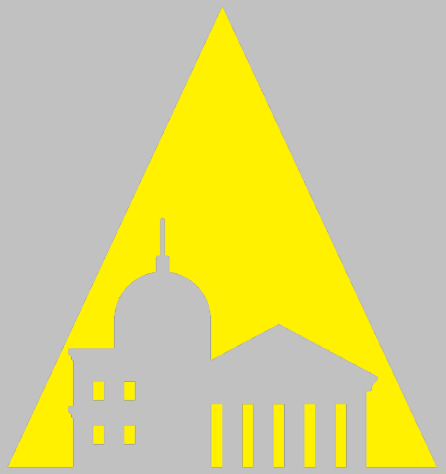

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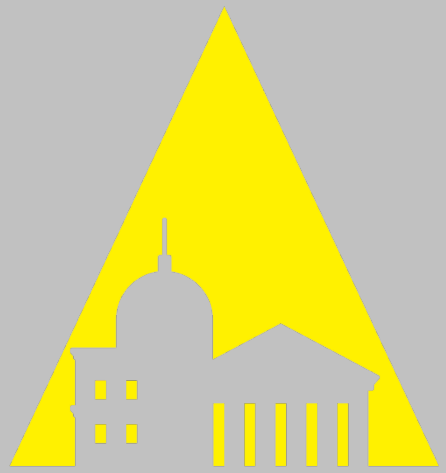

A methodology for combining light pollution, energy consumption and aesthetics of lighting design schemes for historical buildings

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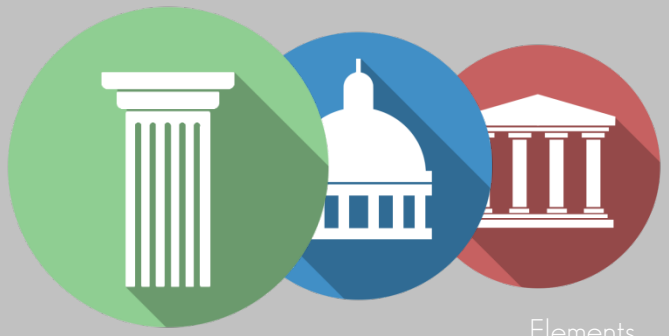
11th International Conference on Improving Energy Efficiency in Commercial Buildings and Smart Communities (IEECB&SC'20)
1-2 December 2020

_Historical and listed buildings provide a challenge for façade lighting due to placement and specification restrictions that confine lighting design decisions. These restrictions, besides imposing their influence on the aesthetics of the building, often affect performance issues, such as light pollution and energy consumption, which are difficult to address without visual simulation at the design stage due to the complex geometry and ornamental elements found on the facades of historical buildings.

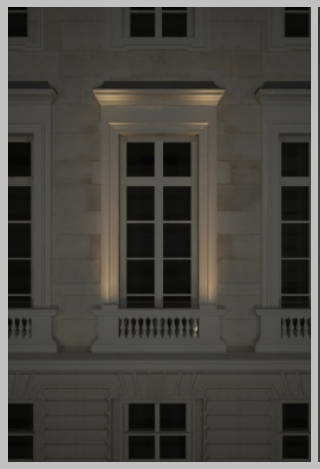
Buildings



Elements

_The aim

is to investigate appropriate ways of lighting the facades of historic buildings that contribute to reducing the phenomenon of light pollution.



_Methodology

STEP 1

-Methods of outdoor lighting

-Basic categories of lighting design for historical buildings

-Lighting design examples

STEP 2

-Calculation surfaces

-Lighting fixtures selection & positioning

-Accuracy of the calculations and selection of the calculation grid.

