SEMINAR ON
REVISED LIGHTING AND POWER SUPPLY STANDARDS
SS 531 : PART 1 : 2006 and
SS 535 : 2007 (Formerly CP 31 : 1996)

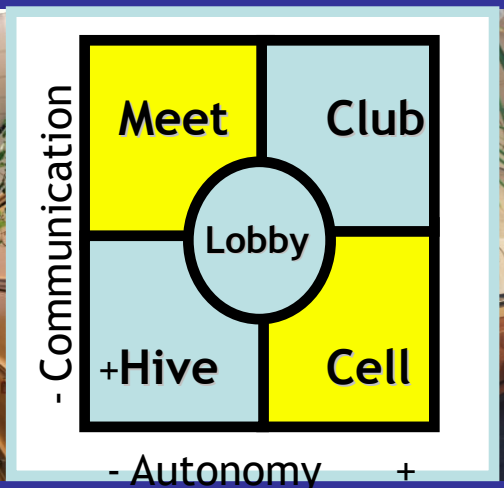
Date : **17 September 2007 (Friday)**
Time : **1.30 pm – 5.15 pm**
Venue : **SPRING Singapore, Auditorium**
2 Bukit Merah Central
Podium Block, Level 3
Singapore 159835

PROGRAMME

1.30pm	**Registration**
2.00pm	**Welcome Address** Mr Teo Nam Kuan Group Director, Quality & Standards Group, SPRING Singapore
2.05pm	**Introduction of SS 531 and New Direction in Lighting Design** Mr K Seshadri Chairman of the Technical Committee of Lamps and Related Equipment and Senior Consultant of Philips Lighting Asia Pacific
2.35pm	**Good Lighting Practices** Mr Tay Hooi Seng Member of the Technical Committee of Lamps and Related Equipment and Managing Director, Clipsal Singapore Pte Ltd
3.15pm	**Refreshments**
3.45pm	**Introduction of SS 535** Mr Sim Wee Meng Chairman of the Technical Committee on Mains Failure Standby Generating Systems and Acting Group Director, Rail, Land Transport Authority
3.55pm	**Changes Introduced in SS 535 : 2007** Mr Stephen Mok Member of Technical Committee on Mains Failure Standby Generating Systems, Senior Executive Engineer, Special Functions Division, Building Construction Authority
4.20pm	**Good Earthing Practices** Mr Melvyn Thong Member of Technical Committee on Mains Failure Standby Generating Systems, Deputy Director, Mechanical And Electrical Services Division, Land Transport Authority
4.45pm	**Panel Discussion** Moderators: Mr K Seshadri, Chairman of the Technical Committee of Lamps and Related Equipment and Mr Sim Wee Meng, Chairman of the Technical Committee on Mains Failure Standby Generating Systems
5.15pm	**End of Seminar**

Presentation materials can be downloaded at
http://www.standards.org.sg/files/SeminarLightPower.htm
from 19 September 2007









K.Seshadri, Chairman
TC TC 118/1/9R (Lamps and Related equipment)

Introduction to SS531-1:2006

Singapore, 17 Sept 2007

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SPRING guidelines for the TC

- As far as possible, keep to IEC or ISO standards and adopt with minimum deviations
- Deviations are allowed, so long as the reasons could be explained scientifically or with proper supporting evidence in the local context
- Avoid putting-in Product-related data for Codes of Practice. They belong to the products' own SS or IEC standards.
- Lighting levels should be achievable within the Power budget set forth in SS 530: 2006 (= the former CP 24 that limits a buildings' solar heat gain, air-conditioning and lighting loads in Watts per Sq.M)

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TC decision

- The previous lighting standard CP 38: 1999 was based on CIBSE:1994 Lighting Guide 3.
- In line with SPRING directive to use IEC or ISO standard, we recommended and worked to adopt:
  - ISO 8995-1 Lighting of *indoor* work places &
  - ISO 8995-2 Lighting of *outdoor* work places, which is just at Final draft stage
- CP 87 (Illumination in industrial premises) was transferred to our TC in April 2005. It was also based mainly on ISO 8995:1989 and CP 38. Thus it was opportune to amalgamate the two standards as a single SS 531-1 now.

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Our WG for ISO 8995:1

Mr.Ong Ser Huan	IES (= Convener)
Mr.Tay Hooi Seng	Smaf (= Co-Convener)
Jeremy Kwok	NPB (= WG Secretary)
Mohd Rithaudin	MOM
John Gui	ACES
Jimi Wong	Maxspid
Wong Lee Yit	Ngee Ann Poly
Adrian Cheong	LTA
Chan Hong Meng	SCDF
Ng Kok Liang	SIA
Ms Goh Siam Imm	BCA

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What is good lighting ?

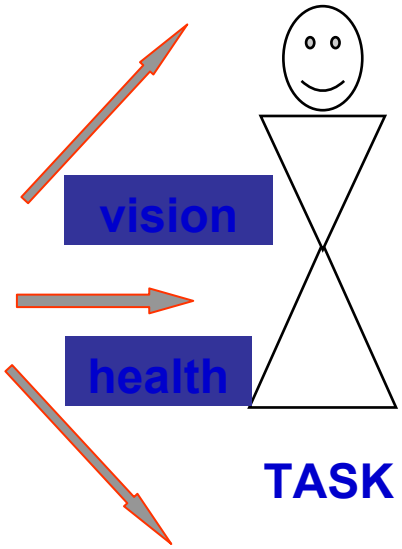
WORKING ENVIRONMENT

surrounds

- Sound/noise
- Hygiene
- Heating/cooling

- LIGHTING

- Infrastructure
- Furniture
- Machinery
- Etc.



- Eye/vision
- (Visual) task performance
- Speed/failure rate

- Physical/mental health
- Safety/accidents
- Absenteeism

Productivity

Good lighting is a Facilitator of ***vision and health***

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SS 531-1 The Essentials

- ***Safety, Productivity & Quality of working***
- ***Visual Comfort***
- ***Visual Satisfaction & the joy of colours***

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SS 531-1 The Essentials

Quality aspect	Quality parameter
Lighting level	maintained illuminance
Uniformity	E_{min} / E_{av}
Glare restriction	UGR
Colour rendering	R_a

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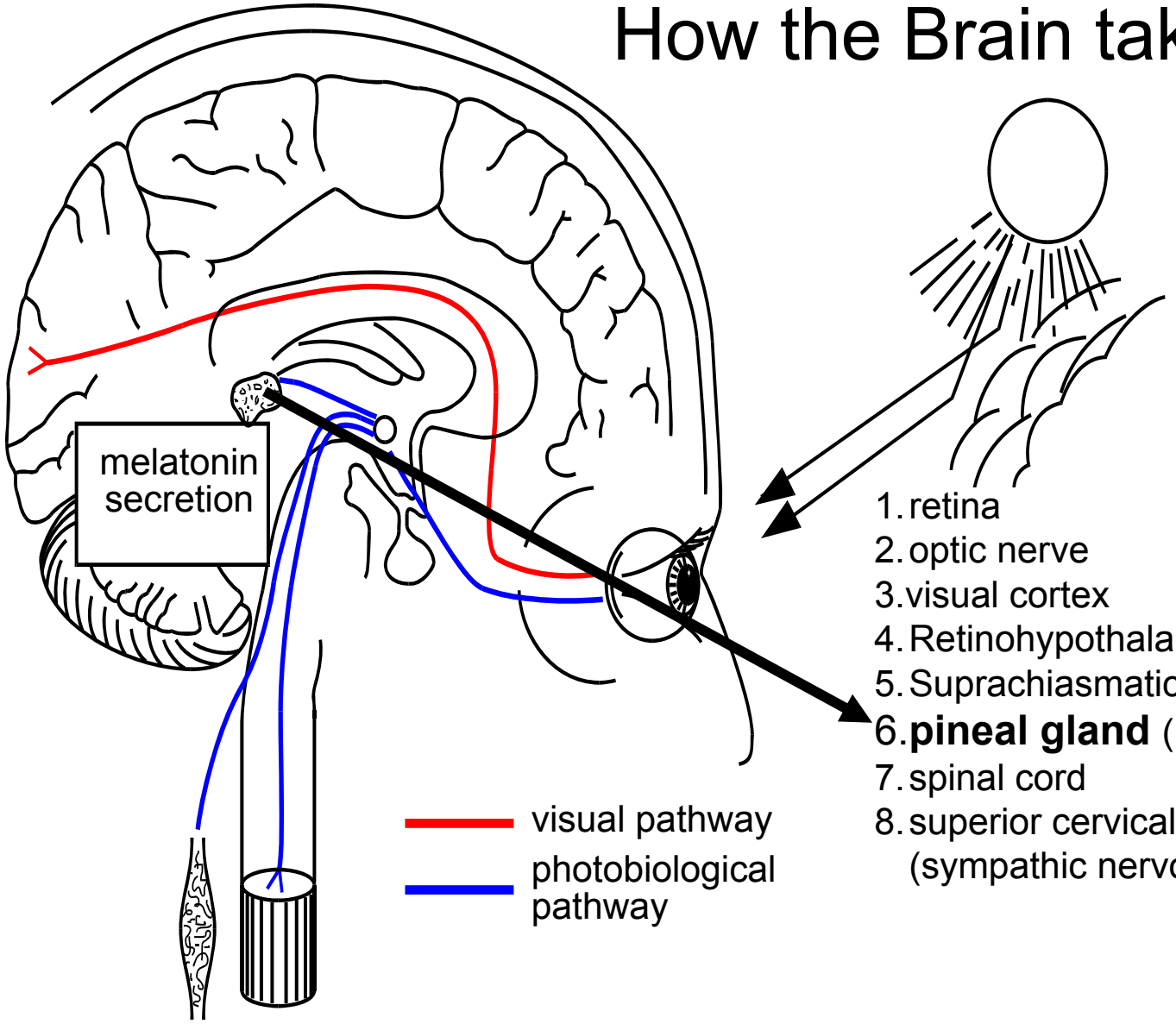
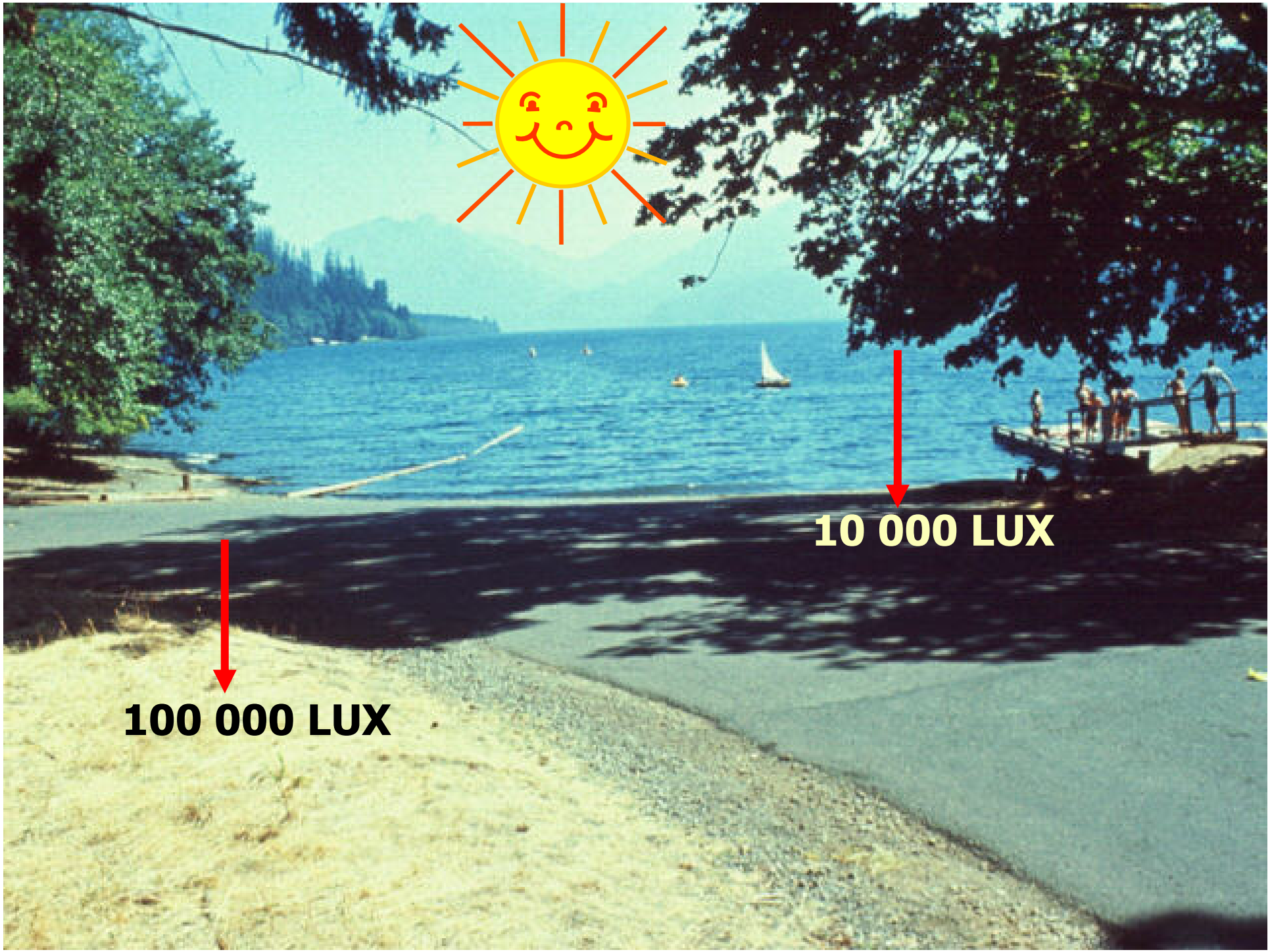
How the Brain takes Light



1. retina
2. optic nerve
3. visual cortex
4. Retinohypothalamic tract (RHT)
5. Suprachiasmatic nucleus (SCN)
6. **pineal gland** (melatonin secretion)
7. spinal cord
8. superior cervical ganglion (sympathic nervous system)


10 000 LUX
100 000 LUX

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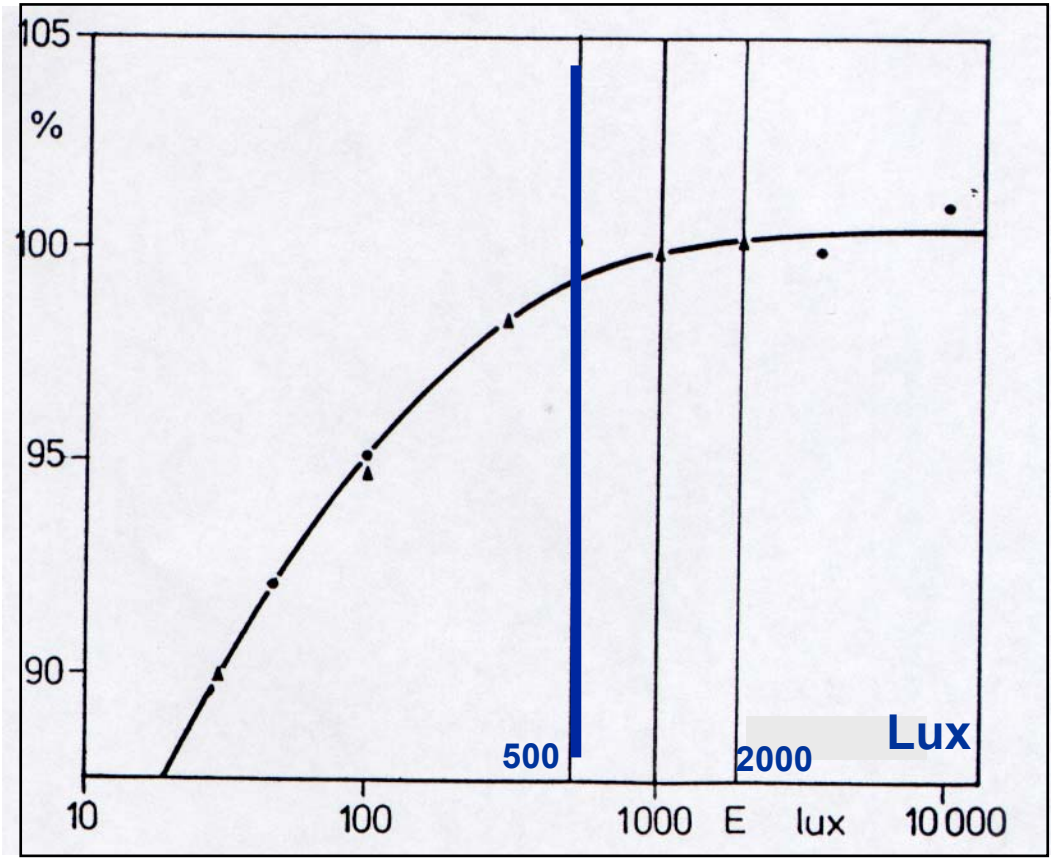
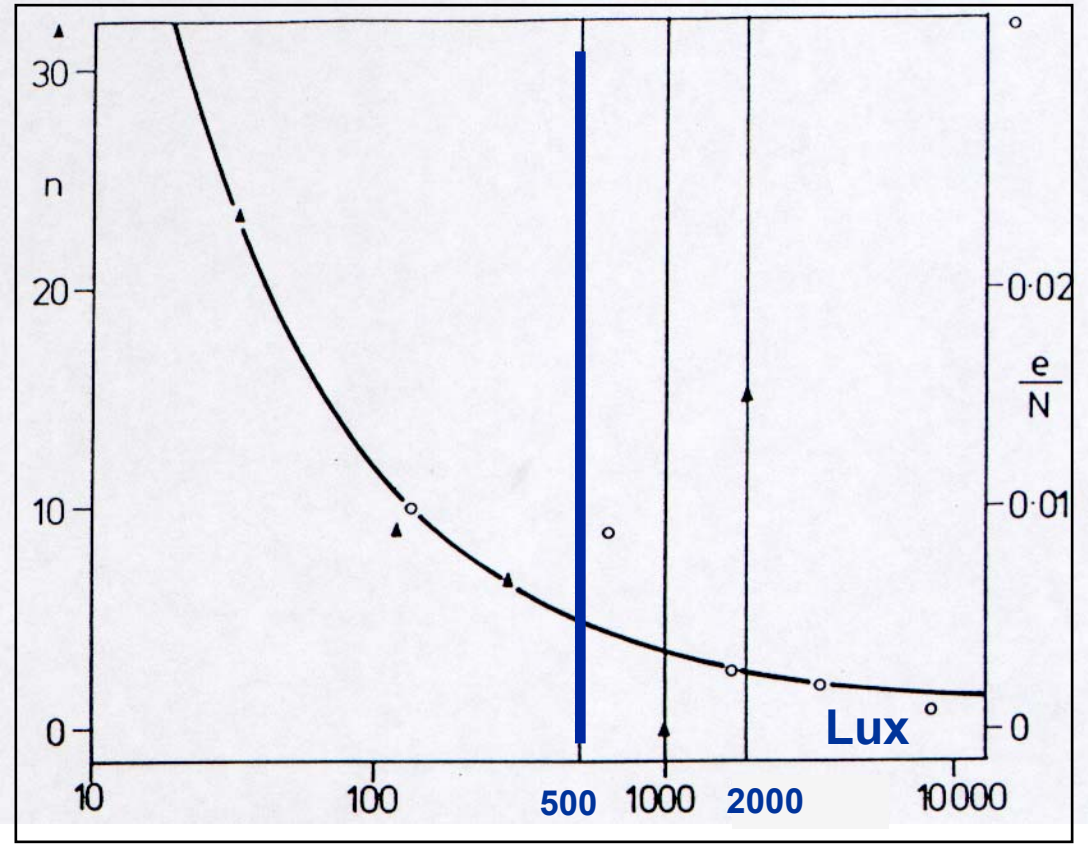
Lighting and Productivity



Productivity and Task Illuminance

Dr.D.Fischer, International Lighting Review 85/2

Lighting and Errors



Errors and Task Illuminance

Dr.D.Fischer, International Lighting Review 85/2

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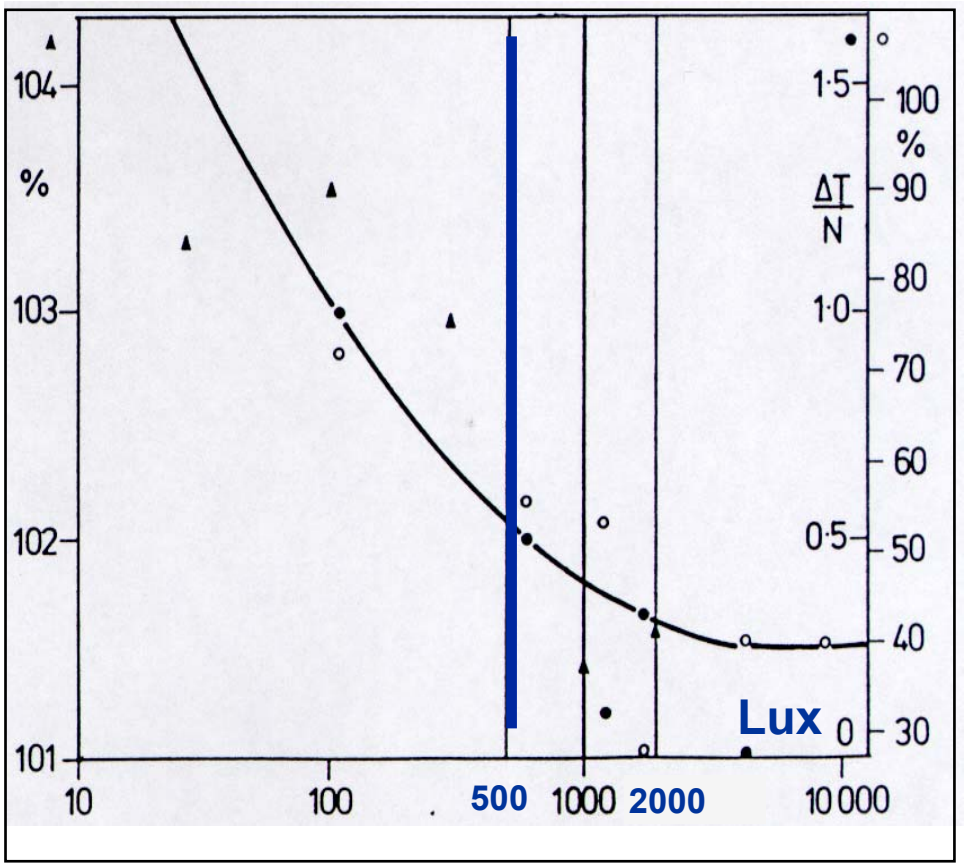
Lighting and Fatigue



Fatigue and Task Illuminance

Dr.D.Fischer, International Lighting Review 85/2

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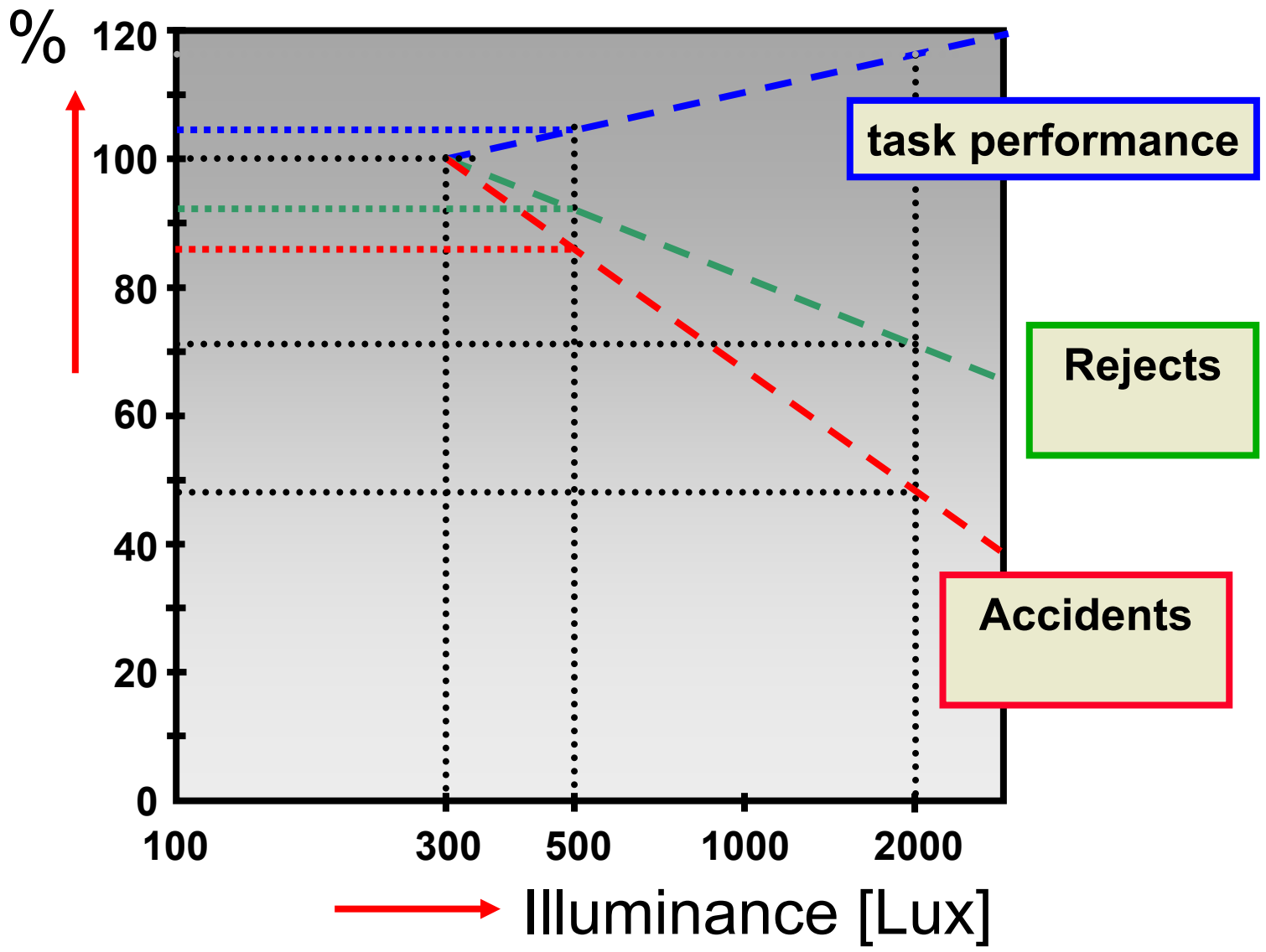
Example: Productivity in Metal industry



