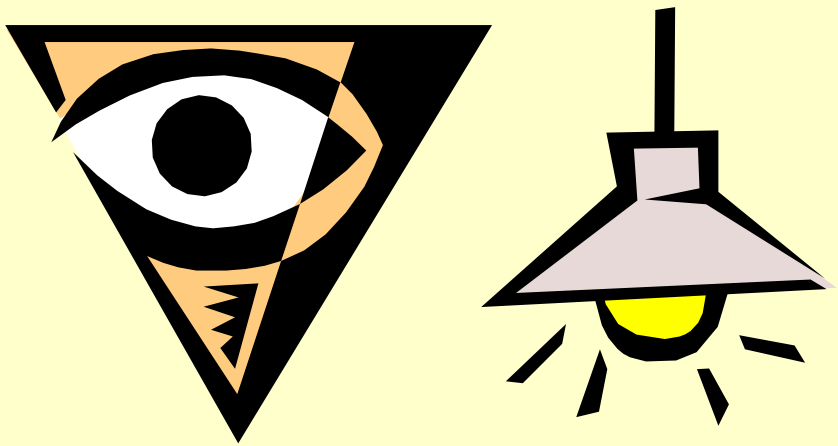
SBS5312 Lighting Technology

http://ibse.hk/SBS5312/



Indoor Lighting Design

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Contents

- 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.

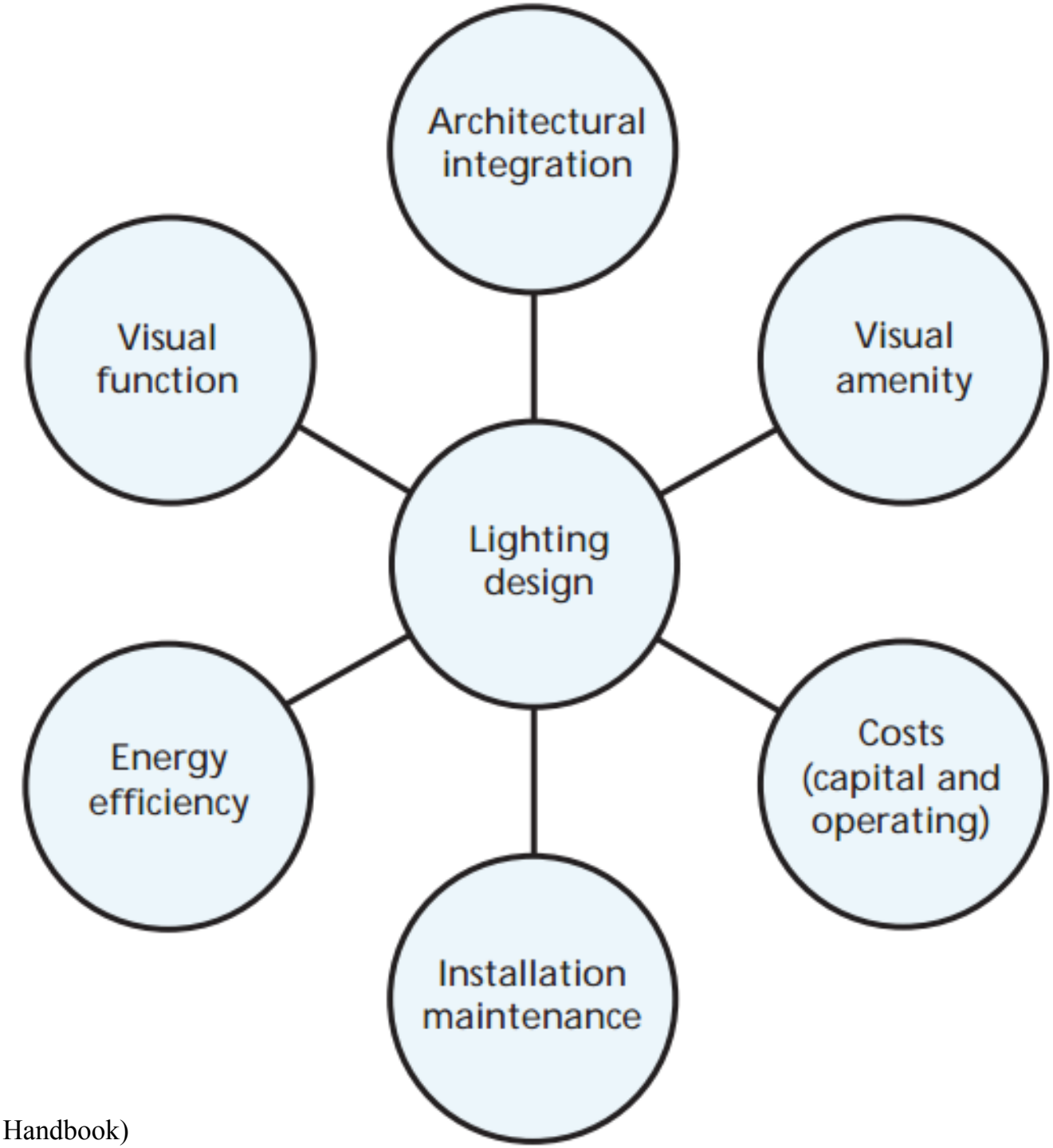
  - Galleries of lighting design portfolio by Annette Hladio:
    - http://www.archltg.com/gallery.htm

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



(Source: The SLL Lighting Handbook)

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

(* For details, please refer to the *SLL Lighting Handbook*.)

