

Natural lighting environment in existing school buildings: experimental studies and renovation design proposals

by Amoretti Laura and Taraglio Rossella

Relatore: Aghemo Chiara

Correlatori: Pellegrino Anna, Serra Valentina

The main study purpose consists first in **natural lighting environment evaluation of existing school buildings** placed in Turin or in its area, then in **building renovation proposals** to enhance visual comfort.

To evaluate **natural lighting environment** means to analyse the interaction of:

- **confined room**, that presents particular characteristics and that takes in several fittings;
- **fenestration** perhaps with control system, that has an influence upon coming light performances;
- **outside lighting environment** that is yielded by sun and sky and building site obstructions shape.

Users peculiarities, their **main activities** and also **room functions** are very important in lighting environment and so it is necessary to take the interaction of **user** and **visual task** characteristics and lighting environment in consideration, with reference to visual comfort parameters and indices reported in technical legislation.

Public Education efficiency, offered by **school buildings** selected to develop on this study, can be sure only if it takes care of classrooms environmental quality.

This kind of buildings involves also **high energy use** because of their great volume; since users make the greater part of the activities during the day it is important to optimize the daylighting systems design.

Then to optimize the energy efficiency too it is necessary to take care of solar radiation that is source of light but also of heat and so it needs to study both visual and thermic features together.

The **main thesis theme** is natural lighting in **high school buildings** and especially in classrooms and computers laboratories, common spaces, and so comparable, in this kind of school.

Students, in those schools taken in consideration, are from 14 since 19 years old: these ages are fundamental in their growth and education.

Thesis is developed into **two parts**:

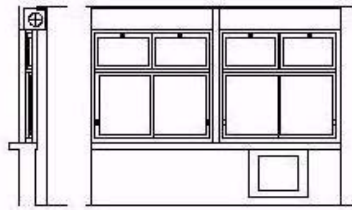
- **existing school building general knowledge** in Turin area;
- **renovation design proposals** of studied reality.

The **first part** main purpose is to evaluate environmental conditions in which users make their activities and to find out principal problems concerning visual comfort.

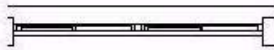
This part is divided into:

- (1) a **“General and wide research”**, in which several data about general building aspects and activities, and about classrooms and daylighting systems characteristics are investigated

SISTEMA DI ILLUMINAZIONE NATURALE



scala 1:50



DEPPAMENTO dimensioni: area sistema di apertura tipo di movimento telai area telai (m ²)	a due ante scorrevoli + valvola superiore a serrata scorrevole in alluminio, s = 80 mm 2,8
VERRO tipologia area vetrata (m ²) fattore di trasmissione luminosa (t) in vetro fattore di riflessione luminosa (r) alveata	doppio 4,76 0,55 0,13
SCHEPPIATURA applicazione dimensioni: materiale, colore tipo di movimento funzionamento	calano avvolgibile, PVC, grigio chiaro via locale manuale; movimento differenziale: 1 avvolgibile (altezza: 1,25 m, altezza: 1,8 m) ogni 2 ante scorrevoli 2 avvolgibili (I e II) a pannello sup. A) bloccati, coprono il vetrata.
PRACTICA (facilità di utilizzo e di pulizia/manutenzione)	1 2 3 4 5

FOTOGRAFIE DELLO SKYLINE ESTERNO



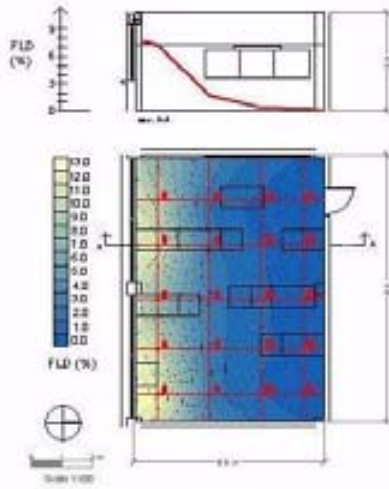
Characteristics of an analysed classroom, the daylighting system

an **“Experimental measurement”**, through which an objective evaluation of visual comfort parameters in daylighting conditions is made

FATTORE DI LUCE DIURNA, piano di lavoro orizzontale

VALORI MISURATI IN CAMPO

21/05/02; cielo coperto variabile; ora inizio 15.02; ora fine 15.24



PUNTI	D _x [m]	S _{max} [lx]	FLD [%]
1	1.20	1000	3.18
2	1.10	1000	2.18
3	0.90	1000	0.18
4	0.80	1000	0.17
5	0.70	1000	0.16
6	1.10	1000	3.27
7	1.00	1000	2.28
8	1.00	1000	2.28
9	1.10	1000	3.27
10	1.00	1000	2.28
11	0.90	1000	0.17
12	0.80	1000	0.16
13	0.70	1000	0.15
14	0.60	1000	0.14
15	0.50	1000	0.13
16	0.40	1000	0.12
17	0.30	1000	0.11
18	0.20	1000	0.10
19	0.10	1000	0.09
20	0.00	1000	0.08

