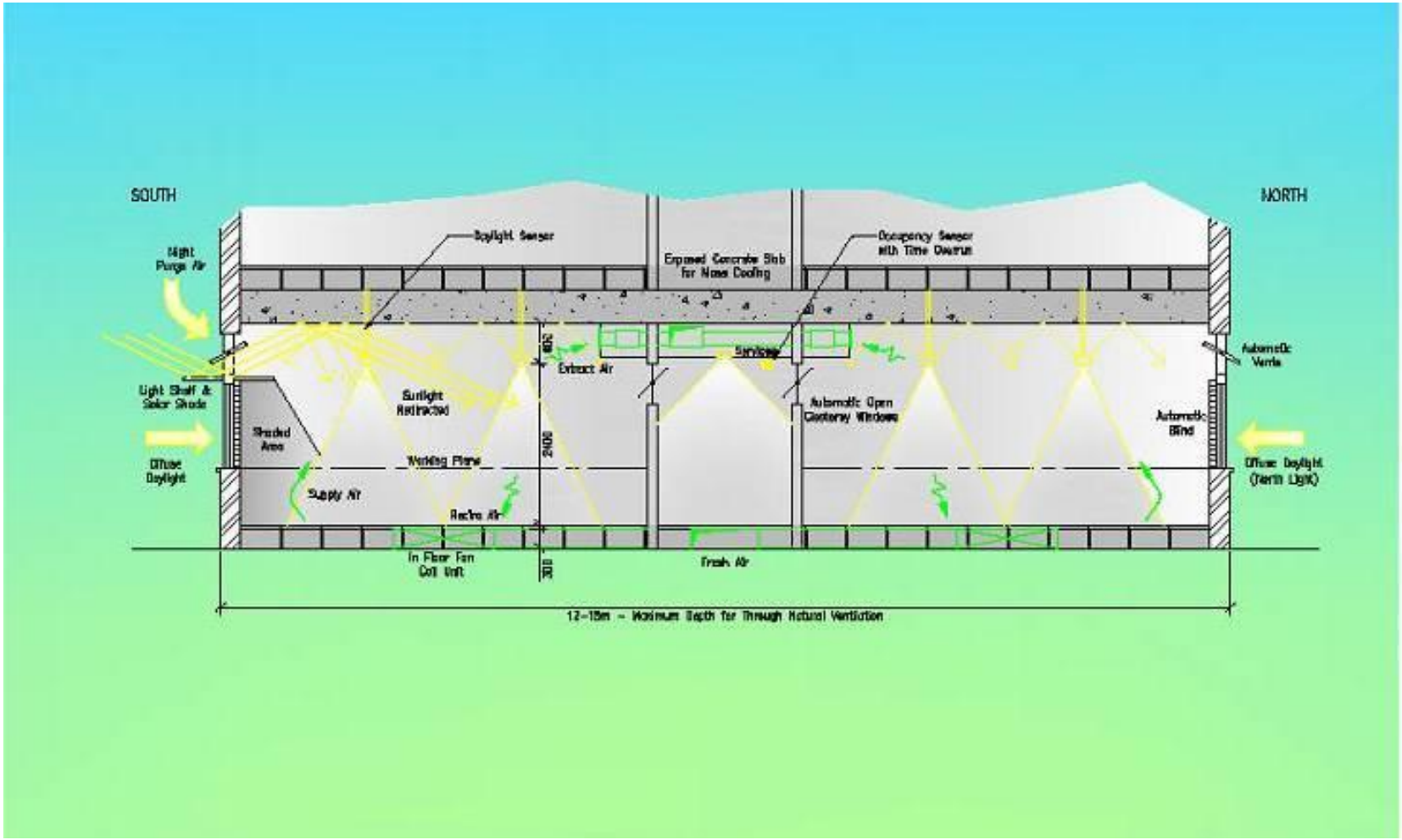
- We need open protocols such as DALI
- We simple yet effective control philosophies.
- We user interfaces that are simple and intuitive
- Our control systems must deliver daylight lumen for electric lumen savings.