STEP 3

-Calculations with a structural element

-Useful illumination results & light pollution

STEP 4

-Calculations with a current facade

-Observations and analysis of the results

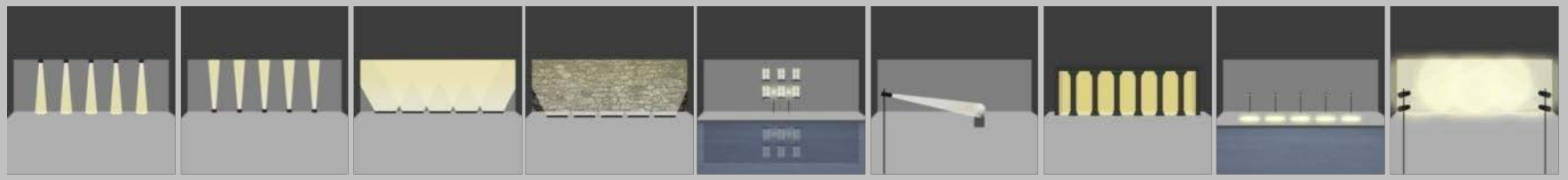
STEP 5

-Calculations with the surroundings

-Observations and analysis of the results

STEP 1

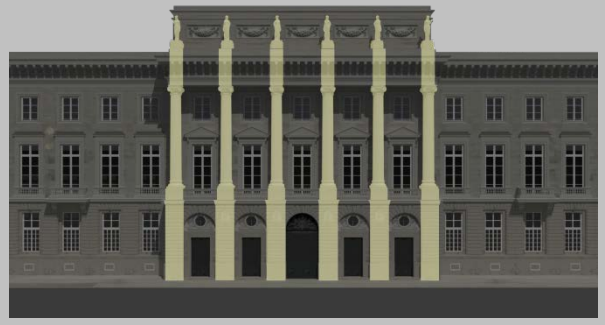
_Methods of Outdoor Lighting



Down Lighting | Up Lighting | Wall Washing | Grazing | Mirroring | Accent Lighting | Silhouetting | Spotlighting | Floodlighting

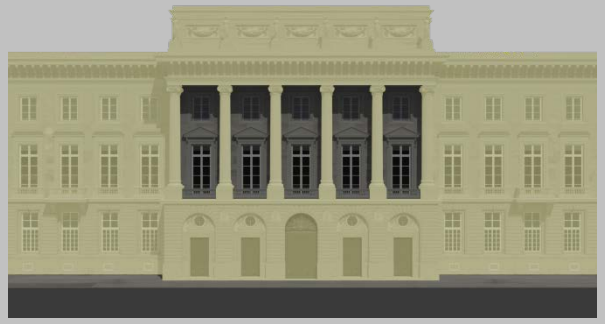
STEP 1

_Basic Categories Of Lighting Design for Historical Buildings

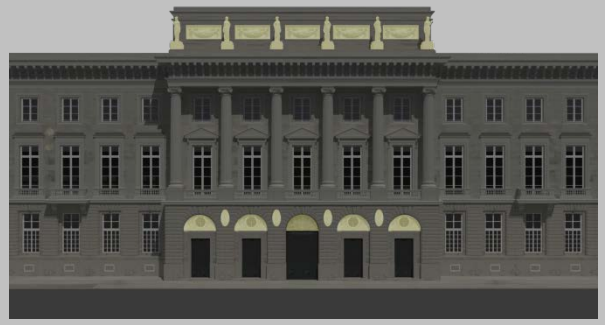


_Verticality

_Horizontality



_Volume



_ Individual Elements

_Openings

_Layers

STEP 1

_Lighting design examples

Municipal Building, Rieti, Italy.
(Photo: Luca Petrucci)

