

Indoor Lighting Design



Ir. Dr. Sam C. M. Hui

Faculty of Science and Technology

E-mail: cmhui@vtc.edu.hk

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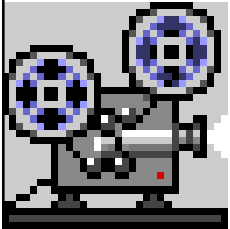
- Overview
- Basic Principles
- Design Process
- Design Factors & Issues
- Emergency Lighting





Overview

- Video: What is lighting design? (4:13)



- <http://www.youtube.com/watch?v=hqT4alUaHfQ>

- Award winning Architectural Lighting Designer, Annette Hladio, discusses her views on lighting design.

- Galleries of lighting design portfolio by Annette Hladio:

- <http://www.archltg.com/gallery.htm>



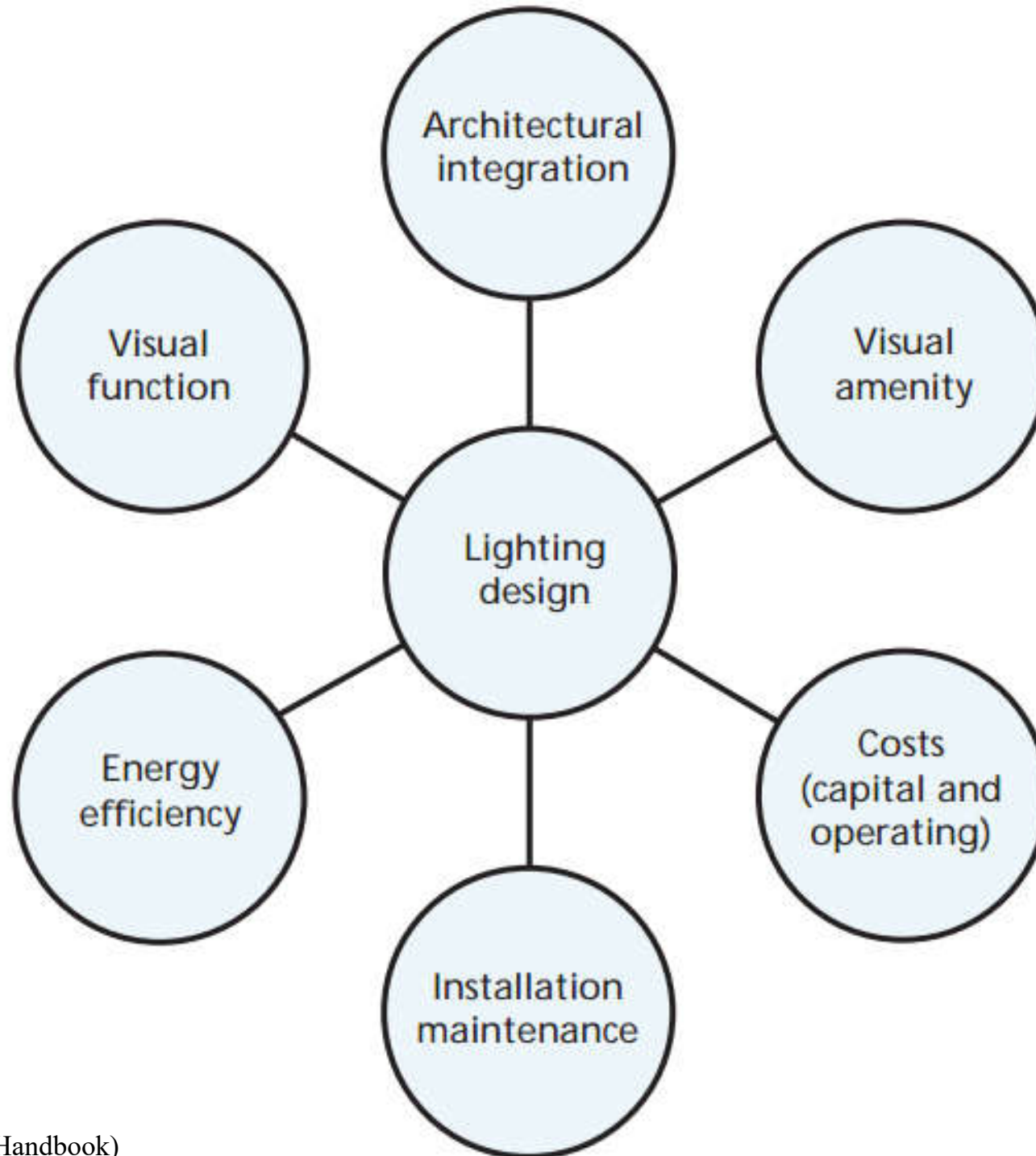


Overview

- Lighting design can have many different objectives
 - Determined by the client and the designer
 - The most common objective is to allow the users of a space to carry out their work quickly and accurately, without discomfort
- Design constraints
 - Such as financial and environmental concerns
 - Architectural integration, installation & maintenance issues



Considerations for lighting design





Overview

- A holistic strategy for lighting should consider:
 - Legal requirements
 - Visual function
 - Visual amenity
 - Architectural integration
 - Energy efficiency and sustainability
 - Maintenance
 - Costs
 - Photopic or mesopic vision
 - Light trespass and sky glow (light pollution)



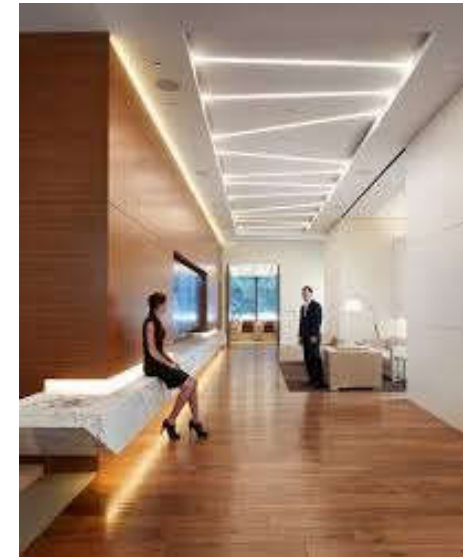
Overview

- Defining the lighting design project:
 - Lighting for a new space?
 - Need to correct existing lighting problems?
 - Change in the use of the space?
 - Desire to save energy and stretch the budget
- Opening assessment:
 - Meet with owner, occupants, architect, etc.
 - Identify legal constraints
 - Identify uses of space
 - Identify physical challenges, opportunities



Overview

- Examples of **indoor lighting design**:*
 - Emergency lighting
 - Office lighting
 - Industrial lighting
 - Lighting for educational purposes
 - Retail lighting
 - Lighting for museums and art galleries
 - Lighting for hospitals
 - Lighting for homes and hotels





Overview

- Basic design decisions
 - Use of daylight (what role would daylight plays)
 - To provide a view out
 - To provide enough light to work by
 - To save energy
 - To provide lighting for particular tasks requiring very good colour rendering
 - To enhance the appearance of the space by providing meaningful variation in the lighting
 - Choice of electric lighting system
 - Such as general, localised and local lighting systems



Overview

- Basic design decisions (cont'd)
 - Integration
 - Within the space, architecture, interior design
 - With other services (e.g. fire, HVAC)
 - With daylight
 - With the surroundings





Overview

- “Lighting designer”
 - Determine how things will look and feel in a space
 - Understand and interpret the clients intent
 - Devise a suitable lighting concept & translate it into a plan (*creative vision*)
- “Illuminating/Lighting engineer”
 - Usually works from someone elses’ conceptual plan
 - Provides the “how to” or solves the problems....optical, visual or mechanical....of making the concept work

(* See also http://en.wikipedia.org/wiki/Architectural_lighting_design)

Basic Principles



- Three main functions of lighting:
 - Ensure the safety of people
 - Facilitate the performance of visual tasks
 - Aid the creation of an appropriate visual environment (appearance & character)