Source: Handbuch für Beleuchtung

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The Human Eye

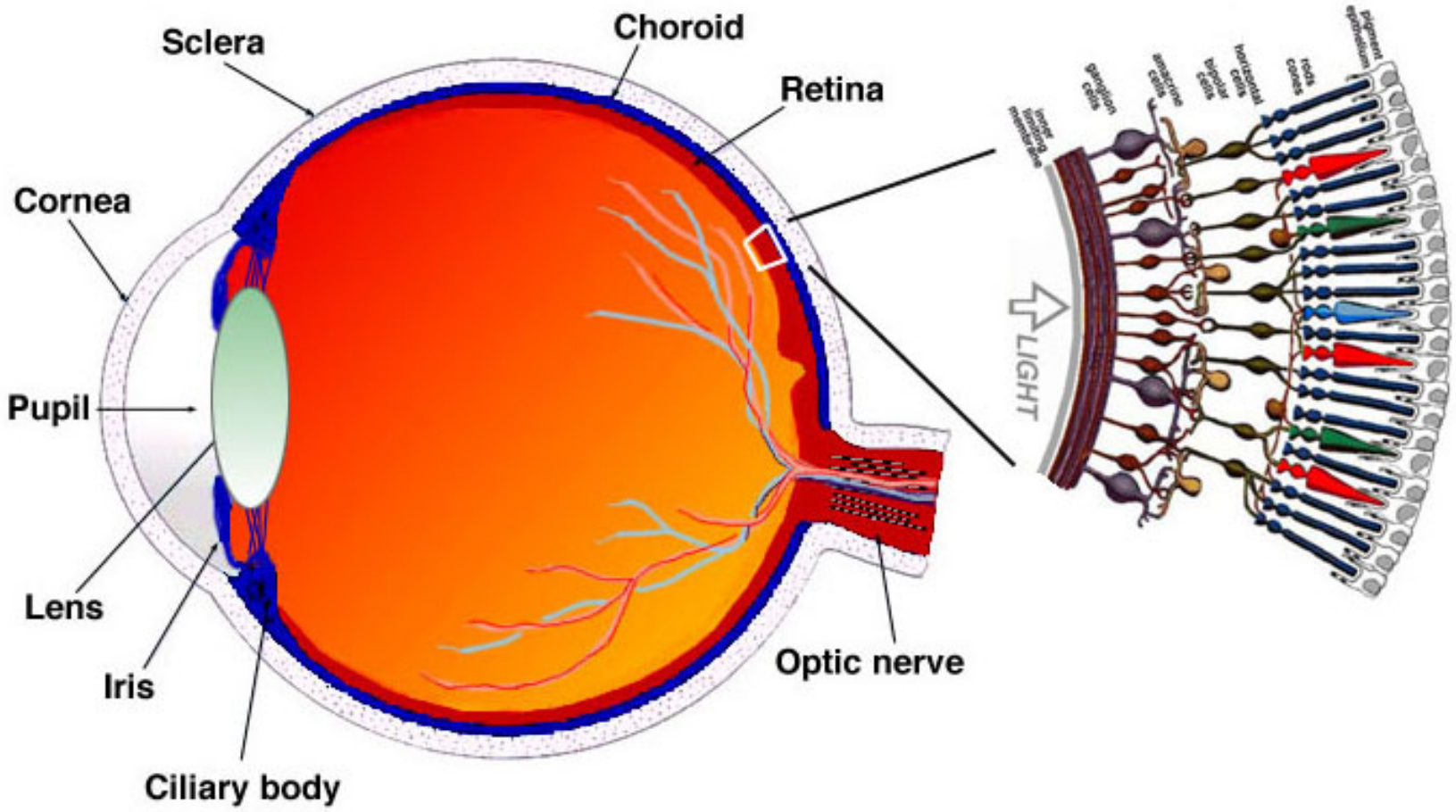
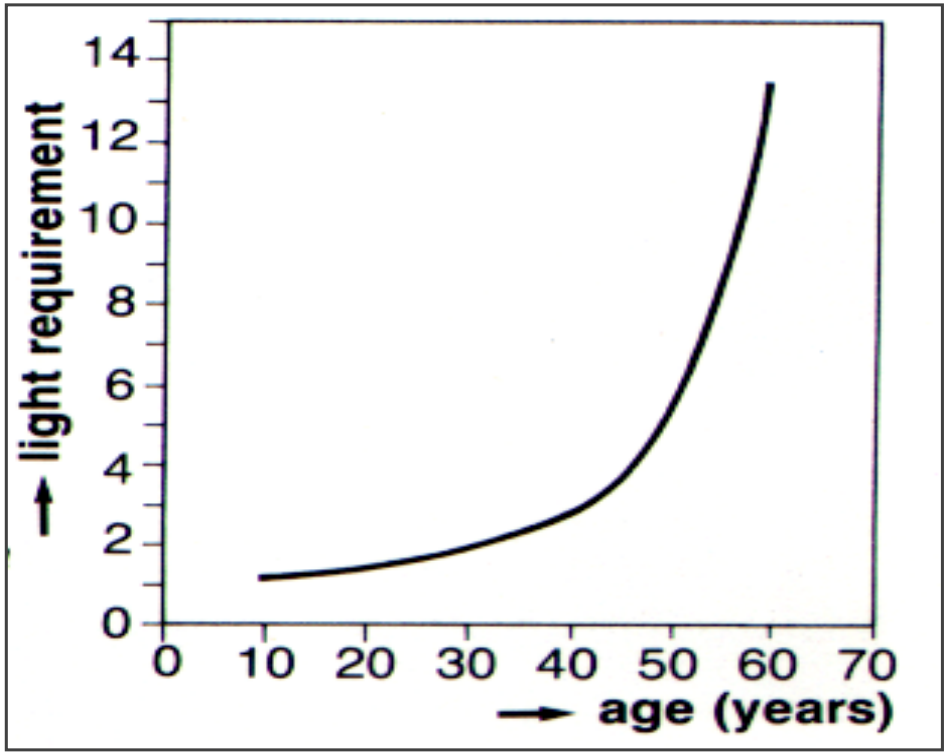


Fig. 1.1. A drawing of a section through the human eye with a schematic enlargement of the retina.

Lighting Level

Lighting Level is also determined by age of users



- **A person of 60 yrs will need about 15 times higher lighting level than a 10 yr old.**

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Age vs Illuminance

(For continuous Working)

12 years	=	200 lux
40 years	=	600 lux
60 years	=	3000 lux

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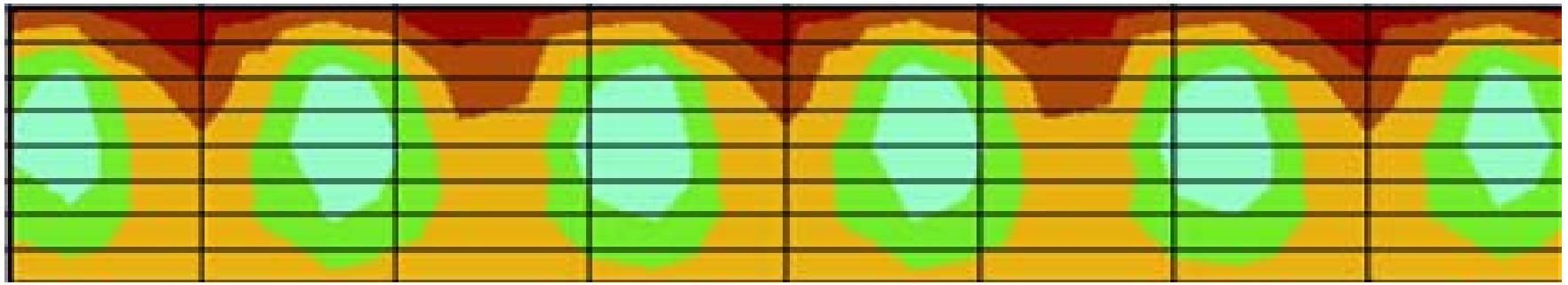

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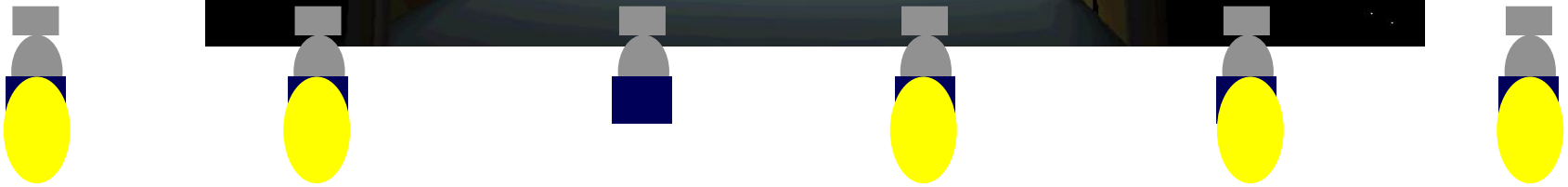

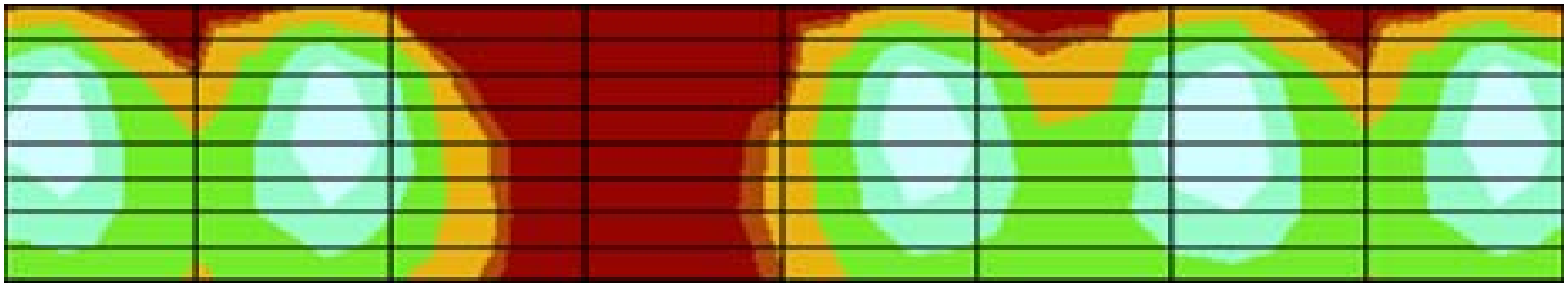

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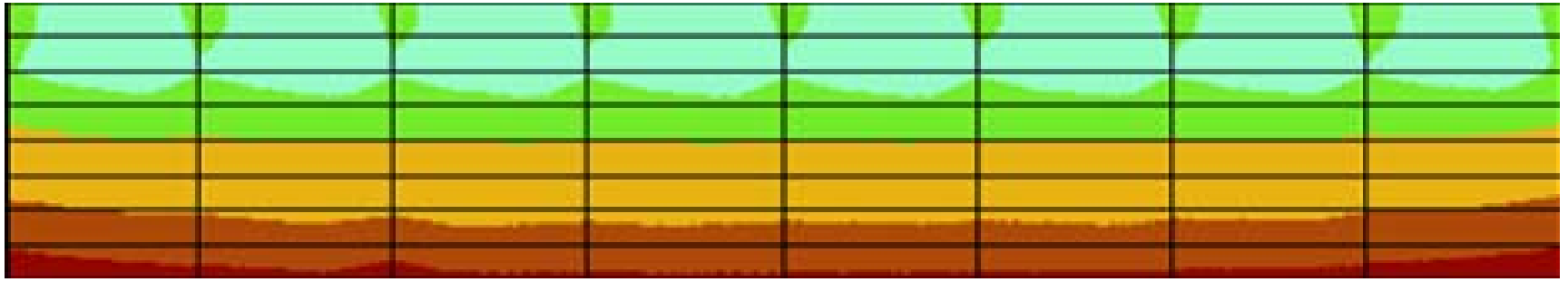

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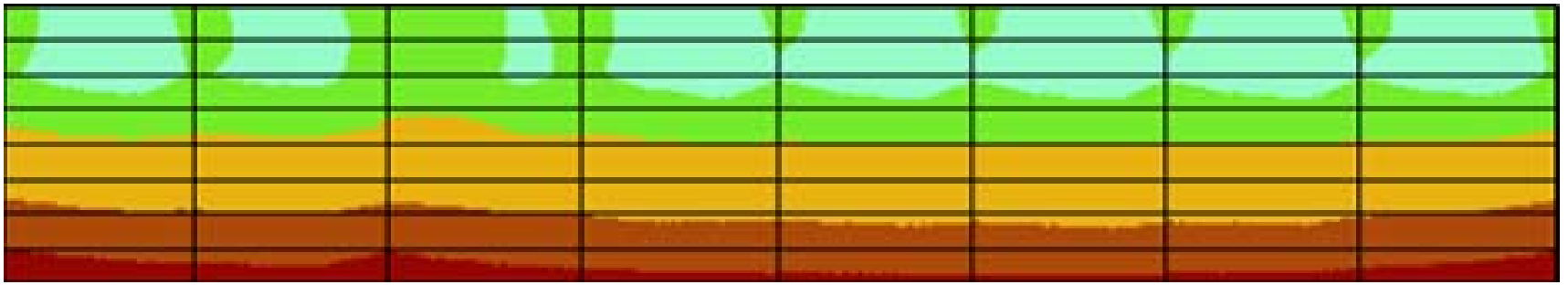





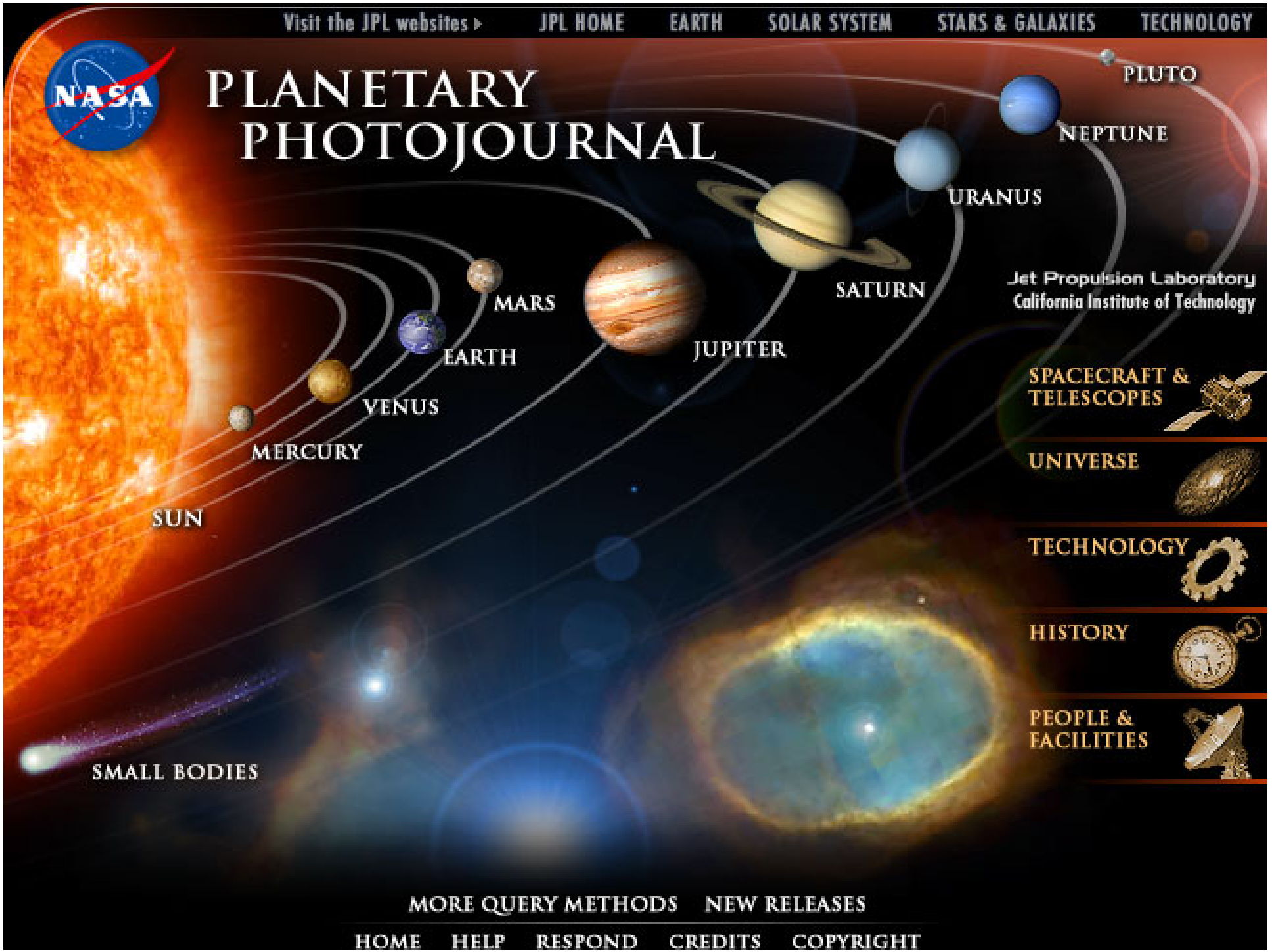
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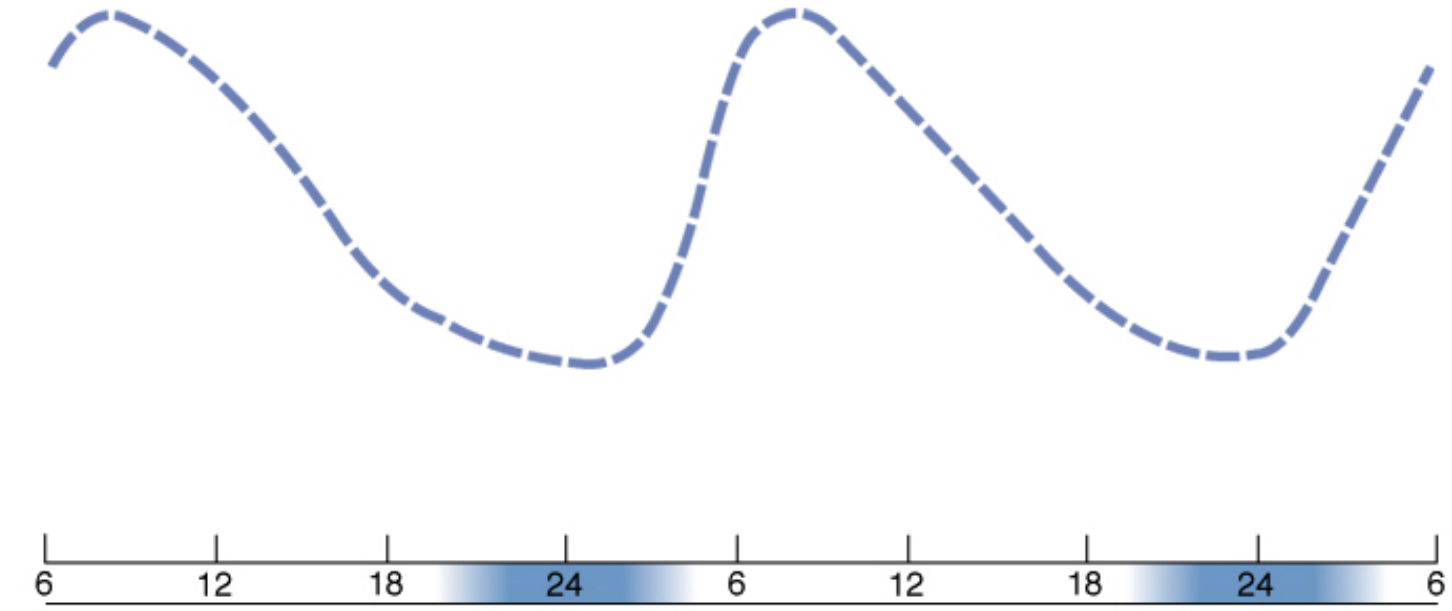
Circadian Rhythm



cortisol

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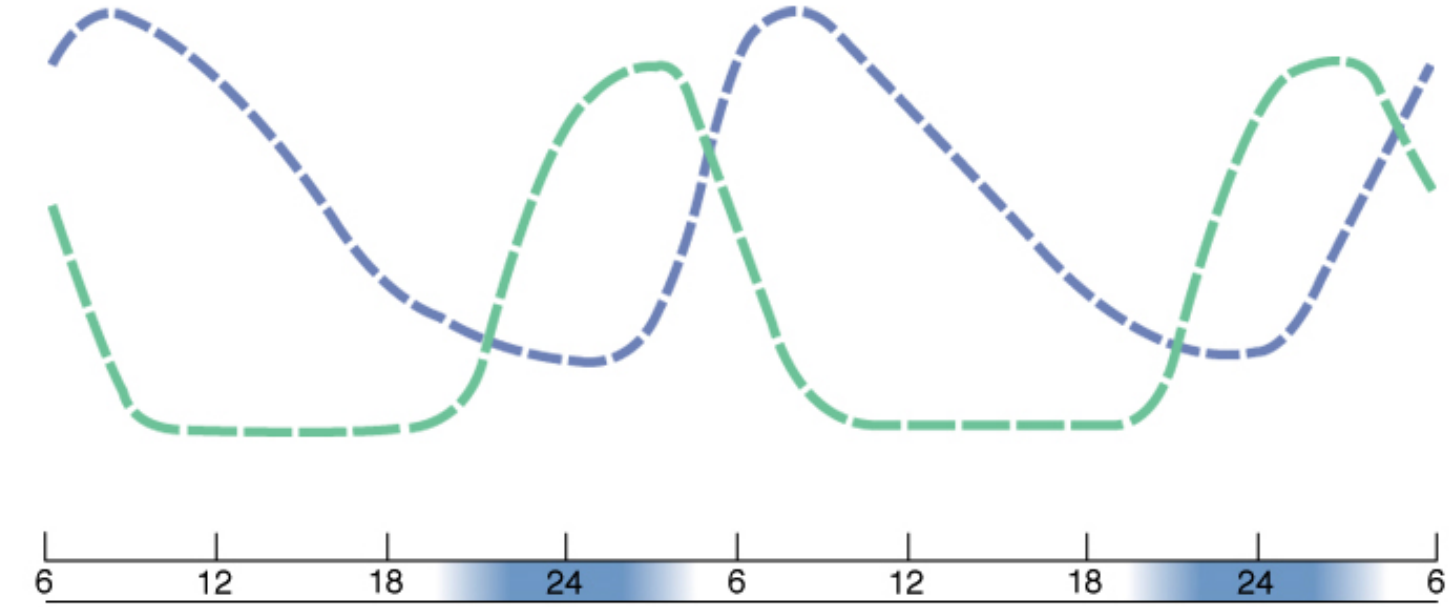
Circadian Rhythm



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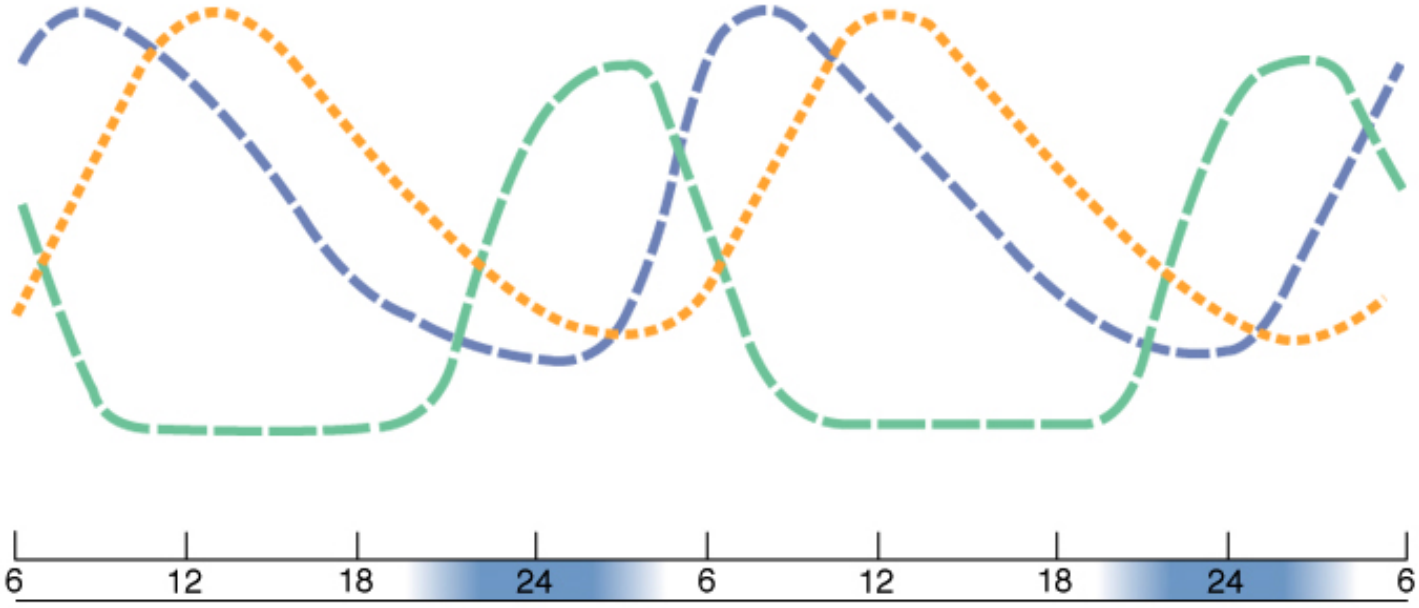
Circadian Rhythm



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What is good lighting ?

WORKING ENVIRONMENT

surrounds

- Sound/noise
- Hygiene
- Heating/cooling

- LIGHTING

- Infrastructure
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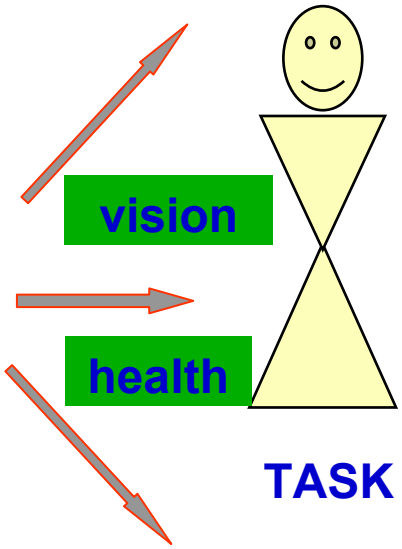
- Etc.



