DAY LIGHTING

Why Daylighting

Daylight Evaluation Criteria

Daylight Design Criteria

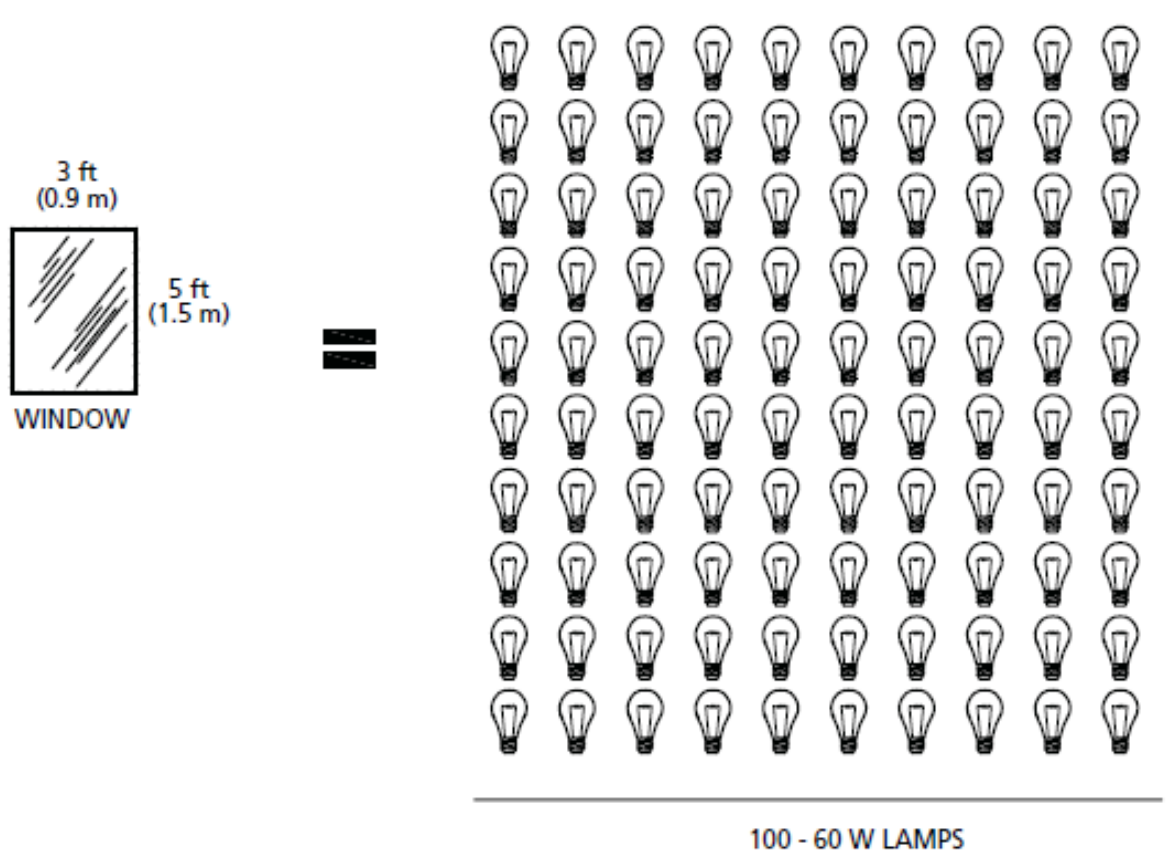
Daylight examples

WHY DAYLIGHT

To connect building occupants with the outdoors, reinforce circadian rhythms, and reduce the use of electrical lighting by introducing daylight into the space.

To determine the suitable lighting intensity to meet the required applications

Lower electricity bills - Improves quality of life - Connectivity to exterior environment. - Better health and well-being of occupants



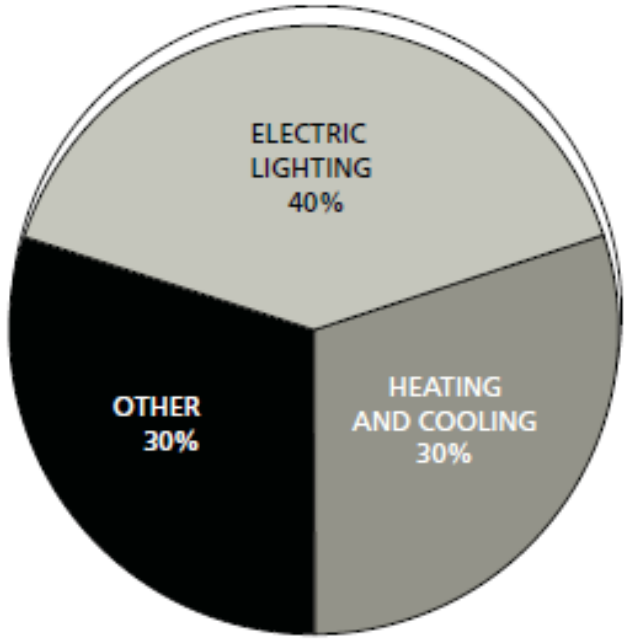


Figure 13.2a Typical distribution of energy use for buildings such as offices, schools, and many industrial facilities.