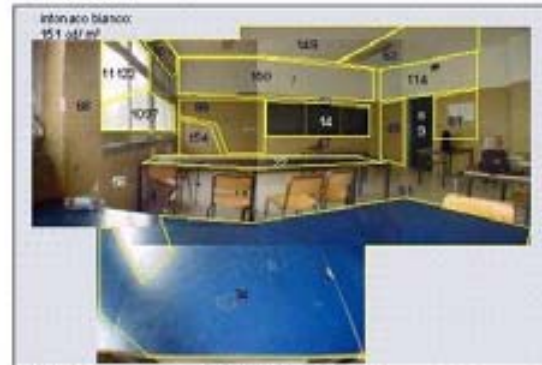
FLD_a = 3.7%

MAPPATURA DEI VALORI MEDI DI LUMINANZA

POSTAZIONE 1

21/05/02; cielo coperto variabile; ora inizio 15.08; ora fine 15.18

E_{d,med} = 47496 lux; L_{a,med} = 9886 cd/m²



VALORI MISURATI	INTERVALLI ACCETTABILI (Rif. UNI 10338: maggio 1992)	
COMPITO VISIVO L [cd/m ²]	SUP. ADIACENTI L [cd/m ²]	SUP. LONTANE L [cd/m ²]
Foglio bianco: 071	324 < L < 2013	87 < L < 8783
Lavagna: 14	48 < L < 42	1.4 < L < 145
SORGENTI LUMINOSE L [cd/m ²]	SUP. ADIACENTI L [cd/m ²]	
Volta celeste: 11122	L > 506	
Ostruzione: 1007	L = 55	

AMBIENTE: L_{amb} e L_{sup} (misurate)
 L_{amb} = 11122 cd/m² (volta celeste) L_{sup} / L_{amb} = 1238
 L_{amb} = 0 cd/m² (porta bb) (Rif. UNI 10338: maggio 1992: L_{sup} / L_{amb} < 40)

Illuminances and luminances results about an analysed classroom

Remarks and data obtained synthesis is the start point to develop the thesis **second part**, whose purpose is to make several **renovation proposals of examined school buildings** to optimize visual comfort conditions, in the light of problems pointed out in the first part of the study.

Design proposals are organized in “**Generical design proposals**”, some marks to solve existing problems, and in a section set only to **study in depth daylighting control system**.

Therefore thesis proceeds in making a “**Performance Matrix**”, that is an useful and versatile work tool and that can be used to select a possible control system for a specific classroom.

The Matrix is a statement in form of a table that shows several aspects of control system application

CATEGORIE	SPECIFICHE	CODICE	BENESSERE VISIVO							BENESSERE IGROTERMICO			FRUIBILITÀ		SICUREZZA	DURABILITÀ	GESTIONE		INTEGRAZIONE PER LUCE NATURALE E ARTIFICIALE		
			Controllo del livello luminoso (LEVA)	Controllo del livello luminoso (MANIPOLAZIONE)	Controllo del livello luminoso (MANIPOLAZIONE)	Controllo della temperatura (MANIPOLAZIONE)	Controllo della temperatura (MANIPOLAZIONE)	Controllo della temperatura (MANIPOLAZIONE)	Controllo della temperatura (MANIPOLAZIONE)	Controllo della temperatura (MANIPOLAZIONE)	Controllo della temperatura (MANIPOLAZIONE)	Controllo della temperatura (MANIPOLAZIONE)	Controllo della temperatura (MANIPOLAZIONE)	Controllo della temperatura (MANIPOLAZIONE)			Controllo della temperatura (MANIPOLAZIONE)	Controllo della temperatura (MANIPOLAZIONE)		Controllo della temperatura (MANIPOLAZIONE)	Controllo della temperatura (MANIPOLAZIONE)
Tenda per Interno	in continua	A14; A2; A3; A4; A5; A6; A7; A8; A9; A10; A11; A12; A13; A14; A15; A16; A17; A18; A19; A20																			
Tenda per Esterno	a filo	E10																			
Tenda in Motorcamera	a filo e battenti pleonemi	E11																			
Tenda in Motorcamera	pleon	E12																			
Tenda orientata per Interno	a lamelle continue	D13																			
Tenda orientata per Interno	a lamelle microslat	D14																			
Tenda orientata per Esterno	a lamelle continue con guida di scorrimento	E15																			
Tenda orientata per Esterno	a lamelle continue con guida di scorrimento	E16																			
Tenda orientata in Motorcamera		F17																			
Fangolo per Esterno	verticale, a eglise orizzontali fase fessure	G18																			
	verticale, a eglise orizzontali fase con microslat	G19																			
	verticale, a eglise orizzontali fase fessure, pannello sulla finestra	G20																			
	verticale, a eglise orizzontali fase fessure, pannello sulla finestra	G21																			
	verticale, a eglise orizzontali fase fessure, pannello sulla finestra	G22																			
	verticale, a eglise orizzontali fase fessure, pannello sulla finestra	G23																			
	verticale, a eglise orizzontali fase fessure, pannello sulla finestra	G24																			
	verticale, a eglise orizzontali fase fessure, pannello sulla finestra	G25																			
	verticale, a eglise orizzontali fase fessure, pannello sulla finestra	G26																			
	verticale, a eglise orizzontali fase fessure, pannello sulla finestra	G27																			
Fangolo in Motorcamera	a lamelle orientate orientate	H28																			
	pleon - microslat	H29																			
Pannello orientabile per Esterno	anche con intesa di polivalenza	I30																			
	anche con intesa di polivalenza	I31																			

Performance Matrix about control system application

It is composed by:

- **real products**, selected through a marketing research, arranged on lines;
- **performance evaluation methods**, arranged on columns.

Then thesis proceeds in reading system controls performance through system controls direct comparison.

This comparison is useful to express a **judgement set** and **concise evaluations** about system controls performance during their using, and it makes to be able to select that system that optimizes the design.

This approach is an attempt to realize a **knowledge tool in picking out a daylighting control system through a well reasoned selection**.

For further information, e-mail

Amoretti Laura laura.amoretti@libero.it

Taraglio Rossella t-rossella@tiscali.it