- Eye/vision
- (Visual) task performance
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- Physical/mental health
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- Absenteeism

Productivity

Good lighting is a Facilitator of ***vision and health***

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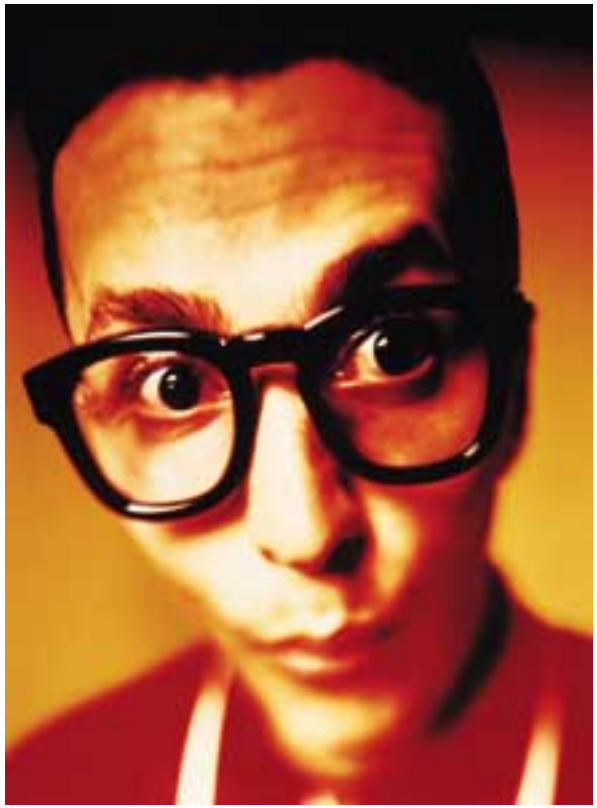
Lighting level and energy consumption

Our eye is used to	= 100,000 lux
Recommended office lighting level	= 500 lux
Max. Electrical load for lighting per user	= 80W
For 10 hrs per day, energy consumed	= 80 x 10 WHr = 0.80 Kw Hr
@S$ 0.25 / KwHr, the cost of energy / day	= S$ 0.20!

How much does a cup of tea cost ?

How many cups would we drink everyday?



Thank you !

Good Lighting Practices

according to
SS 531-2006: Code of Practice for Lighting of Work Places Part 1 – Indoor Lighting

By: Tay Hooi Seng

Managing Director

Schneider Electric (BU Installation & Controls)

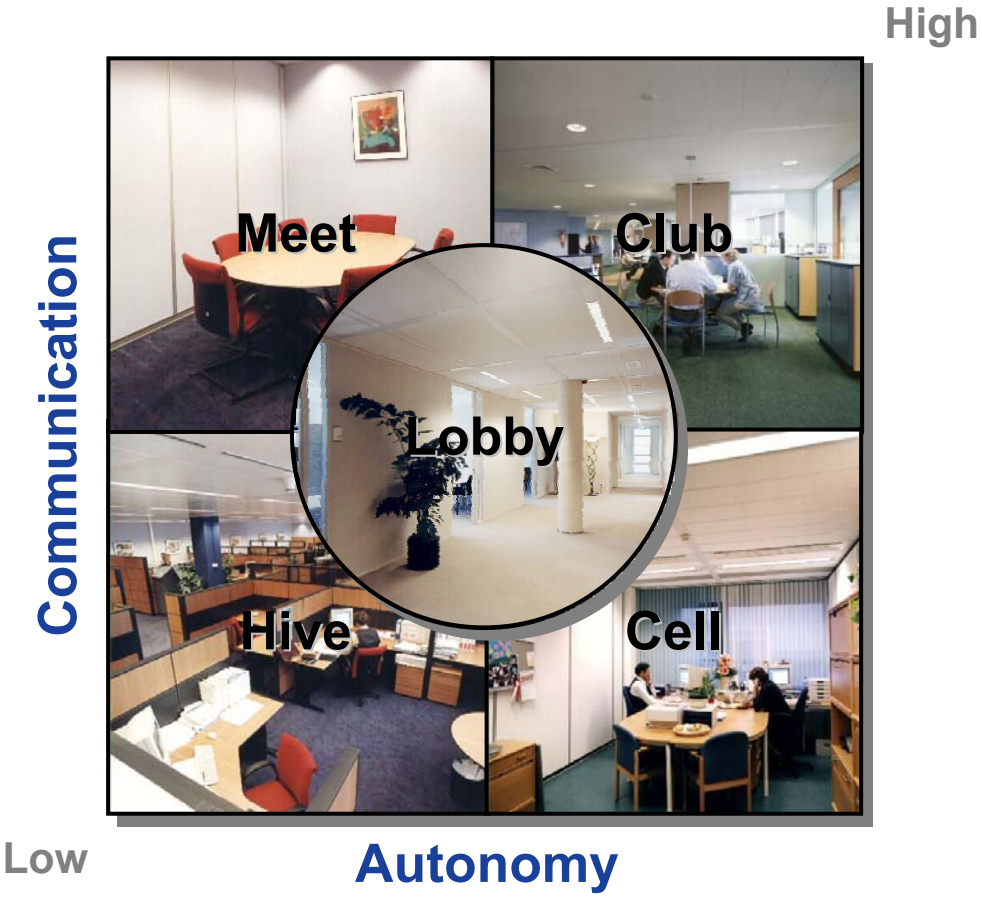
Clipsal Singapore/PDL Singapore/Merten

Date: 20070917

Content

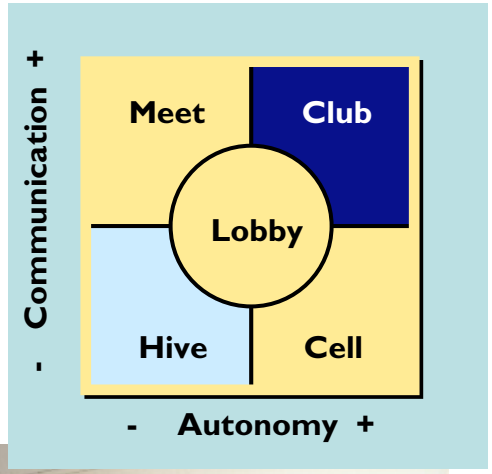
1. New views on office lighting
2. Model for Office environments
3. SS 531-2006: Code of Practice for Lighting of Work Places Part 1 – Indoor Lighting

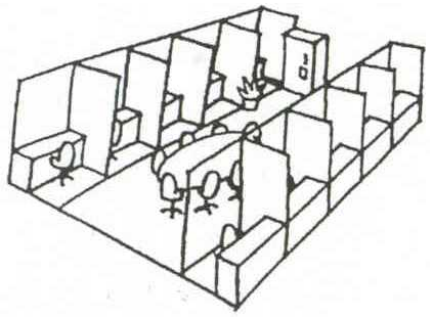
Model for Office environments

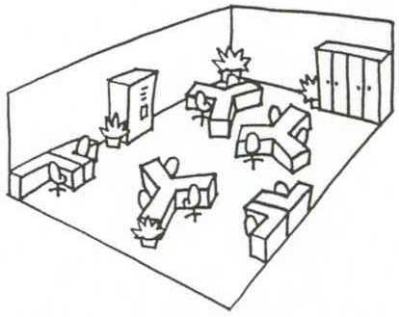


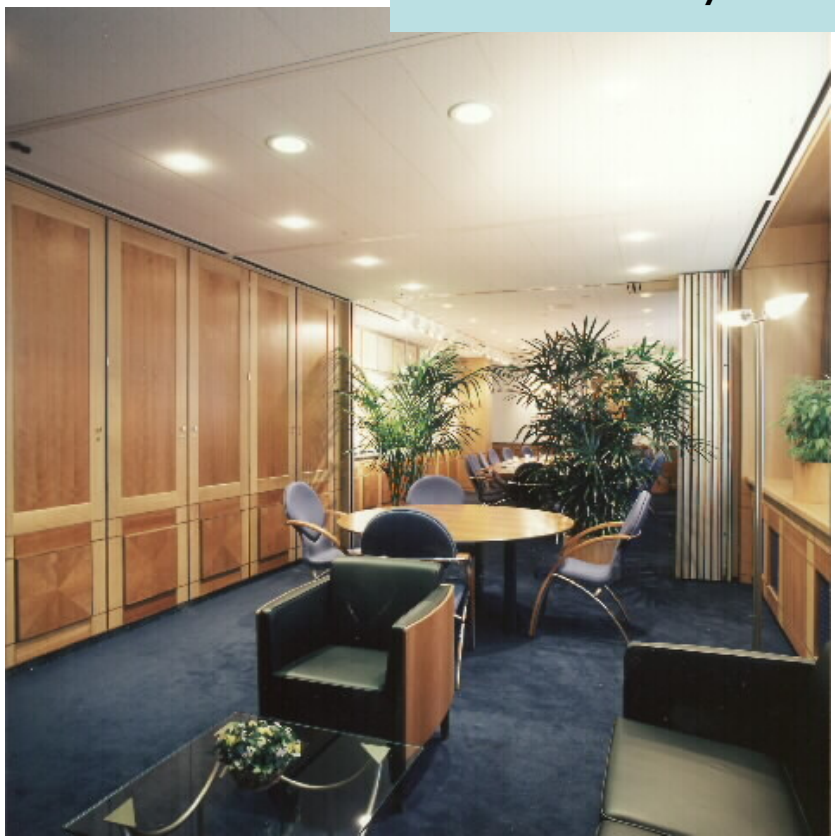
Club

- Medium sized open plan office with integrated concentration and communication functions
- Concentration and communication type of work



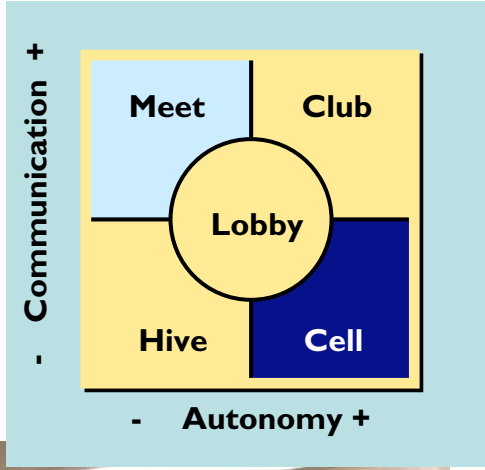


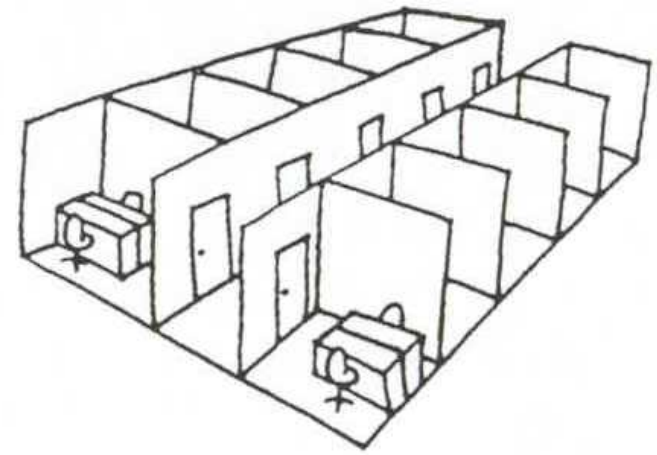




Cell

- Cell structure
- Individual concentration work
- Limited communication between colleagues

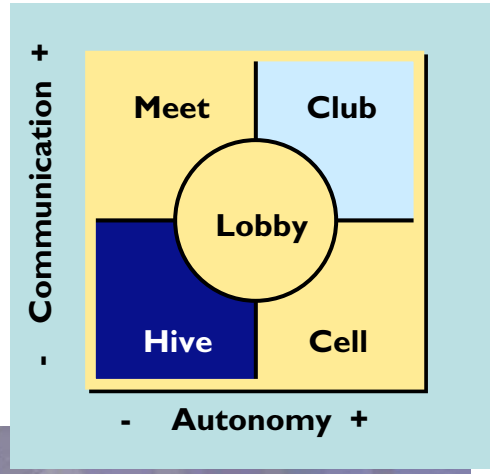


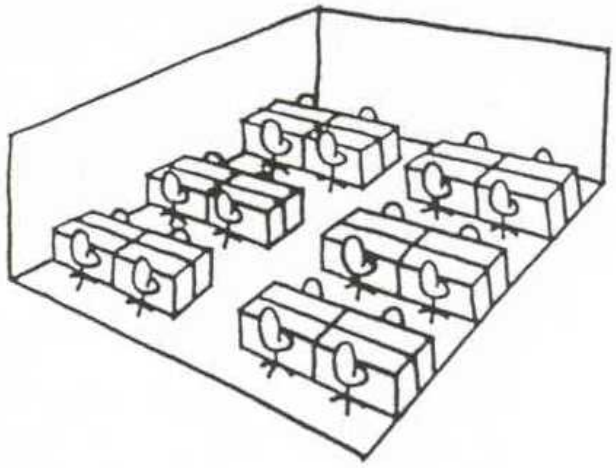


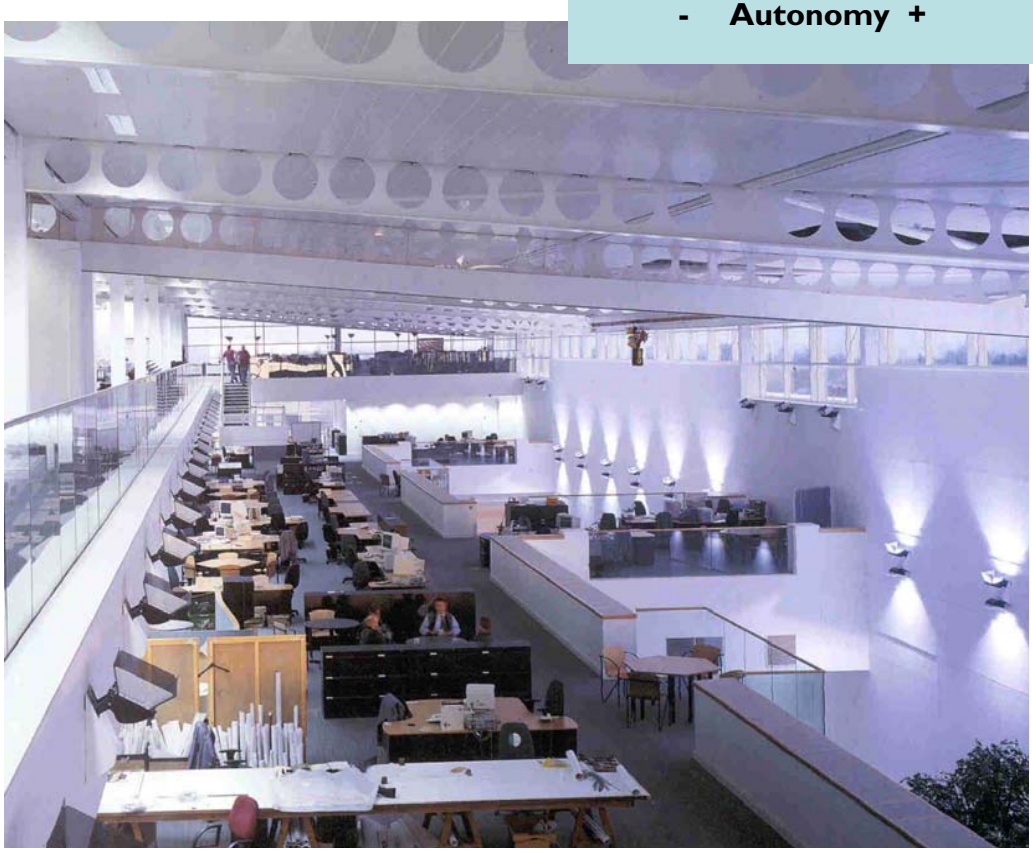


Hive

- Open plan offices
- Individual process work
- Repetitive character
- Limited autonomy
- Hierarchical

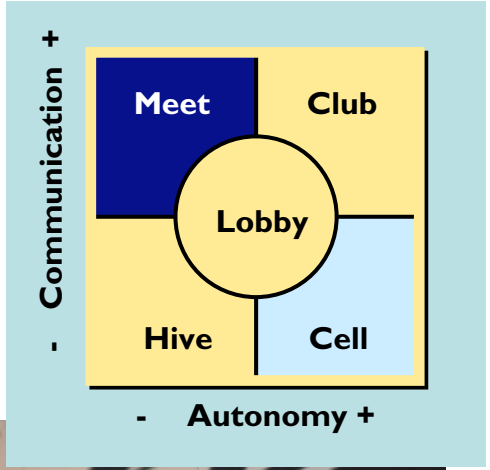


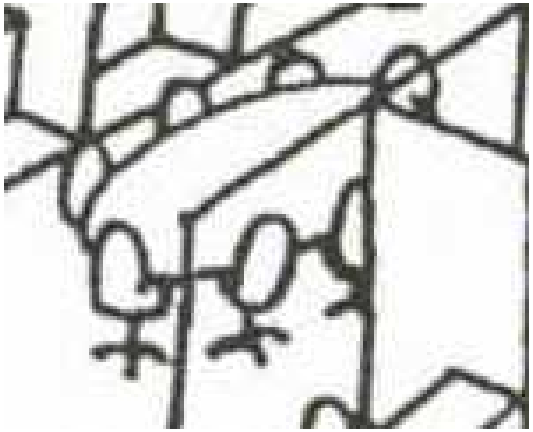


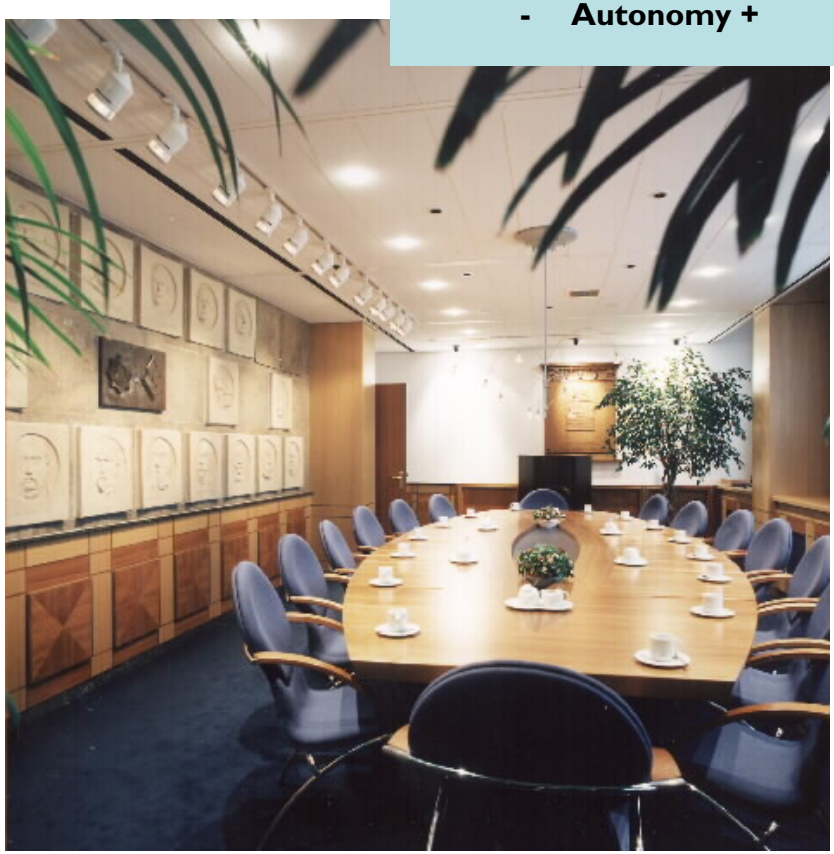


Meet

- Areas specially intended for meetings
- Communication most essential

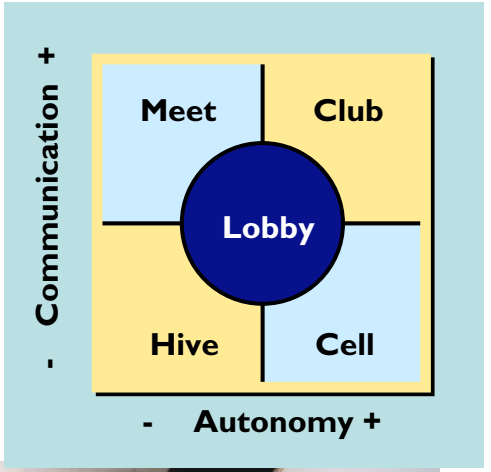






Lobby

- Walking routes
- Corridors
- Staircases
- Atrium
- Entrance hall

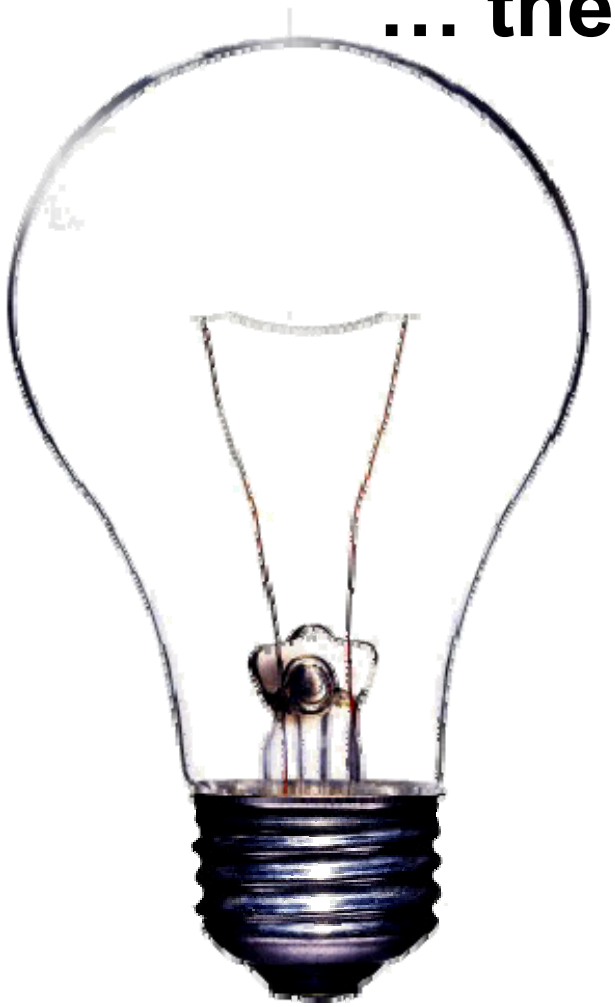




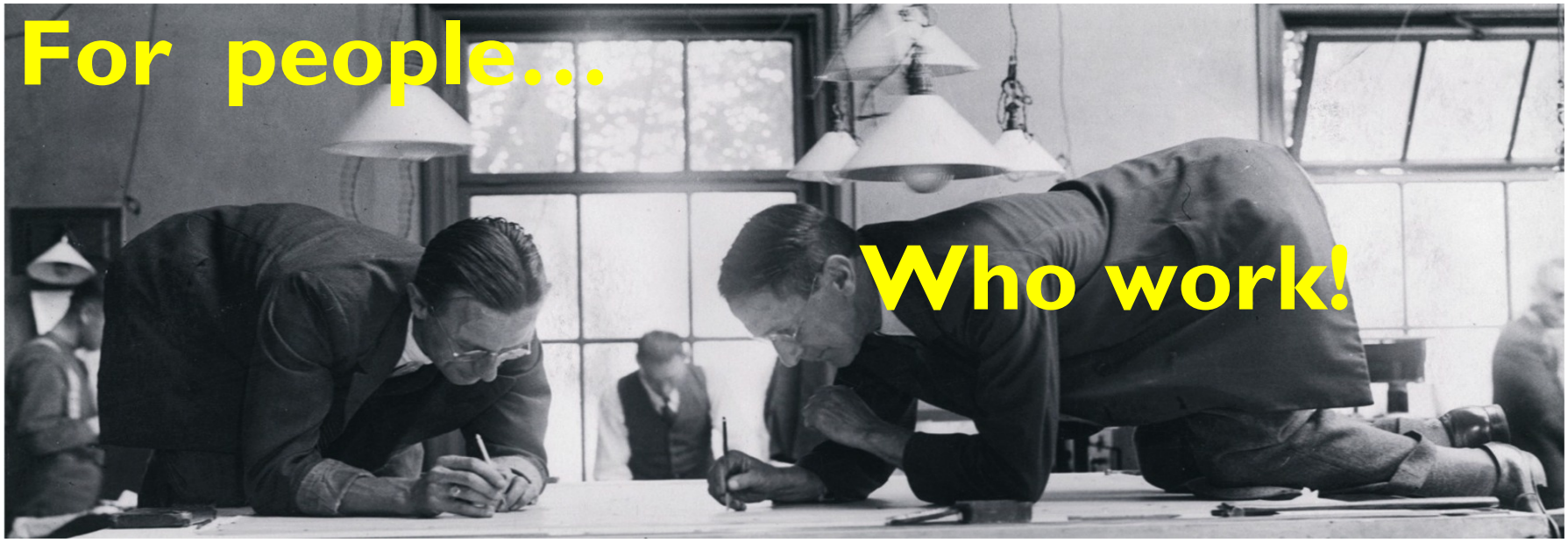


MORE THAN A HUNDRED YEARS AGO…

… there was an idea,



Let's make light !