ENERGY REDUCTION

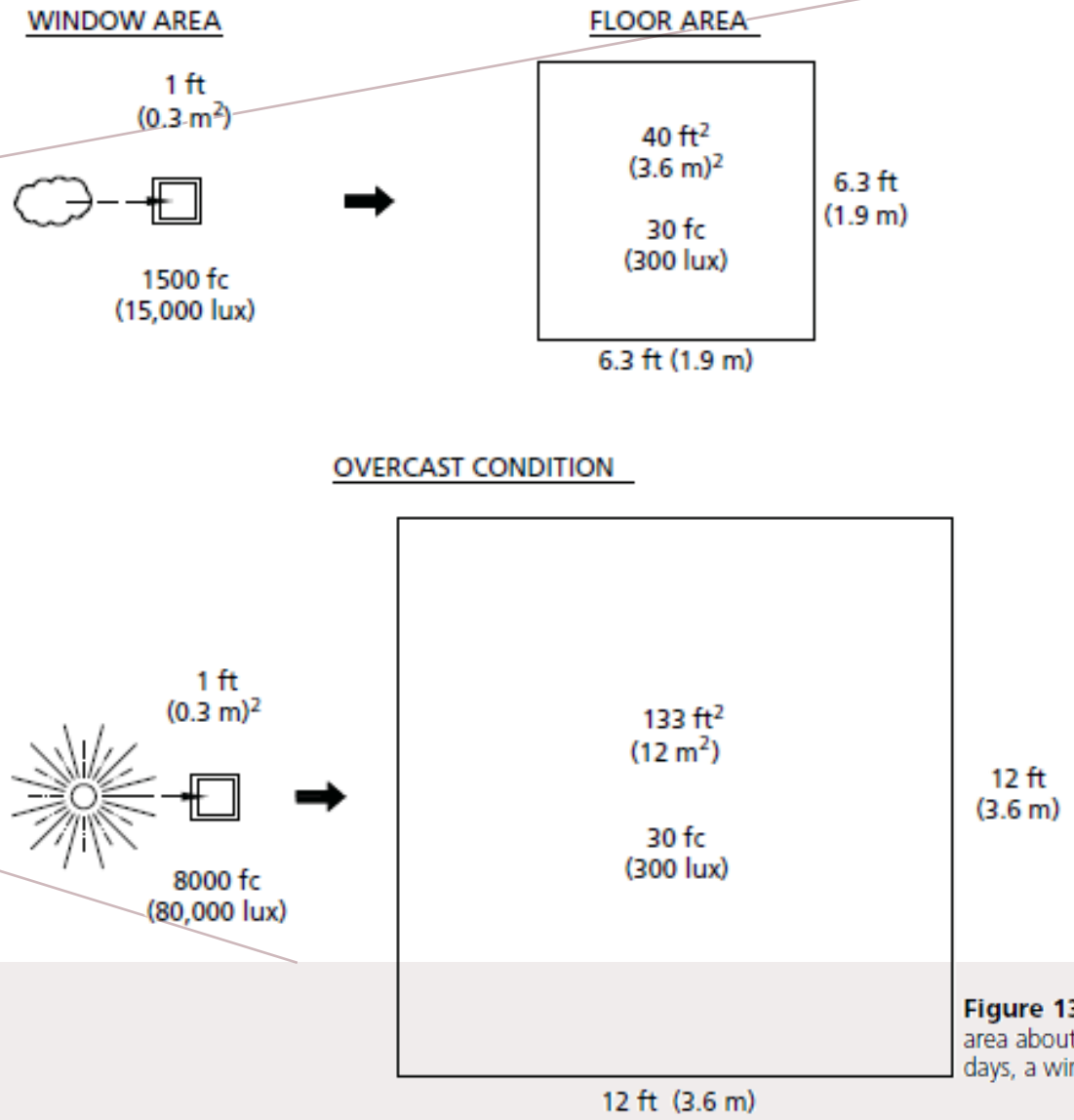


Figure 13.3e Sunlight is such an abundant source of light that a window can illuminate a floor area about 133 times the size of the window if the light is distributed evenly. Even on overcast days, a window can illuminate a floor area about 40 times the size of the window.

ENERGY REDUCTION

Energy lights simulate the natural power of daylight to help improve energy levels and wellbeing

MENTAL HEALTH

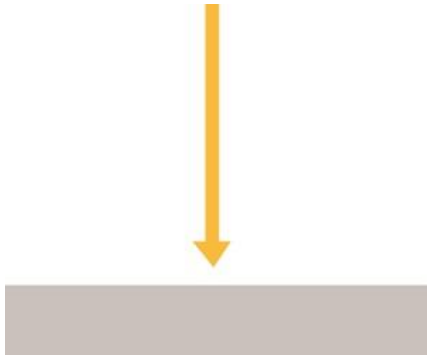
DAYLIGHT EVALUATION CRITERIA

DAY- LIGHTING EVALUATION CRITERIA

- Day Lighting Intensity LUX
- Day Lighting Distribution

ILLUMINANCE

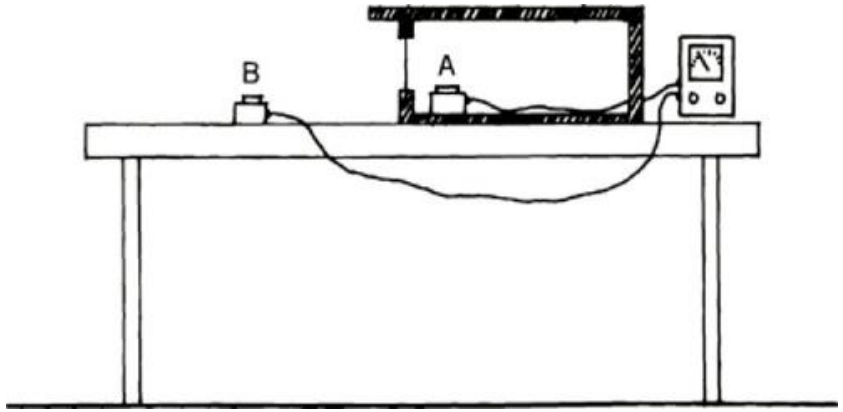
- Illuminance is the measure of the amount of light received on the surface. It is typically expressed in lux (lm/m^2). Illuminance levels can be measured with a luxmeter.