Basic Principles



- Lighting of interior as a whole is affected by:
 - General brightness
 - Patterns of light, shade, colour
 - Degree of glare
 - Modelling of people, objects and features
- Illuminance needed for the task depends on:
 - Visual difficulty & complexity of the task
 - Average standard of eyesight
 - Level of visual performance required

Basic Principles



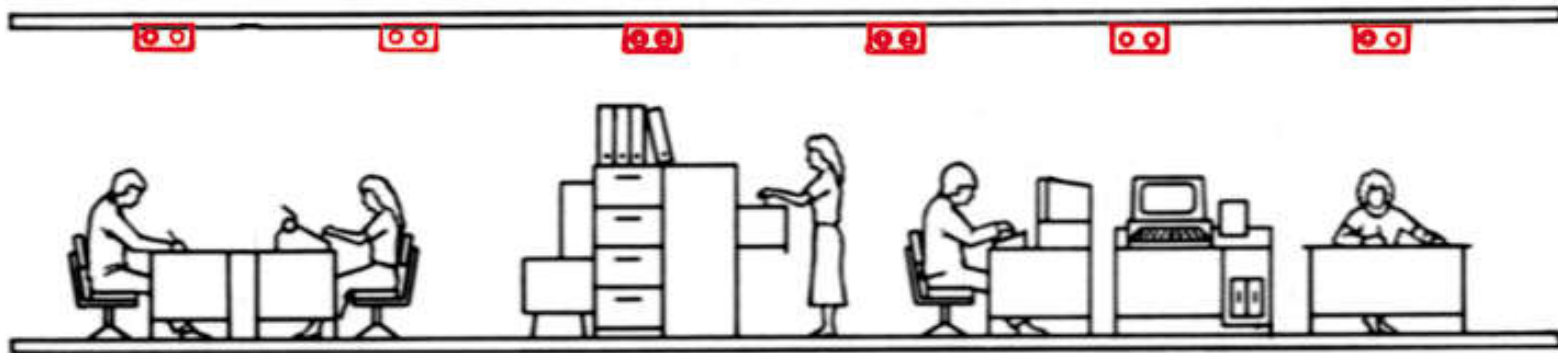
- Lighting design criteria*
 - Luminous environment & luminance distribution
 - Illuminance and uniformity
 - Lighting directional effects
 - Colour aspects, variability of light
 - Glare, flicker and stroboscopic effects
 - Lighting of work stations with display screen equipment (DSE)
 - Maintenance factor
 - Energy efficiency requirements

Basic Principles



- Effect of lighting
 - On architecture (defines space & shows form)
 - On interior design (reveals texture & colour)
- Psychological effects of an environment are as important as the physiological
 - Good quality light to “see by” and to “feel by”
- Three main aspects to consider:
 - General lighting
 - Localised lighting
 - Local (task) lighting

General lighting



[Source: CIBSE Lighting Code]

Localised lighting



[Source: CIBSE Lighting Code]

Local (task) lighting



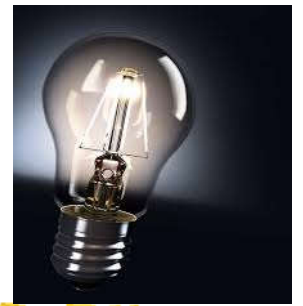
Basic Principles



- Methods for creating the total (visual) environment:
 - 1. Ambient lighting
 - 2. Accent lighting
 - 3. Task lighting
 - 4. Perimeter lighting



Basic Principles



- Ambient lighting

- Provides general, overall illumination
- Defines the space, and makes it a comfortable visual environment
- Two approaches:
 - Direct lighting (brightens objects and surfaces)
 - Indirect lighting (can give the feeling of spaciousness)

- Accent lighting

- Focuses on selected objects and surfaces, providing drama and excitement
 - Such as key light, fill light and silhouetting, sparkle & glitter

Basic Principles

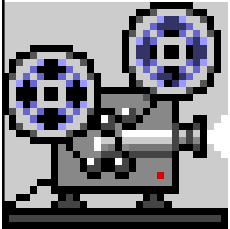


- Task lighting
 - Illuminates areas where work is performed, such as concentrated light from above
- Perimeter lighting
 - By lighting vertical surfaces to emphasize the architecture of the space and provide the necessary surround brightness
 - Two common approaches:
 - Wall Washing: appropriate for smooth surfaces; provide a uniform wash of light from floor to ceiling
 - Grazing: for non-uniform surfaces; emphasize the features of rough surfaces, e.g. wood-grain finishes, stone, brick and other textured surfaces

Design Process



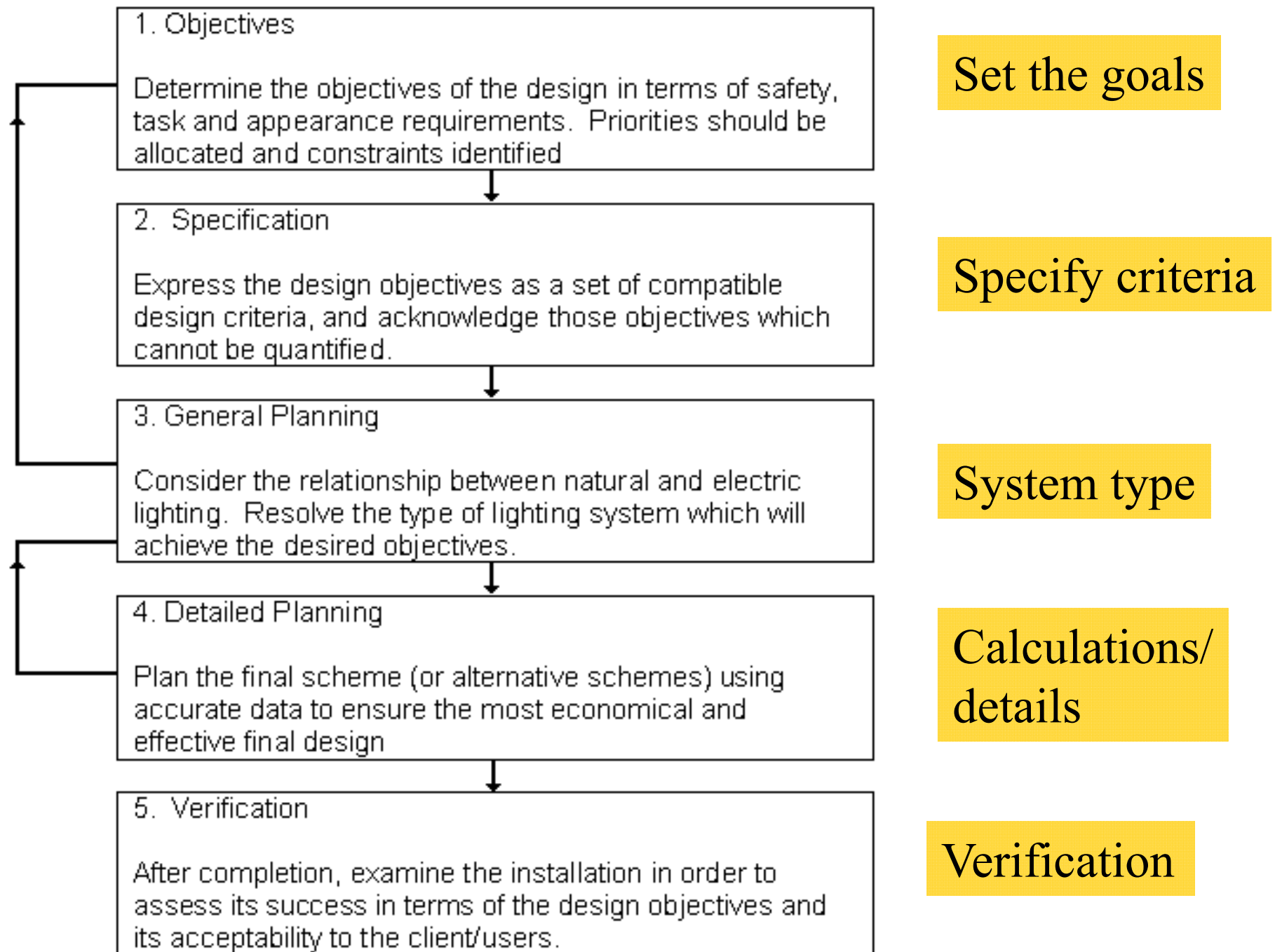
- Video: Lighting Design Process (4:12)