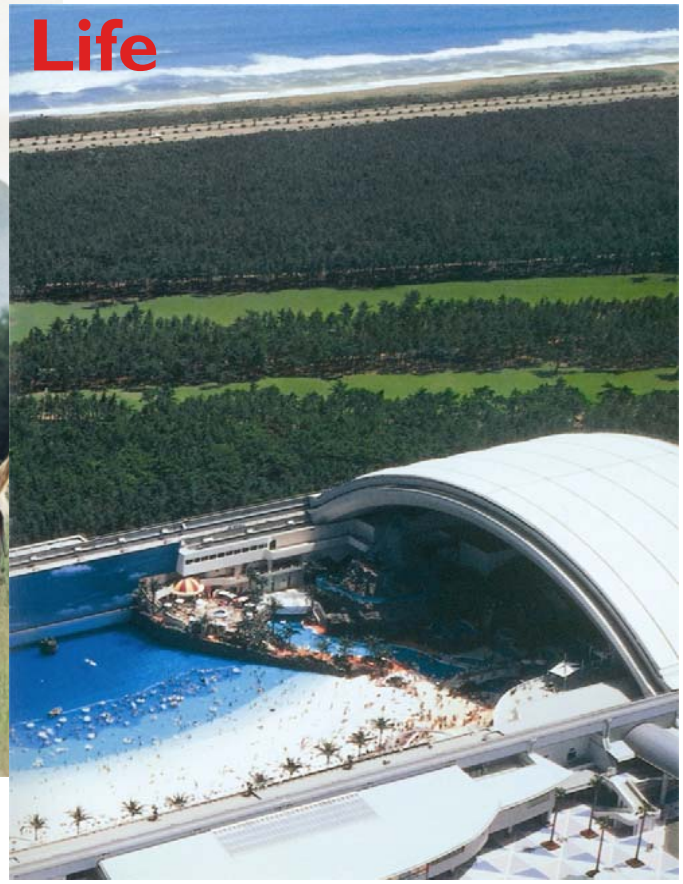

For people…
Who work!



TODAY EVERYTHING HAS CHANGED.



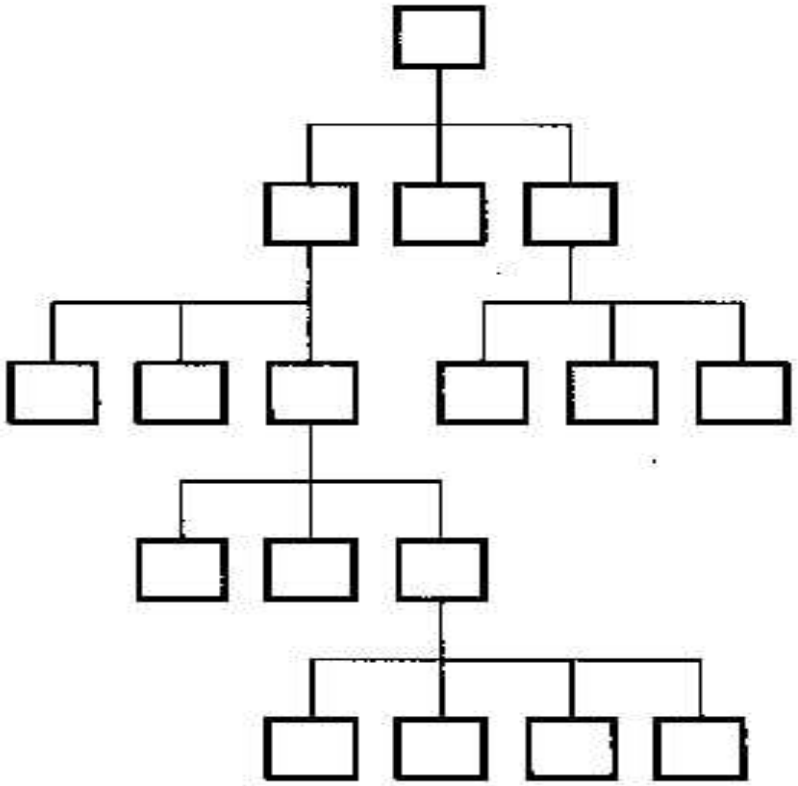


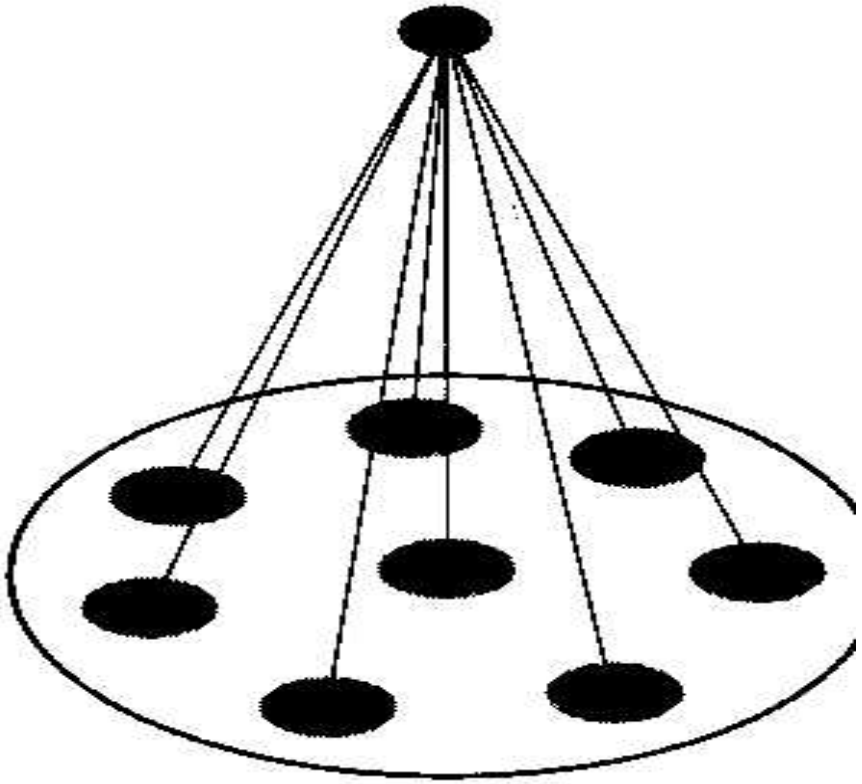


New Trends in offices

Changing organisations

- A change from a hierarchical organisation towards a more flat organisation
- The employee gets more responsibility!

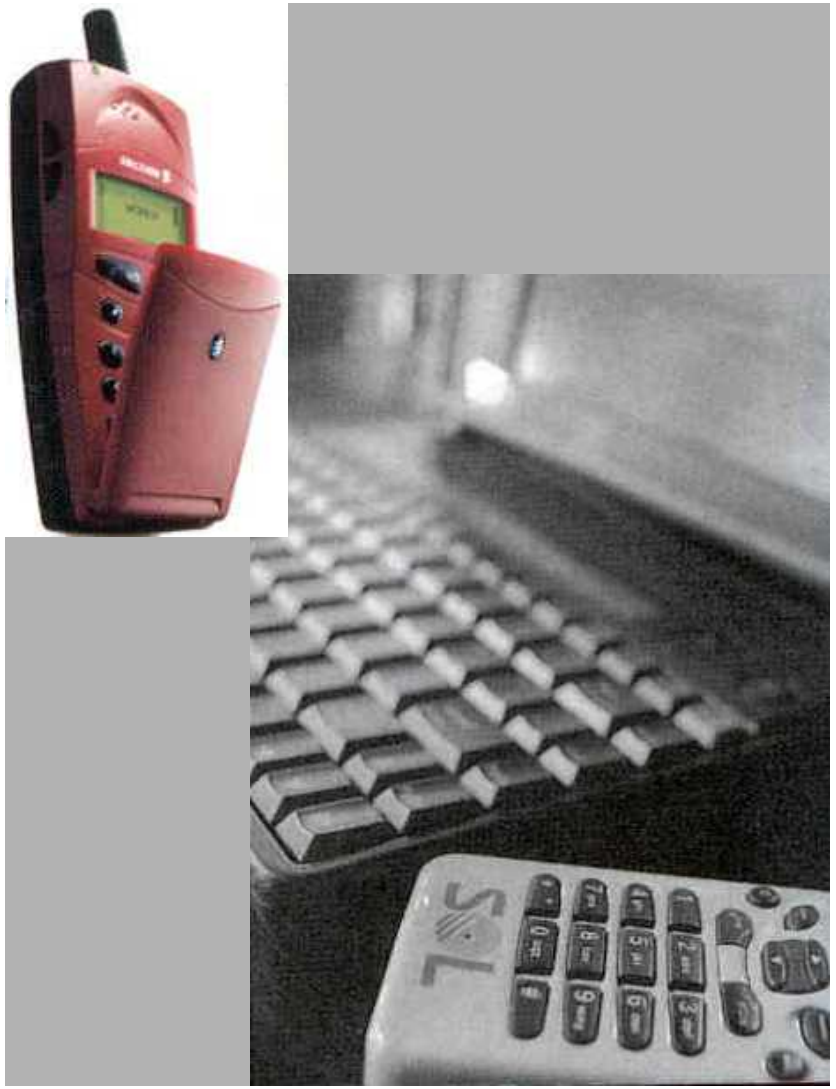




New Trends in offices

Where to work today?

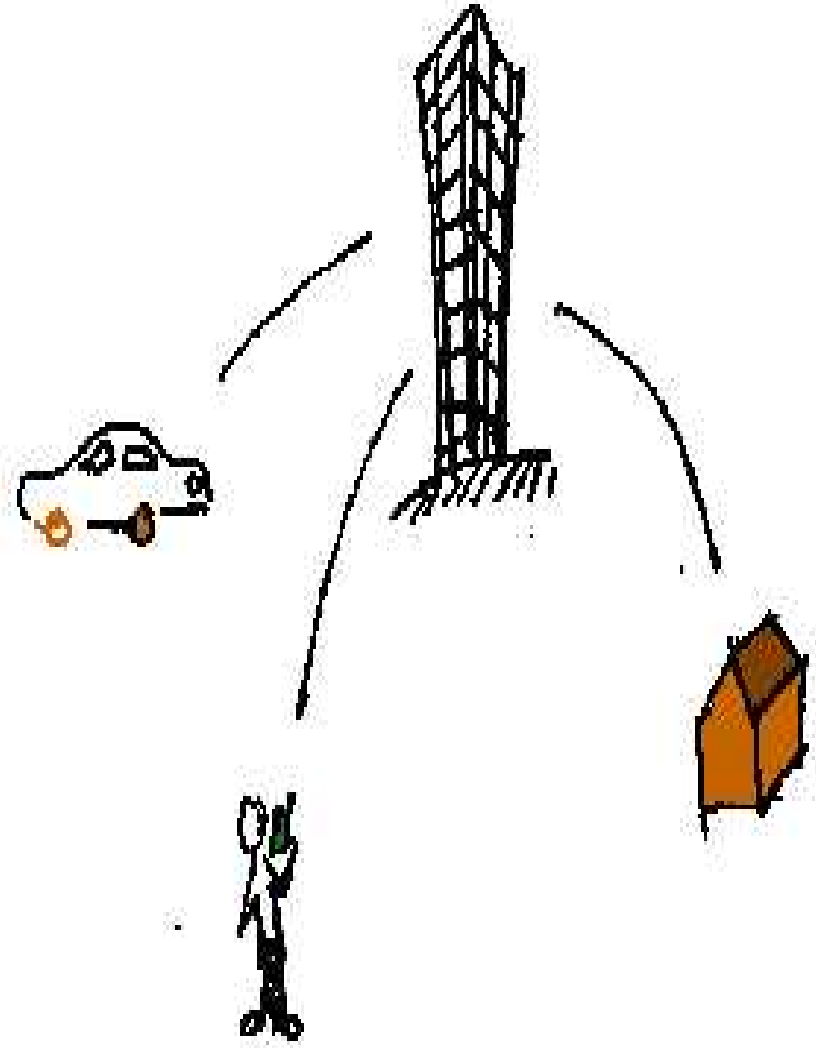
- Office work can be done anywhere
- Employee less dependent on permanent workplace
- Bring work to home or home to work
- Daily routine changes
- We will adapt our lives and way of working to this change
- Create own intimate place within office



New Trends in offices

New Offices

- The office will be the place to come together and to share the collective vision
- Place for teamwork and meetings



New Trends in offices

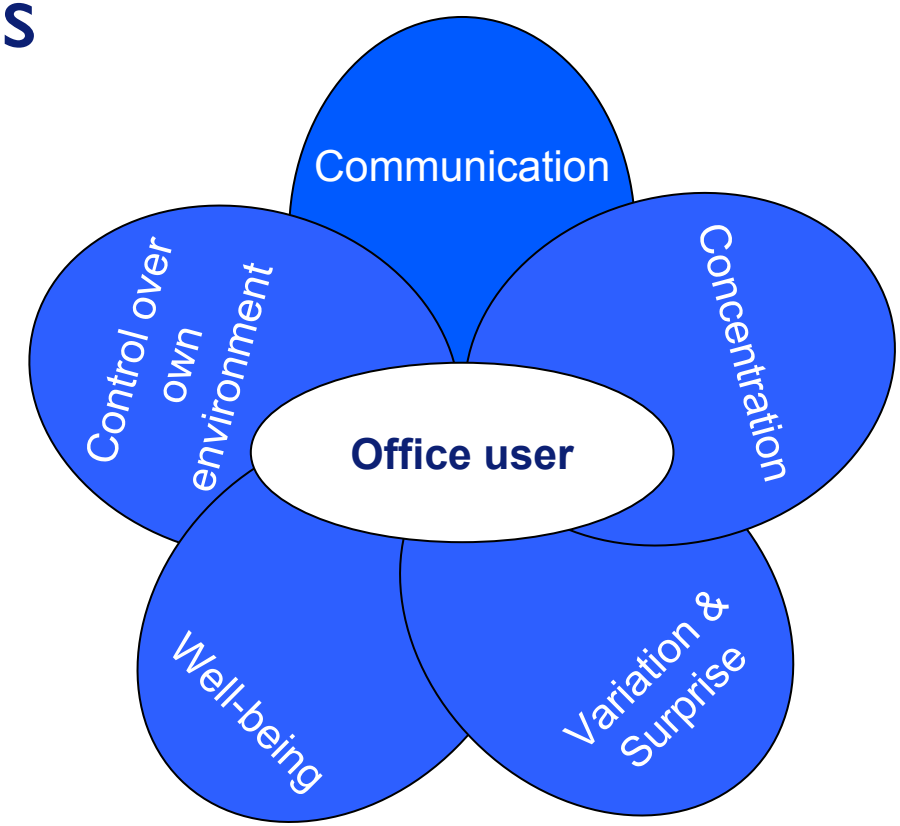
New way of working

- Team working
- Office like home
  - *home office*
  - *tele-work*
  - *flexible working hours*
- Work stations
  - *flexible/ adaptable*
  - *working in workstations*
  - *from desktop to laptop via palmtop to backdrop*



New Trends in offices

Focus on the office user and his needs



Needs of the office user



Direct

Contacts with customers

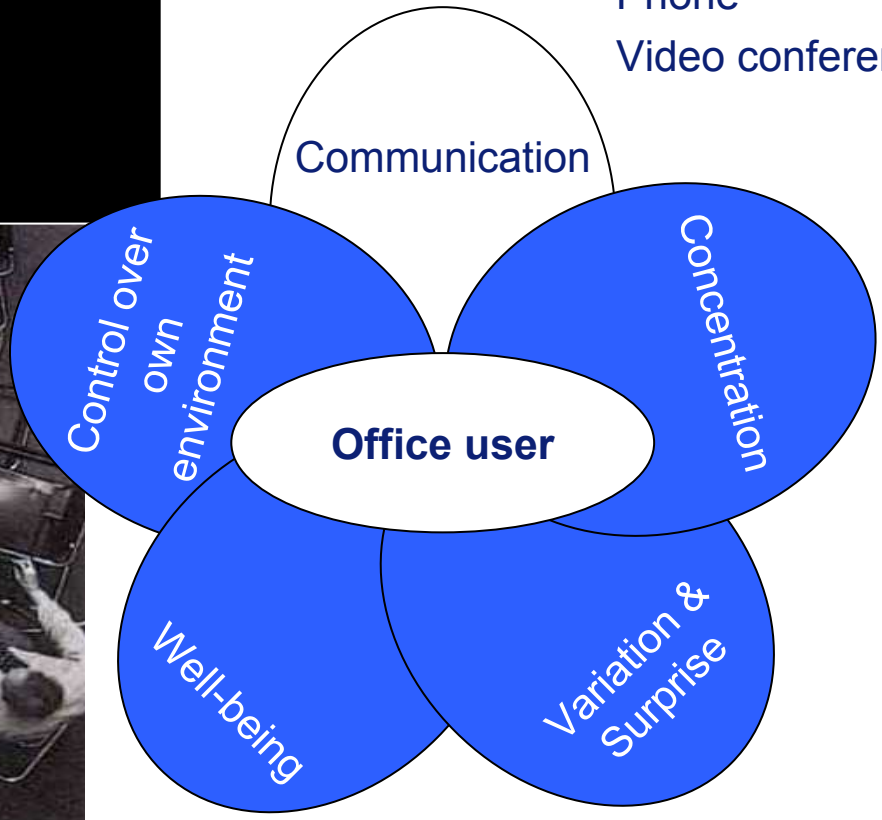
Contacts with colleagues

Indirect

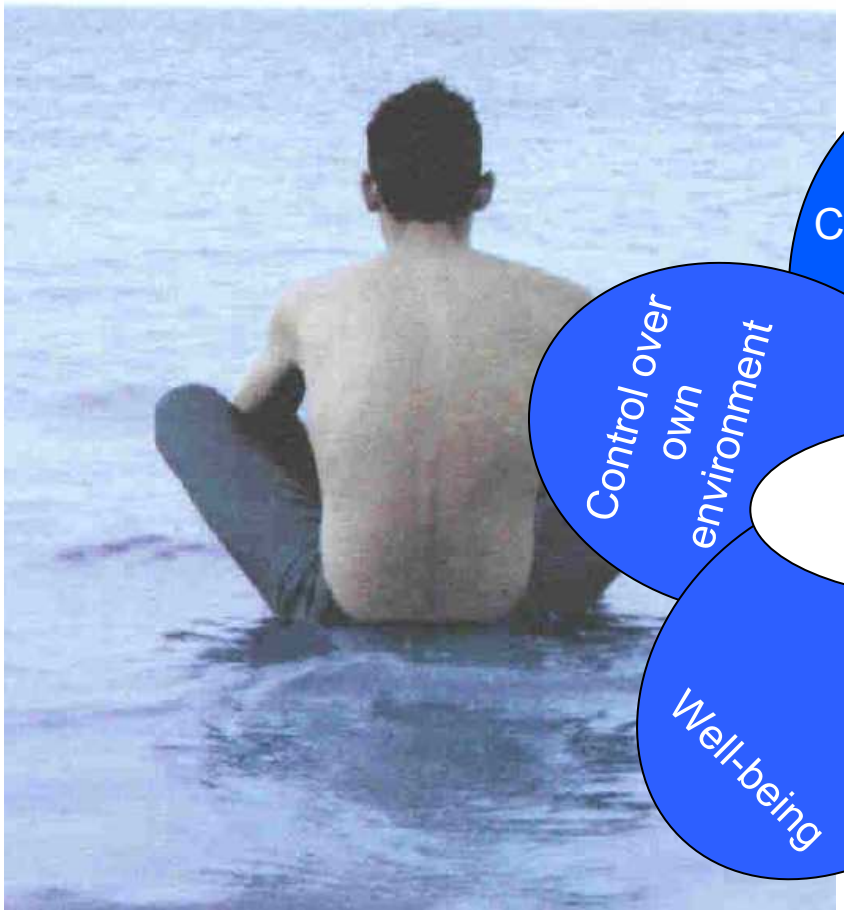
Computer network

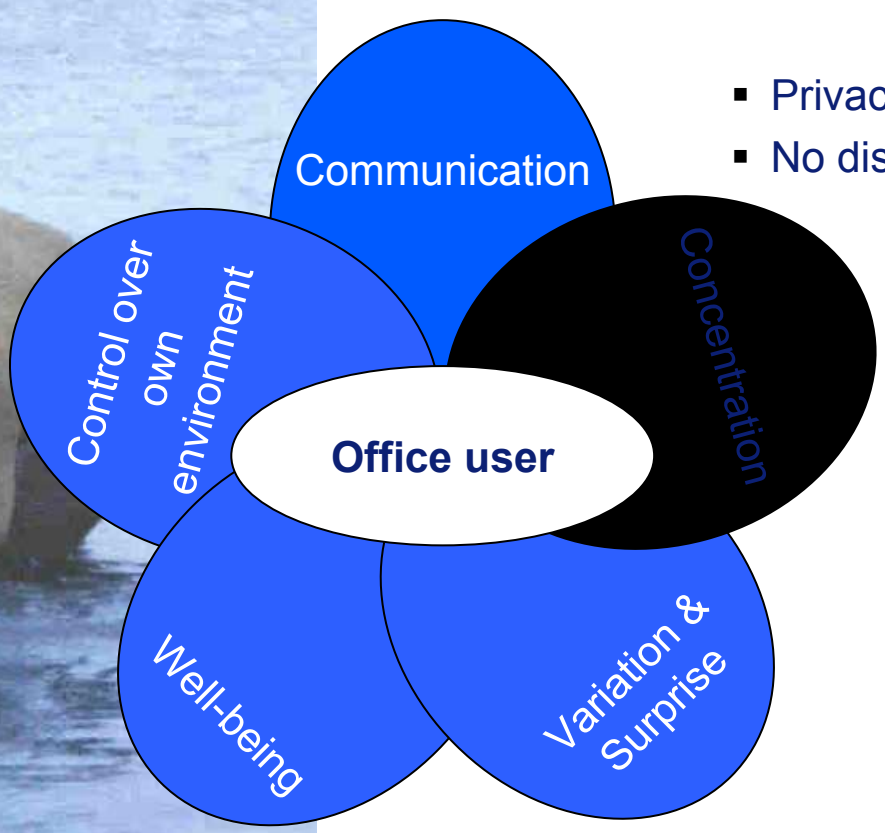
Phone

Video conferencing



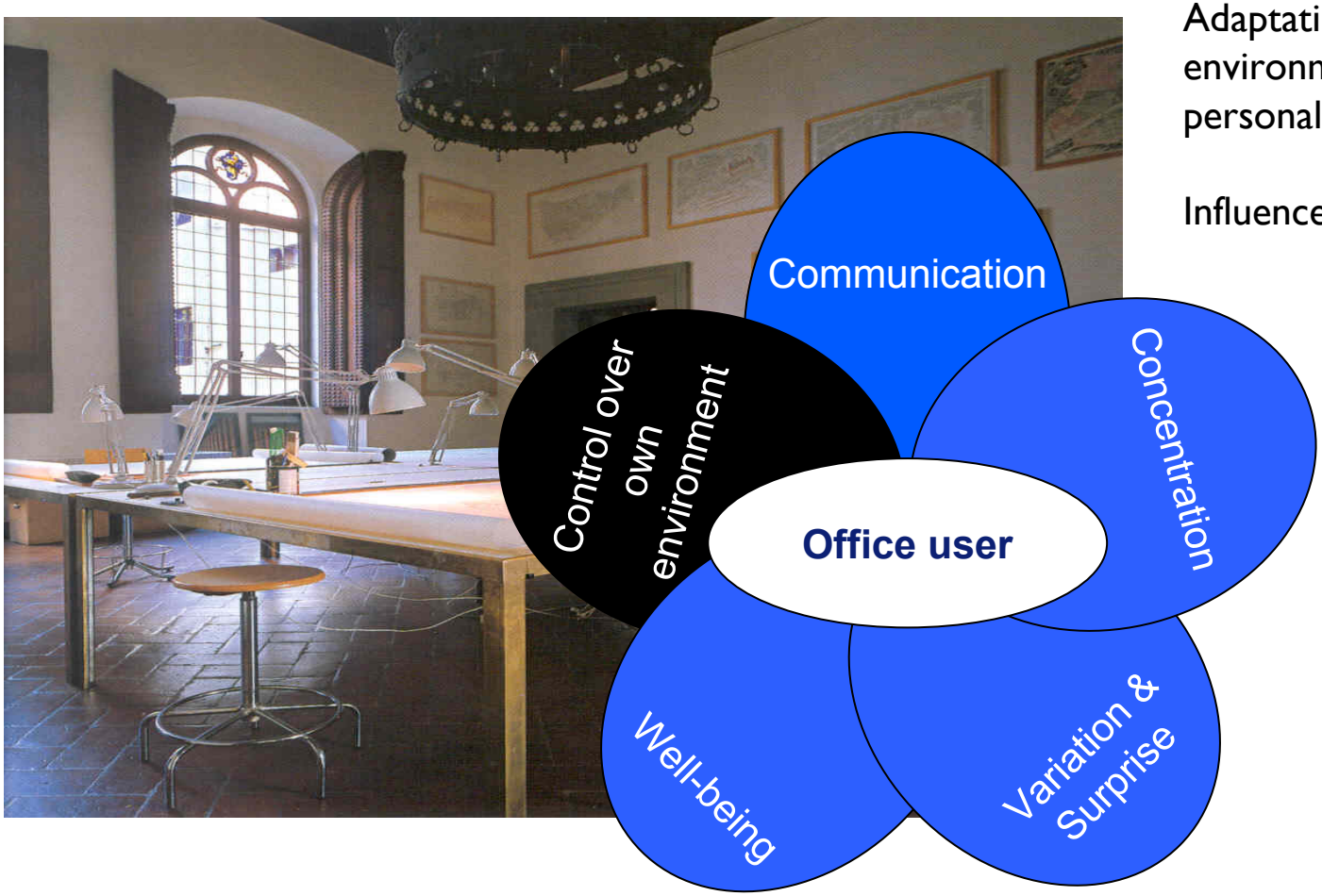
Needs of the office user





- Privacy
- No disturbance

Needs of the office user



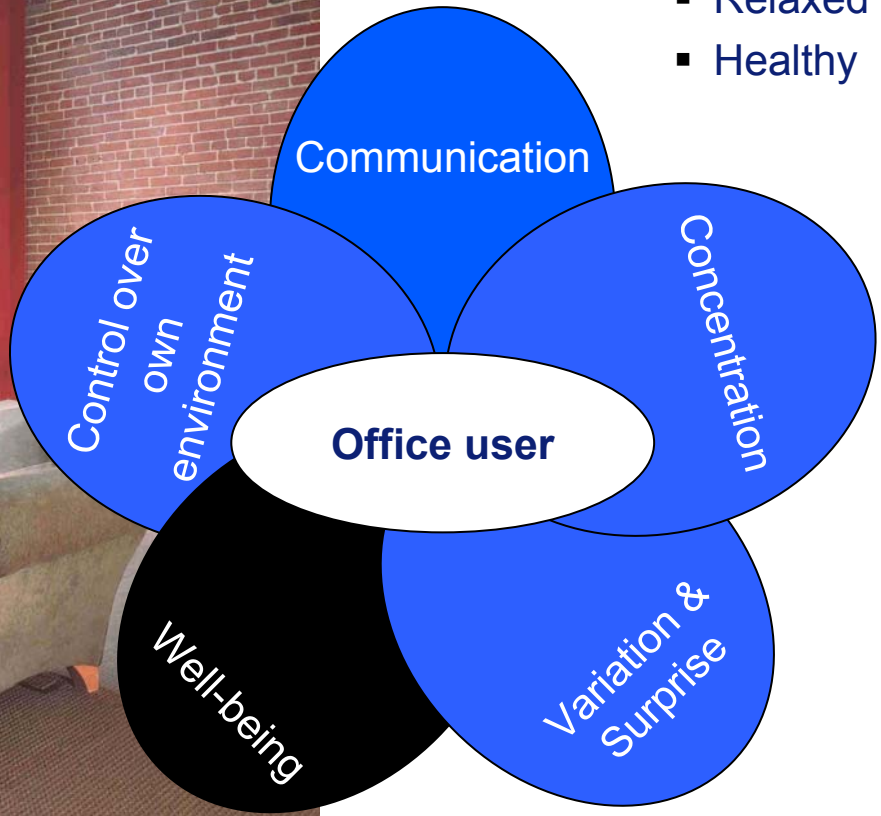
Adaptation of own environment to personal whishes