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

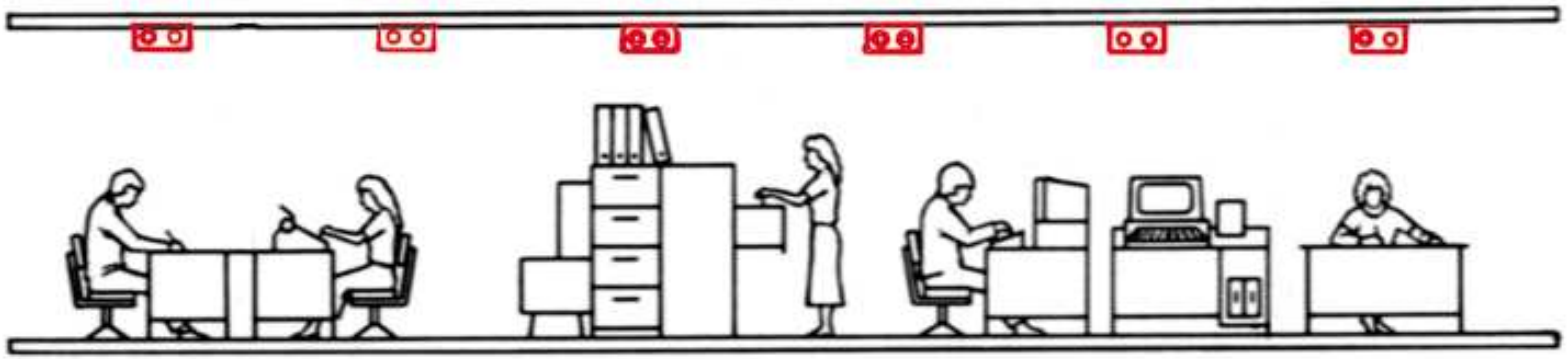
- Lighting design criteria*
  - Luminous environment & luminance distribution
  - Illuminance and uniformity
  - Lighting directional effects
  - Colour aspects, variability of light
  - Glare, flicker and stroboscopic effects
  - Lighting of work stations with display screen equipment (DSE)
  - Maintenance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

(* For details, please refer to the *SLL Code for Lighting*, Chapter 2.)

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

[Source: CIBSE Lighting Code]

