

**Systems and devices for the lighting of works of art exposed in showcases:
experimentation and directions for planning**

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Museums are the most representative spaces of modern times because they bring together evidences of the past and present it in such a way that people can appreciate and enjoy them. The possibility of visually delighting in works of art exposed in museums depends on the way they are lighted: therefore, in the theme of exposing, the issue of lighting works of art appropriately brings up problems which cannot be left out of consideration.

This aspect is true especially for sensitive works of art which require an adequate protection: that is to say all the works that, for preservation or security reasons, are exposed in showcases.

An adequate lighting of works of art exposed in museum showcases has to take into account a series of recurrent problems, related to the preservation of exposed objects and to their users' correct perception. The illuminating engineering project has to meet a series of requirements for these recurrent problems.

After having defined typological and technological features of the exposing item "showcase", it is necessary to analyse the devices and lighting systems currently on the market and their relevant characteristics. Finally, it is essential to examine the problems and to define what parameters have to be checked in order to realise an optimal exposure.





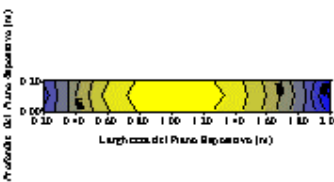
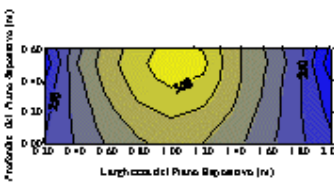

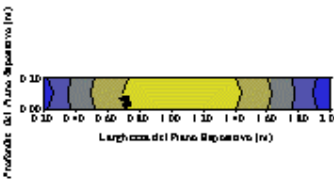
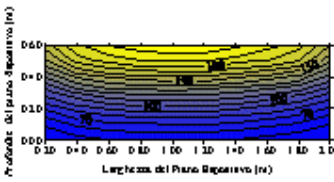

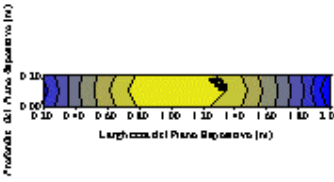
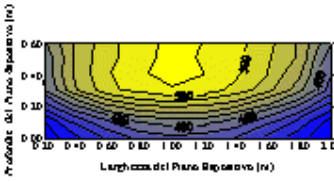
A possible answer to the recurring problems outlined can be provided by an accurate experimental research, aimed at comparing some lighting systems (of which characteristics are known) on the basis of previously established themes.

The subjects of experimentation - directly inferred from problems linked with the analysis of damaging factors on works of art and with the visual disturbing factors for the visitors - give origin to an experimentation conducted into a laboratory and articulated in six stages:

1. the 1st stage consists of a quantitative analysis pointing out the distribution of illumination and illumination uniformity on the different exposing surfaces, which are inclined and horizontal plans of a sample-showcase;
2. the 2nd stage also consists of a quantitative analysis aimed to determine energetic content of UVA radiation emitted by specific systems in order to evaluate their capacity of damaging works of art;
3. the 3rd stage completes the experimentation portion which focuses on the parameters concerning the preservation of works of art. It quantitatively indicates temperature and relevant humidity fluctuations in the sample-showcase, caused by the presence of lighting systems and by their emission in the sphere of IR;
- 4./5. The 4th and the 5th stages are perceptive and objective analyses, in which the visitors' physical and visual itinerary are simulated in order to locate areas affected by direct or reflected glare. Furthermore, by simulating different kinds of exhibited

objects, in different colours, it is possible to determine the perception of such objects with respect to the backgrounds against which they are placed - this is done in order to evaluate the different possibilities of enjoying works of art in relation to changing lighting systems;

6. the 6th stage is also a (quantitatively) perceptive analysis suitable to determine shade and gloom percentages generated on bidimensional and tridimensional objects by their small reliefs or simply by modelling works. This stage helps us evaluate both the negative impression produced by shaded areas when enjoying works of art and its importance in showing the chiaroscuro effect on solid bodies.

1° TEMA DI SPERIMENTAZIONE		
VERIFICA DELL'UNIFORMITÀ DI ILLUMINAMENTO		
PARAMETRI FISSI	PARAMETRI VARIABILI	
Modalità di Illuminazione	Altezza dei piani orizzontali	
<p>Alto</p> 	 <p>H = 30 cm; Griglia: 220x 0 cm</p>	 <p>H = 70 cm; Griglia: 220x40 cm</p>
<p>Sistema a tubi fluorescenti</p> 	 <p>Emed = 272.2 lx Emin / Emed = 0.82 > 0.5 Emax / Emin = 1.38 < 5</p>	 <p>Emed = 153.1 lx Emin / Emed = 0.81 > 0.5 Emax / Emin = 1.36 < 5</p>
<p>Sist. a tubi fluor. con schermo e vetro diffondente</p> 	 <p>Emed = 84.8 lx Emin / Emed = 0.83 > 0.5 Emax / Emin = 1.34 < 5</p>	 <p>Emed = 117.5 lx Emin / Emed = 0.43 Emax / Emin = 3.82 < 5</p>
<p>Sist. a tubi fluor. con ottica asimmetrica</p> 	 <p>Emed = 275.6 lx Emin / Emed = 0.80 > 0.5 Emax / Emin = 1.40 < 5</p>	 <p>Emed = 433.6 lx Emin / Emed = 0.67 > 0.5 Emax / Emin = 1.81 < 5</p>

Sample of synoptic table suitable for comparing different lighting systems on the basis of different themes



Experimental research should not be considered as having an end in itself: its aim is to provide a series of principles established on precise empirical results. The collection of all these general data gives origin to the **USERS' MANUAL for internal lighting systems in museum showcases**, a potential *trait d'union* between the designer's requirements and the results of this experimental research. It is articulated in two sections which deal with bidimensional and tridimensional works of art, for each of which planning requirements are defined and expressed in terms of technical qualifications. For each qualification a direct comparison is made between the different lighting systems by means of a requirement/system matrix. A more exhaustive description of the performances for each system is provided by specific analysis sheets.