- <http://www.youtube.com/watch?v=hpyq6uktBwM>

- Typical building design process (7 steps):

- Programming
- Schematic design
- Design development
- Construction documents
- Bidding (tendering)
- Construction
- Post-occupancy evaluation (POE)



Lighting design and planning

[Source: CIBSE Lighting Code]

Design Process



- Basic approach to lighting design
 - Determine lighting design criteria
 - Quantity of illumination (lighting level, lux)
 - Quality of illumination (e.g. overall appearance, colour)
 - Codes and regulations (e.g. building, electrical, energy)
 - Record architectural conditions & constraints, e.g.
 - Window location & size, ceiling height, finish materials
 - Determine visual functions & tasks to be served
 - Select lighting system to be used

Design Process



- Basic approach to lighting design (cont'd)
 - Select luminaire and lamp types
 - To produce the desired light & fit the client's needs
 - Determine number & location of luminaires
 - Through calculations & assessment
 - Place switching & other control devices
 - User convenience & energy management
 - Aesthetic & other intangibles
 - Aesthetic & psychological factors

Design Process



- The process of designing with light focuses on:
 - What to light
 - How to light it
 - What to light it with



Design Process



- Questions to ask at the planning stage:
 - What activities will the space be used for?
 - What tasks are to be accomplished in the space?
 - What are the object(s) you most want to see?
 - Which architectural features are to be emphasized?
 - Where is the seating area?
 - What is the desired mood (ambience). Does it need to be varied?
 - What style must the lighting coordinate with?

Design Process



- What to light
 - Setting priorities
 - Give the space a focus
 - Consider the space as a whole
 - Analyse the space
- How best to light it
 - Using ambient, accent, and task lighting
- How much light
 - Depends on these factors: age, speed, accuracy, and the reflectance of the task
 - Also consider architectural and energy/environment



Design Process



- Where to place the light
 - To avoid glare and veiling reflections
 - To emphasize or minimise surface texture
- What to light with
 - The lamp, the luminaire, and the controls
 - Choosing the lamp
 - Light distribution
 - Electric energy consumed
 - Colour rendering and color appearance
 - Maintenance costs



Design Process



- Obtaining the desired distribution
 - Depends on the lamp and luminaire, and purpose
 - The required light distribution may range from broad and widely diffused to narrow and focused
- Choosing the luminaire
 - Intended light distribution, function or purpose
 - Appearance or style
 - Mounting: recessed, surface, pendant, wall
 - Type of building construction: new, existing, insulated
 - Product quality: detailing, finish, durability
 - Operating cost: energy, relamping, cleaning
 - Initial cost

Design Process



- Choose the lighting controls when you want to:
 - Change the lighting scene to suit the activity
 - Set a mood
 - Create an atmosphere
 - Extend incandescent lamp life
 - Control the lights from several locations
 - Save energy by turning off the lights automatically when no one is present

Design Process



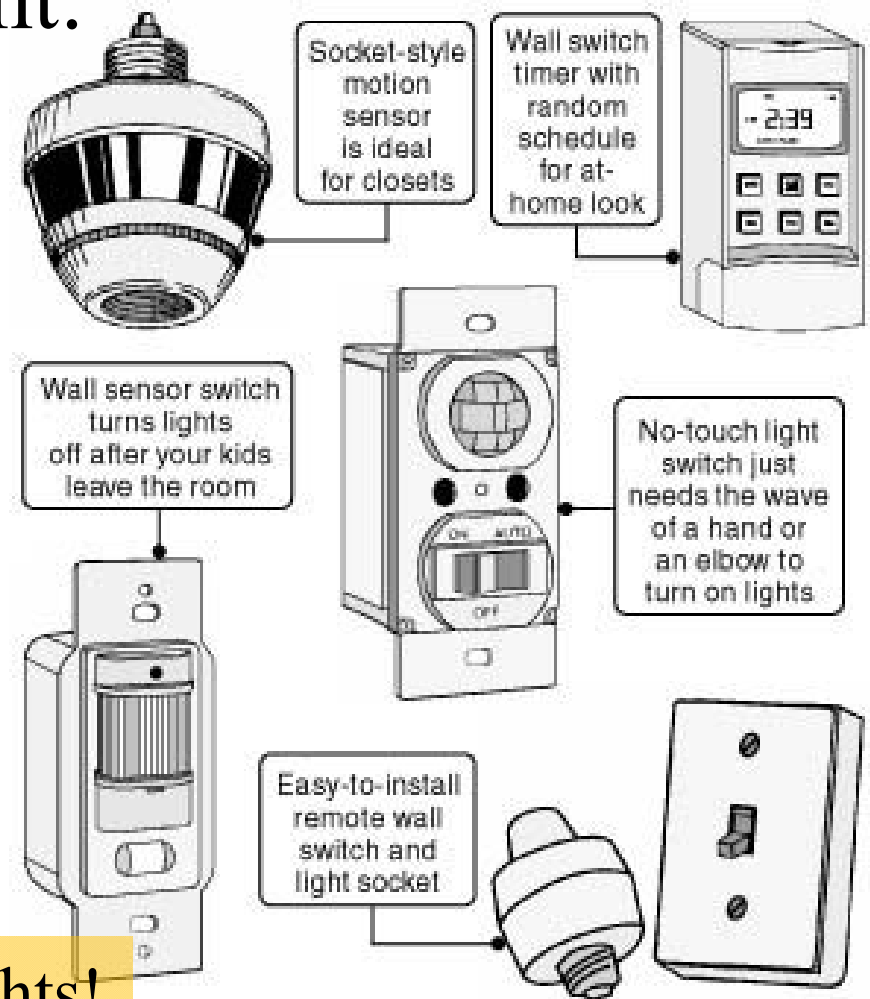
- Typical lighting control strategies:
 - User controlled lighting
 - Scheduling
 - Daylight harvesting
 - Task tuning
 - Adaptive compensation
 - Lumen maintenance
 - Occupancy sensing



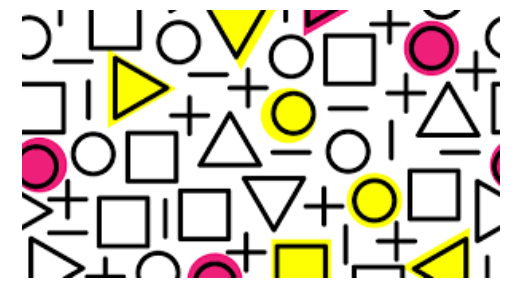
Design Process



- Lighting control equipment:
 - Switches
 - Occupancy sensing
 - Scheduling (timeclocks)
 - Daylight dimming
 - Tuning
 - Preset dimming
 - Building management

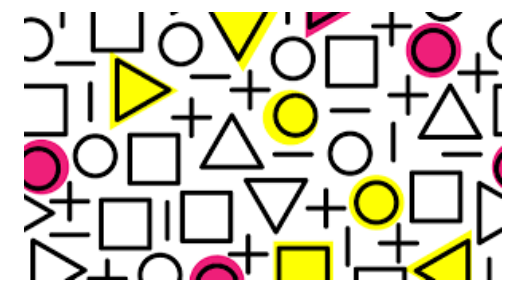


Remember: switch off unnecessary lights!