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

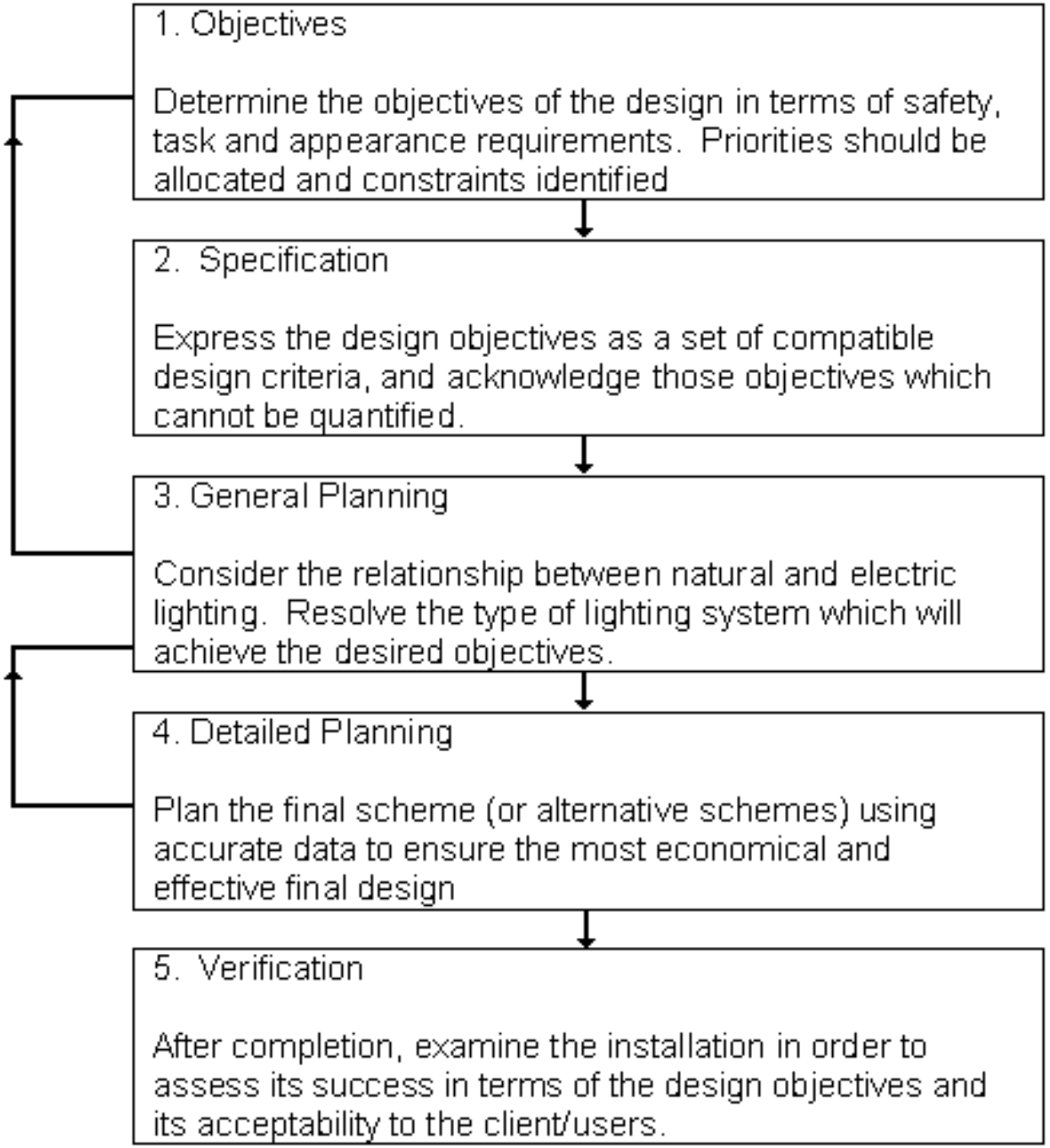
Basic Principles

- 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)