Typical illuminance values:	
Direct sunlight	100,000 lux
Diffuse skylight	3,000-18,000 lux

Minimum levels for tasks and activities:	
Residential rooms	200-500 lux
Classrooms (general)	300-500 lux
Workspace lighting	200-500 lux

- Daylight factor (DF) is a daylight availability metric that expresses as a percentage the amount of daylight available inside a room (on a work plane) compared to the amount of unobstructed daylight available outside under overcast sky conditions (Hopkins,1963).



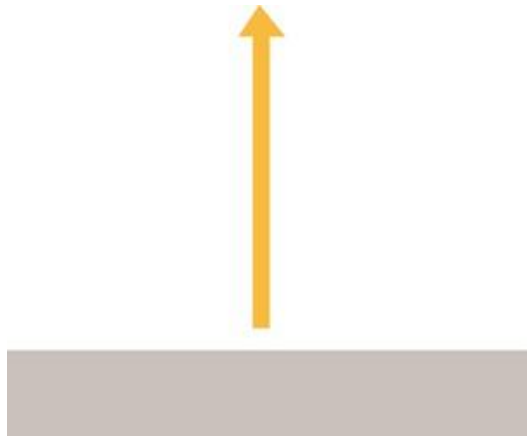
The daylight factor (DF) is determined by the ratio of indoor to outdoor illumination on an overcast day.
DF = A/B x100

Table 13.5A Typical Minimum Daylight Factors

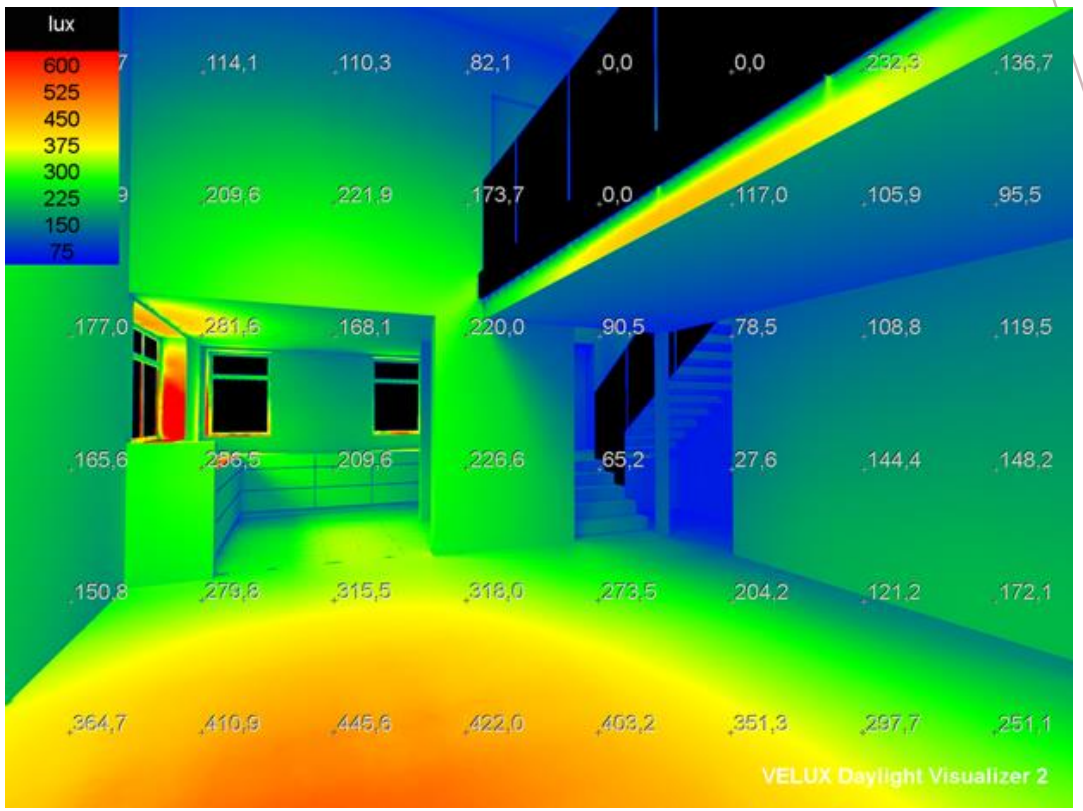
Type of Space	Daylight Factor
Art studios, galleries	4–6
Factories, laboratories	3–5
Offices, classrooms, gymnasiums, kitchens	2
Lobbies, lounges, living rooms, churches	1
Corridors, bedrooms	0.5