180 Wellington, Ottawa, Canada.
(Photo: Gordon King)

STEP 2

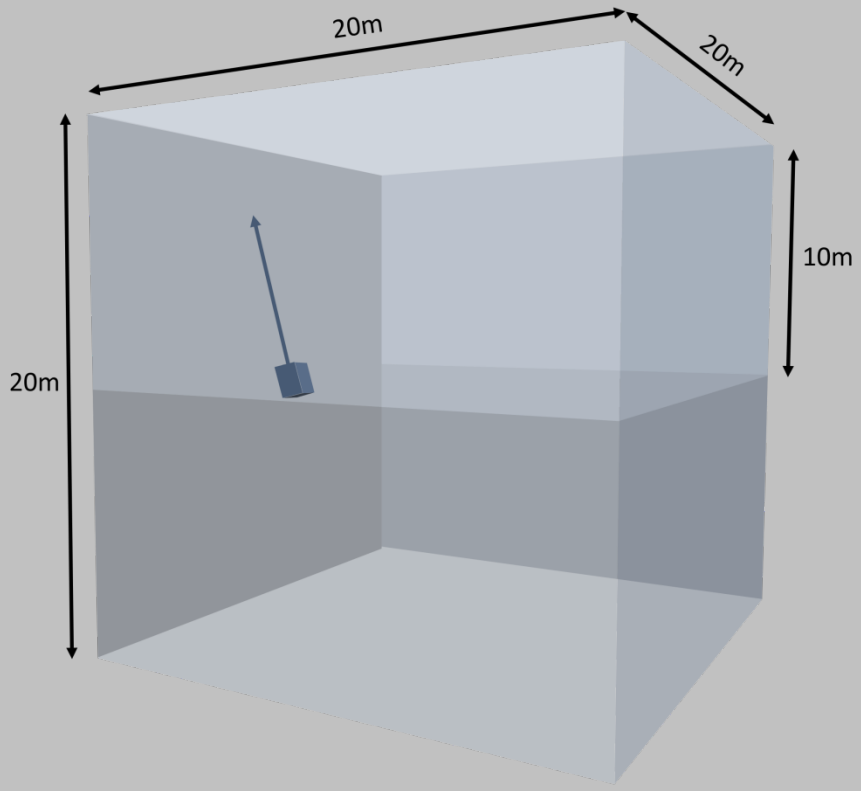


Figure 1: Rectangular parallelepiped consisting of calculation surfaces

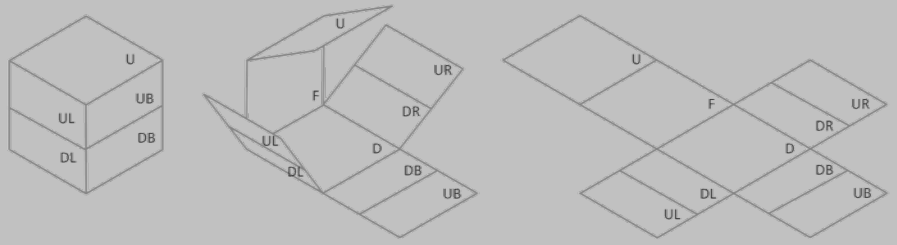
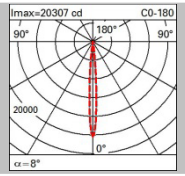
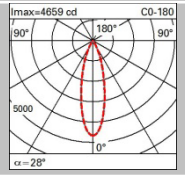
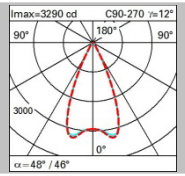
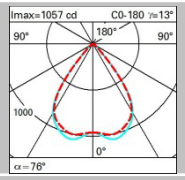


Figure 2: Development of the rectangular parallelepiped consisting of calculation surfaces

STEP 2

Table 1: Technical characteristics of the chosen luminaires.

#	Description	Polar Luminous Intensity	Lumen (Syst.)
L1	Super Spot (8°)		550lm
L2	Medium Spot (28°)		1394lm
L3	Wide Flood Spot (46°)		1875lm
L4	Very Wide Flood Spot (76°)		1373,5lm