Set the goals

Specify criteria

System type

Calculations/ details

Verification

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

the 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

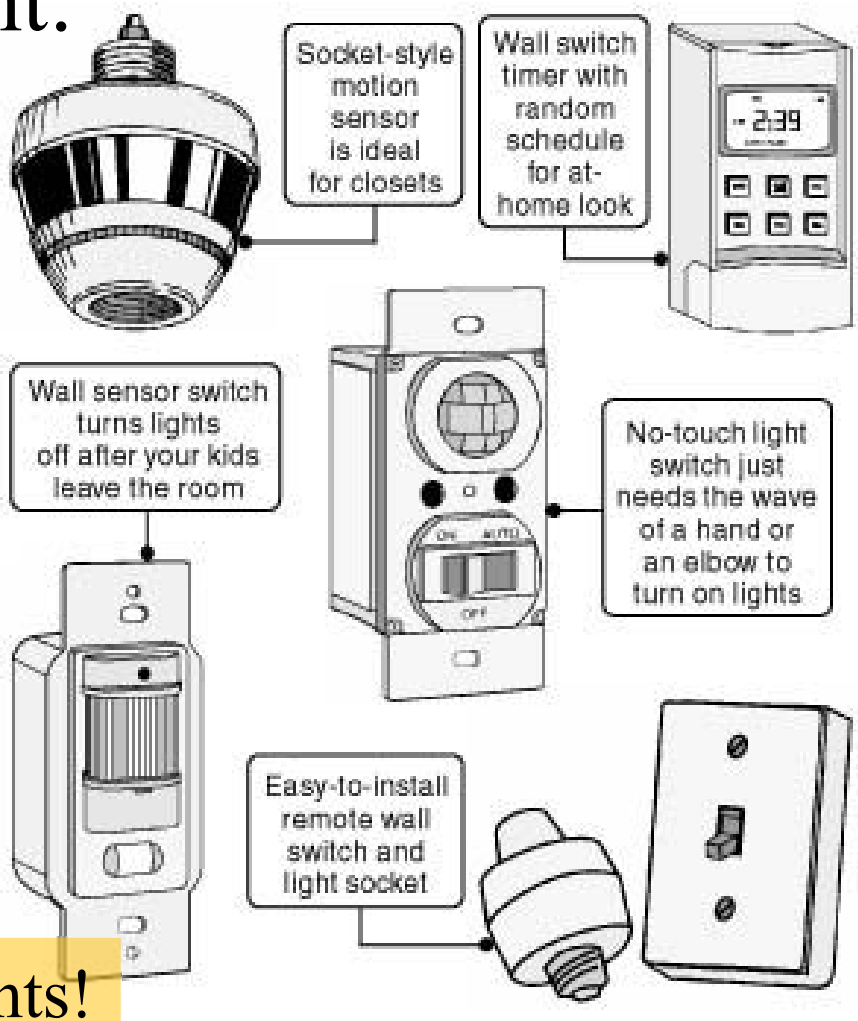
Design Process

the design process

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

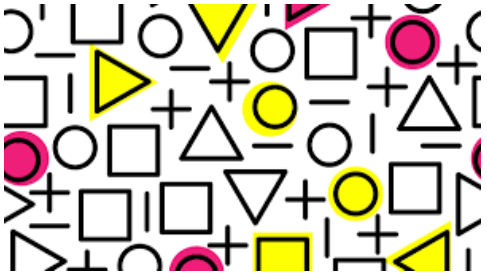
Design Process

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



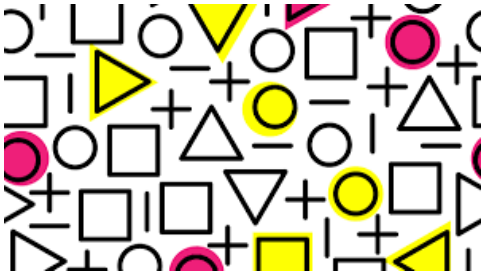
Remember: switch off unnecessary lights!

Design Factors & Issues



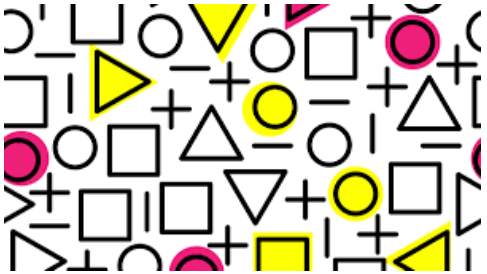
- Factors affecting visual performance:
  - Inadequate illuminance
  - Too great or too low a contrast
  - Disability and discomfort glare
  - Veiling reflection
  - Flicker from fluorescent lamps
  - Psychological factor (occupant's satisfaction with the environment)

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

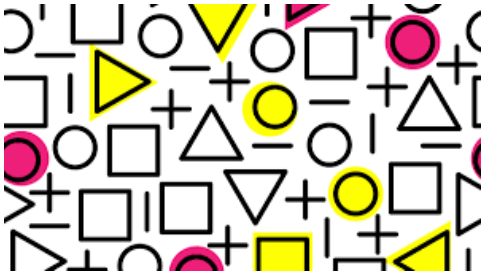


- Lighting quality and criteria
  - Lighting level (lux or luminance e.g. road lighting)
  - Luminance distribution
    - Better distribution of brightness within the field of view
  - Freedom from disturbing glare
  - Spatial distribution of light
    - General lighting, directional lighting, backlighting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

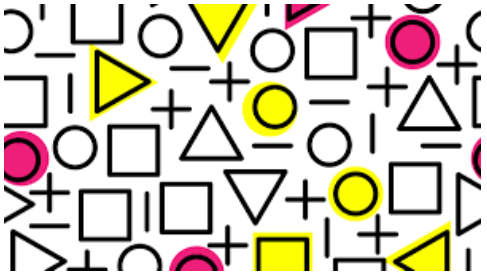
Design Factors & Issues



- 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

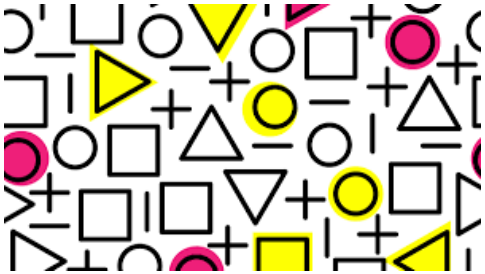
Examples of directional effects in lighting design