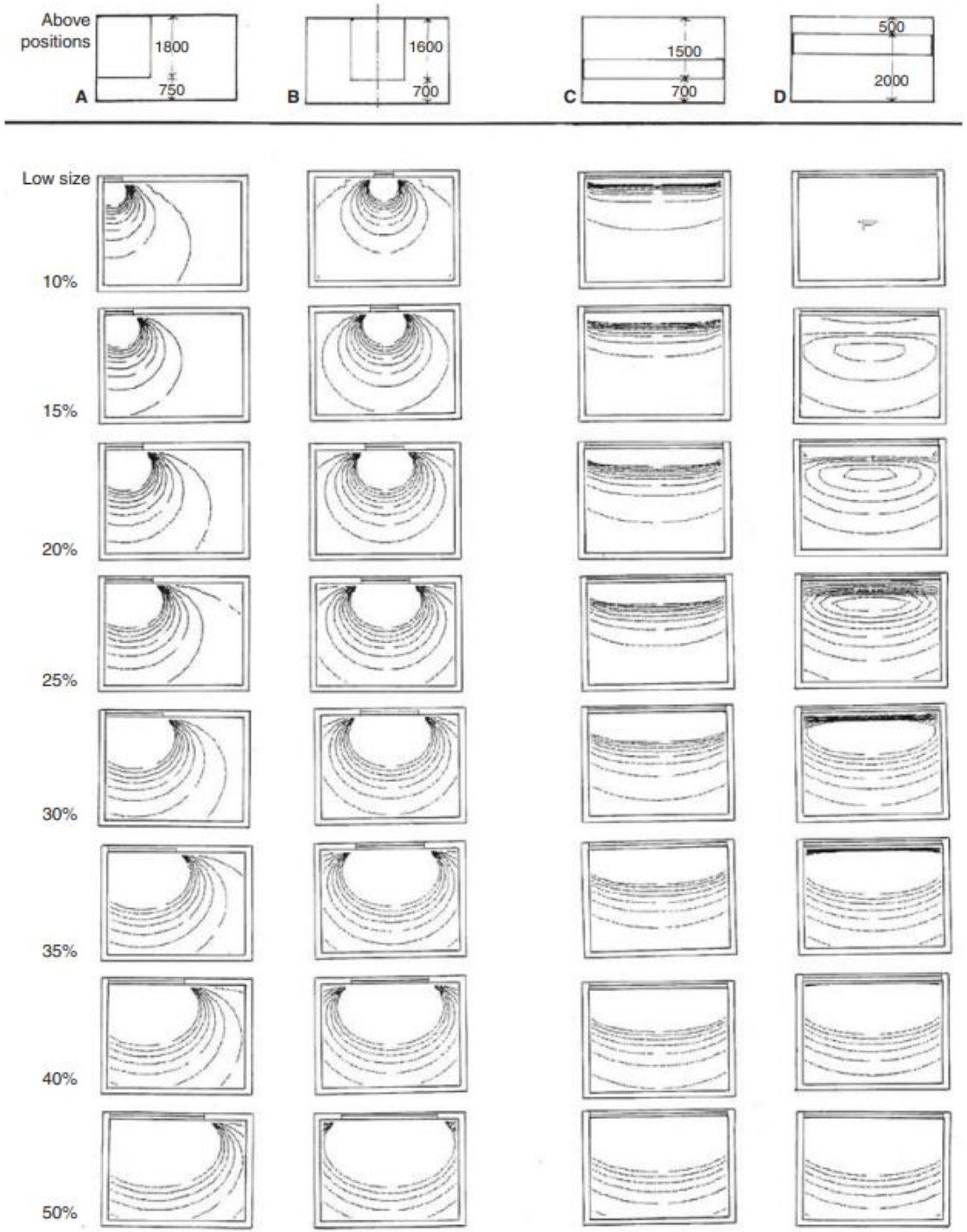
LUMINANCE

Luminance is the measure of the amount of light reflected or emitted from a surface. It is typically expressed in cd/m². Luminance levels can be measured with a luminance meter. Luminance is the measure of light used to evaluate visual comfort and glare in the interior