Lighting Integration



Case studies

Worked example of good practice daylight design



Worked example: Summary

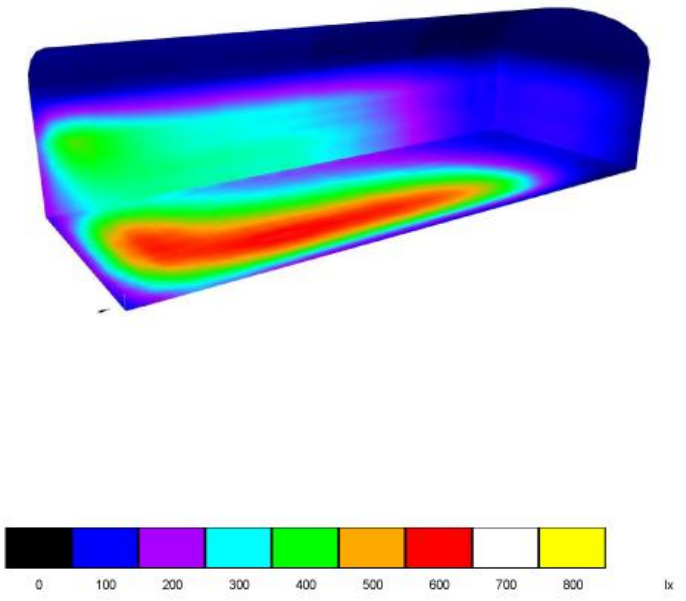
DAYLIGHT FACTOR SUMMARY						
MODEL	% WALL AREA GLAZED	DF AVE	DF MAX	DF MIN	U_o MIN/AVE	DF POINTS => 2%
1 TYPICAL	37%	4.21	17.33	1.20	0.29	64%
2 HIGH WINDOWS	40%	5.25	18.83	1.65	0.31	81%
3 LOW WINDOWS	21%	2.10	23.10	0.30	0.14	24%
4 DEEP PLAN	28%	2.83	13.73	0.75	0.27	42%

We predict that Model 2 would save in the order of 8153 kWh/yr which equates to 3441 kg of CO_2/yr. This represents 80% of the artificial lighting load

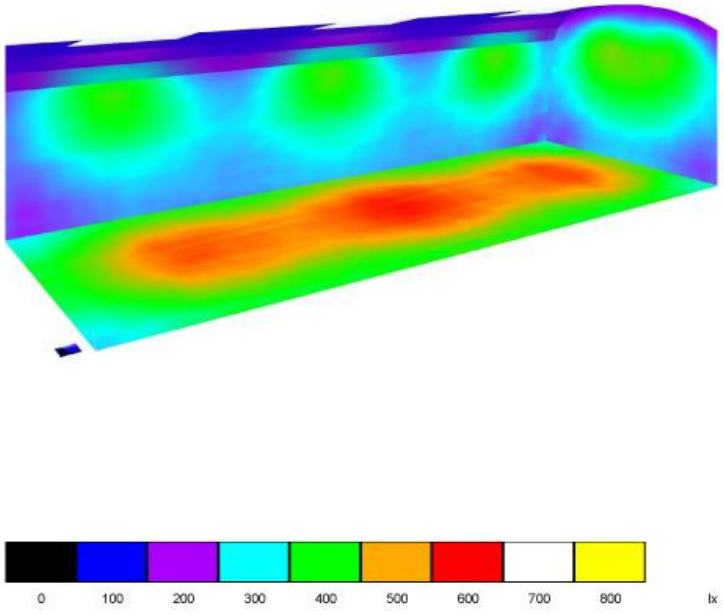
(based on artificial lighting load of 11w/m^2 and 8hrs/day daylight)

SAR-H Hanger Options

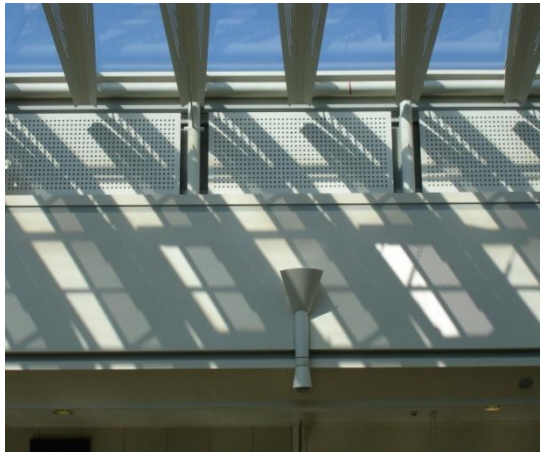
Hanger (with side windows) / Light scene 1 / **False Colour Rendering**