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

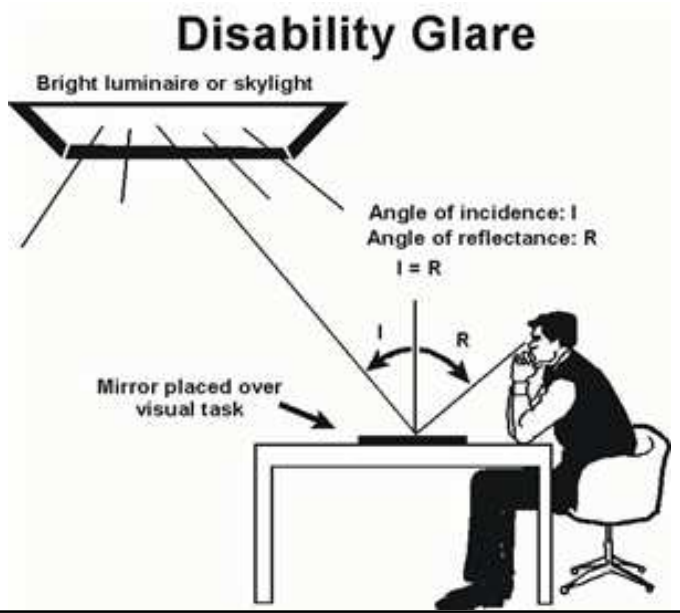


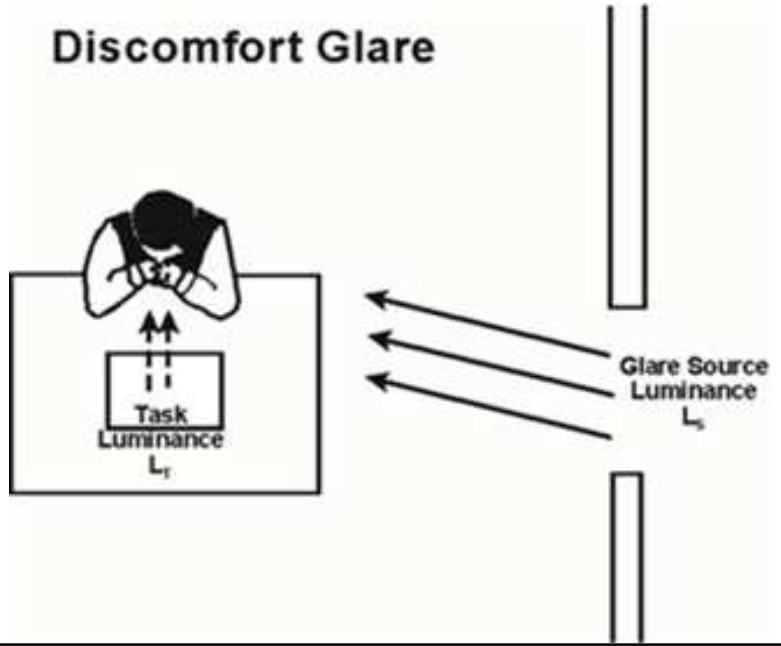
- Glare 眩目光
  - Occurs when objects, seen directly or by reflection, are too bright c.f. the general background
  - Disability glare - impairs ability to see detail w/o necessarily causing visual discomfort
    - Shift in adaptation level
  - Discomfort glare - causes visual discomfort w/o necessarily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

(Video: What is glare? (2:13) http://www.youtube.com/watch?v=PwHXut8lw4M)

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

Discomfort glare from bright luminaires





Design Factors & Issues

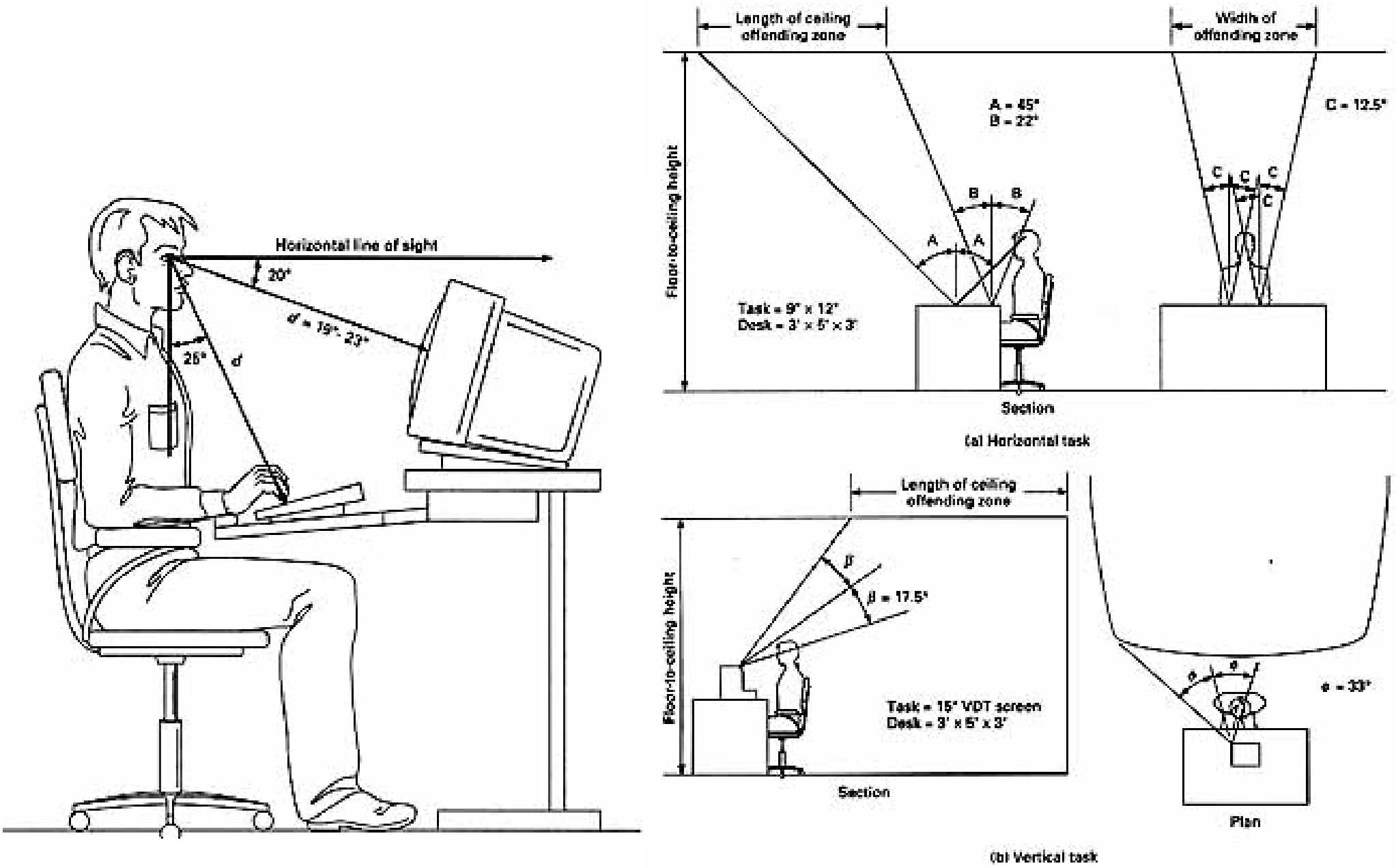
- Reduce glare from artificial light sources
  - Limit the luminance of sources in eye's direction
    - Replace a bright source with few weak sources
    - Restrict light distribution to ↓ sideways light to the eye
  - Screen the sources from view
    - Introduce downstand screens
    - Use screening 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