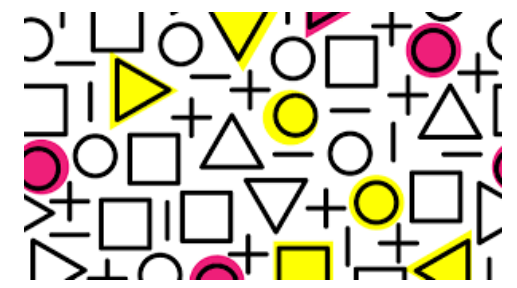
Design Factors & Issues

- Factors affecting visual performance:
 - Inadequate illuminance
 - Too great or too low a contrast
 - Disability and discomfort glare
 - Veiling reflection
 - Flicker from fluorescent lamps
 - Psychological factor (occupant's satisfaction with the environment)



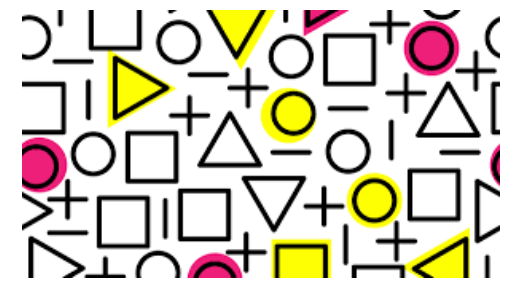
Design Factors & Issues

- Important to consider:
 - Situation – is it a working, viewing, circulation or a living space?
 - Function – what will people do in the space?
 - Quantity and Quality of Light – what's needed to perform the tasks?
 - Architecture and Décor – consider the aesthetic of the space
 - “Atmosphere” – what is the mood or ambience of the space?



Design Factors & Issues

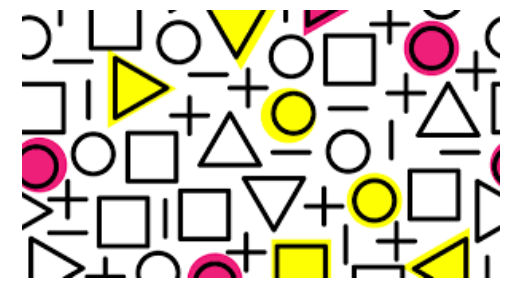
- Lighting quality and criteria
 - Lighting level (lux or luminance e.g. road lighting)
 - Luminance distribution
 - Better distribution of brightness within the field of view
 - Freedom from disturbing glare
 - Spatial distribution of light
 - General lighting, directional lighting, backlighting and uplighting, diffuse lighting
 - Light colour and colour rendering
 - Colour temperature and colour rendering index



Design Factors & Issues

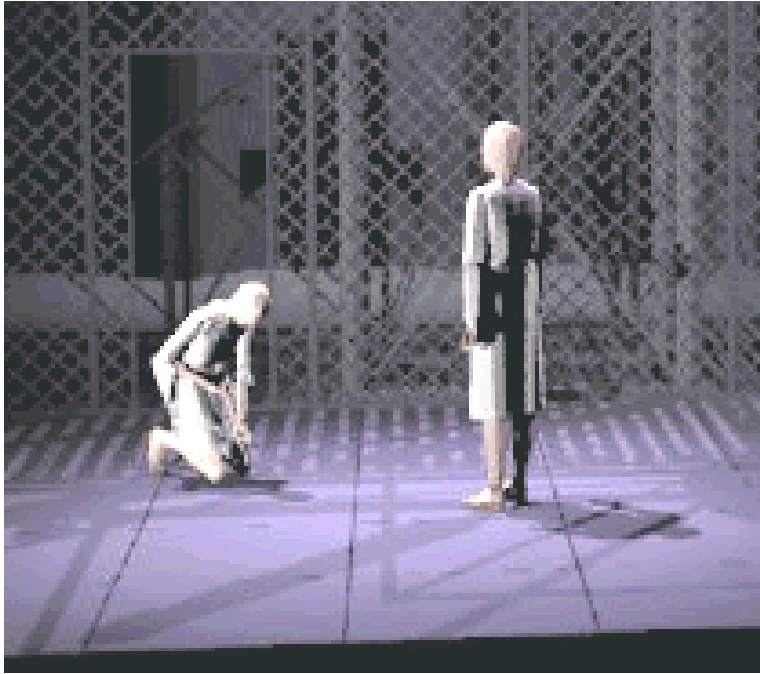
- Typical lighting design issues
 - Planes of brightness (high brightness creates cheerful atmosphere)
 - Glitter and sparkle (stimulating points)
 - Light and shadow (create focal points)
 - Modelling (reveal dimensionality)



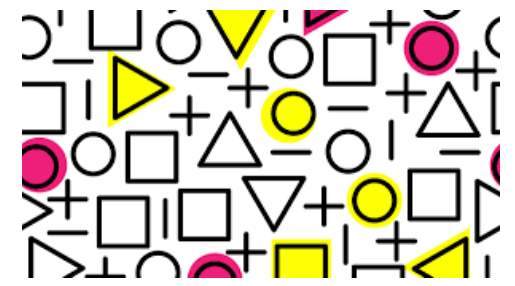


Design Factors & Issues

- Directional effects (form, dimension & texture)
 - Direction and distribution of light within a space
 - Influence perception of the space
 - Relates partly to desirable illumination levels and partly to architectural style and visual emphasis
 - Good light design - an appreciation of the nature and qualities of the surfaces
 - Modelling – ability of light to reveal solid form
 - Fail to do that will result as bland and monotonous
 - Emphasis – e.g. surface texture & characteristics

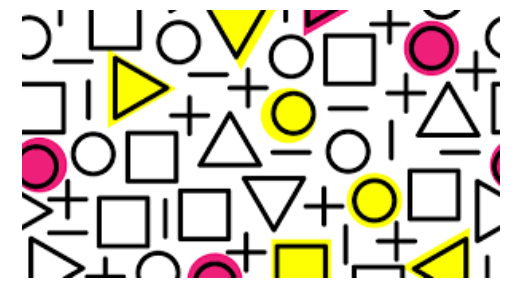


Examples of directional effects in lighting design



Design Factors & Issues

- Choice of appropriate colour of light source
 - Determined by the function of the room
 - Involve psychological aspects & practical factors
- Appearance of coloured surfaces
 - Controlled by spectral power of source
 - Power balance and presence or absence of certain wavelengths affect colour rendering



Design Factors & Issues

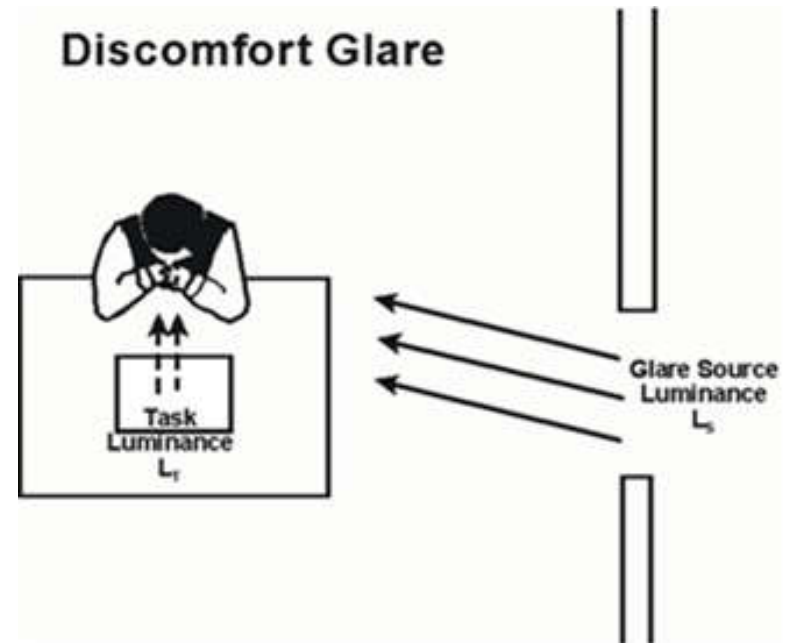
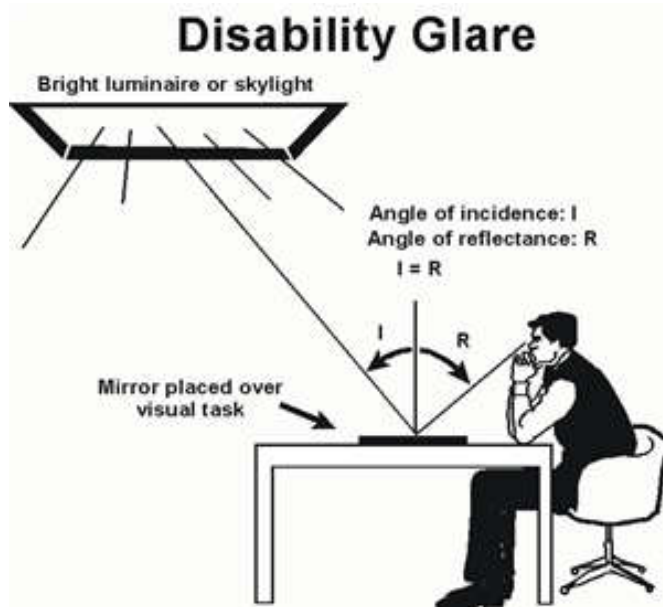
- Glare 眩目光
 - Occurs when objects, seen directly or by reflection, are too bright c.f. the general background
 - Disability glare - impairs ability to see detail w/o necessarily causing visual discomfort
 - Shift in adaptation level
 - Discomfort glare - causes visual discomfort w/o necessarily impairing vision
 - Depends on occupant's activity, angle of view, size and brightness of source, average luminance of background