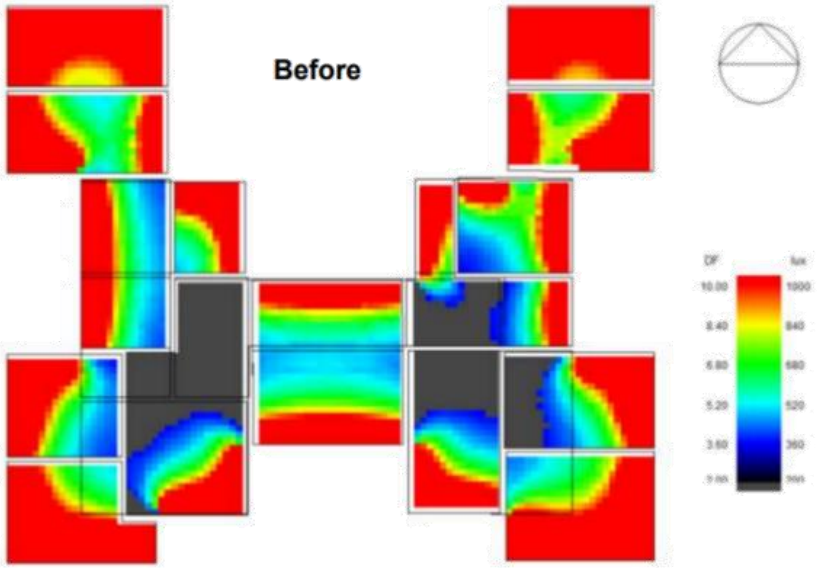


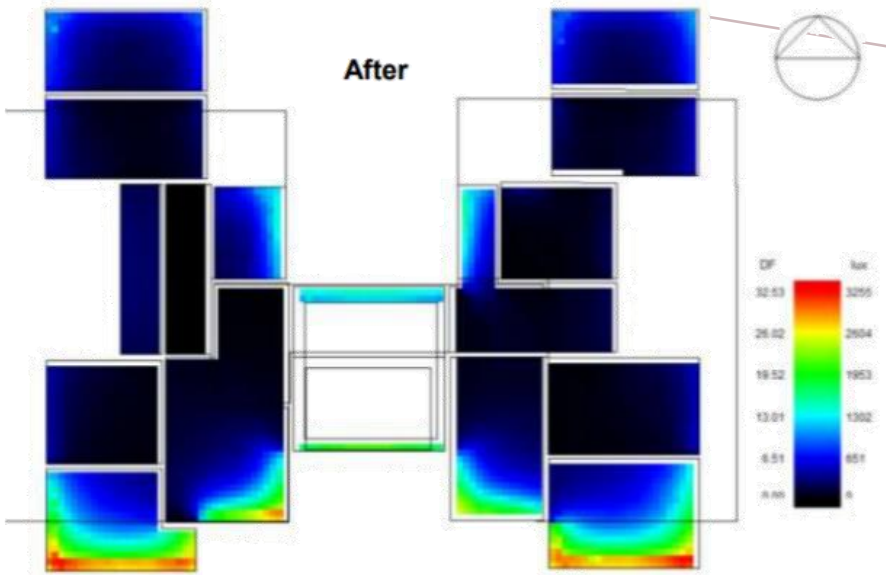

VELUX Daylight Visualizer 2


lux
600
525
450
375
300
225
150
75
,114,1
,110,3
,82,1
,0,0
,0,0
,232,3
,136,7
,209,6
,221,9
,173,7
,0,0
,117,0
,105,9
,95,5
,177,0
,281,6
,168,1
,220,0
,90,5
,78,5
,108,8
,119,5
,165,6
,209,6
,226,6
,65,2
,27,6
,144,4
,148,2
,150,8
,279,8
,315,5
,318,0
,273,5
,204,2
,121,2
,172,1
,364,7
,410,9
,445,6
,422,0
,403,2
,351,3
,297,7
,251,1
VELUX Daylight Visualizer 2

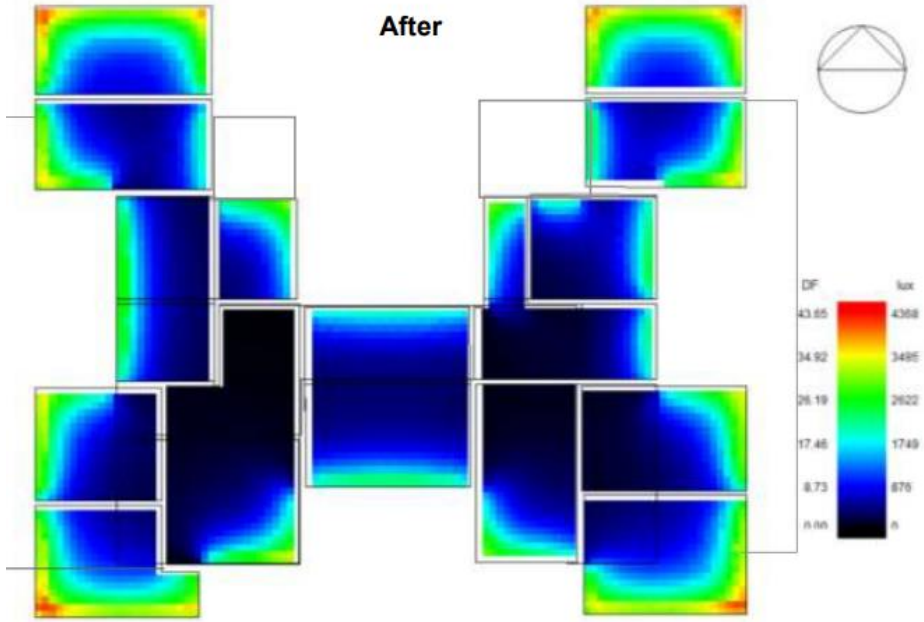


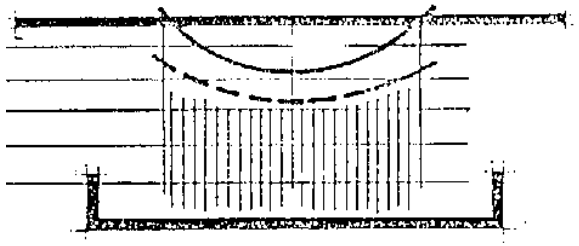
A study of daylight distribution. Column A: jamb fixed at side wall, width variable, Column B: centre of window on room centreline, width variable, Column C: full width, sill fixed, height variable, Column D: full width, window head fixed, height variable. Each variant is examined with sizes of 10–50% of wall area (after T. Yamaguchi).