Glare control for video display unit (VDU)

[Source: CIBSE Lighting Code]

緊急照明燈

Emergency Lighting

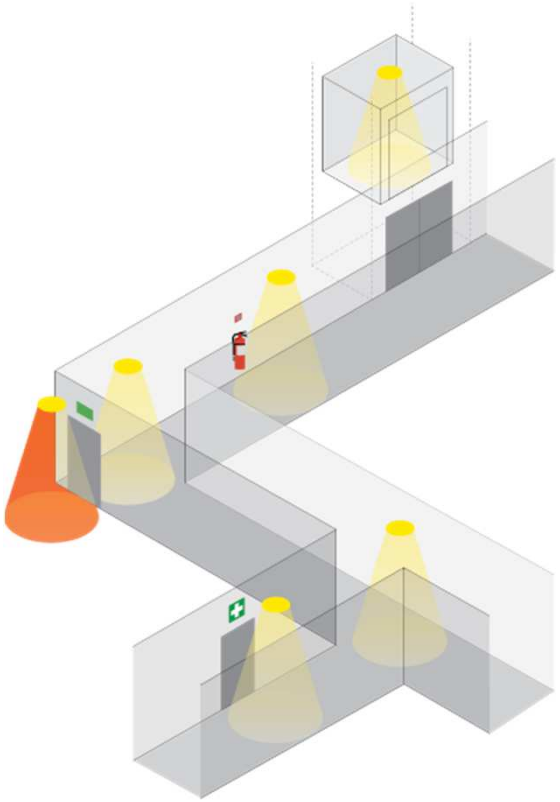
- Main purpose (when normal lighting fails)
  - Guide people quickly & safely from the building
  - Enable specific tasks to be completed
  - Avoid panic
  - Restore confidence

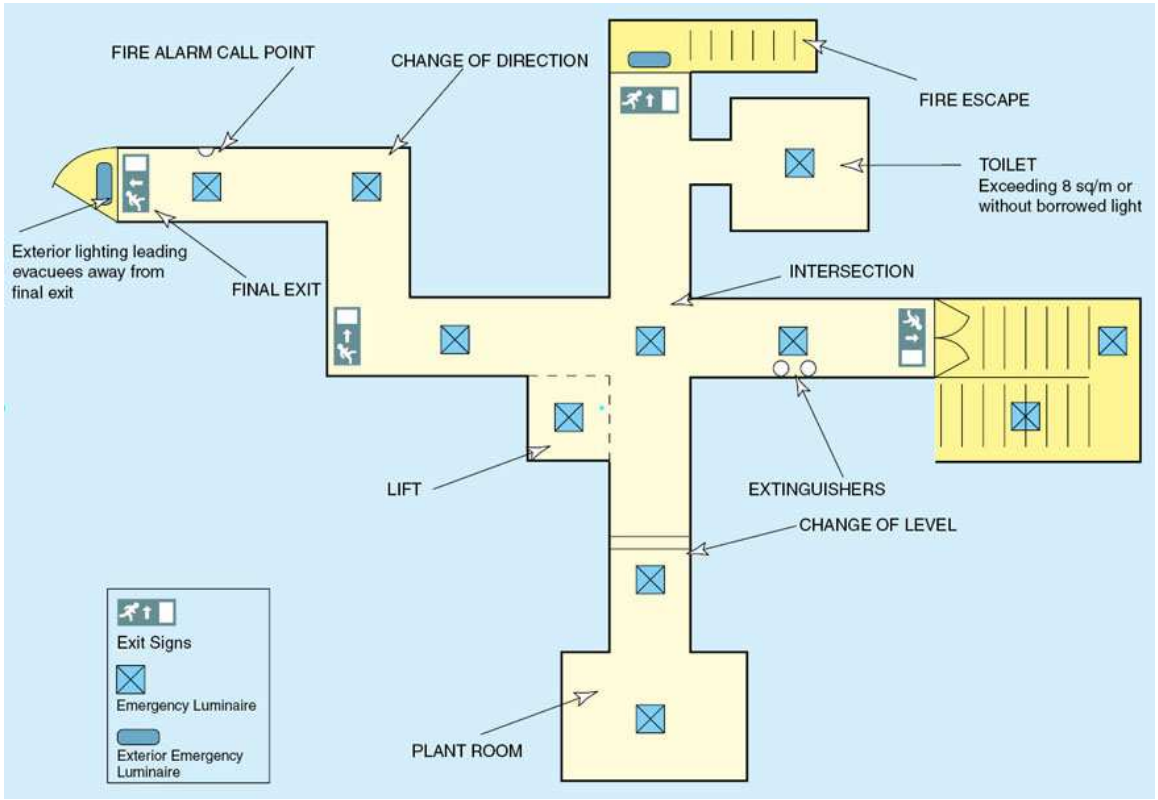
- Design shall follow the relevant regulations (e.g. fire services) & standards/codes (e.g. BS5266)
- Also, exit signs & signage lights