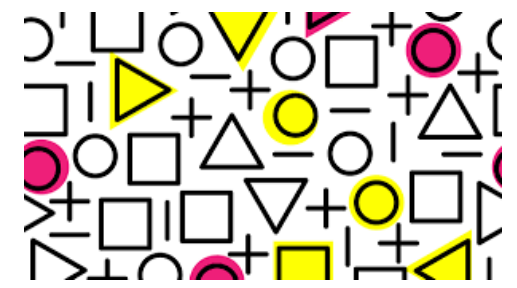


Disability glare from bright sky in front of a VDT makes the screen difficult to read



Discomfort glare from bright luminaires

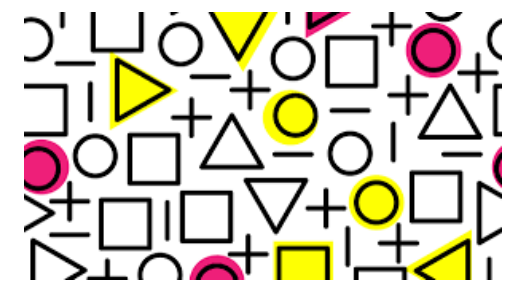




Design Factors & Issues

- Reduce glare from artificial light sources
 - Limit the luminance of sources in eye's direction
 - Replace a bright source with few weak sources
 - Restrict light distribution to ↓ sideways light to the eye
 - Screen the sources from view
 - Introduce downstand screens
 - Use screening within the fitting (e.g. louvres)
 - Enclose source in light diffusing panel/fitting
 - Conceal fittings from view (e.g. by beams)

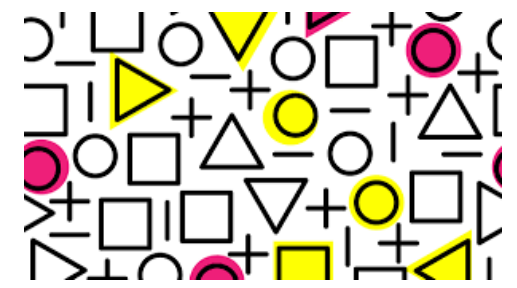




Design Factors & Issues

- Reduce glare from artificial light sources
(Cont'd)
 - Re-position the work station to avoid glare
 - Raise background luminance
 - Use fittings with more upward flux (brighten ceiling)
 - Specify higher reflectance floor
 - Use light-coloured finishes

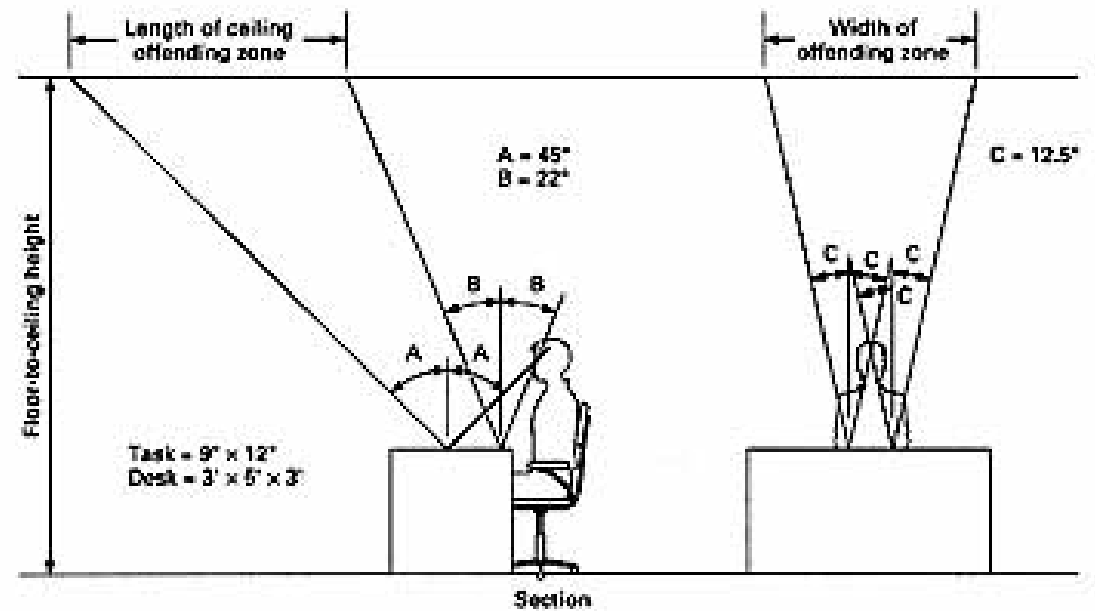
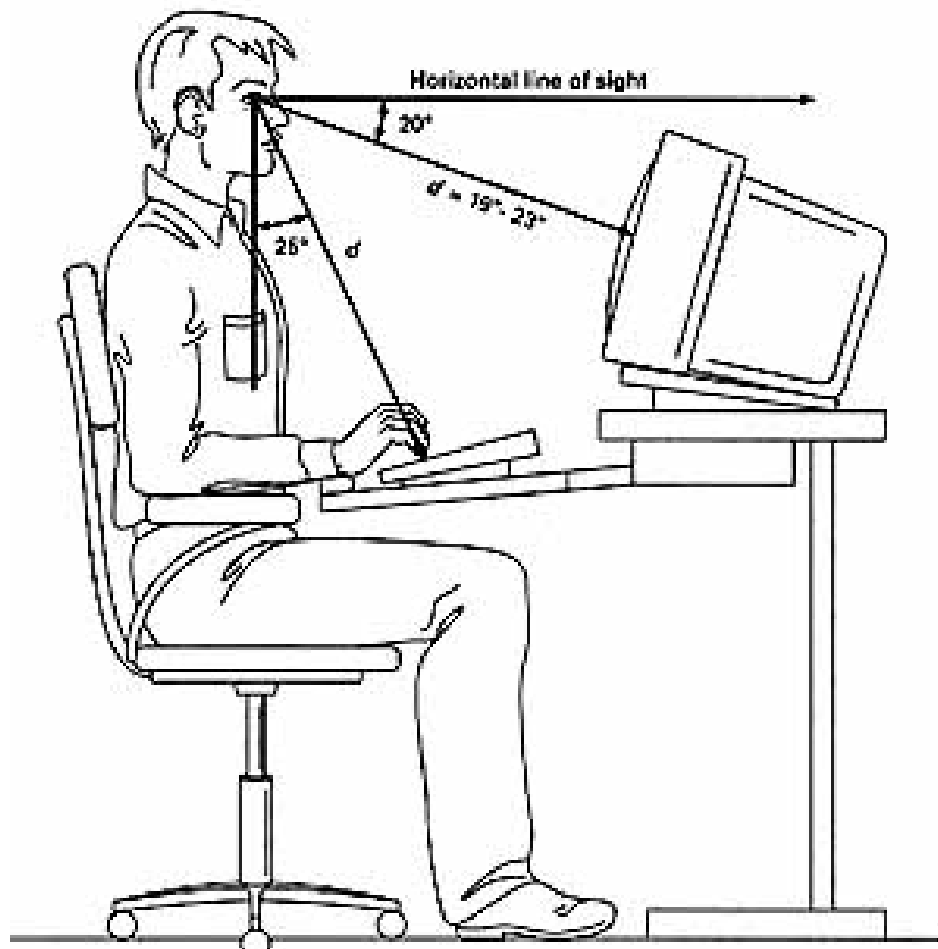