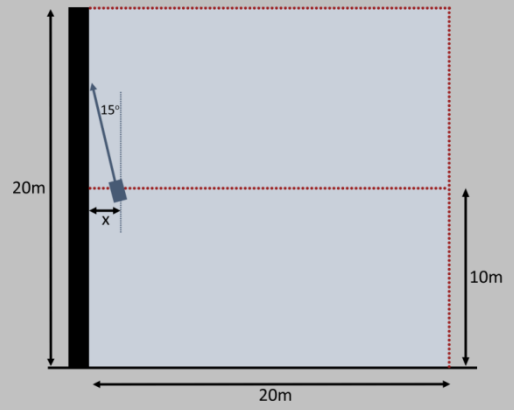
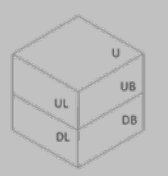
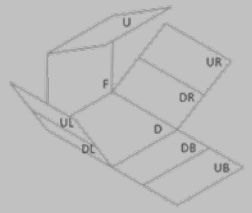
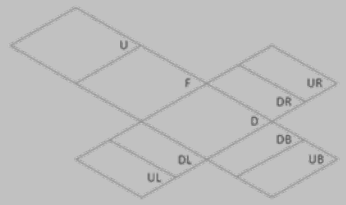


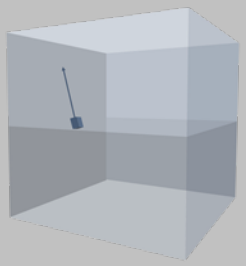
Figure 3: Placement of the selected luminaire

STEP 2









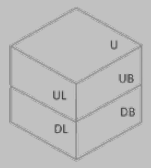
$E(lx)=\Phi(lm)/A(m2) \rightarrow 1\ lx = 1\ lm/m2 \rightarrow 1\ lm = 1\ lx*m2$

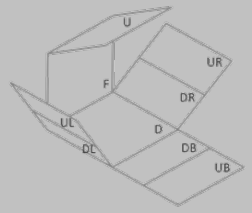
Where:
E - Illuminance (lx)
Φ - Luminous Flux (lm)

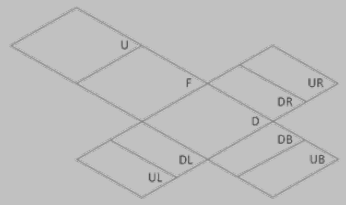
Table 2: Luminaire L1 results.

LUMINAIRE L1: 8^0 Luminaire Lumens: 1000lm/550lm (system)											
GRID DISTANCE: 20X20						GRID DISTANCE: 15X15					
Calc. Area	Area m^2	Eav (lx) A (No Façade)	Φ (lm) A (No Façade)	Eav (lx) B (With Façade)	Φ (lm) B (With Façade)	Calc. Area	Area m^2	Eav (lx) A (No Façade)	Φ (lm) A (No Façade)	Eav (lx) B (With Façade)	Φ (lm) B (With Façade)
U	400	0.0805	32.2	0.2922	116.9	U	400	0.0883	35.3	0.2989	119.6
D	400	0.0000	0.0	0.0682	27.3	D	400	0.0000	0.0	0.0681	27.3
F	400	0.3048	121.9	0.3048	121.9	F	400	2.0641	825.6	2.0641	825.6
DR	200	0.0000	0.0	0.0664	13.3	DR	200	0.0000	0.0	0.0663	13.3
UR	200	0.0016	0.3	0.1447	28.9	UR	200	0.0016	0.3	0.1444	28.9
DL	200	0.0000	0.0	0.0664	13.3	DL	200	0.0000	0.0	0.0663	13.3
UL	200	0.0016	0.3	0.1447	28.9	UL	200	0.0016	0.3	0.1443	28.9
DB	200	0.0000	0.0	0.1070	21.4	DB	200	0.0000	0.0	0.1069	21.4
UB	200	0.0000	0.0	0.1595	31.9	UB	200	0.0000	0.0	0.1594	31.9
		Sum A:	154.8	Sum B:	403.8			Sum A:	861.6	Sum B:	1110.0

