building on experience:
learning from the Past to plan the Future

light, books & man

arch. Marina Vio
Università IUAV di Venezia
studio associato vio - venezia
the drama of vision has three actors
the drama of vision has three actors

light

human mind

surfaces
the light has got:

- intensity
- direction
- color

these properties are common to artificial and natural light
In the part of mountain illuminated by global radiation (solar and sky radiation) the snow appears white and shining. In the shadows, instead, illuminated only by sky's radiation, snow appears dark and blue. Those are the effects of direction, intensity and spectral distribution (color) of the natural light.
these attractive fruits have not the same aspect changing the light color

we perceive differents aspect if they are illuminated by colored light ...

this joking is an example of dialog between light and surfaces colors (or surfaces spectral distributions)
these attractive fruits have not the same aspect changing the light color

this joking is an example of dialog between light and surfaces colors (or surfaces spectral distributions)

we perceive differents aspect if they are illuminated by colored light …
these attractive fruits have not the same aspect changing the light color

this joking is an example of dialog between light and surfaces colors (or surfaces spectral distributions)

we perceive differents aspect if they are illuminated by colored light …
these attractive fruits have not the same aspect changing the light color

this joking is an example of dialog between light and surfaces colors (or surfaces spectral distributions)

we perceive differents aspect if they are illuminated by colored light …
How do we see?

Really, we see by means of the mind, not by the eyes: the eyes are only the means, or the tools, for the vision.

The behaviour of the mind is wonderful and complex
what is the color of cushion? YELLOW
what is the color of cushion?  YELLOW

In this image, a blue film was superimposed to the yellow cushion and, for a little part, to the white dress of the woman.

This fact is equivalent to illuminating those parts of scene with blue light.

what is the color of cushion?  GREEN
the cushion is again yellow!

our mind divides the color of illuminating light from the color of surfaces

this phenomena is said COLOR CONSTANCY, and explains that we see by means of the mind, not by means of the eyes
another important fact is the nature of light

we must remember that light is the effect on human mind
of one small band of radiation
for all the surfaces, instead, the light is only radiation with
short wavelength, and this radiation may be dangerous
those are some samples of printed colored ink
and this is the aspect of the same samples after about 120 hours of exposition to a light similar to the sky light

research of L. Fellin, P. Fiorentin, E. Pedrotti
Dipartimento Energia Elettrica- laboratorio di fotometria e illuminotecnica Università di Padova
Inks and papers fear the light. Digital and photographic materials also fear the light, although in lesser way.

readers have a passion for high light levels but… they can read also with low levels!
Part 4

Lighting design

4.1 Introduction

The flow diagram in Figure 4.1 presents a design approach, based on reasonable practice, to applying the principles, recommendations and technology described elsewhere in the Code. With experience, the lighting designer will develop this to arrive at individual design solutions. This reference to the lighting designer should not be read to imply that the design process can be carried out in isolation. All successful lighting is the result of close collaboration and interaction within the building design team, to interpret the client’s brief. The purpose of this section, however, is to concentrate on the lighting designer’s responsibility and contribution to the total design process.

4.2 Objectives

The first stage in planning is to establish the lighting design objectives which guide the decisions in all the other stages of the design process. It is matter of deciding for what, and for whom, the lighting is intended, rather than referring to this stage to the lighting schedule. These objectives can be considered in three parts.

4.2.1 Safety

The lighting installation must be electrically and mechanically safe and must allow the occupants to use the space safely. These are not...
13 lux

<table>
<thead>
<tr>
<th>1. Objective (section 4.2)</th>
<th></th>
</tr>
</thead>
<tbody>
<tr>
<td>Determine the objectives of the design in terms of the safety, task and appearance requirements. Priorities should be allocated and constraints identified.</td>
<td></td>
</tr>
</tbody>
</table>

<table>
<thead>
<tr>
<th>2. Specification (section 4.2)</th>
<th></th>
</tr>
</thead>
<tbody>
<tr>
<td>Express the design objectives as a set of compatible design criteria, and acknowledge those objectives which cannot be quantified.</td>
<td></td>
</tr>
</tbody>
</table>