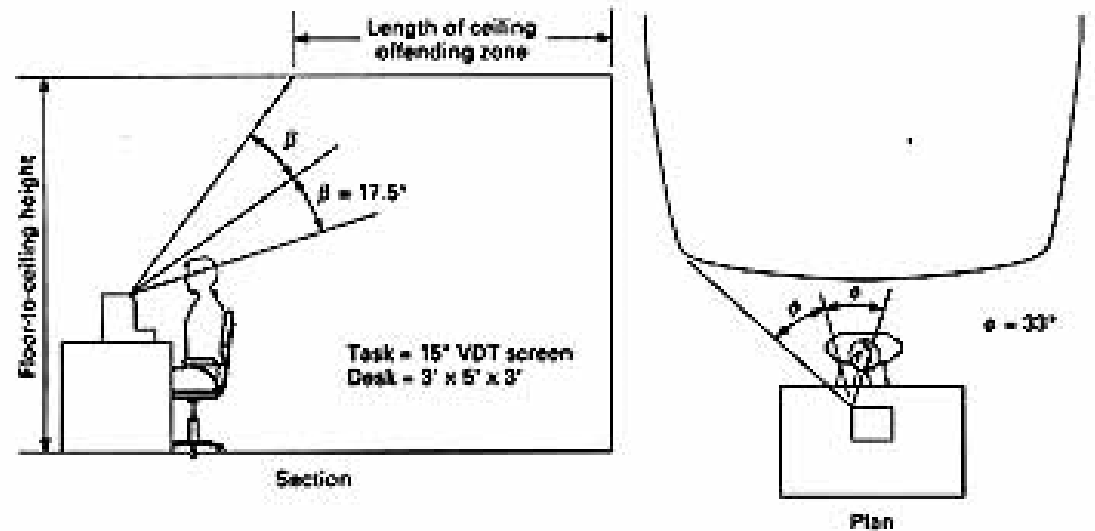
Design Factors & Issues

- Reflected glare & veiling reflection
 - Bright patches on glossy surfaces from reflection
 - *Reflected glare* - produce visual discomfort
 - *Veiling reflection* - reduce contrast and visibility
 - May be minimised by:
 - Ensure no part of the task is at or near the mirror angle with respect to the eye & bright source
 - Increase light falling sideways onto the visual task
 - Use luminaires w/ large surface area & low luminance
 - Use paper, machines, materials etc. with matt surfaces





(a) Horizontal task



(b) Vertical task

Glare control for video display unit (VDU)

[Source: CIBSE Lighting Code]

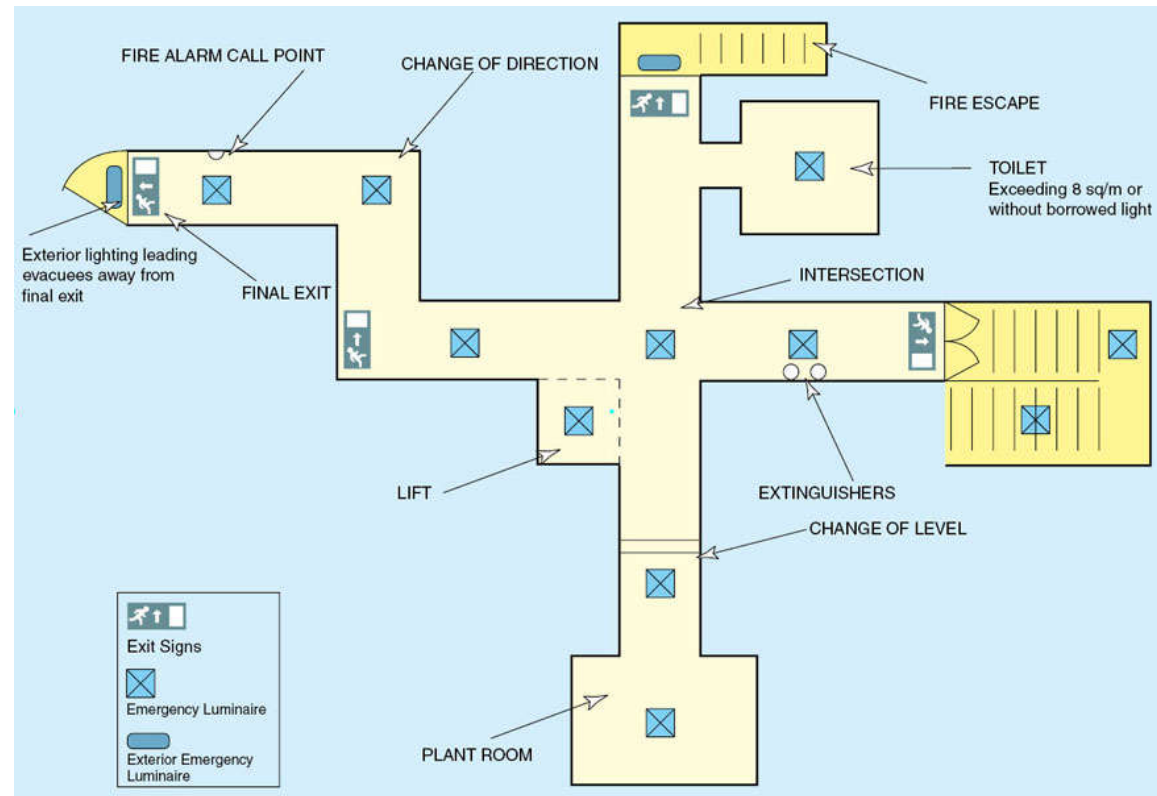
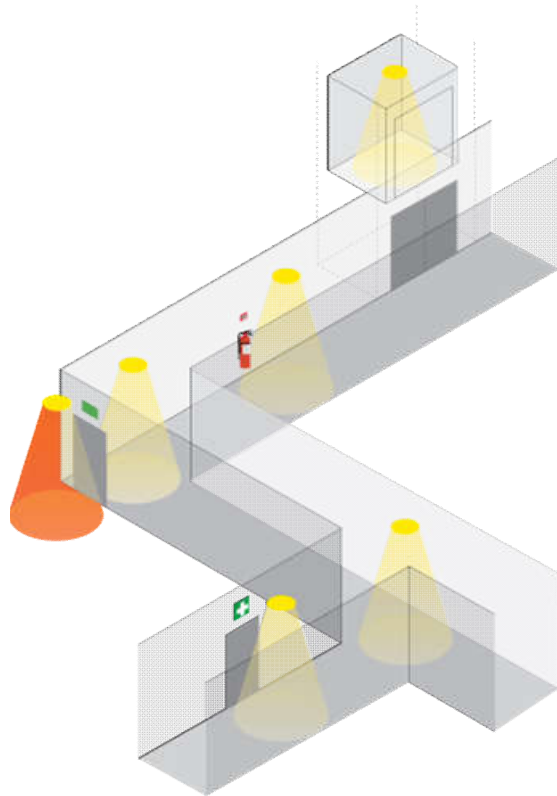
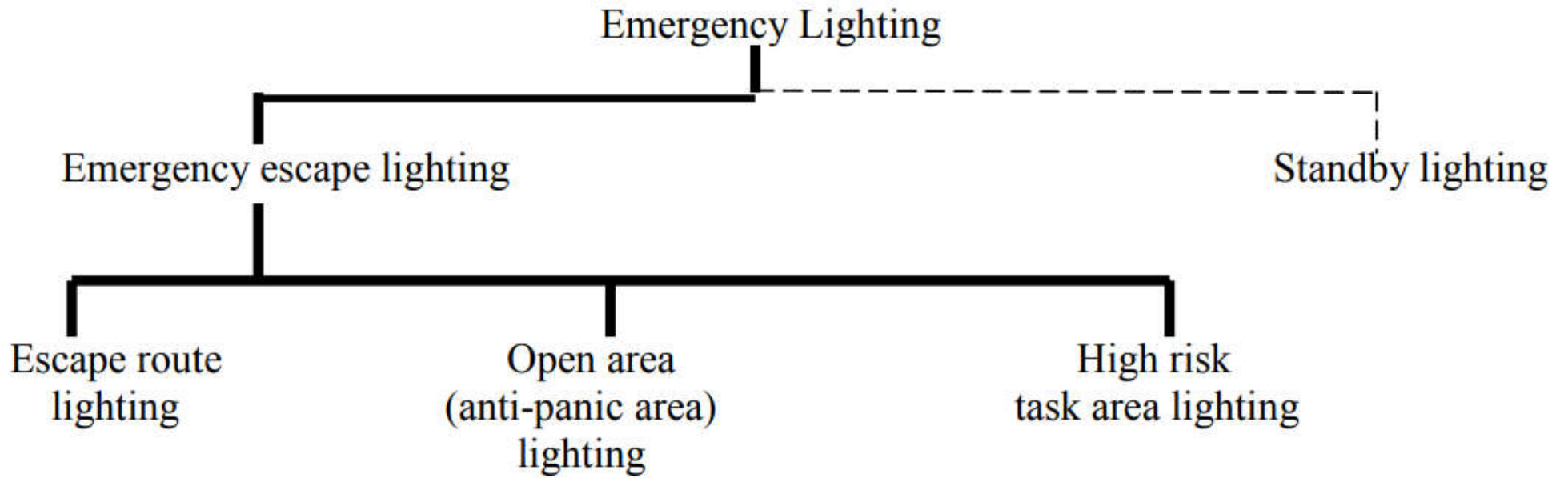