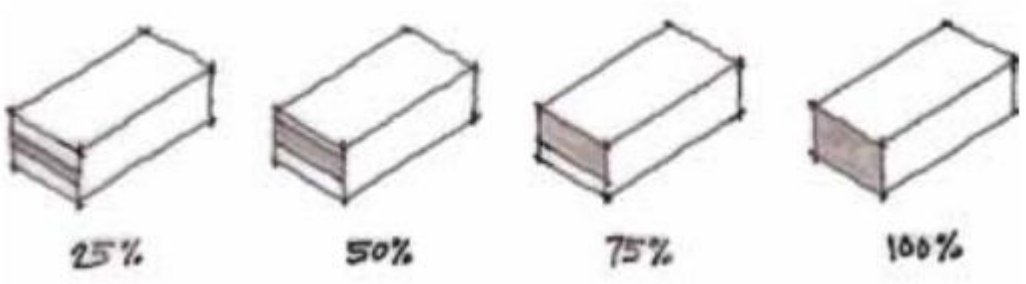
3-D View	Section/Plan	Ideal orientation	View restriction
Horizontal single blade		South	★★★★
Outrigger system		South	★★★★
Horizontal multiple blades		South	★★★★
Vertical fin		East/West	★★★★
Slanted Vertical fin		East/West	★★★★
Eggcrate		East/West	★★★★

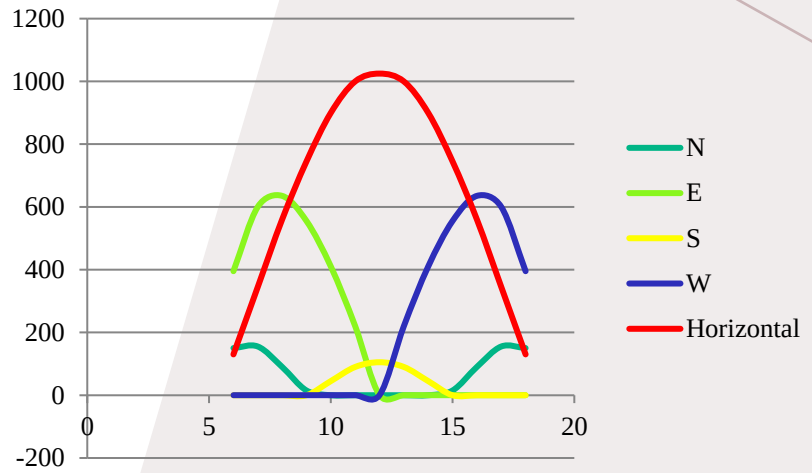




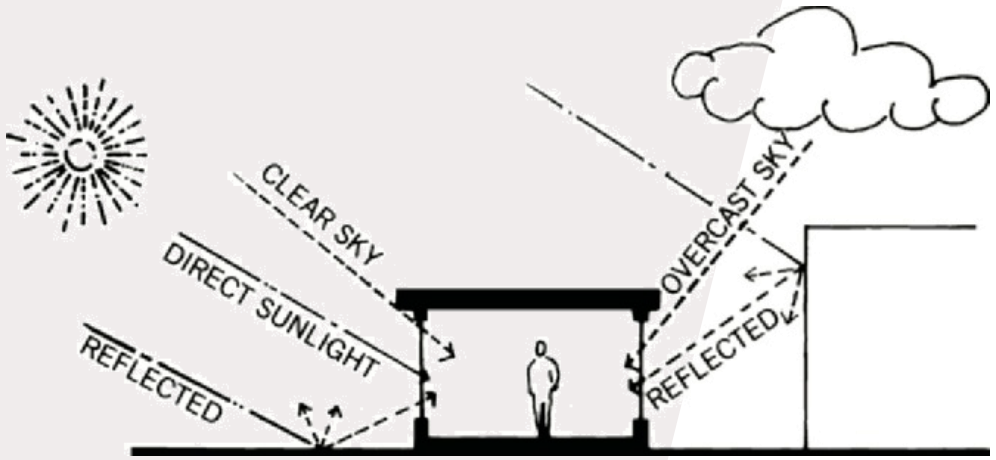
DAYLIGHT DESIGN CRITERIA

The challenge for the building envelope is to design it in such a way that there is an optimal balance between **sufficient day light** in the building, and a **minimal heat transfer** through the envelope. The transparent parts of the envelope, such as windows or doors, can transfer heat around five times faster than the closed, or opaque, part of the envelope.



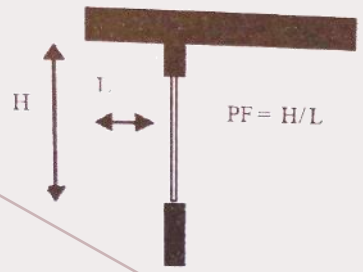


- A maximum WWR of 18% building envelope .
- A maximum of 10% glazed area for a room with south orientation
- Large glazed areas are preferred on the north side, since the north has the lowest radiation of all elevations,
- Reduce windows area on west, east and south-oriented facades.
- Large window areas, exposed to direct solar radiation, should have exterior solar shading devices

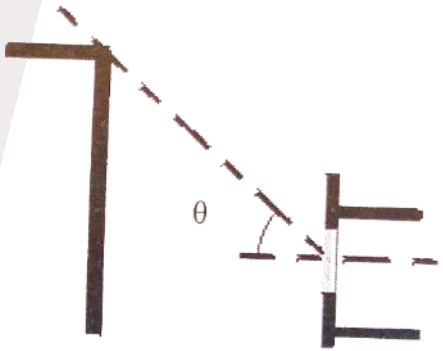


- Natural daylight requirements:

1. Obstruction angle θ should not exceed 70^{o}
2. Window wall ratio (WWR) is not less than:10% for service spaces
   :15 % for living spaces
3. Visibility transmittance factor (VLT):is not less than 0.45
4. Finishing colours for : service spaces should be light
   living spaces should be light to moderate



Projection Factor



Obstruction Angle

Egyptian energy code

Table 13.7 Light-to-Solar-Gain (LSG) Ratios for Various Glazing Systems

Glass Type (All Double-Glazed)	Visible Transmittance (VT)	Solar Heat Gain Coefficient (SHGC)	Light-to-Solar-Gain Ratio (LSG)
Clear	0.82	0.75	1.20
Bronze	0.62	0.60	1.03
Reflective	0.20	0.16	1.25
Spectrally selective	0.70	0.46	1.52

$$TV = Tvis = \frac{\text{transmitted light}}{\text{incident light}}$$

$$\text{Light-to-solar-gain ratio} = \frac{\text{visible transmittance}}{\text{solar heat gain coefficient}}$$

or

$$LSG = \frac{VT}{SHGC}$$

- **Visible transmittance** (VT or Tvis) is the factor that quantifies the amount of visible light that passes through glazing. It varies from 0.9 for very clear glass to less than 0.1 for highly reflective or tinted glass. For cool daylight, the VT should be high compared to the transmission of the solar infrared.