Hanger (with rooflights) / Light scene 1 / **False Colour Rendering**

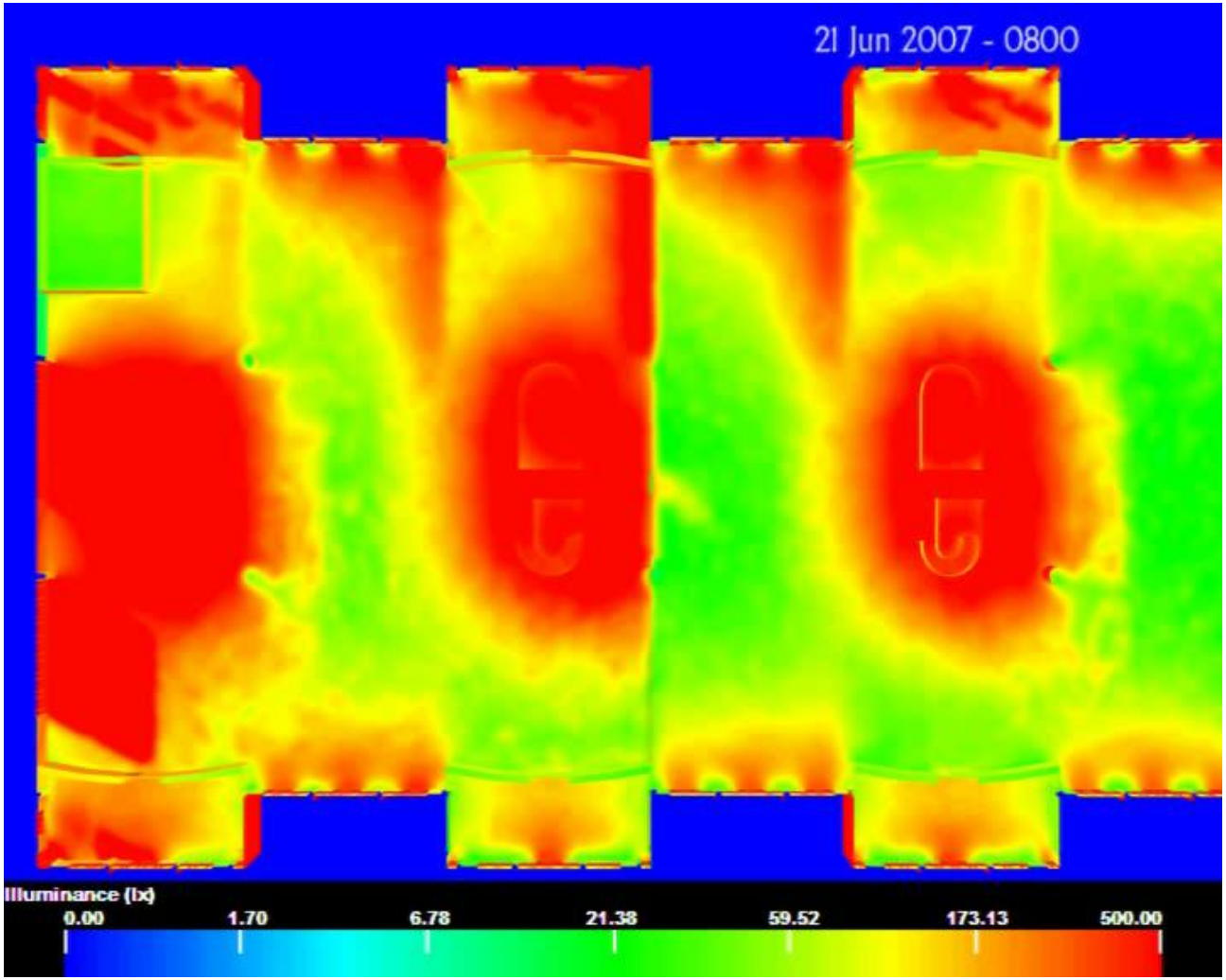


Cribbs Causeway RSC

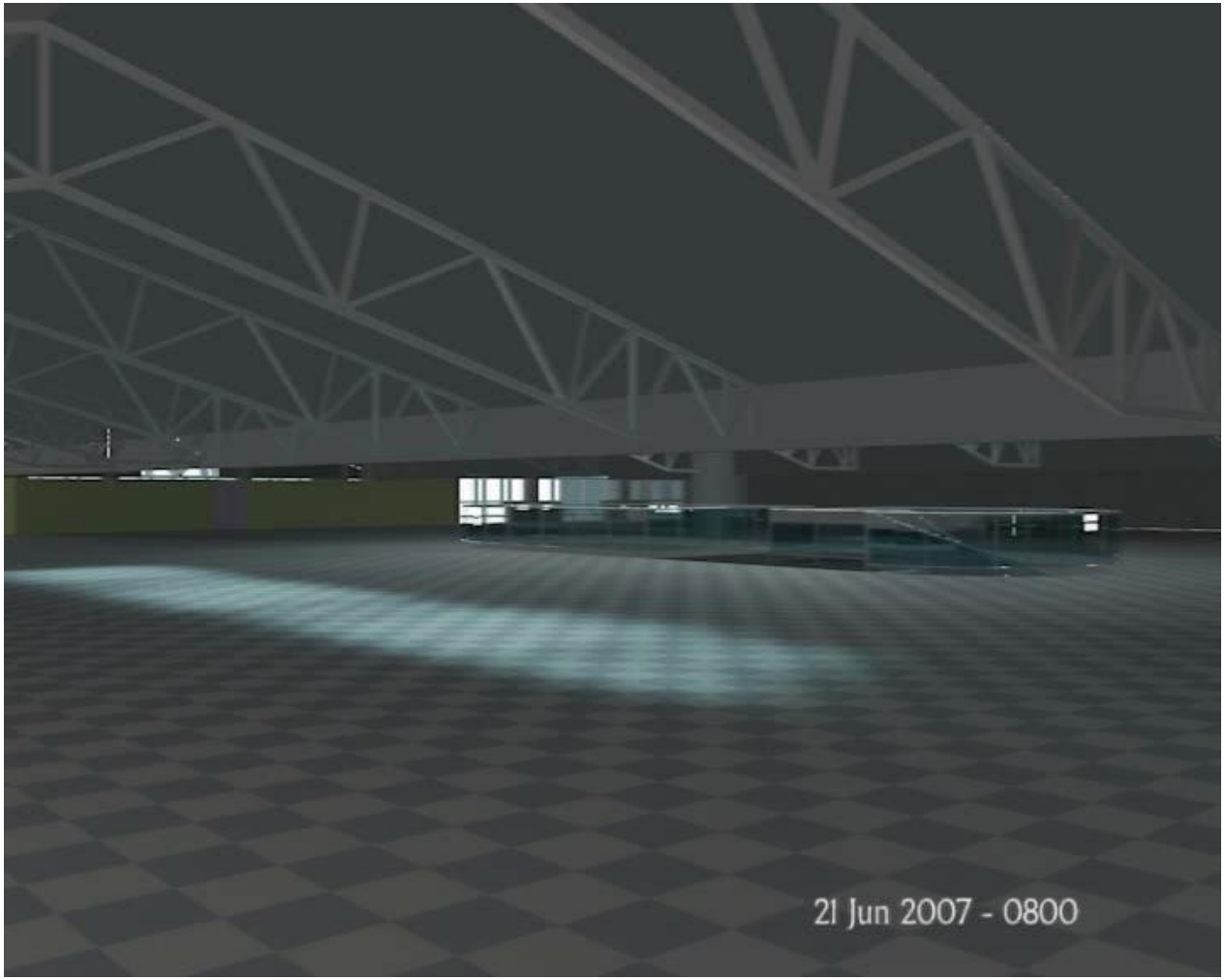


Scottish & Southern Energy, Havant

Scottish and Southern Energy Havant



Scottish and Southern Energy Havant



Conclusions

- Daylight is a renewable source it is carbon neutral.
- Good daylight design is for all buildings
- Controlled daylight can replace up to 80% of lighting energy consumption during daytime hours.
- Daylight design needs to be combined with intelligent lighting control.
- Increased regulation will limit lighting energy usage. good daylight design will become essential.

Conclusions 2

- The UK should incorporate minimum daylight standards to access carbon savings.
- Daylight design can create dynamic internal visual environments.
- Daylight improves health, wellbeing and attentiveness of occupants
- Lights on blinds down = bad design
- We need a professional to lead on daylight.

Conclusions 3

- Daylight needs coordinated design.
- Artificial lighting design and daylight design are linked.
- Intelligent lighting controls are an essential component of daylight.
- The correct contractual procurement method needs to be entered into to deliver the optimal design.

People *like* natural light

BIM needs to deliver buildings that can replace electric lumens with useful daylight lumens

CINDERELLA STILL HAS HER BALLROOM TICKET IN HER HAND

Contact details

Thank you for your attention.

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