<table>
<thead>
<tr>
<th>3. General planning (section 4.3)</th>
<th></th>
</tr>
</thead>
<tbody>
<tr>
<td>Consider the relationship between natural and electric lighting. Resolve the type of lighting system which will achieve the desired objectives.</td>
<td></td>
</tr>
</tbody>
</table>

<table>
<thead>
<tr>
<th>4. Detailed planning (section 4.3)</th>
<th></th>
</tr>
</thead>
<tbody>
<tr>
<td>Plan the final scheme (or alternative schemes) using accurate data to ensure the most economical and efficient final design.</td>
<td></td>
</tr>
</tbody>
</table>

<table>
<thead>
<tr>
<th>5. Verification (section 5.3)</th>
<th></th>
</tr>
</thead>
<tbody>
<tr>
<td>After completion, examine the installation in order to assess its success in terms of the design objectives and its acceptability to the client/user.</td>
<td></td>
</tr>
</tbody>
</table>
13 lux illuminance corresponds to a “mesopic” condition or twilight vision.
another important concept is necessary

in an indoor space, as in rooms of buildings, the luminous climate depends on two components
another important concept is necessary

in an indoor space, as in rooms of buildings, the luminous climate depends on two components

the direct component, that comes directly from luminous sources

the diffuse components, caused by reflections of envelope
direct component
diffuse component
The diffuse component has less intensity, color depending by sky and envelope color, and no distinct direction. The direct component has high intensity, color and direction of sunlight.
and now, we are ready to see the libraries with new eyes
What about the libraries?

In ancient times, the library was an intimate and private space.

Vittore Carpaccio - Sant'Agostino
when the culture becomes plural, as in monastic life, the space increases, and light increases as well
then, more light… but from where?

from windows near the floor

or near the ceiling?

Biblioteca do Palacio e Convento de Mafra
What difference?

It depends on:

- latitude of site
- sky conditions (overcast or clear sky)
latitude of site

latitude 19 °N
Biblioteca palafoxiana at Puebla, Mexico

latitude 50°N
Strahov Monestary Library – Prague
**latitude of site**

**low** latitude values means **high** sun altitude angles

direct component has high intensity but does not penetrate into interiors

**latitude 19 °N**
Biblioteca palafoxiana at Puebla, Mexico

**latitude 50°N**
Strahov Monestary Library – Prague

**high** latitude values means **low** sun altitude angles

direct component has low intensity but penetrates deeply into interiors
Municipal library of Gunnar Asplund - Stockholm, 1921-28
the hall is illuminated by a lot of vertical windows
because of high latitude of site, also in clear sky conditions the direct component never strikes the books
this fact does not happen at low latitude sites because there is an important difference in sun paths
yearly sun paths in **STOCKHOLM**
latitude 59.3°N

yearly sun paths in **CAIRO** latitude
28.9°N
yearly sun paths in **STOCKHOLM**
latitude 59.3°N

at high latitude values, the sun moves on lower part of sky dome

yearly sun paths in **CAIRO** latitude 28.9°N

at low latitude values, the sun moves on higher part of sky dome
sky conditions

diffuse component prevails with overcast sky
sky conditions

direct component prevails with clear sky
now we have an answer to the question:
windows near the ceiling or near the floor?

now we can understand their different effects
Budapest April 11 at 10:38 am
south facing windows

**overcast sky**

**windows near the floor:**
- lower medium illuminance
- too much light in some areas
- lower illuminance levels on vertical walls

**windows near the ceiling:**
- higher medium illuminance
- good light everywhere
- higher illuminance levels on vertical walls

with overcast sky the diffuse component prevails
Budapest April 11 at 10:38 am
south facing windows

**clear sky**

**windows near the floor:**
- lower medium illuminance
- too much light in some areas
- lower illuminance levels on vertical walls

**windows near the ceiling:**
- higher medium illuminance
- too much light in some areas
- higher illuminance levels on vertical walls

*with overcast sky the direct component generates too high differences of luminous levels*
any alternatives?

light from the ceiling using skylights

this solutions is **CORRECT** for high latitudes and for sites where overcast sky conditions prevail

It is **WRONG** for low latitudes and for sites where clear sky conditions prevail
Budapest April 11 at 10:38 am
with skylight