Influence on ambience

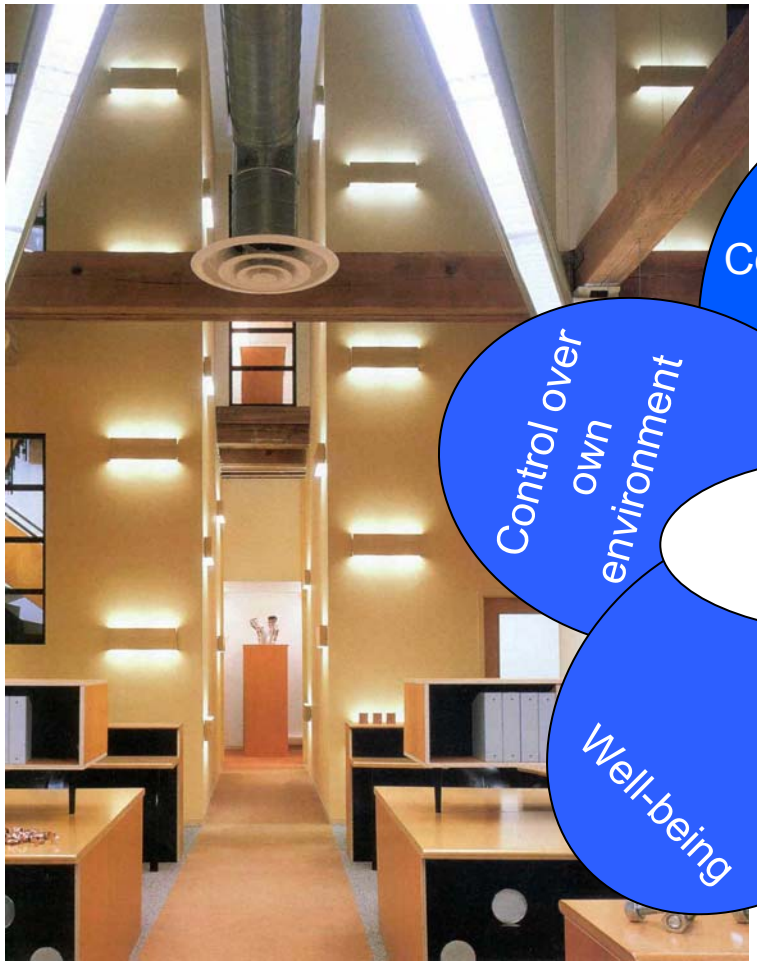
Needs of the office user

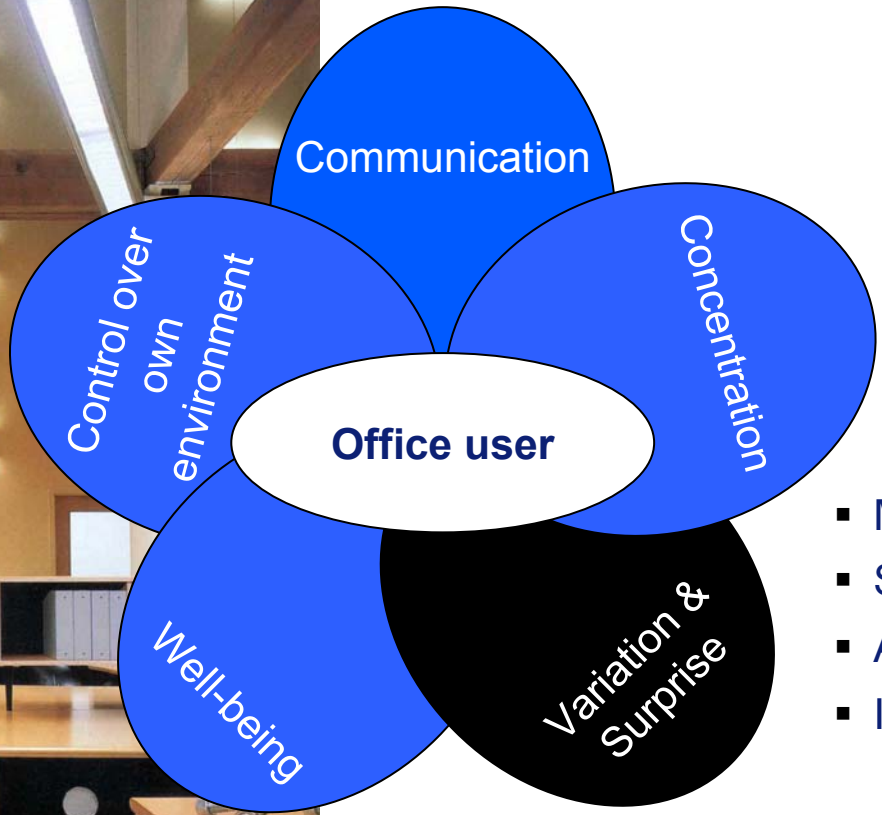


- Feel at ease
- Relaxed
- Healthy



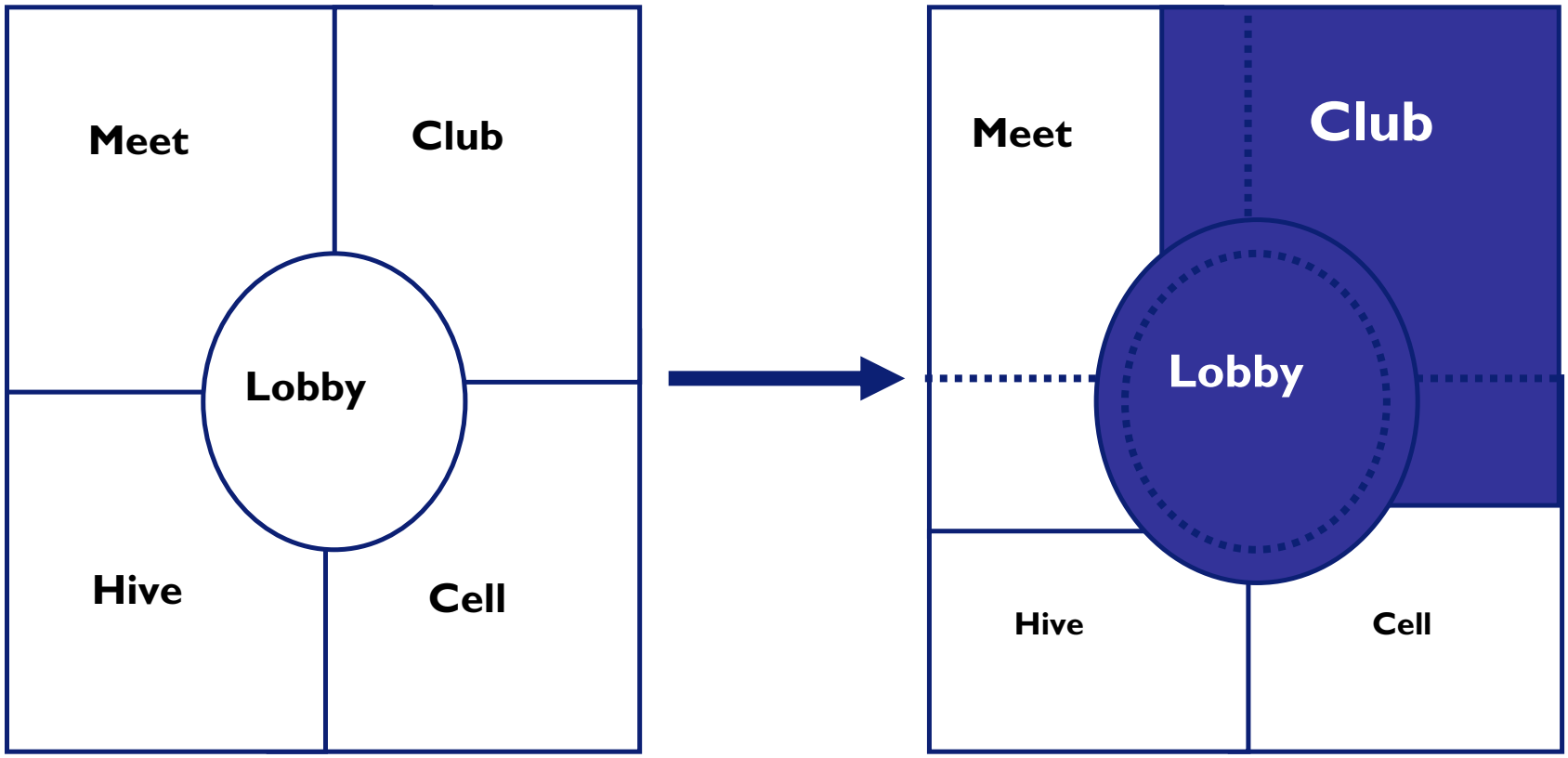
Needs of the office user





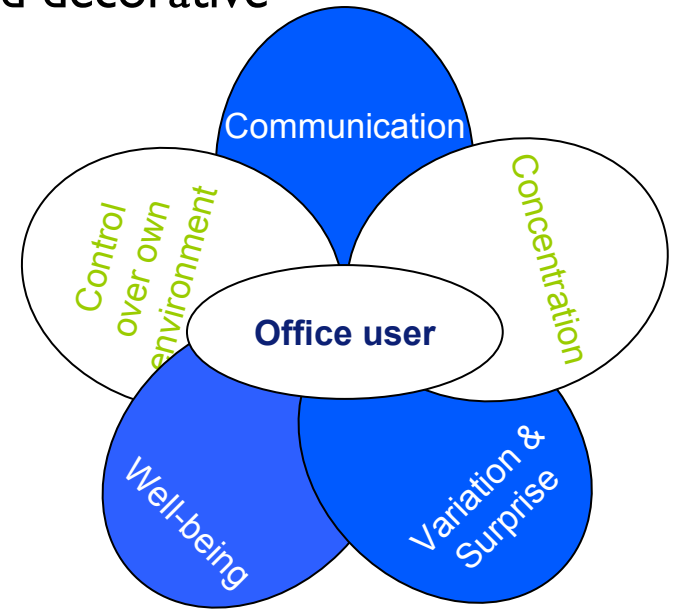
- Motivation
- Stimulation
- Activation
- Inspiration

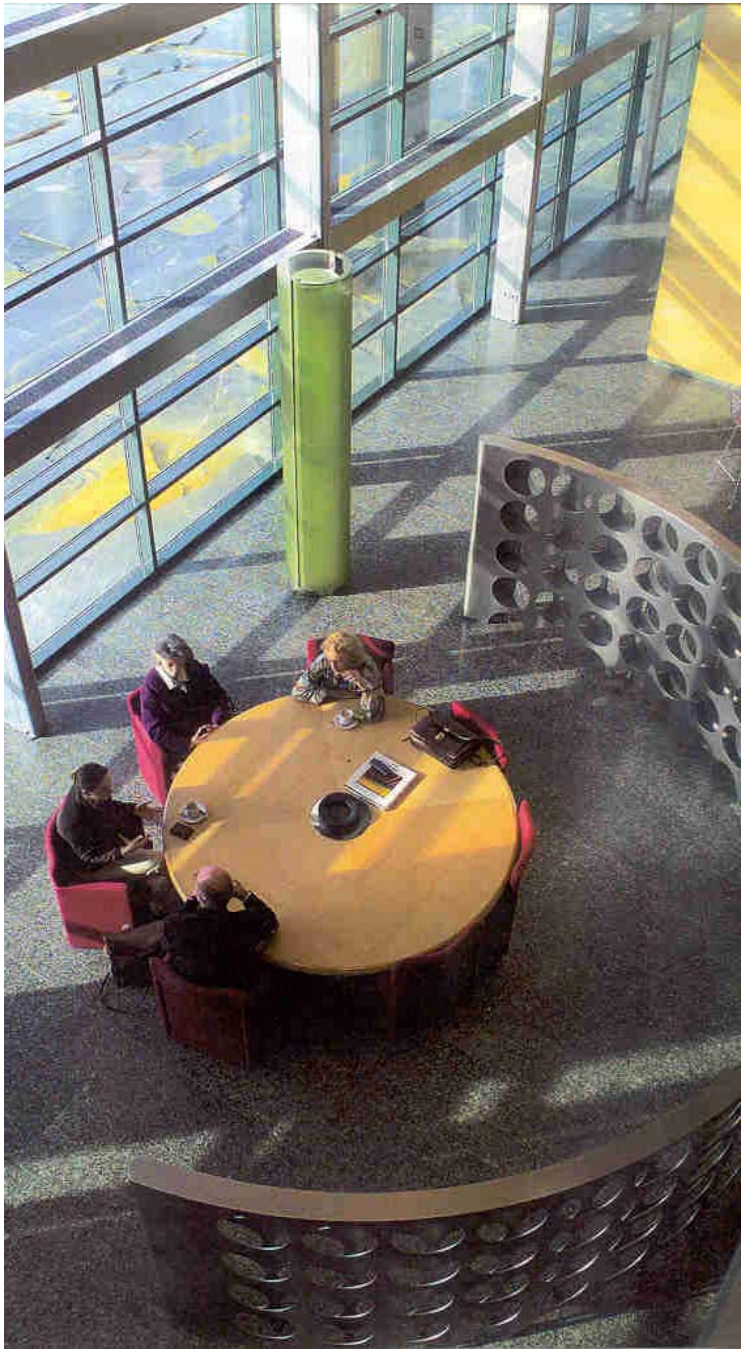
New Trends in offices



Lobby

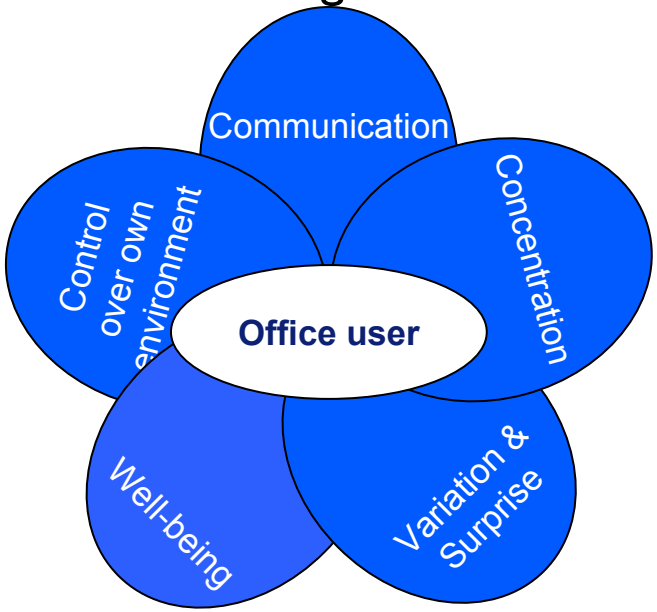
- The *Heart* of the organization
- Openness
- Identity and image
- Dynamics
- Ornamental and decorative





Club

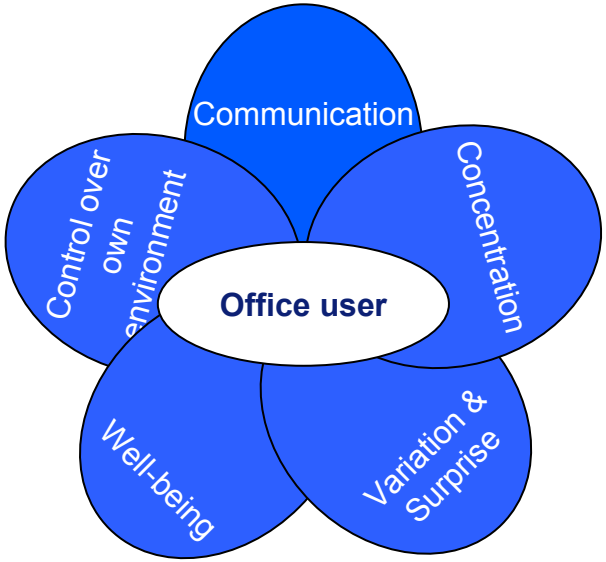
- The *Soul* of the organization
- Privacy and transparency
- Reference to domestic elements
- Individual
- High quality materials & finishing





How can lighting contribute to these needs?

Create a stimulating working environment.



A stimulating working environment means:

- **Contact with the outside world**
  People like the dynamics of day light
- **Privacy and flexibilityy**
  Different people have different preferences in lighting. So, flexibility in light level and color.
- **Comfort**
  Lighting that makes you feel at ease.
- **Emotion**
  People like surprising light effects. It stimulates, activates, and motivates..

SS 531-2006: Code of Practice for Lighting of Work Places Part 1 – Indoor Lighting

- Good lighting will create a
  - visual environment that enables people to see,
  - to move about safely
  - to perform visual tasks
    - efficiently, accurately and safely without causing undue visual fatigue and discomfort.
- This CP specify for various work places and task types
  - Illuminance E
  - limiting discomfort glare
  - Light source minimum colour rendering Ra
  - Parameters to create comfortable visual conditions are proposed in the body of this CP

SS 531-2006: Code of Practice for Lighting of Work Places Part 1 – Indoor Lighting

- The recommended values are considered to represent a reasonable balance,
  - safe, healthy and efficient work performance.
  - values can be achieved with practical energy efficient solutions.
  - ergonomic parameters such as perceptual ability
  - characteristics and attributes of the task, which determine the quality of the operator's visual skills, and hence performance levels.

- In some cases enhancement of these influencing factors can improve performance without the need to raise illuminance.
  - For example by improving the contrast of the task attributes
  - enlarging the task by the use of up to date visual aids (glasses)
  - provision of special lighting systems with local directional lighting capability.

SS 531-2006: Code of Practice for Lighting of Work Places Part 1 – Indoor Lighting

Lighting design criteria

- **Lighting environment**
  - **Luminous environment**
  - **Luminance distribution**
  - **Illuminance levels**
  - **Maintenance factor**
- **Glare**
  - **Direct glare**
  - **Indirect glare - Lighting for workstations**
- **Directionality**
- **Colour aspects**
- **Energy considerations**
- **Daylight**
- **Maintenance**
- **Emergency lighting**

SS 531-2006: Code of Practice for Lighting of Work Places
Part 1 – Indoor Lighting

Definitions **Luminous environment**

Lighting requirements are determined by the satisfaction of three basic **human** needs:

- **Visual comfort** (mainly task)
- **Visual environment** (mainly surrounding, space)
- **Safety**

SS 531-2006: Code of Practice for Lighting of Work Places
Part 1 – Indoor Lighting

Definitions Luminous environment

Luminance distribution is determined by:

- Reflectance of surfaces
- Illuminance of surfaces

	Useful reflectance	Min. – Max.
– Ceiling	0.7	0.6 – 0.9
– Wall	0.5	0.3 – 0.8
– Working plane	0.6	0.2 – 0.6
– Floor	0.3	0.1 – 0.5

Lighting requirements

Office lighting requirements change from:

Fixed uniform illuminance levels on the working plane, for different types of areas (CIE)

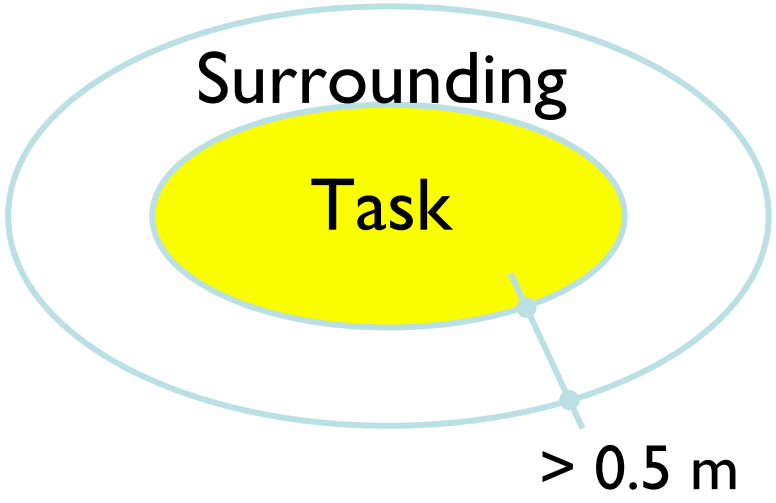
to

Variable and/or dynamic, zoned lighting that is derived from human needs, well being, the task, and the perception of the space (CEN)

SS 531-2006: Code of Practice for Lighting of Work Places
Part 1 – Indoor Lighting

Definitions **Task and surrounding area**

Task area (any shape and slope) and **surrounding area**



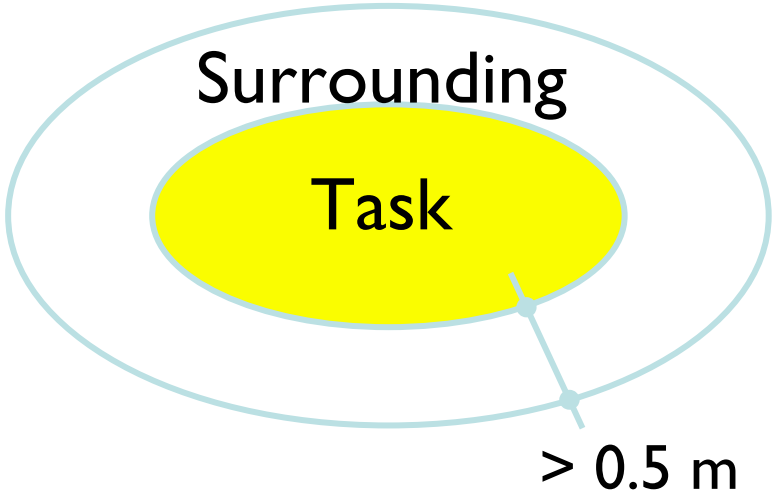
If task area is unknown:

where task MAY occur

SS 531-2006: Code of Practice for Lighting of Work Places
Part 1 – Indoor Lighting

Definitions **Task and surrounding areas**

Task / Surrounding area



- Illuminance

Task	Surrounding
≥ **750 lux**	**500 lux**
500 lux	**300 lux**
300 lux	**200 lux**
≤ **200 lux**	**200 lux**

- Uniformity (E_{min}/E_{ave})

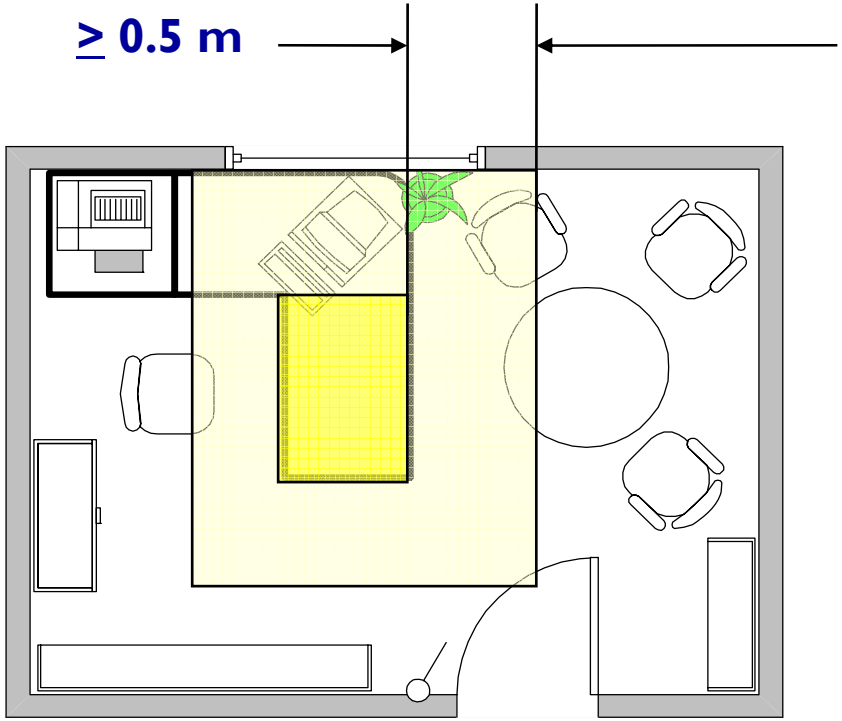
Task	Surrounding
≥ 0.70	≥ 0.50

SS 531-2006: Code of Practice for Lighting of Work Places

Part 1 – Indoor Lighting

Definitions **Task and surrounding areas**

Task / Surrounding area



- Maintained illuminance

Task	Surrounding
≥ 750 lux	500 lux
500 lux	**300 lux**
300 lux	200 lux
≤ 200 lux	E_{task}

- Uniformity (E_{min}/E_{ave})

Task	Surrounding
≥ 0.70	**≥ 0.50**

Continuously occupied areas: > 200 lux

Lighting design criteria

3. Illuminance - Scale of illuminance

- A factor of approximately 1,5 represents the smallest significant difference in subjective effect of illuminance. In normal lighting conditions approximately 20 lux of horizontal illuminance is required to just discern features of the human face and is the lowest value taken for the scale of illuminances.
- The recommended scale of illuminance is:
- 20 - 30 - 50 - 75 - 100 - 150 - 200 - 300 - 500 - 750 - 1000 - 1500 - 2000 - 3000 - 5000 lux.

Lighting design criteria

3. Illuminance - of immediate surroundings

- The illuminance of immediate surrounding areas shall be related to the illuminance of the task area and should provide a well-balanced luminance distribution in the field of view.

- Rapid spatial changes in illuminances around the task area may lead to visual stress and discomfort.