- **The solar heat gain coefficient** (SHGC) is a factor that quantifies the total solar radiation (visible, UV, and solar infrared) that passes through glazing.

- The ratio of the VT to the SHGC is called the **light-to-solar-gain** (LSG) ratio. The higher the ratio, the cooler the light.

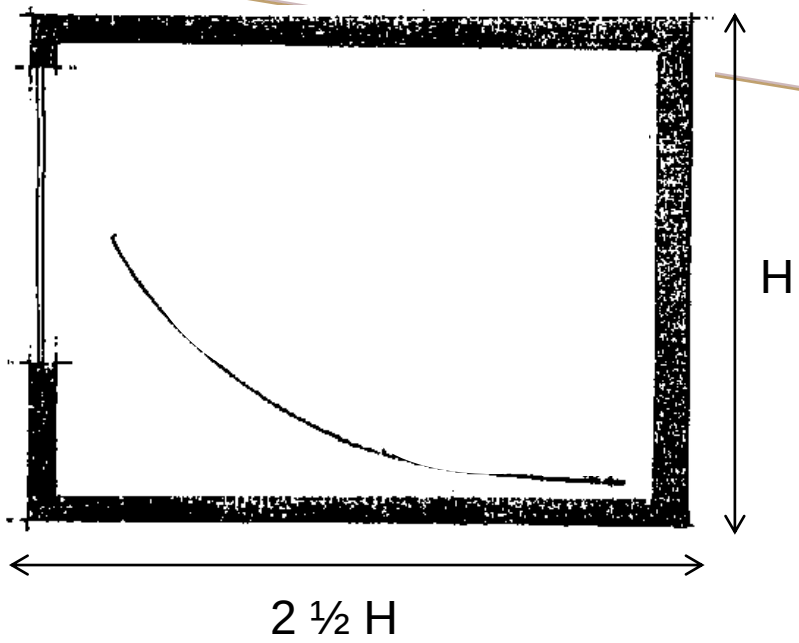
OUR PRODUCTS FOR FACADES in **Double Glazing Units**

Product	Color in reflection	Light transmission LT %	External reflection LRe %	Internal reflection LRi %	Solar Factor g-value %	Shading Coefficient	Ug-Value W/(m2.K)
Colored appearance, as well as basic solar control properties							
PARSOL in double glazing unit (6I 16 I6 mm, Air) with PLANILUX Values given according to the standards EN 410 and EN 673							
PARSOL	Blue	51	9	13	0.44	0.50	2.7
PARSOL	Dark Blue	25	6	12	0.37	0.42	2.7
PARSOL	Green	65	11	14	0.45	0.52	2.7
PARSOL	Bronze	44	7	12	0.49	0.56	2.7
PARSOL	Grey	39	7	12	0.46	0.53	2.7
PARSOL in double glazing unit (6I 16 I6 mm, Air) with PLANITHERM UN II coating on face # 3							
PARSOL	Blue	49	7	10	0.36	0.41	1.4
PARSOL	Dark Blue	25	5	10	0.28	0.33	1.4
PARSOL	Green	64	9	11	0.38	0.44	1.4
PARSOL	Bronze	43	7	10	0.37	0.43	1.4
PARSOL	Grey	38	6	10	0.35	0.40	1.4
Reflective and solar control glass							
REFLECTASOL in double glazing unit (6 I 16 I6 mm, Air, coating on face # 2) with PLANILUX Values given according to the standards EN 410 and EN 673							
REFLECTASOL	Light Bronze	30	47	53	0.44	0.51	2.7
REFLECTASOL	Blue	18	22	52	0.26	0.30	2.7
REFLECTASOL	Dark Blue	9	9	52	0.23	0.27	2.7
REFLECTASOL	Green	24	33	53	0.25	0.29	2.7
REFLECTASOL	Bronze	16	17	52	0.33	0.38	2.7
REFLECTASOL	Grey	14	14	52	0.31	0.36	2.7
REFLECTASOL in double glazing unit (6I 16 I6 mm, Air, coating on face # 2) with PLANITHERM UN II coating on face # 3							
REFLECTASOL	Light Bronze	28	47	48	0.31	0.36	1.4
REFLECTASOL	Blue	18	21	47	0.18	0.21	1.4
REFLECTASOL	Dark Blue	8	9	47	0.15	0.17	1.4
REFLECTASOL	Green	23	33	48	0.18	0.21	1.4
REFLECTASOL	Bronze	16	17	47	0.22	0.25	1.4
REFLECTASOL	Grey	14	14	47	0.20	0.23	1.4
Solar control coating offering full flexibility for processing							
COOL-LITE ST in double glazing unit (6I 16 I6 mm, Air, coating on face # 2) with PLANILUX Values given according to the standards EN 410 and EN 673							
COOL-LITE ST 150	Grey	46	20	22	0.46	0.52	2.7
COOL-LITE ST 767 II	Blue	38	12	22	0.35	0.41	2.7
COOL-LITE ST 136 II	Neutral	34	23	23	0.35	0.40	2.6
COOL-LITE ST in double glazing uni (6 I 16 I 6 mm, Air, coating on face # 2) with PLANITHERM UN II coating on face # 3							
COOL-LITE ST 767 II	Blue	37	11	20	0.28	0.32	1.4
COOL-LITE ST 136 II	Neutral	33	23	20	0.28	0.32	1.4
COOL-LITE ST 150	Grey	45	19	19	0.38	0.43	1.4