Emergency Lighting

- Main purpose (when normal lighting fails)
 - Guide people quickly & safely from the building
 - Enable specific tasks to be completed
 - Avoid panic
 - Restore confidence
- Design shall follow the relevant regulations (e.g. fire services) & standards/codes (e.g. BS5266)
- Also, exit signs & signage lights



Specific forms of emergency lighting and design drawings

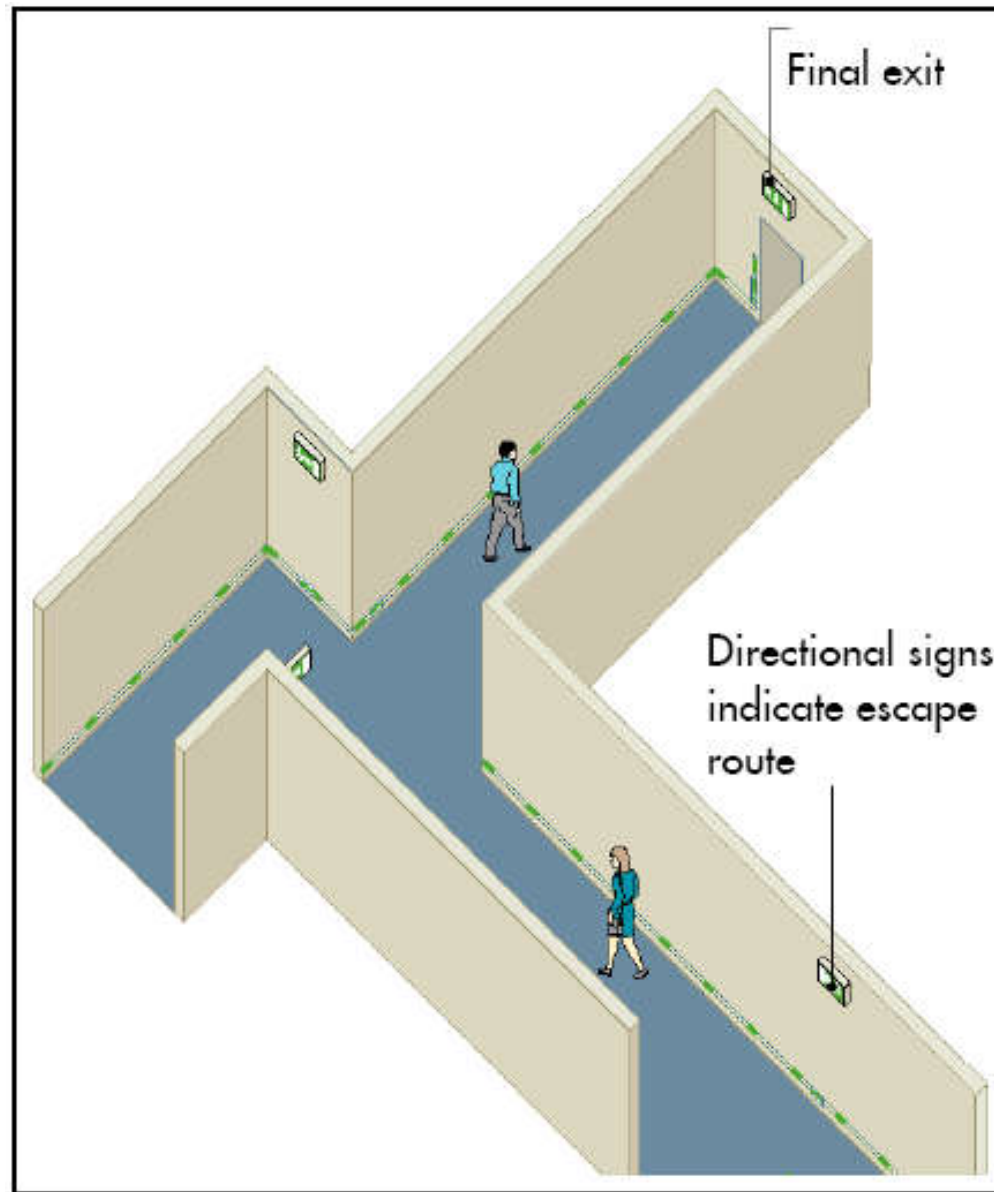
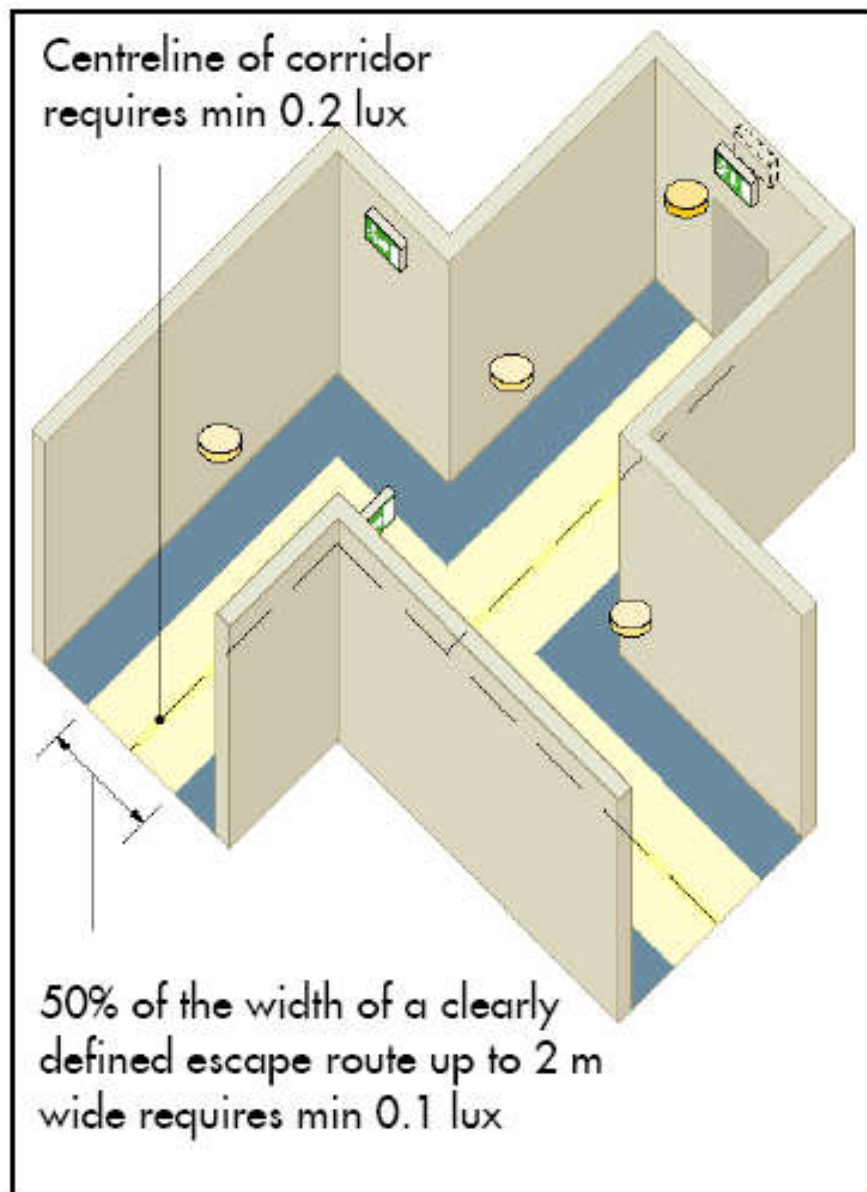