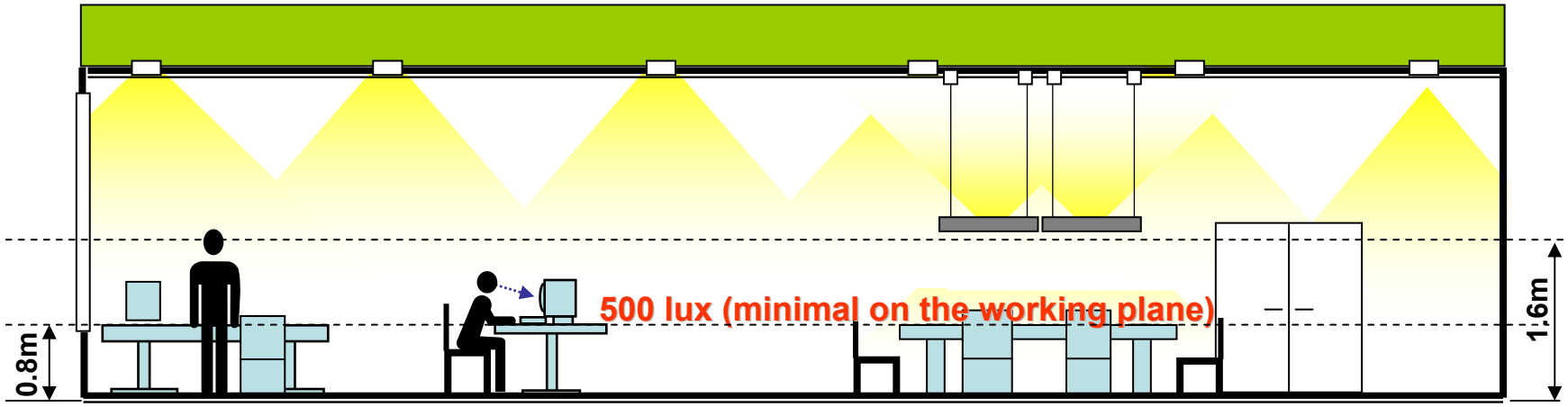
- Maintained illuminance of the immediate surrounding areas < task illuminance but shall not be less than the values given in the table below.

Task illuminance lux	Illuminance of immediate surroundings lux
≥ 750	500
500	300
300	200
≤ 200	Same as task illuminance

- In addition to the task illuminance the lighting shall provide adequate adaptation luminance in accordance with clause 4.2.

Lighting requirements (Traditional)

Previous Approach - lighting requirements for offices (CIE)

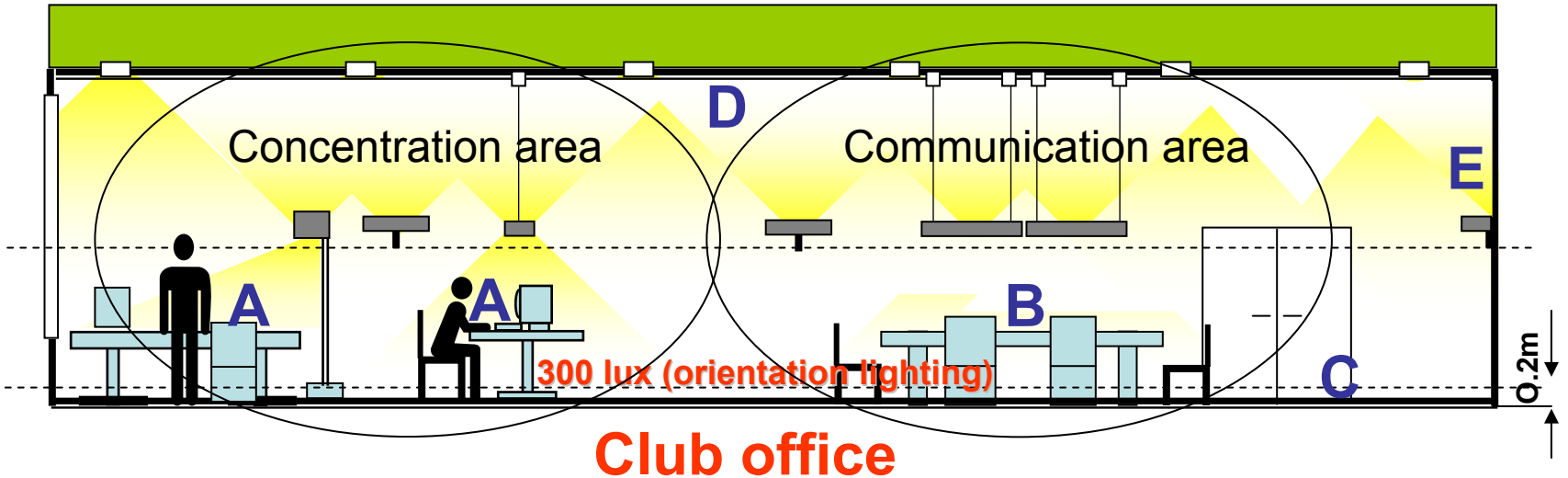


Former approach (Space related)

Average illuminance levels on the working plane

filing, copying, circulation areas	300 lux
writing, typing, reading, data processing areas	500 lux
technical drawing offices	750 lux
CAD work stations	500 lux
conference and meeting rooms	500 lux
reception desk areas	300 lux
archives	200 lux

Direction **Lighting requirements**



Club office

Individual task

TASK - concentration zone (A)
- Lighting level : 300-1000 lux
- Colour Temp. : 3000-5000K
- Colour rendering: 80-100
- Glare restriction :<1000cd/m²/65⁰
- uniformity :>0.7 (task area)
- Beam shape : triangle or asym

TASK - Communication zone (B)
- Lighting level : 300-1000 lux
- Colour Temp. : 3000-5000K
- Colour rendering: 80-100
- Glare restriction :No direct glare
- uniformity :> 0.5 (table)
- Beam shape : wide beam

Control
switching steps

Collective space

ROOM - Floor (C)
- Lighting level : > 300 lux (hor.)
- Colour Temp. : 3000-4000K
- Colour rendering: 80-100
- Glare restriction : -
- uniformity : > 0.3
- Beam shape : -

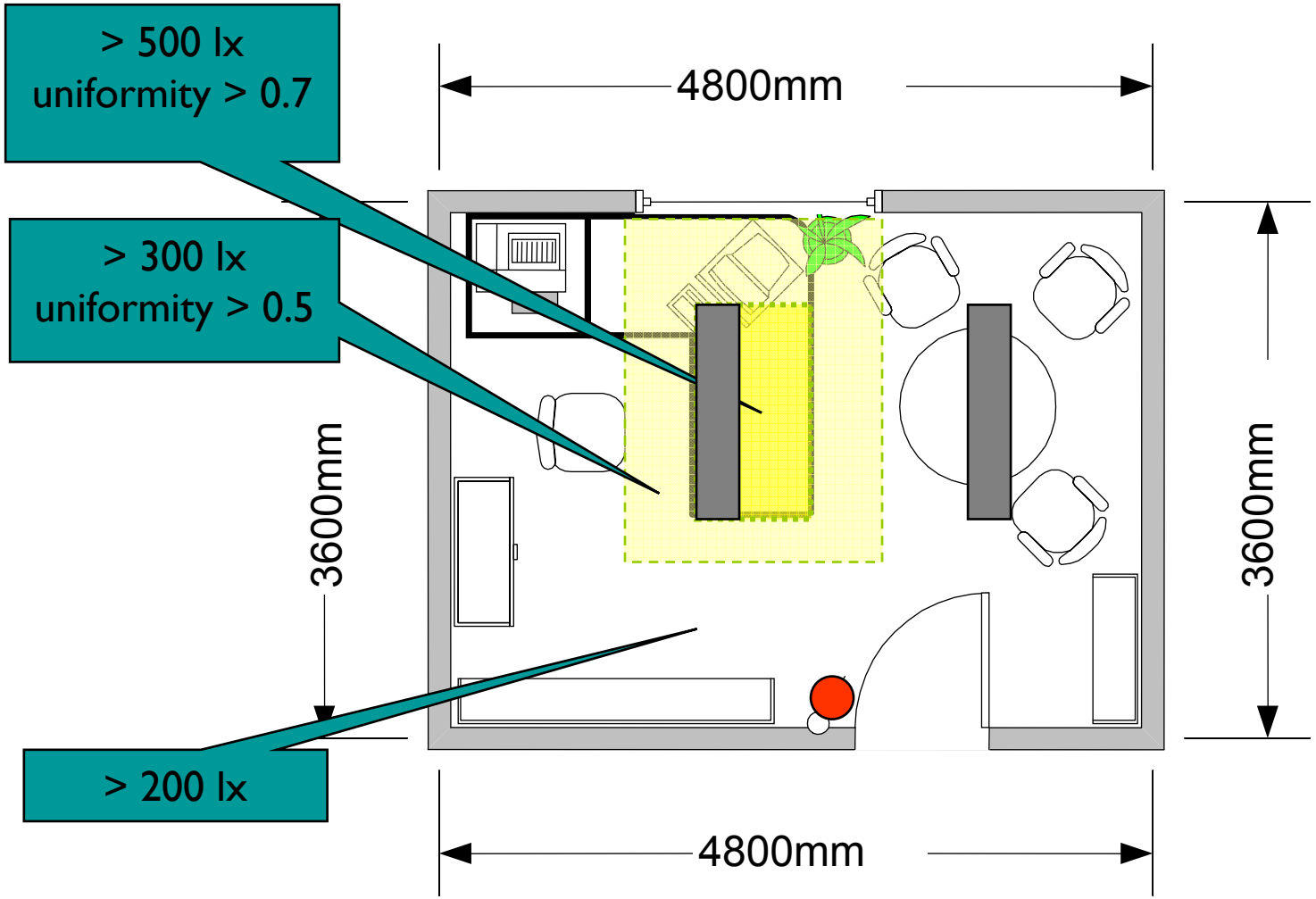
ROOM - Ceiling (D)
- Lighting level : > 150 lux
- Colour Temp. : 3000-4000K
- Colour rendering: 80-100
- Glare restriction : -
- uniformity : > 0.5
- Beam shape : -

ROOM - Walls (E)
- Lighting level : > 200 lux (Vert.)
- Colour Temp. : 3000-4000K
- Colour rendering: 80-100
- Glare restriction : -
- uniformity : > 0.1
- Beam shape : -

Control
collectively controlled

Decorative elements
Variation & surprise
How often are the extremes applied?

SS 531-2006: Code of Practice for Lighting of Work Places
Part 1 – Indoor Lighting
Example Office Lighting



SS 531-2006: Code of Practice for Lighting of Work Places

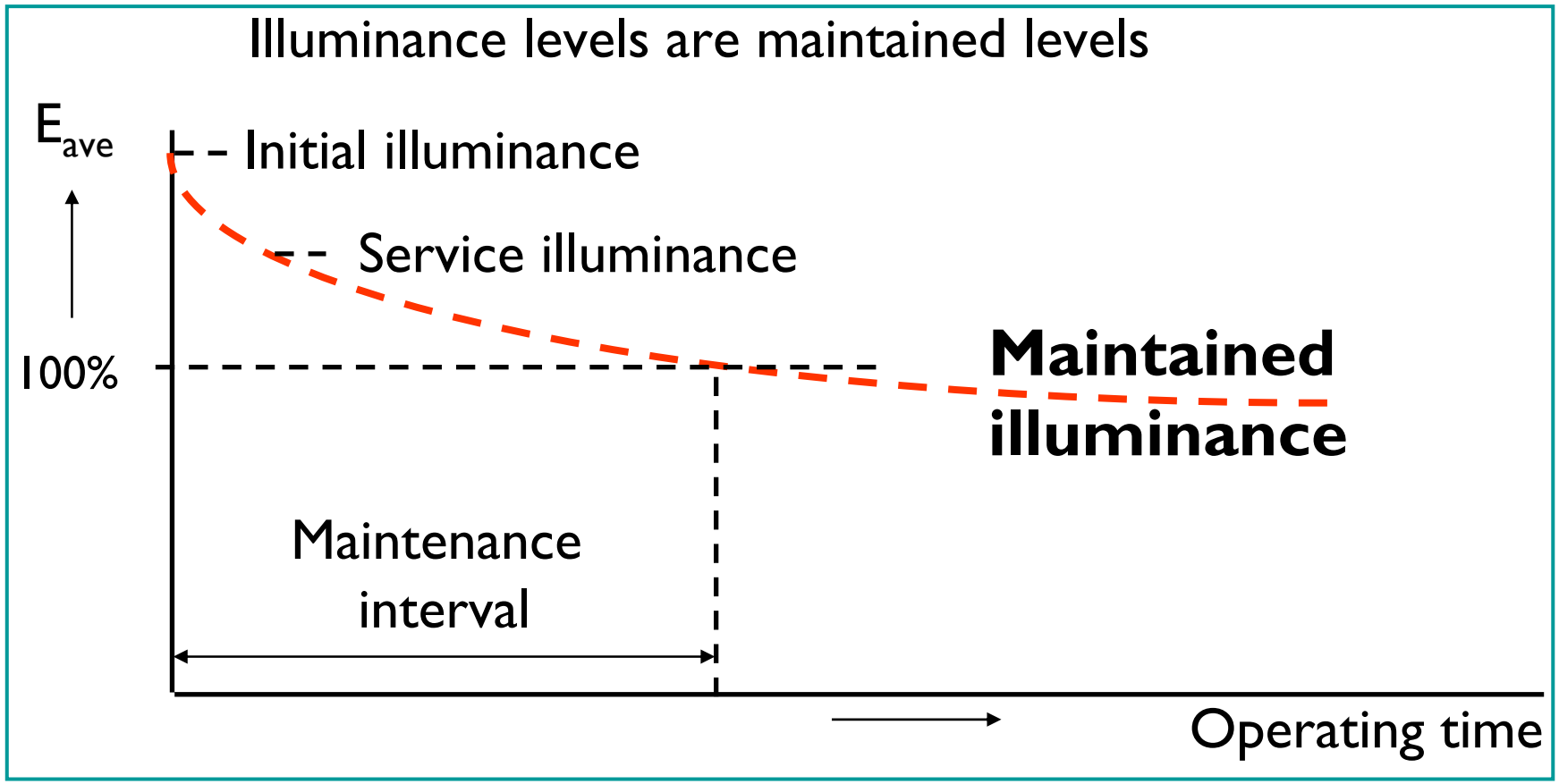
Part 1 – Indoor Lighting

Definitions **Luminance distribution**

- **Consequences:**
  - Close interaction with future user (or general approach)
  - Project layout need to be known
  - Detailed lighting calculations required
- **Opportunities**
  - More detailed lighting advise required
  - Advanced detailed lighting installations to meet clear task area specifications
  - Or: General design for total area

SS 531-2006: Code of Practice for Lighting of Work Places
Part 1 – Indoor Lighting

Definitions **Maintenance factor**



SS 531-2006: Code of Practice for Lighting of Work Places
Part 1 – Indoor Lighting

Definitions **Maintenance factor**

- **Consequences:**
  - Clear definitions in planning with respect to lamp (luminaire and room) maintenance
  - Higher initial values

- **Opportunities**
  - Marketing of constant illuminance lighting controls
  - Marketing of better performing lamps
  - Definition of maintenance schedule

SS 531-2006: Code of Practice for Lighting of Work Places Part 1 – Indoor Lighting

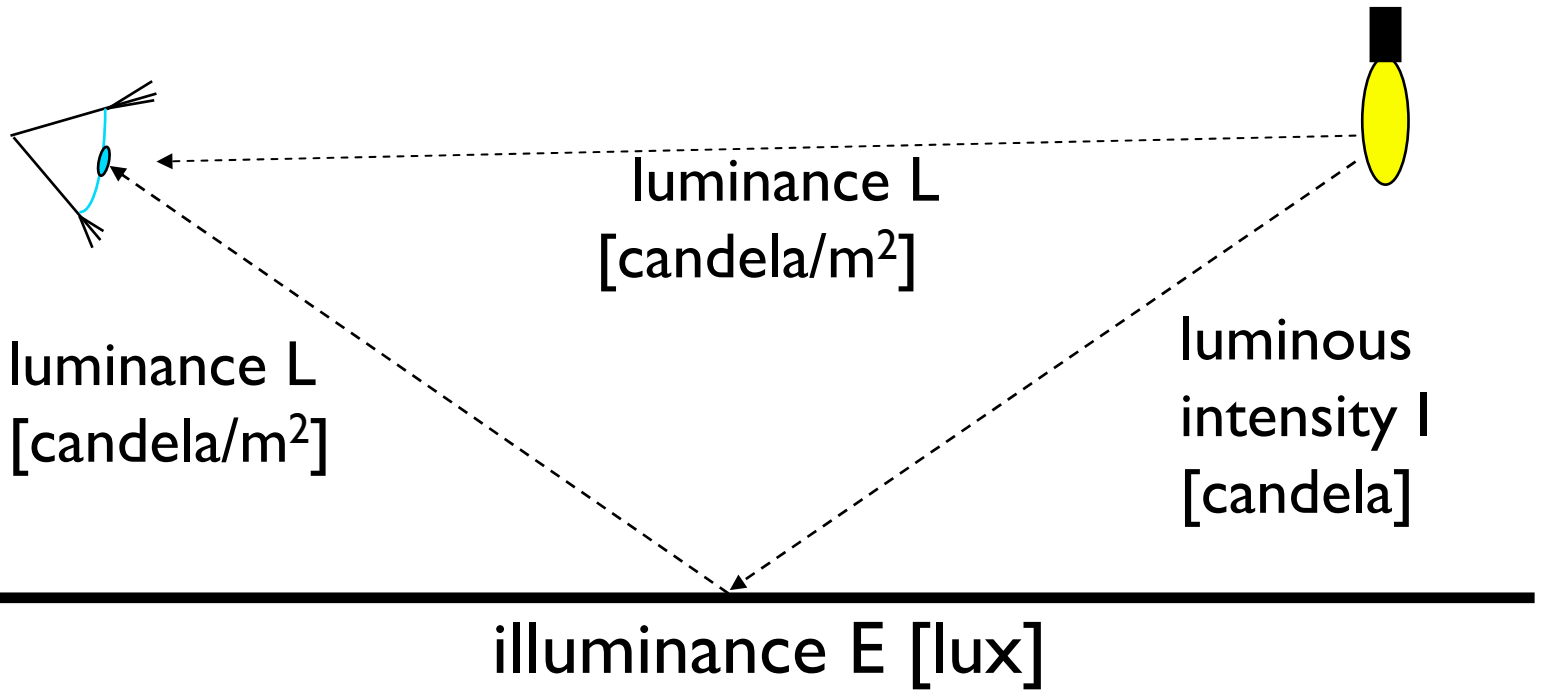
DIRECT AND INDIRECT GLARE

SS 531-2006: Code of Practice for Lighting of Work Places

Part 1 – Indoor Lighting

Definitions **(direct and indirect glare)**

- Luminance and illuminance



SS 531-2006: Code of Practice for Lighting of Work Places
Part 1 – Indoor Lighting

Definitions **(direct and indirect glare)**

- Illuminance E in lux: *measured / calculated*
- Luminance L in cd/m^2: *perceived*

$$L = \frac{E * \rho}{\pi} \text{ in } [cd/m^2]$$

- Examples: illuminance of 500 lux on:
- paper white surface (ρ = 90%) 143 cd/m^2
- cream-coloured desktop (ρ = 60 %) 95 cd/m^2
- grey floor (ρ = 20 %) 32 cd/m^2

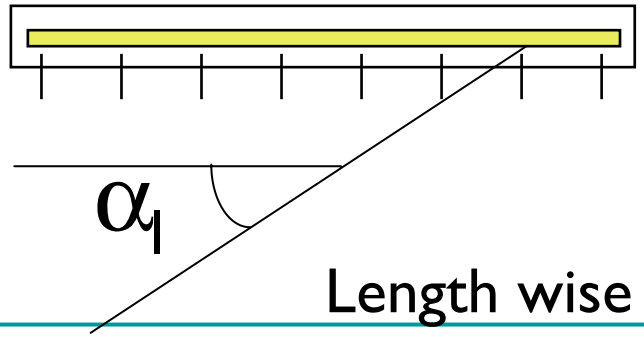
SS 531-2006: Code of Practice for Lighting of Work Places

Part 1 – Indoor Lighting

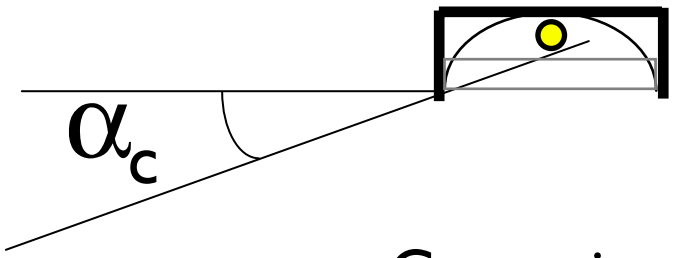
Definitions (direct glare)

Bright lamps should be screened off to prevent direct glare

Lamp luminance		Shielding angle
20 – 50 kcd/m^2		$\alpha > 15^0$
TLD	12 kcd/m^2	Open reflector allowed
TL5 HE	17 kcd/m^2	Open reflector allowed
TL5 80W	30 kcd/m^2	**Louvre required**
PL-L 55W	39 kcd/m^2	**Louvre required**



Length wise



Crosswise

SS 531-2006: Code of Practice for Lighting of Work Places
Part 1 – Indoor Lighting

Definitions **(direct glare)**

Minimum shielding angles at specified lamp luminance

Lamp luminance kcd/m^2	**Minimum Shielding angle**
20 to < 50	**15^0**
50 to < 500	**20^0**
≤ 500	**30^0**

SS 531-2006: Code of Practice for Lighting of Work Places

Part 1 – Indoor Lighting

Definitions **(Direct glare)**

- **Consequences:**
  - High output TL5 lamps and PL-L need a 15^0 louvre
  - Minimum shielding angle of $20\text{-}30^0$ for all HID lamps: change of optics design required (industry)

- **Opportunities**
  - More advanced luminaires for bright lamps

SS 531-2006: Code of Practice for Lighting of Work Places
Part 1 – Indoor Lighting
Definitions **(direct glare) UGR**

UGR

Complicated system to limit direct glare caused by the luminaires in the room

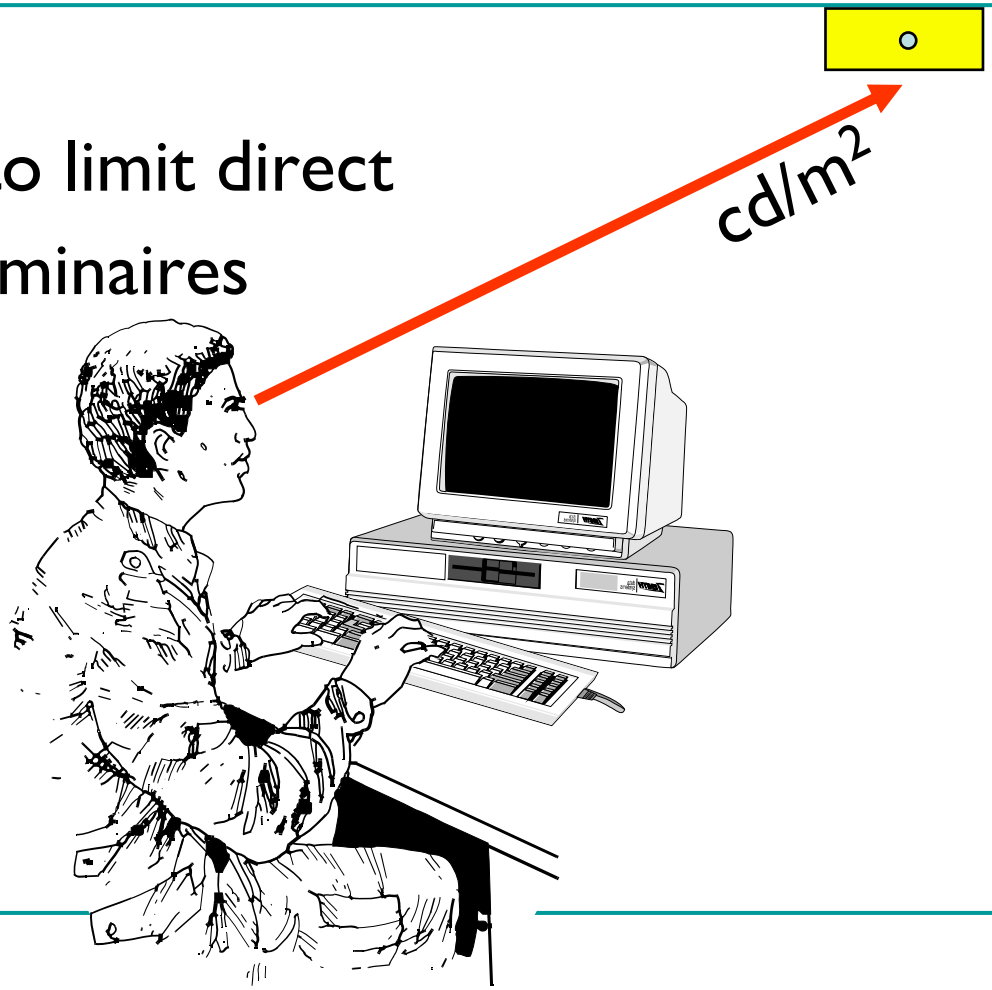


Table 5.3 — Offices

3	Offices				
Ref. no.	Type of interior, task or activity	$\bar{E}_m$ lx	UGR_L -	R_a -	Remarks
3.1	Filing, copying, etc.	300	19	80	
3.2	Writing, typing, reading, data processing	500	19	80	DSE-work: see clause 4.11.
3.3	Technical drawing	750	16	80	
3.4	CAD work stations	500	19	80	DSE-work: see clause 4.11.
3.5	Conference and meeting rooms	500	19	80	Lighting should be controllable.
3.6	Reception desk	300	22	80	
3.7	Archives	200	25	80	

Direct glare evaluation method

• Unified Glare Rating: Formula

- $UGR = 8 \log [\ 0{,}25/L_b \ \Sigma(L^2\ \omega / \ p^2)]$

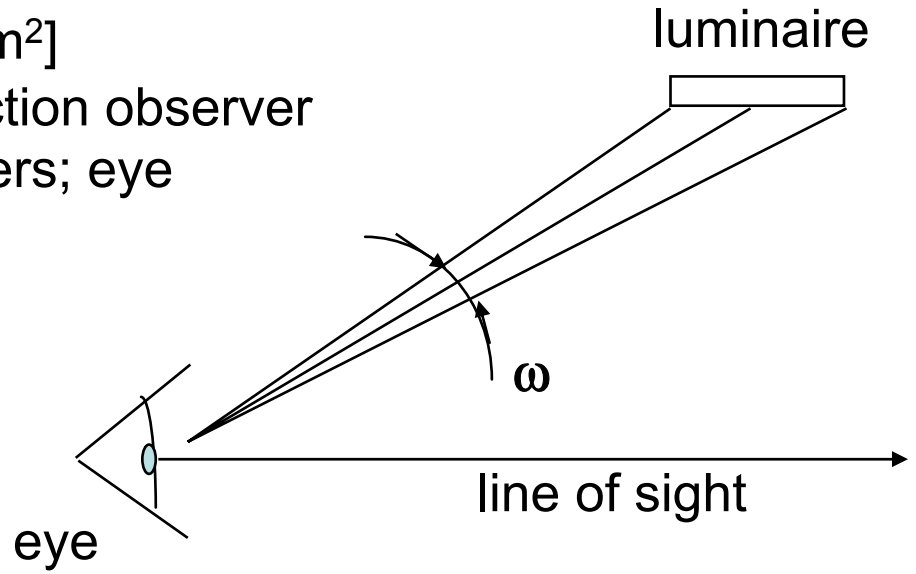
with

L_b background luminance [cd/m²]

L luminaire luminance in direction observer

ω solid angle luminaire at observers; eye

p position index



CIE 117 - 1995

SS 531-2006: Code of Practice for Lighting of Work Places

Part 1 – Indoor Lighting

Definitions **(direct glare) UGR**

UGR

- **Consequences:**
  - Rather severe Unified Glare Limits, especially for industry compared to today's practice
  - No significant difference for office applications, however, luminaire classification highly appreciated

- **Threats**
  - A lot of work for luminaire suppliers (mainly for industry)
  - Too complicated for specifiers/installers
  - Who can check the difference (in a project) afterwards?