**overcast sky**
800 lux
400 lux
200 lux

*skylight is a good solution for overcast sky conditions*

---

Budapest April 11 at 10:38 am
with skylight

**clear sky**
1200 lux
800 lux
400 lux

*skylight is a bad solution for clear sky conditions*
skylight solution works better in high rooms, worse in low rooms
we can now examine the light behaviour in modern libraries
we have learned the importance of direct component control

direct component must be controlled

what happens otherwise?
in a facade facing south,
sun light control
is entrusted to moveable panels
they might have magical effects …
... but they are presently out of order

direct component is not controlled
to read is impossible!
to the North, or under overcast sky, light is quiet, but…
over clear sky the conditions change: the direct component is not controlled
how does a good project control direct component?
Alvaro Siza, library of architecture faculty, Oporto
light must penetrate through a thick skylight with opaline glass

in this way, glass and surfaces of skylight transform the direct into diffuse component
by means of this thick skylight, natural light is quiet also in clear and shining luminous climate of Portugal
we have learned that light is a dangerous radiation: paper, and therefore books, fear the light

in libraries, solar direct light should not enter

what happens otherwise?
glass facades are fascinating
glass facades are fascinating especially at night
...but for books such conditions are terrible

direct sun light is not controlled

preservation of books is impossible
how does a good project control solar direct light?
Santiago Calatrava Zurich Library
this particular design uses high and opaque balustrades
this particular design uses high and opaque balustrades

solar direct light does not strike books
sun can not penetrate through the vertical windows
solar direct light can be controlled also by means of glass properties:
printed glass diffuses solar light
solar direct light can be controlled also by means of glass properties: printed glass diffuses solar light
wiel arets university library of utrecht
how do we evaluate the solar direct light behaviour in our building?

by means of a model exposed to solar light (real sun)
or by means of a model exposed to artificial solar light (artificial sun)
study of solar direct light in Palazzo della Ragione in Padova
we have learned that our mind divides the color of light from the color of surfaces so that color perception results altered.

in libraries, the color of light must be controlled

what happens otherwise?
do you remember attractive fruits?

if illuminated by magenta light, they appear just not the same
do you remember attractive fruits?

if illuminated by magenta light, they appear just not the same
which color for books?
here the glass color causes also the light color
diffuse field has a pink component: how do we perceive books’ colors?

in libraries, the color of light must be neutral
how does a good project control color of light?
richard meyer, City Hall and Central Library The Hague - Netherlands
external light loses its color
In the whiteness of the interior
whiteness of surfaces makes everything clear and quiet
and now

what about artificial light?
libraries need two types of artificial light

- functional light for paths
- key light for the visual task
functional light

functional light **needs:**
- high luminous efficacy
- good and uniform distribution
- low discomfort glare impact

functional light **does not need:**
- great quality of spectrum
- local control

key light

key light **needs:**
- great quality of spectrum
- local control
- low local discomfort glare impact

key light **does not need:**
- high luminous efficacy
- good and uniform distribution
**typical light sources for functional light**

**fluorescent lamps**
- they allow to dim flux, which means energy saving
- typical luminous efficacy: 70 – 90 lm/W

**metal halide (iodide) lamps**
- they do **not allow** to dim flux

**natural light**
- typical luminous efficacy: 60 – 80 lm/W
you always MUST pay attention to the color of light
winter solstice at noon

equinox at noon

summer solstice at noon
Integration between natural and artificial light
typical light sources for key light

incandescent lamps
have little size, vantagious for table use, and very high CRI (Color Rendering Index 100 %)
typical luminous efficacy 16 - 20 lm/W

compact fluorescent lamps
size not too much fit for table use, and reduced CRI (Color Rendering Index 80 – 90 %)
typical luminous efficacy 60 – 90 lm/W
the discomfort glare impact depends on the envelop color:

- It is high (not positive) for dark color.
- It is more low for clear color.
ceilings of dark color and lamps without protective louvre can produce discomfort glare

clear ceilings are better
key light

key light must be near the table
this allows energy saving and local light control
key light must be turned on only when necessary
key light may be carried on the reading place also by means of optical fibres
key light may be carried on the reading place also by means of optical fibres
project by studio traverso-vighy and m.vio for Necropoli Vaticana at Rome
there exist both warm and cold white light LEDs
what conclusions?

I believe that libraries need little but good light
what conclusions?

thank you for your attention

mvio@iuav.it