Matrice Requisiti / Sistemi.

	Sistema a fobi fluorescenti			Sistema a fobi fluorescenti con schermo			Sistema a fobi fluorescenti con ottica sottili			Sistema a cospelli in anodi ossidi distribuiti																				
	Posizione A			Posizione A			Posizione A			Posizione B, $\theta = 0^\circ$				Posizione B, $\theta = 15^\circ$				Posizione C, $\theta = 0^\circ$				Posizione C, $\theta = 30^\circ$								
	A2h	A2Da	Direct	A2h	A2Da	Direct	A2h	A2Da	Direct	A2h	A2Da	Direct	A2h	A2Da	Direct	A2h	A2Da	Direct	A2h	A2Da	Direct	A2h	A2Da	Direct	A2h	A2Da	Direct			
Uniformità di illuminazione	Green	Green	Green	Green	Green	Green	Green	Green	Green	Green	Green	Green	Green	Green	Green	Green	Green	Green	Green	Green	Green	Green	Green	Green	Green	Green	Green	Green	Green	Green
Riduzione ultravioletti	Red	Green	Green	Green	Green	Green	Green	Green	Green	Green	Green	Green	Green	Green	Green	Green	Green	Green	Green	Green	Green	Green	Green	Green	Green	Green	Green	Green	Green	Green
Amalgamamento diretto	Red	Red	Green	Yellow	Yellow	Green	Red	Red	Green	Red	Red	Green	Green	Green	Green	Green	Green	Green	Red	Red	Green	Green	Green	Green	Green	Green	Green	Green	Green	Green
Amalgamamento indiretto	Green	Green	Green	Green	Green	Green	Green	Green	Green	Green	Green	Green	Green	Green	Green	Green	Green	Green	Red	Red	Green	Green	Green	Green	Red	Red	Green	Red	Red	Green
Ordine Prevalso	Red	Red	Red	Yellow	Yellow	Red	Yellow	Yellow	Red	Green	Green	Red	Green	Green	Red	Green	Green	Red	Yellow	Red	Red	Green	Green	Red	Green	Green	Red	Green	Green	Red
NOTE su altri requisiti	AT			AT			AT			AT				AT				AT				AT								

Legend:	■ Prestazione soddisfacente;	■ Prestazione parzialmente accettabile;	■ Prestazione non soddisfacente.
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Requirement/system matrix

	Posizione A e D Illuminazione dall'alto e dal basso	
	SORGENTI: i valori si riferiscono ad 1+1 sorgente incandescente dicroica con riflettore in alluminio, avente le seguenti caratteristiche: diametro 50 mm, resa Ra = 100, 12V/75W/42° spot.	
	SCHERMO: /	
OTTICA: riflettore in alluminio all'interno dell'illuminatore; diametro attivo delle fibre di 4,3 mm.		

area espositiva: 180x80 cm.

med = 82 lux

Il valore è ottimale per l'esposizione di opere moderatamente sensibili alla luce; con l'impiego di un dimmer si può abbassare il valore dell'illuminamento e utilizzare il sistema anche per opere particolarmente sensibili alla luce.

area espositiva: 180x80 cm.

min/Emed = 0,48

max/Emed = 3,26

L'uniformità risulta abbastanza buona su tutta l'area espositiva considerata; il rapporto Emin/Emed, benché ricada oltre il limite imposto, è comunque accettabile.

$UV/Φ_{umidità} = 0,031 \text{ mW/lm}$

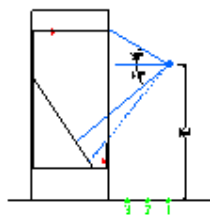
$T_{m(24h)} = 0,7 \text{ °C}$

$T_{m(24h)} = 0,7 \text{ °C}$

$\Delta U.R._{m(24h)} = - 6,3 \%$

$\Delta U.R._{m(24h)} = 2,5 \%$

L'escursione giornaliera della temperatura è compatibile con la conservazione di tutte le opere d'arte esposte; quella dell'umidità relativa, invece, risulta buona per i materiali meno sensibili e inaccettabile per gli oggetti particolarmente sensibili alle variazioni microclimatiche.



Alto:

$L_1 \text{ med} = 1220 \text{ cd/m}^2$

$L_2 \text{ med} = 1850 \text{ cd/m}^2$

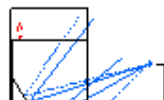
$L_3 \text{ med} = 2730 \text{ cd/m}^2$

Basso:

$L_{1,2,3} = 0 \text{ cd/m}^2$

La luminanza delle sorgenti superiori risulta sempre molto elevata e perciò è causa di abbagliamento diretto.

Le sorgenti luminose inferiori, invece, non risultano più visibili, per qualsiasi posizione assunta dall'osservatore.



Assenza di riflessi.

Sample analysis sheet from the manual

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