SS 531-2006: Code of Practice for Lighting of Work Places Part 1 – Indoor Lighting

How does it work? (UGR)

SS 531-2006: Code of Practice for Lighting of Work Places

Part 1 – Indoor Lighting

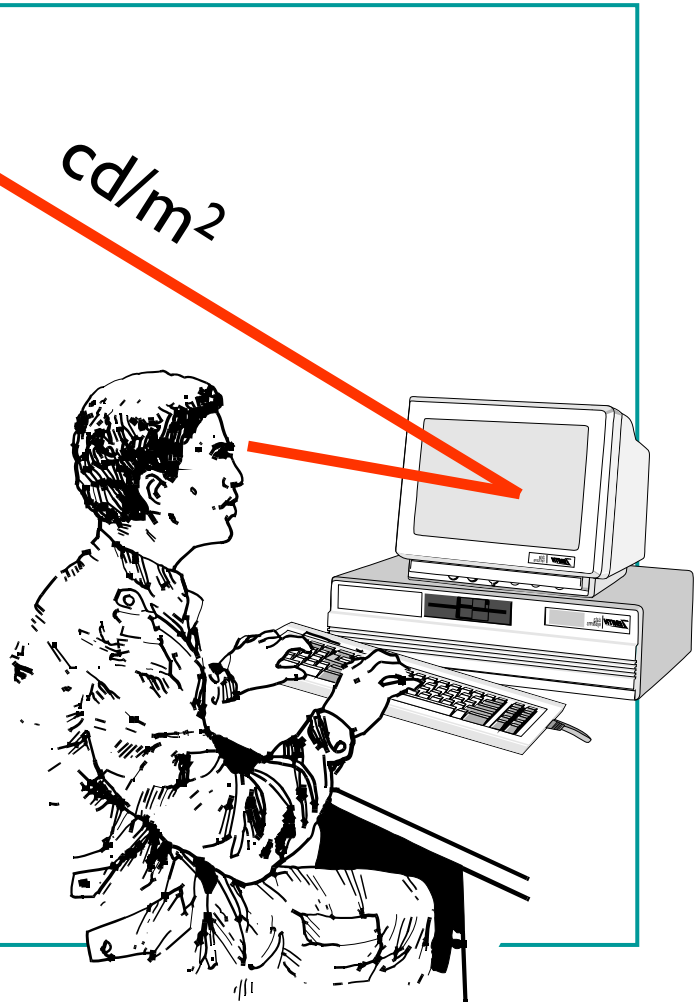
Definitions **(indirect glare)**

Luminance limits for luminaires which can be reflected in the screen

Two luminaire classifications:

- Screen quality good/medium < 1000 cd/m^2
- Screen quality poor < 200 cd/m^2

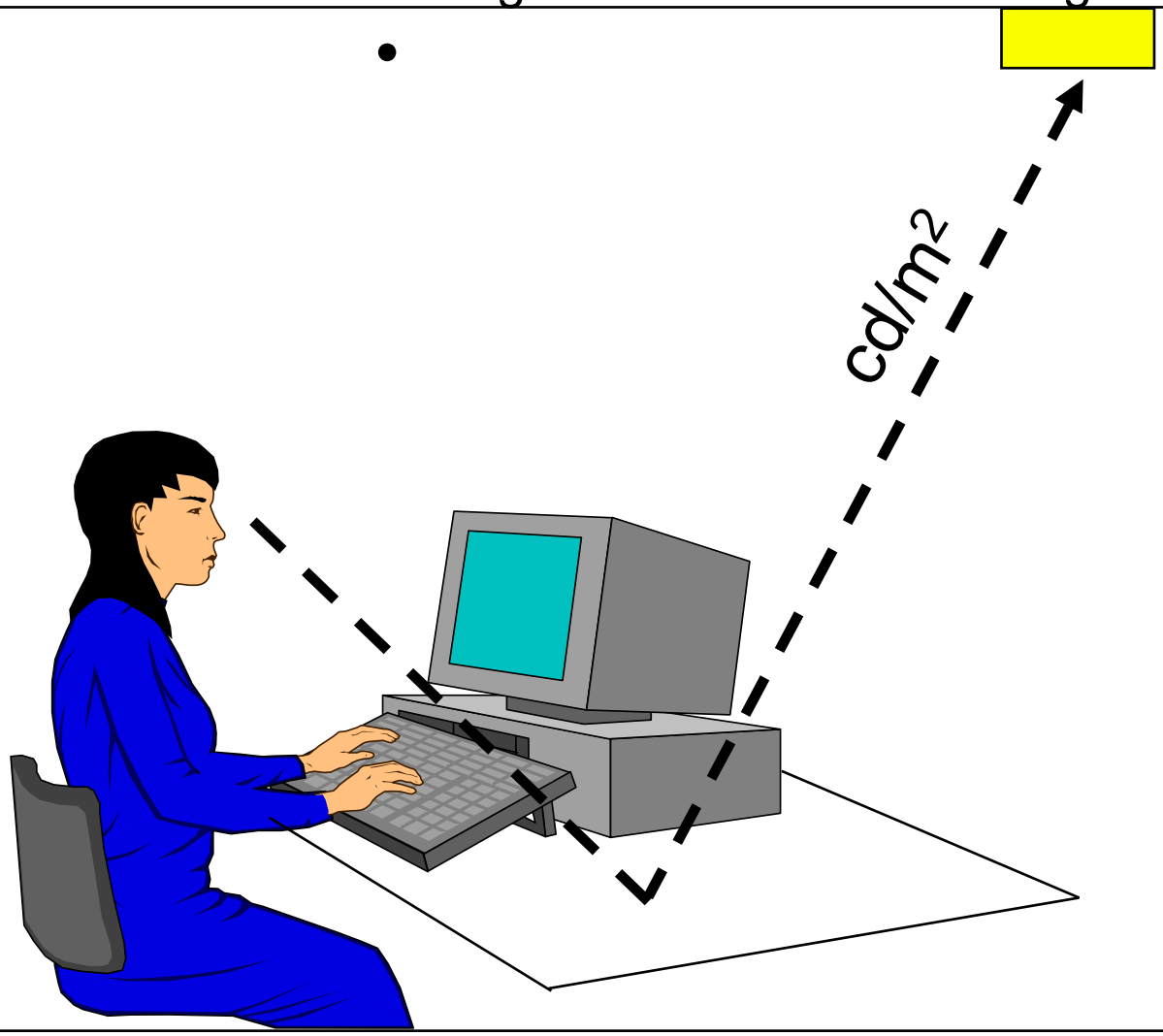
above 65^0



Lighting design criteria

4. Illuminance - Veiling reflections or reflected glare

Reflected brightness



SS 531-2006: Code of Practice for Lighting of Work Places Part 1 – Indoor Lighting

Definitions (indirect glare)

Luminance limits of luminaires which can be

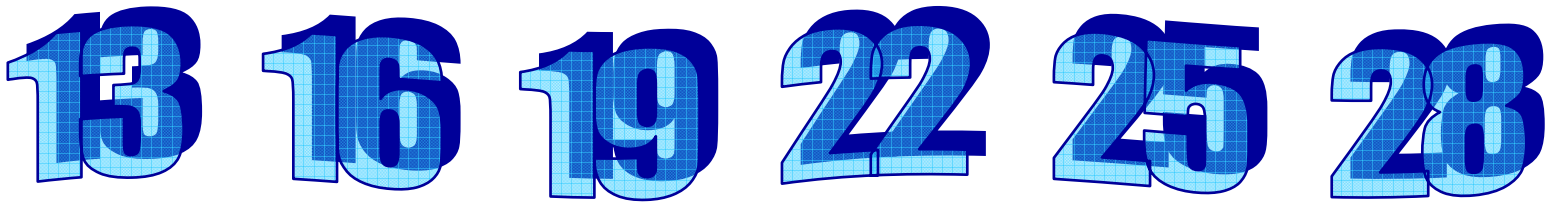
Screen classes in accordance with ISO 9241-7	**I**	**II**	**III**
Screen quality	**good**	**medium**	**poor**
Average luminance of luminaires which are reflected in the screen	**≤ 1000 cd / m²**		**≤ 200 cd / m²**
	above 65^0		

Note: In some special places 55^0 should be applied
For display screen with screen tilt up to 15^0

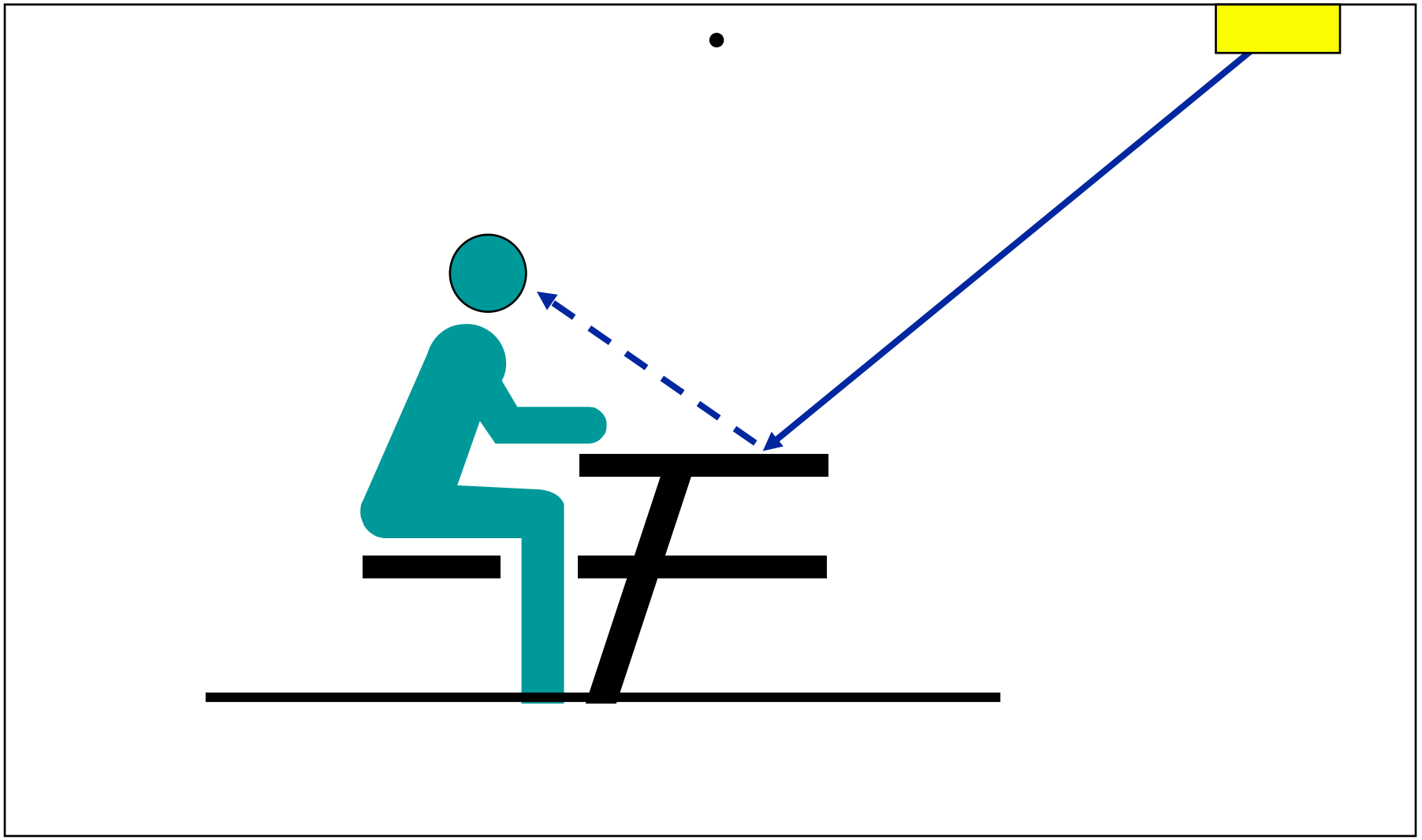
Lighting design criteria

4. Illuminance - Discomfort Glare

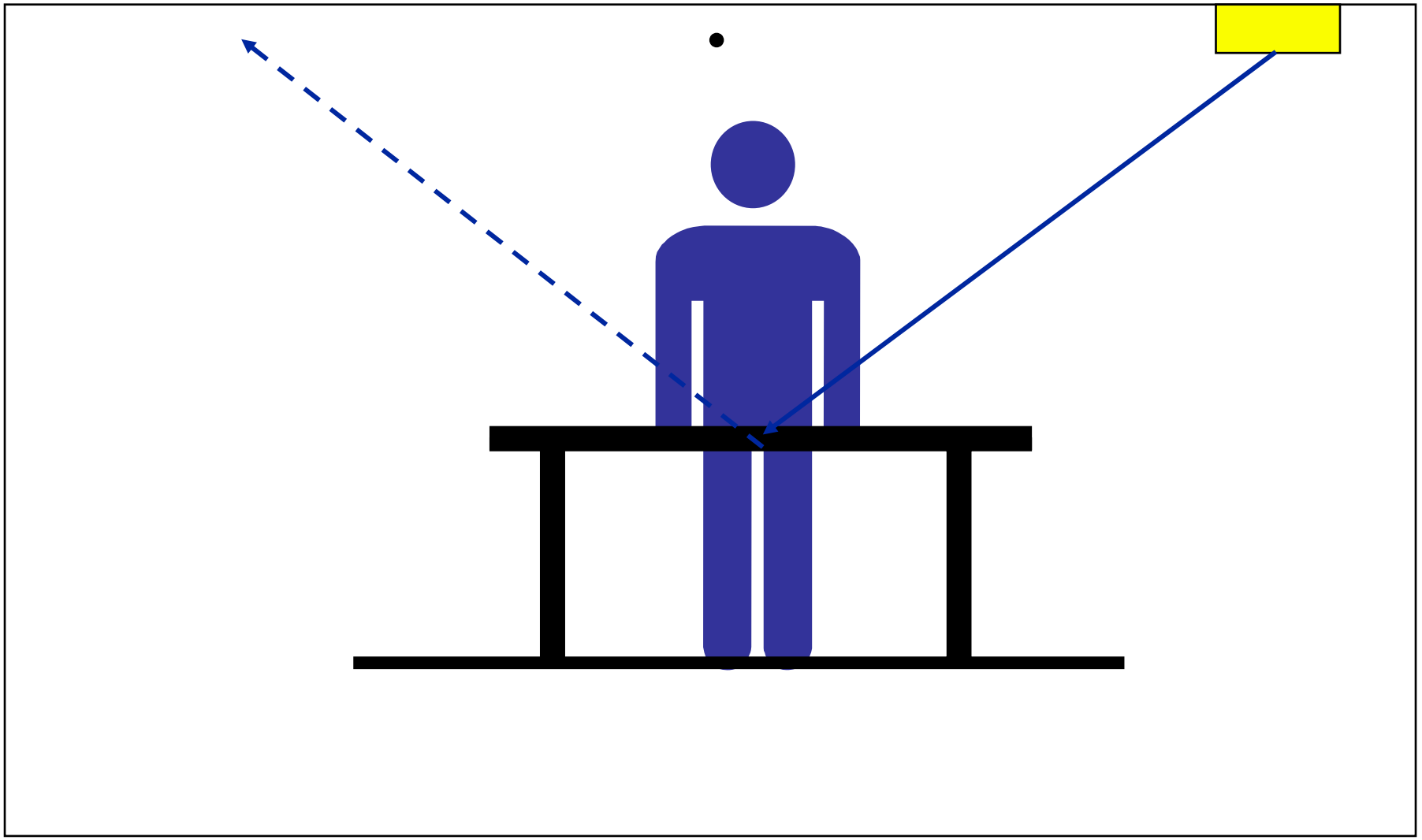
- All assumptions made in the determination of UGR shall be stated in the scheme documentation.
- The UGR value of the lighting installation shall not exceed the value given in clause 5.
- Note: The variations of UGR within the room may be determined using the tabular method or the formula for different observer positions.
- The values of UGR limits in clause 5 were taken from the UGR scale - where each step in the scale represents one significant change in glare effect and 13 represents the least perceptible discomfort glare.
- The UGR scale is:



Reflected glare by wrong positioning



Avoid reflected glare by right positioning



Lighting design criteria

Directionality

- Directional lighting may be used to
  - highlight objects, to reveal texture
  - improve appearance of people within the space.

- Modelling
- Is a balance between diffuse and directional light. It is a valid criterion of lighting quality in virtually all types of interiors. The general appearance of an interior is enhanced when its structural features, the people and objects within it are lit so that form and texture are revealed clearly and pleasingly. This occurs when the light comes noticeably from one direction; the shadows formed are essential to good modelling and are formed without confusion.

- The lighting should not be too directional as it can produce harsh shadows, neither should it be too diffuse or the modelling effect will be lost entirely, resulting in a very dull luminous environment.

Lighting design criteria

Directionality

- Directional lighting of visual tasks
- Lighting from a specific direction can reveal details within a visual task, increasing their visibility and making the task easier to perform. Particularly important for fine textured tasks and scribes/grooves.

Lighting of Indoor workplaces
COLOUR ASPECTS

Lighting for indoor work places

Definitions (Colour aspects)

- **Colour rendering:**
  'good' is standard in industry
  - $R_a \geq 80$ (CEN), occasional lower R_a allowed
- **Colour appearance:**
  essential for atmosphere, depending on illuminance level, style of industry, surrounding climate and personal preference
  - **Warm** $T_c < 3300$ K
  - **Neutral** $3300 < T_c < 5300$ K
  - **Cool / daylight** $T_c > 5300$ K

Lighting design criteria

Daylight

- Daylight
  - may provide all or part of the lighting for visual tasks.
  - varies in level and spectral composition with time and therefore provides variability within an interior.
  - may create a specific modelling and luminance distribution due to its nearly horizontal flow from side windows.
- Daylight can also be provided by roof lights and other fenestration elements.
- Windows can also provide a visual contact with the outside world, which is preferred by most people. Avoid excessive contrast and thermal discomfort caused by direct sunlight in work areas.
- Provide adequate sun control such as blinds or shades, so that direct sunlight does not hit workers and/or surfaces within their field of view.

Lighting design criteria

Daylight

- In interiors with side windows the available daylight decreases rapidly with distance from the window. In these interiors the daylight factor should not fall below 1% on the working plane 3 m from window wall and 1 m from side walls. Supplementary lighting should be provided to ensure the required illuminance at the work place and to balance the luminance distribution within the room. Automatic or manual switching and/or dimming can be used to ensure appropriate integration between electric lighting and daylight.
- To reduce glare from windows, screening shall be provided.

Lighting design criteria

Maintenance

- Maintained illuminance depends on
  - characteristic of the lamp,
  - Characteristic of the luminaire,
  - the environment
  - maintenance programme.
- The lighting scheme should be designed with overall maintenance factor calculated for the selected lighting equipment, space environment and specified maintenance schedule.
- The calculated maintenance factor should not be less than 0,70.

Lighting design criteria

Energy Considerations

- The lighting installation should meet the lighting requirements of a particular interior, task or activity without waste of energy.
- However, it is important not to compromise the visual aspects of a lighting installation simply to reduce energy consumption.
- This requires the consideration of appropriate lighting systems, equipment, controls and the use of available daylight. In some countries there are limits on the available energy for lighting that should be observed.
- These limits may be achieved by prudent selection of the lighting system and the use of automatic or manual switching or dimming of the lamps.

Lighting design criteria

Flicker and stroboscopic effect

- Flicker causes distraction and may give rise to physiological effects such as headaches.
- The lighting system should be designed to avoid flicker and stroboscopic effects. Stroboscopic effects can lead to dangerous situations by changing the perceived motion of rotating or reciprocating machinery.

- Note: This can be achieved by use of DC electrical supply or by operating lamps at high frequency (around 30 kHz) or distribute the connection of the lighting over more than one phase of the supply.

Thank You

Seminar Launch of the Revised Code of Practice for Installation, Operation, Maintenance, Performance and Construction Requirements of Main Failure Standby Generating System (formerly CP31)

Sim Wee Meng
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&
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SPRING singapore

Previous Edition

CP 31: 1996 Code of practice for installation, operation, maintenance, performance and constructional requirements of Mains Failure Standby Generating Systems.

- 1st Published 1985
- 1st Revised in 1996

Need of Revision

- To keep in line with international standards and update to local practices
- Clarification and improvement

Current Revised Standard

- Review started August 2005
- Technical Committee consisting of key stakeholders were formed
- Co-opted experts from industry
- Final Draft completed: April 2007
  Public Comment: April - June 2007

Participating Organisations in Review

- Association of Consulting Engineers Singapore (ACES)
- Building and Construction Authority (BCA)
- Housing Development Board (HDB)
- Jurong Town Corporation (JTC)
- Land Transport Authority (LTA)
- National University of Singapore (NUS)
- Nanyang Technological University (NTU)
- Ngee Ann Polytechnic (NP)
- Singapore Polytechnic (SP)
- Singapore Powergrid
- Singapore Electrical Contractors and Licensed Electrical Workers Association (SECA)
- Singapore Electrical Trade Association (SETA)
- Industry experts in their individual capacity

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Our Topics Today

- **Changes introduced in SS 535 : 2007**
- **Good Earthing Practices**

Thank You

Overview of the Revised Code of Practice for Installation, Operation, Maintenance, Performance and Construction Requirements of Main Failure Standby Generating System (formerly CP31)

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Content of presentation:-

- Principle Changes in Revised CP 31 : 1996
- Standardisation of terms used
- Removal of clauses
- Addition of clauses
- Re-definition of clauses
- Appended new information
- Other changes made to CP 31 : 1996

Principle Changes in Revised CP 31 : 1996

- Power rating definitions in Annex B is based on that given in ISO 8528 - "Reciprocating internal combustion engine driven alternating current generating sets

- Standby generating set test/maintenance guide in Annex C

- New sub clause 11.11 on earthing arrangement of the standby generating set

- Re-arrangement and reshuffling of clauses and requirements of the previous edition to ensure relevance and correctness.