STEP 3







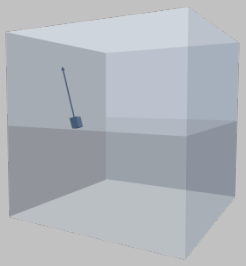
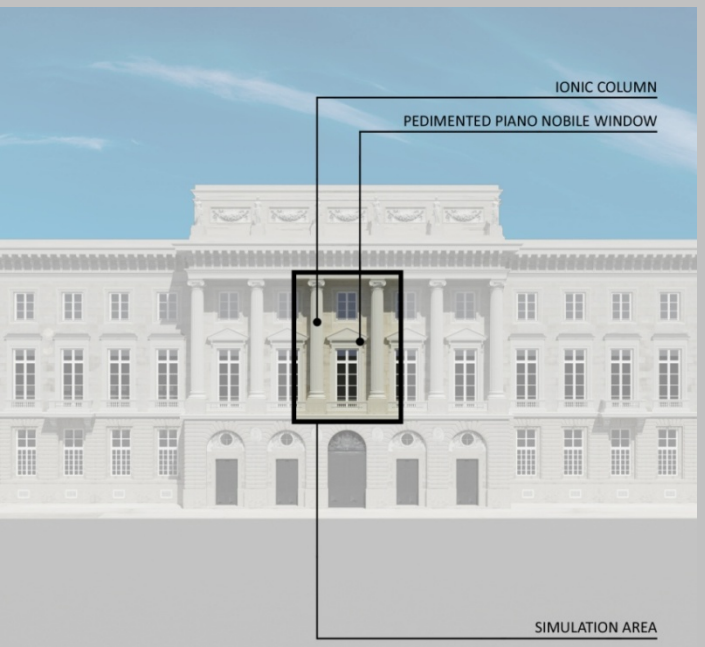


Table 3: Percentages of useful illumination of the luminaire L1.

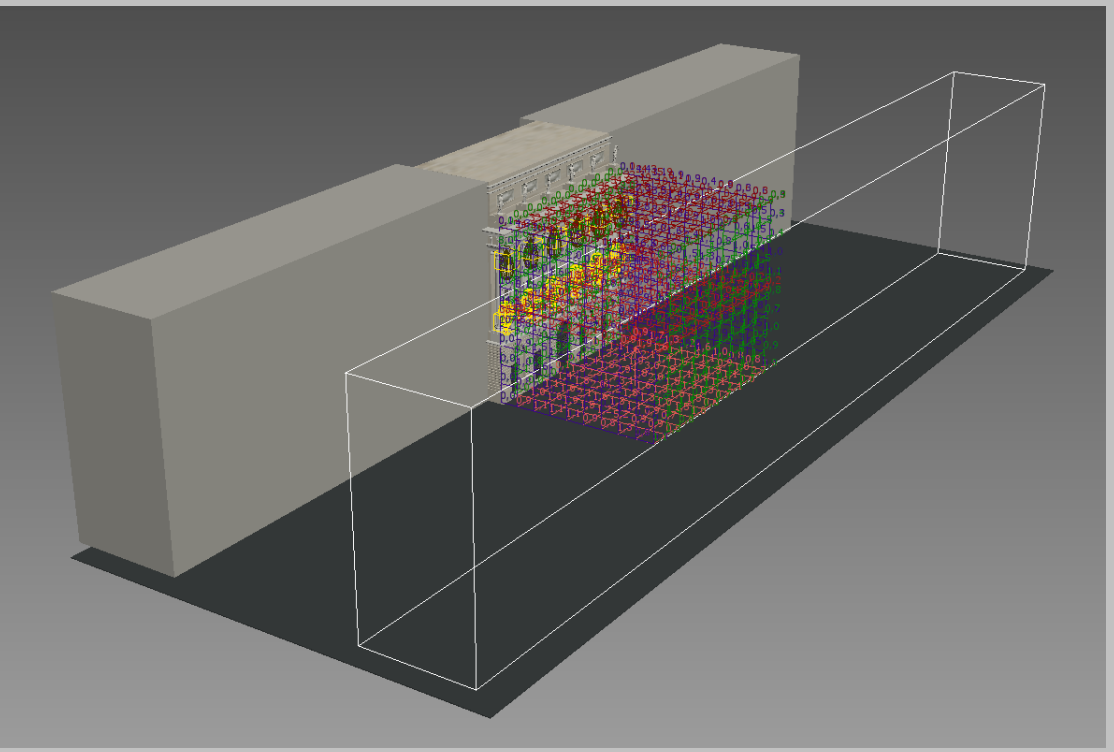
Calculation Area	Direct & Indirect Illumination (Φ (lm) B /Sum A)		Direct Illumination (Φ (lm) A/Sum A)
U	24,0%		8,7%
D	5,0%		0,0%
F	/		91,2%
DR	2,4%		0,0%
UR	5,3%		0,1%
DL	2,4%		0,0%
UL	5,3%		0,1%
DB	3,9%		0,0%
UB	5,9%		0,0%
D1 Illumination to the ground (=D)	5,0%		0,0%
D2 Illumination to other properties (=DR+DL+DB)	8,8%		0,0%
U1 Upwards illumination (=U+UR+UL+UB)	40,4%		8,8%
Useful illumination (=1-D1-D2-U1)	46%		91%