(See also: Emergency Light – Wikipedia http://en.wikipedia.org/wiki/Emergency_light)

Specific forms of emergency lighting and design drawings

- Emergency Lighting
  - Emergency escape lighting
    - Escape route lighting
    - Open area (anti-panic area) lighting
    - High risk task area lighting
  - Standby lighting



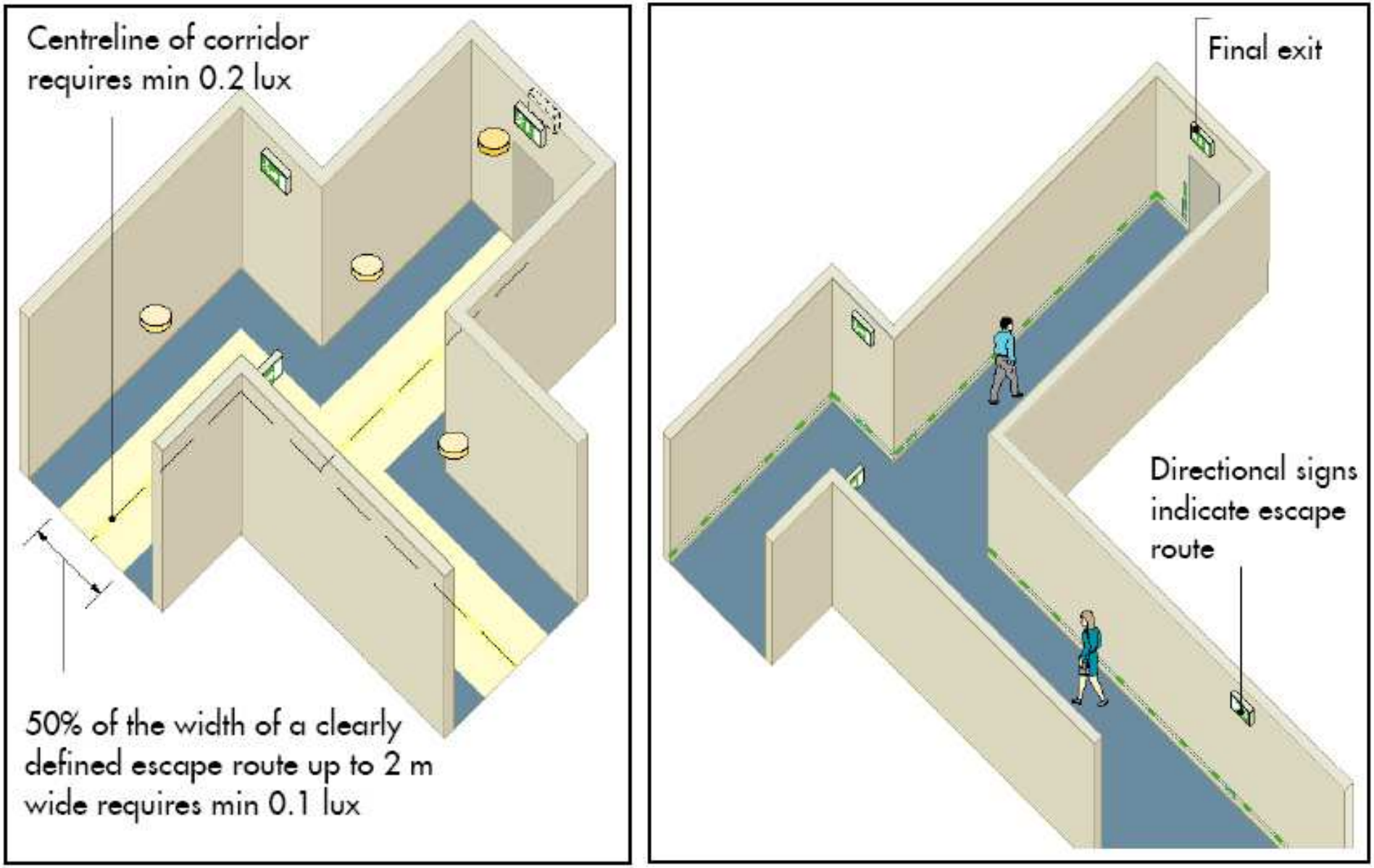


(Source: ICEL 1006: Emergency Lighting Design Guide http://www.icel.co.uk)