Emergency Lighting

- Three typical types:
 - Emergency lighting (when normal lighting fails)
 - Escape lighting (assure means of escape)
 - Escape route, open area (anti-panic), high risk task area
 - Standby lighting
- Design requirements:
 - Illumination level = 1 lux; uniformity 40 : 1
 - Must be in operation ≤ 5 sec, last for 1 or 2 hours
 - Correct positioning & power supply
 - Battery backed up & automatic switch on





Emergency lighting & signage on escape route

[Source: Thorn Lighting, UK]



Emergency Lighting

- Two types:

- Maintained luminaires

- Permanently illuminated, and remain illuminated when power fails, such as for emergency exit lighting
 - In some cases they may be switched off deliberately, but are usually required to be active when a building is occupied, or when the public are admitted, such as for a theatre

- Sustained or non-maintained luminaires

- May be switched on and off normally
 - If the power fails, they turn on automatically



Example of an escape route lighting design

Escape route with transverse luminaires

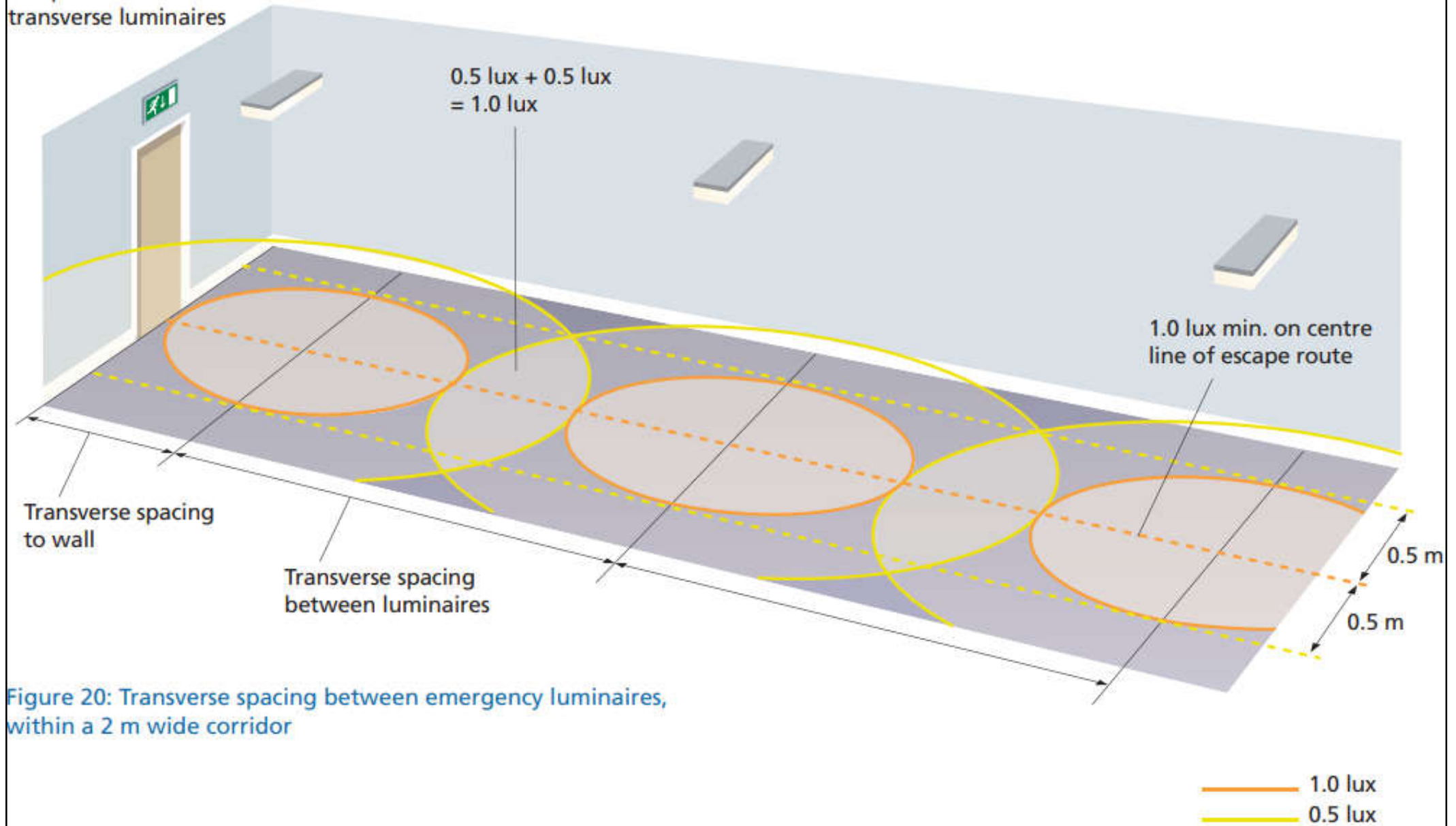
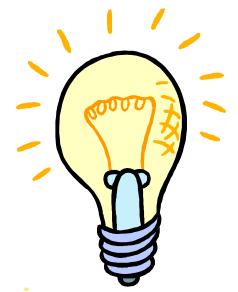


Figure 20: Transverse spacing between emergency luminaires, within a 2 m wide corridor



Further Reading

- Lighting Training Courses (Online) by Philips Lighting University:
 - Introduction to Lighting Application
<http://www.lighting.philips.com/main/experience/education/lighting-academy/lighting-academy-browser/course/introduction-to-lighting-application.html>
- Office Lighting: Knowhow [Design Lights Consortium] [[PDF](#)]
- Small Retail Lighting: Knowhow [Design Lights Consortium] [[PDF](#)]
- Task Lighting Design (EMSD)
 - http://www.emsd.gov.hk/filemanager/en/content_2/Task_Lighting_Design.pdf



References

- SLL, 2009. *The SLL Lighting Handbook*, Society of Light and Lighting (SLL), Chartered Institution of Building Services Engineers, London.
 - Chapter 6: Lighting design
 - Chapter 8: Emergency lighting
 - Chapter 9: Office lighting
 - Chapter 11: Lighting for educational premises
 - Chapter 12: Retail lighting
- Raynham, P., 2012. *The SLL Code for Lighting*, Society of Light and Lighting (SLL), London.
 - Chapter 2: Indoor workplaces