Major changes in the revision

Standardisation of terms used

1. “Generator” or “Alternator” to “Alternator”

2. “Generator” to “Generating set”

Major changes in the revision (cont'd)

Removal of clauses in previous edition

1. Clause 3.5 : Mutual Standby to Mains Supply

2. Clause 4.2k), l), m) : Provision of fuel for testing, witness tests, tools or spares

3. Clause 4.4 : Commencement and Completion of the generating set

Major changes in the revision (cont'd)

Removal of clauses in previous edition

4. Clause 5.1 : Approval for housing of generating set in a room

5. Clause 5.3 : Requirement of extensive foundation work for the generating set

6. Clause 11.2b) : Checking of crankshaft alignment after installation of engine and alternator

Major changes in the revision (cont'd)

Removal of clauses in previous edition

7. Clause 11.7d : Excess fuel storage requirement

8. Clause 11.10d : Acoustic canopy requirement

9. Clause 14.2d&e : Weekly running of generating set and setting of automatic operation

Major changes in the revision (cont'd)

Removal of clauses in previous edition

10. Clause 14.3.1b : Quarterly checking of lubricating oil and leaks

Major changes in the revision (cont'd)

Addition of clauses

1. Clause 4.2k), l) : Noise criteria and Load characteristics

2. Clause 5.17 : Ramps criteria



3. Clause 8.6 : Earthing of generating system

Major changes in the revision (cont'd)

Addition of clauses

4. Clause 8.8 : Labelling of components, cables, terminals, etc

5. Clause 11.8 (Part): Requirement for compressed air starting system

6. Clause 14.3 : Monthly testing of generating set and checking of control at automatic mode

Major changes in the revision (cont'd)

Re-definition of clauses

1. Clause 3.1 : Generating set is defined as an internal combustion engine driving an alternator

2. Clause 5.5 : 150 to 200 lux during normal time and minimum 30 lux during power failure

3. Clause 11.11 : Earthing requirements for alternators and metal parts

Major changes in the revision (cont'd)

Re-definition of clauses

4. Clause 13.2.1 : Terminology of technical information required in the instruction manual

5. Clause 14.4.5d : Checking of unusual performance

6. Clause 15.2.2 : Restricted earth fault protection

Major changes in the revision (cont'd)

Re-definition of clauses

6. Clause 15.2.3 : Protection against direct contact of live parts

7. Clause 15.3.1 : Noise pollution to comply with EPCA

8. Clause 15.3.4 : Exhaust emission to comply with EPCA

Major changes in the revision (cont'd)

Appended Information

1.Revised label of earth terminal



2.Standby generating set maintenance

Other changes made to CP 31 : 1996

1. Editorial

2. Re-phrasing of clauses

3. Update to latest local practices

Thank You

Seminar Launch of the Revised Code of Practice for Installation, Operation, Maintenance, Performance and Construction Requirements of Main Failure Standby Generating System (formerly CP31) Good Earthing Practices

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SPRING singapore

GOOD EARTHING PRACTICES

1) Clauses on Genset Earthing

2) Objective of Good Earthing Practices

3) Transfer Switch & Associated Genset Earthing

4) Conclusion

SS535 CLAUSES ON GENSET EARTHING

Addition of clauses (Clause 8 Control Panel):

- **Clause 8.6 : Earthing**
- **Clause 8.8 : Labelling**

Re-definition of clauses (Clause 11 Installation):

- **Clause 11.11 : Earthing Arrangement**

Changes to earthing label:

- **Annex A: Label for earth terminals**

OBJECTIVE OF

GOOD EARTHING PRACTICES

a) Electrical safety - protection against electric shock

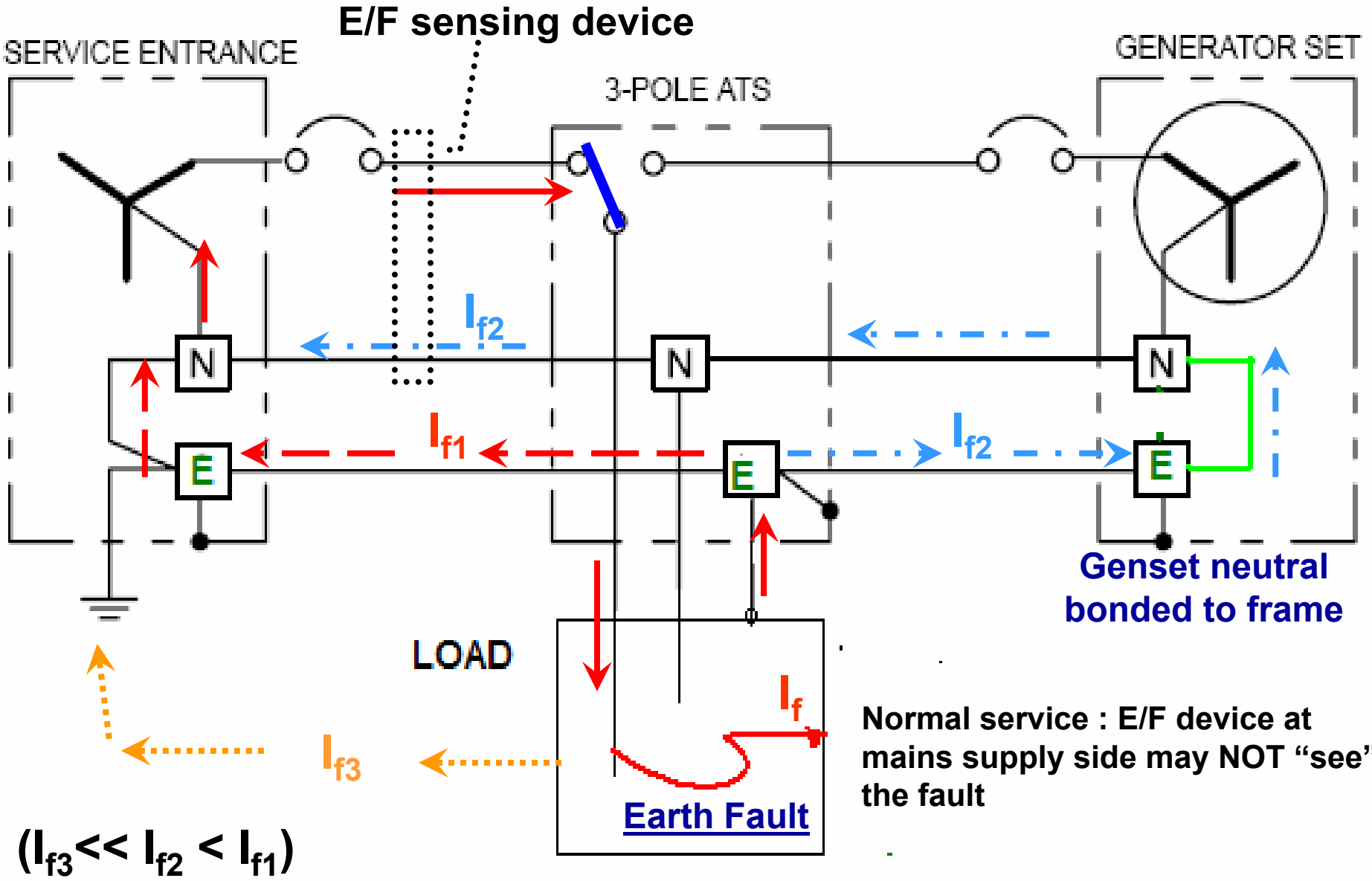
b) Protection of Equipment

- provide an effective electrical conductor system over which earth-fault currents can flow, reducing fire hazard
- Stabilise the system voltage w.r.t earth, reducing damage to equipment

c) Facilitate operation of protection devices - low impedance conducting paths for earth-fault current

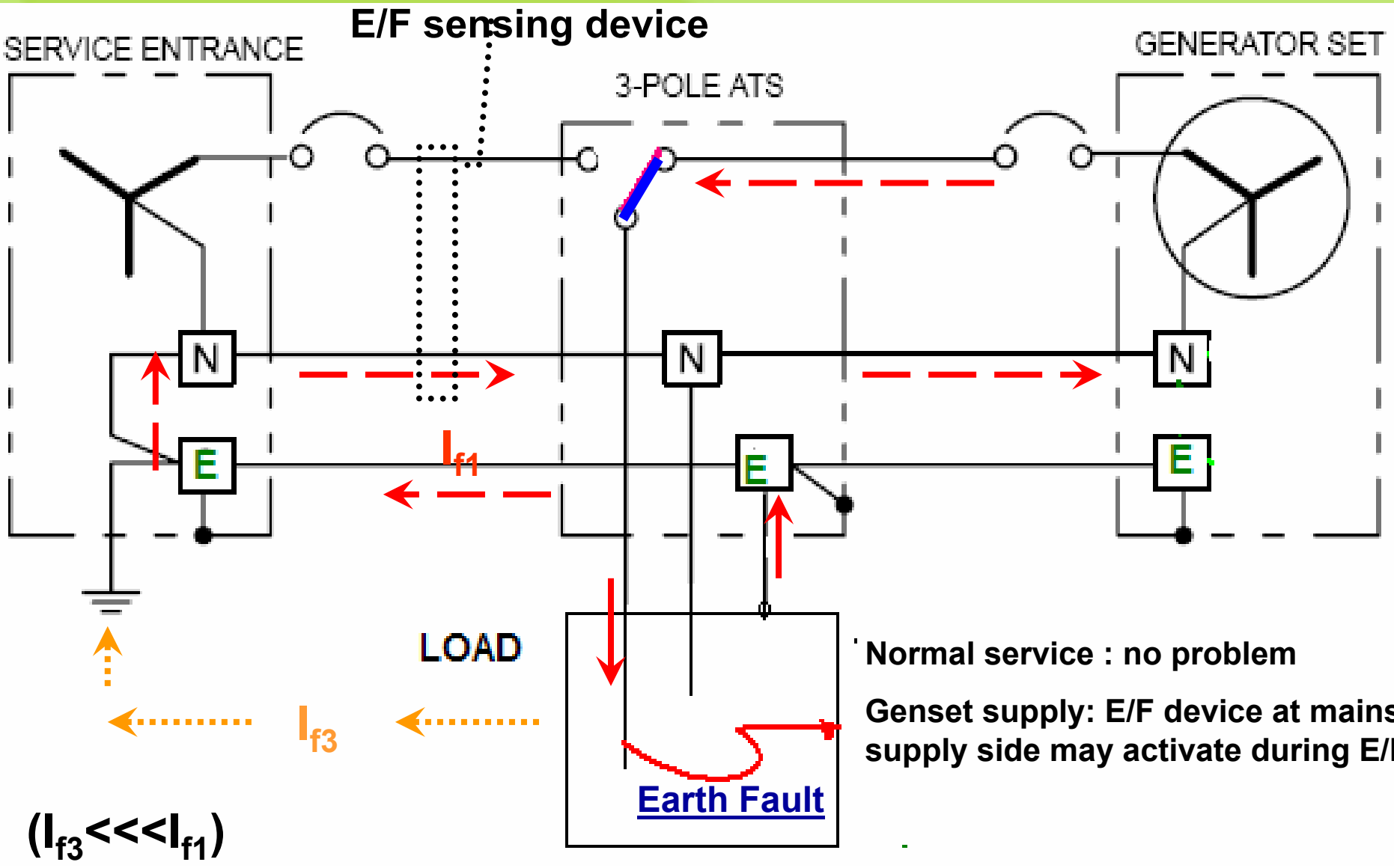
TRANSFER SWITCH AND ASSOCIATED GENSET EARTHING

Improper Genset Earthing for 3-pole ATS: Genset neutral bonded to frame



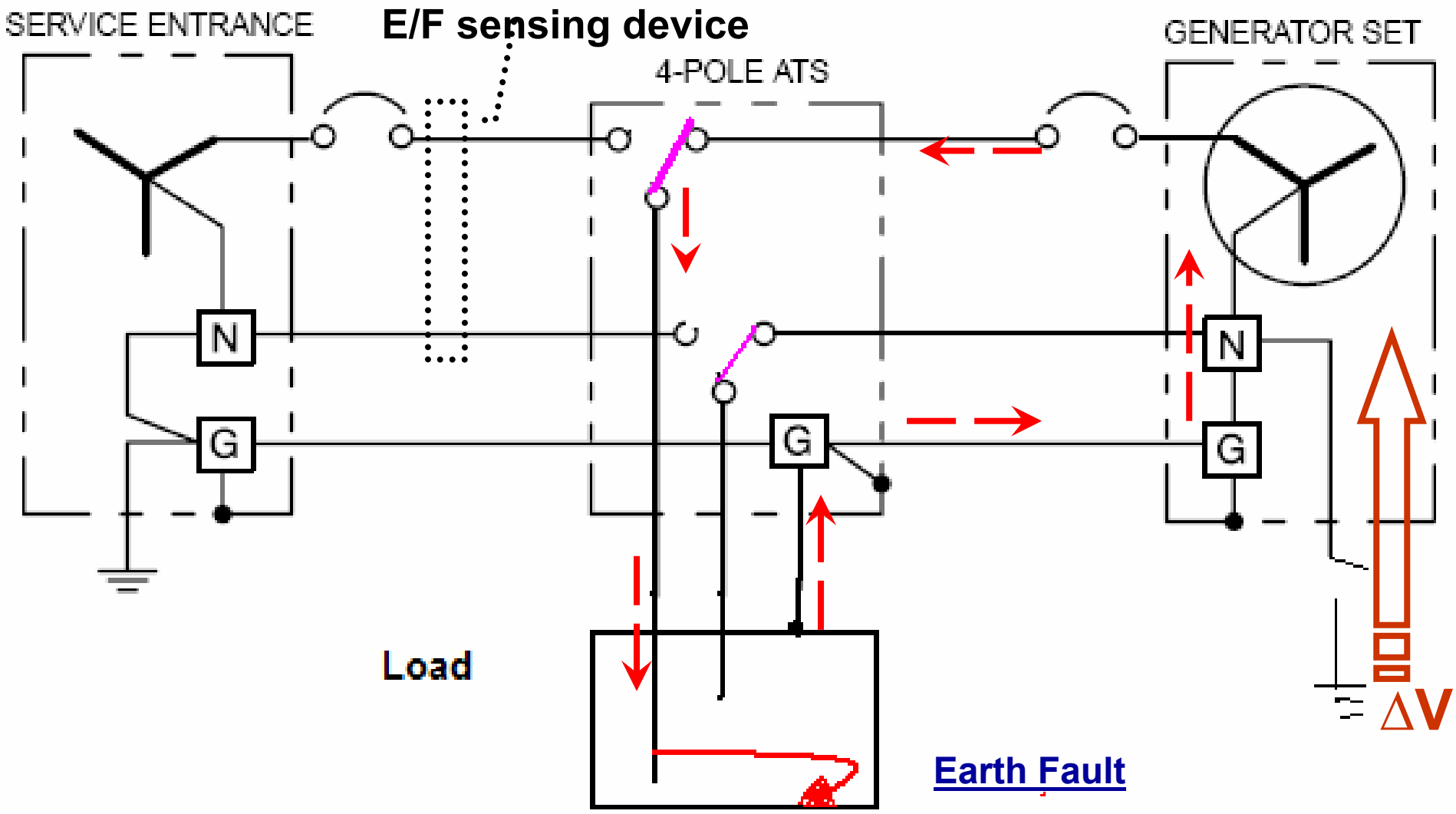
TRANSFER SWITCH AND ASSOCIATED GENSET EARTHING

Proper Genset Earthing for 3-pole ATS: Genset neutral must NOT be bonded to Genset Frame



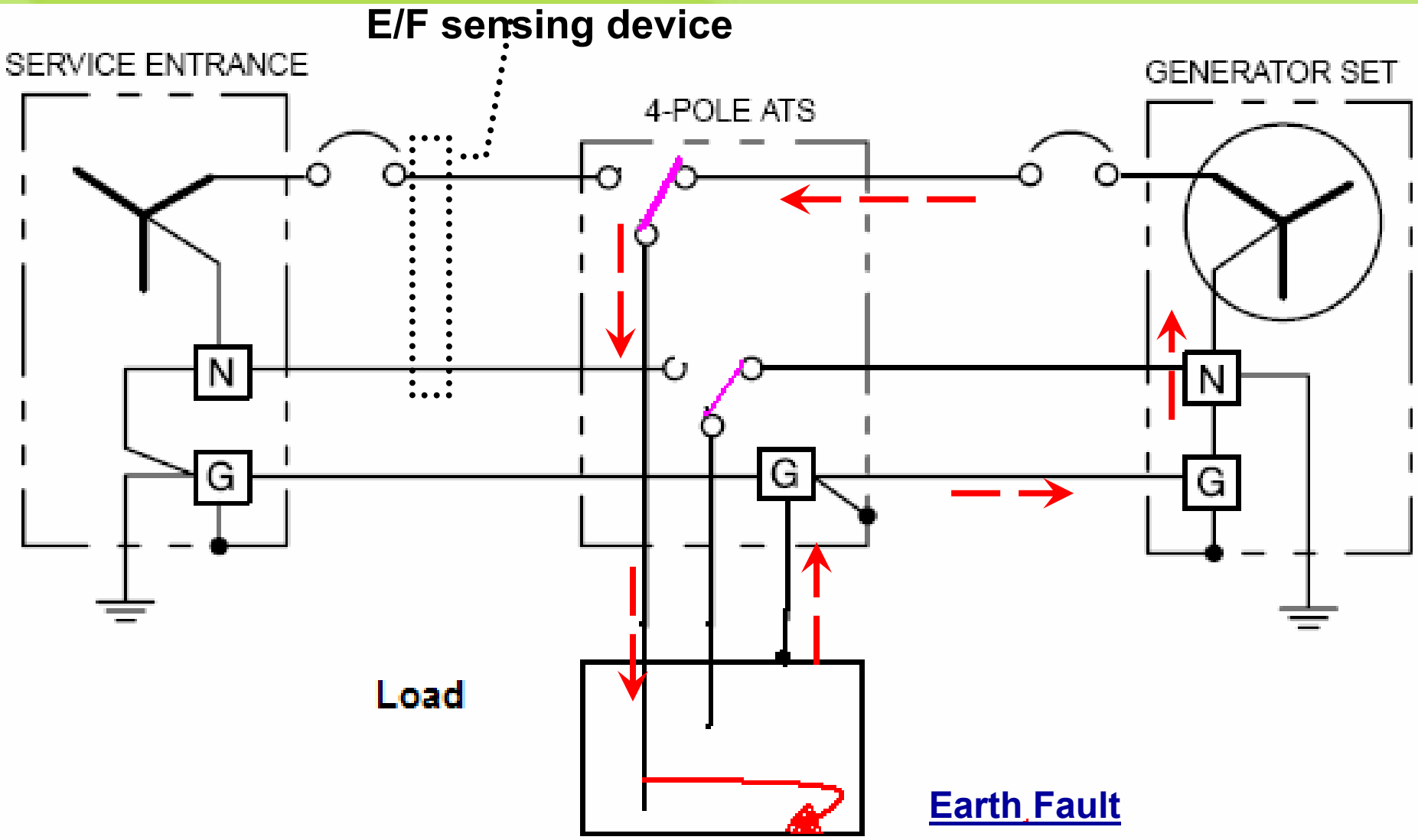
TRANSFER SWITCH AND ASSOCIATED GENSET EARTHING

Genset Earthing for 4-pole ATS - Poor earthing provided at genset neutral



TRANSFER SWITCH AND ASSOCIATED GENSET EARTHING

Genset Earthing for 4-pole ATS - good earthing provided at genset neutral)



TRANSFER SWITCH AND ASSOCIATED GENSET EARTHING

a) Proper coordination:

- **genset earthing and 3-pole/4-pole transfer switches**

b) For 3-pole transfer switch:

- **genset neutral is solidly bonded to Mains supply system neutral**
- **Precautional measures to be taken during genset maintainance**
- **Check to ensure genset neutral is not bonded to the frame**

TRANSFER SWITCH AND ASSOCIATED GENSET EARTHING

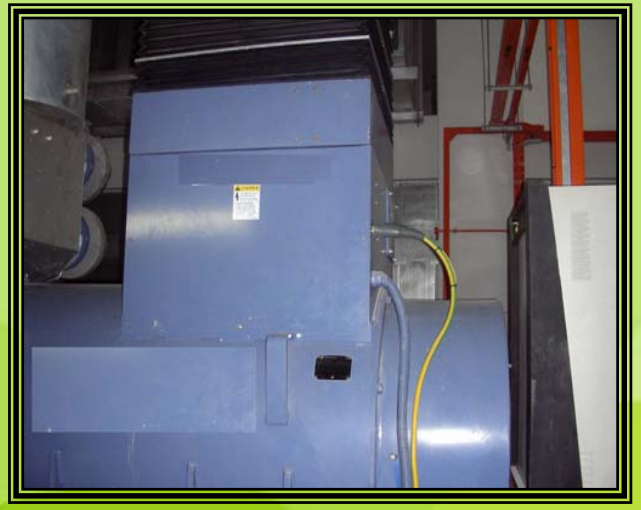
c) For 4-pole transfer switch (recommended):

- **genset neutral is not physically connected to the Mains supply system neutral**
- **genset neutral is in complete isolation**
- **check to ensure good grounding is provided for the Genset neutral**

d) Parallel operation of Gensets_:

- **During parallel operation, only one genset is to be earthed to prevent circulating currents amongst the generators**









Photos of Genset frame bonded to earth



Photo of Generator Control Panel and Earthing Bar in Genset Room

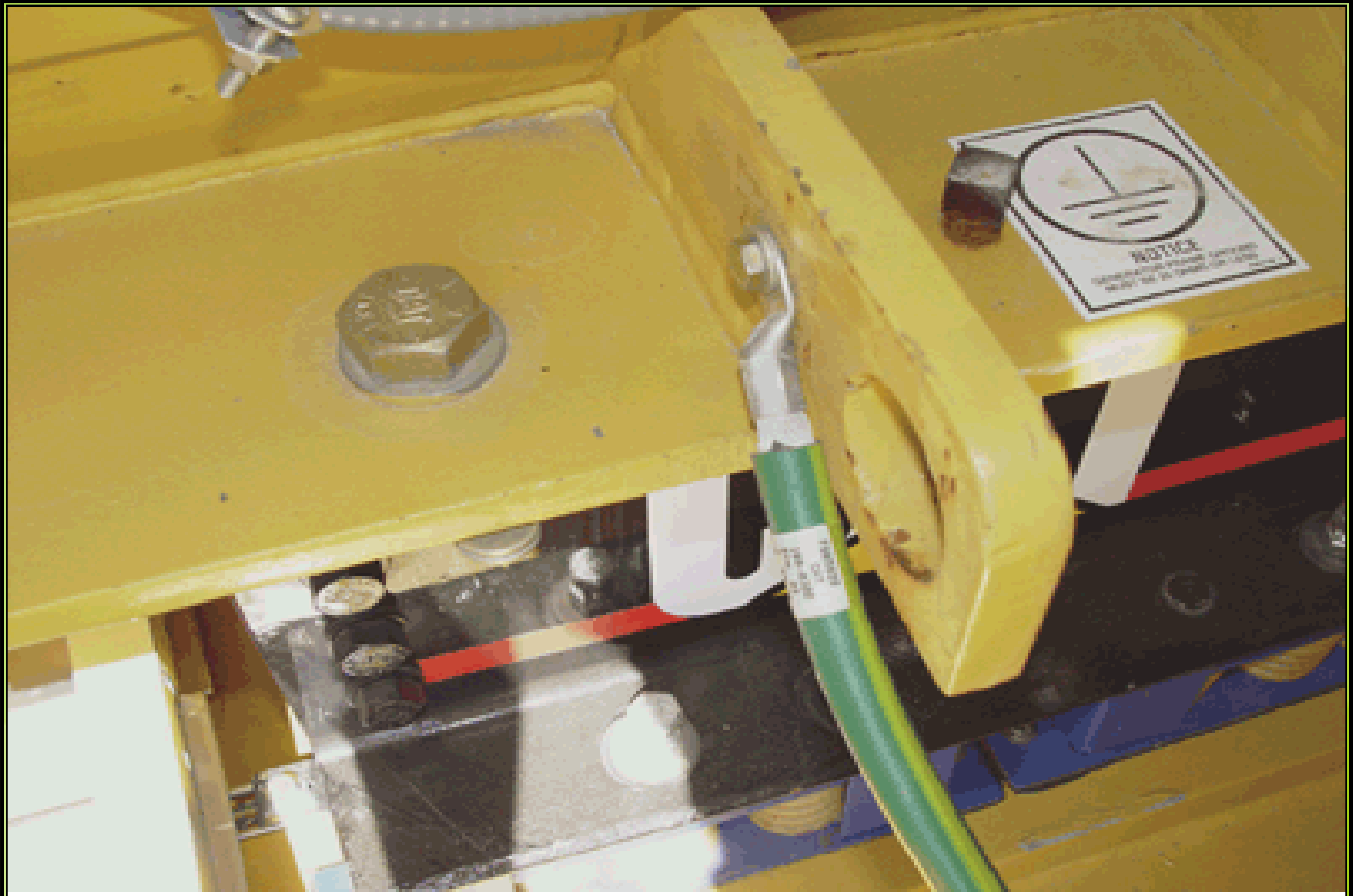


Photo of Genset earthing label

CONCLUSION

Good earthing practices are necessary:

- **Electrical safety**
- **Protection of equipment**

THANK YOU !

Clause 8 CONTROL PANEL

SS535 Cl. 8.6 Earthing

Electrical components shall be effectively earthed by earthing conductor of the appropriate size. The earthing conductor shall be readily distinguishable (green and yellow). Earthing terminals shall be clearly identifiable by a symbol shown in Annex A.

An earth rail with a suitable number of earthing bolts or screws shall be provided in position close to the external cable glands to facilitate termination of cable earth braids or armouring.

Electrical components shall be directly earthed to the earthing rail. Individual connections for all earth conductors shall be provided.

Clause 8 CONTROL PANEL

SS535 Cl. 8.8 Labelling:

All external operating, measuring and indicating components shall be clearly identified with permanent descriptive labels that facilitate easy recognition by the operator.

All components shall be identified by labels inscribed in accordance with the system of identification as used on the Manufacturer's reference drawings and documents.
All labels shall be of corrosion resistant material with indelible inscriptions as specified in the requisition.

Rail-mounted terminals of equipment and components shall be identified by numerical or alphabetical markings in accordance with the Manufacturer's drawings. Terminals of input and output supply cables shall be clearly marked to indicate the nominal system voltage and the phase/polarity of the supply. The identification of terminals shall be in accordance with IEC 60445.

Clause 11 INSTALLATION

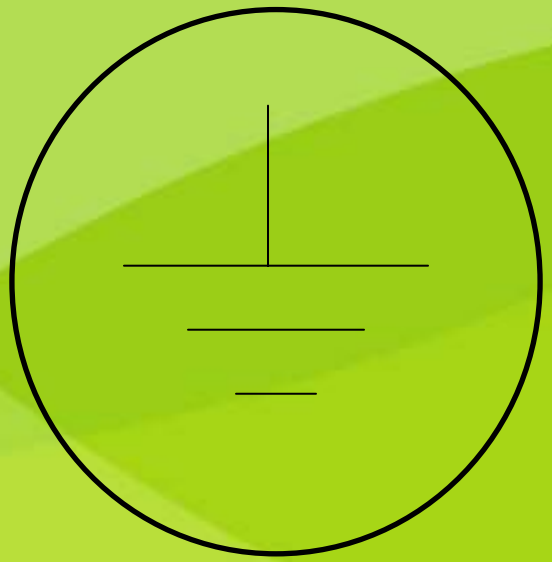
CL 11.11 Earthing Arrangement

a) Electrical installation supplied from generating sets shall share a common TN-S earthing system with the generating set or generating sets connected to it. In any electrical installation, a main earthing terminal or bar of adequate rating shall be provided and connected to the earthing conductors. The star point of a three-phase alternator winding or the mid-point of a single-phase centre-tapped alternator winding shall be solidly earthed through adequately rated conductors to the earthing system of the electrical installation.

b) All other metal and machine frame work shall be bonded to the earth terminal with appropriate conductors.

Clause 11 INSTALLATION

SS535 Annex A Label for earth terminals



SS CP5 : Code of Practice for Electrical Installation

CL. 413 Protection Against Indirect Contact

a) Protection by earthed equipotential bonding and automatic disconnection of

b) Protection by Class II equipment…

c) Protection by non-conducting location

- *Cl. 413-04:This method of protection is not recognised for general application….*
- *Cl. 471-10: …..This measure is not recognised in the Code for general use and shall be applied only in special situations which are under effective supervision…*

d) Protection by earth-free local equipotential bonding

- *Cl.413-05: This method shall be used only in special circumstances*
- *Cl. 471-1: ….It shall be applied under effective supervision of a skilled person only in special situations which are earth-free……For some installations and increased shock risk this measure shall not be used…*

e) Protection by electrical separation

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