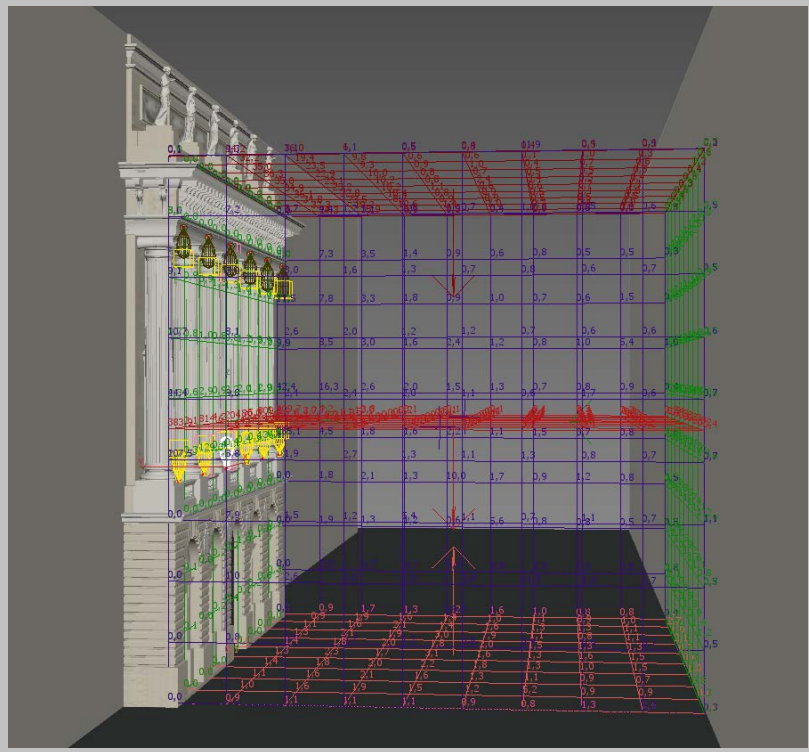
STEP 4


IONIC COLUMN
PEDIMENTED PIANO NOBILE WINDOW
SIMULATION AREA


1
2
3
4
1
2
3
4
5
6
7
7
8

STEP 5





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A METHODOLOGY FOR LIGHTING HISTORICAL BUILDINGS

HOME
HISTORY
METHODOLOGY
DATABASE
ABOUT
CONTACT

BUILDINGS.

Buildings

St. John Lateran Basilica

ROME - ITALY

Pantheon

PARIS - FRANCE

Petit Trianon

VERSAILLES - FRANCE

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Please, feel free to respond and provide us
with feedback by answering the following questionnaire!

https://www.ecoslight.eu/

ECOSLIGHT

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