緊急照明燈

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]

緊急照明燈

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

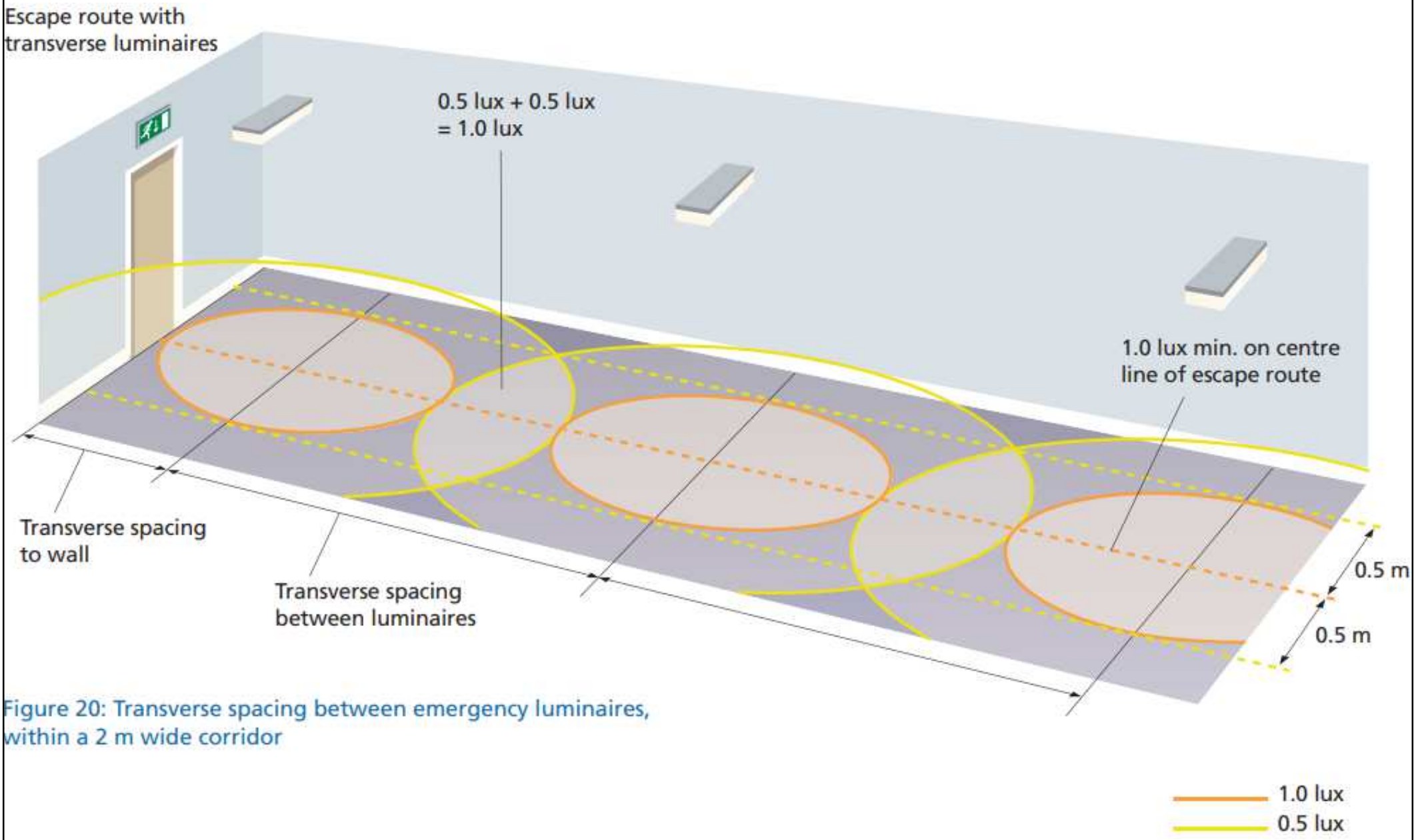
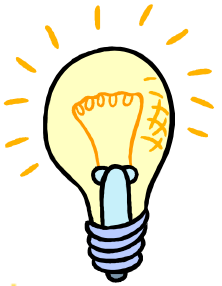


Figure 20: Transverse spacing between emergency luminaires, within a 2 m wide corridor

(Source: http://www.emergi-lite.co.uk/)

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