Product	Color in reflection	Light transmission LT %	External reflection LRe %	Internal reflection LRi %	Solar Factor g-value %	Shading Coefficient	Ug-Value W/(m2.K)
Selective solar control coating with reinforced thermal insulation							
COOL-LITE K in double glazing unit (6I 16 I6 mm, Air, coating on face # 2) with PLANILUX Values given according to the standards EN 410 and EN 673							
COOL-LITE KN 130 II	Neutral	31	22	13	0.25	0.28	1.6
COOL-LITE KN 177 II	Neutral	69	24	21	0.48	0.55	1.3
COOL-LITE KBT 140	Blue	36	24	17	0.30	0.34	1.6
COOL-LITE KB 130 II	Blue	25	21	22	0.21	0.25	1.5
COOL-LITE KN 166 II	Neutral	60	23	25	0.39	0.45	1.3
COOL-LITE KN 148 II	Grey	46	27	18	0.32	0.37	1.3
COOL-LITE KS 138 II	Neutral	36	38	20	0.26	0.30	1.4
COOL-LITE KNT 140	Neutral	37	23	12	0.29	0.33	1.6
Highly selective solar control coating with reinforced thermal insulation							
COOL-LITE SKN in double glazing unit (6I 16 I6 mm, Air, coating on face # 2) with PLANILUX Values given according to the standards EN 410 and EN 673							
COOL-LITE SKB 140 II	Blue	41	16	12	0.23	0.26	1.4
COOL-LITE SKN 152 II	Grey	49	18	14	0.26	0.30	1.3
COOL-LITE SKN 133 II	Neutral	30	13	10	0.19	0.21	1.4
COOL-LITE SKN 154 II	Neutral	51	18	22	0.28	0.32	1.3
COOL-LITE SKN 146 II	Neutral	40	11	11	0.24	0.28	1.4
COOL-LITE SKN 176 II	Neutral	68	13	15	0.37	0.42	1.3
Highly transparent low-E glass with natural aesthetics							
PLANITHERM in double glazing unit (6I 16 I6 mm, Air, coating on face # 2) with PLANILUX Values given according to the standards EN 410 and EN 673							
PLANITHERM UN II #3	Neutral	78	12	12	0.61	0.70	1.4
PLANITHERM HN #3	Neutral	74	12	12	0.65	0.74	1.6
PLANITHERM ONE II #3	Neutral	69	22	21	0.47	0.54	1.3
PLANITHERM 1.3 on Blue #2	Blue	48	7	11	0.34	0.39	1.5
Extremely selective solar control coating with reinforced thermal insulation							
COOL-LITE EXTREME in double glazing unit (6I 16 I6 mm, Air, coating on face # 2) with PLANILUX Values given according to the standards EN 410 and EN 673							
COOL-LITE XTREME 6129/ II	Neutral	60	11	15	0.29	0.34	1.3
COOL-LITE XTREME 50 / 22 II	Neutral	47	16	18	0.21	0.25	1.3

ROOM DEPTH

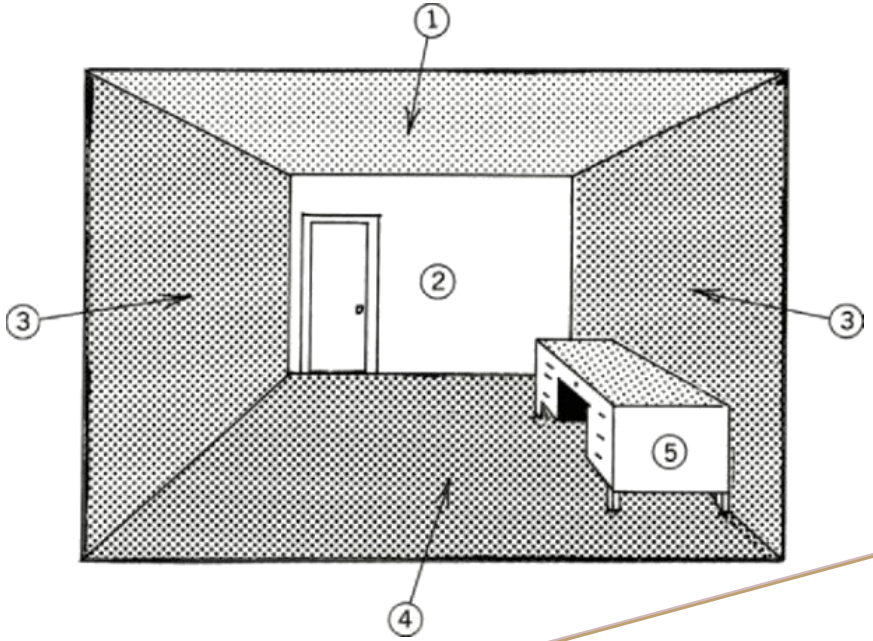
Room depth should not exceed 2 ½ times the height of the room



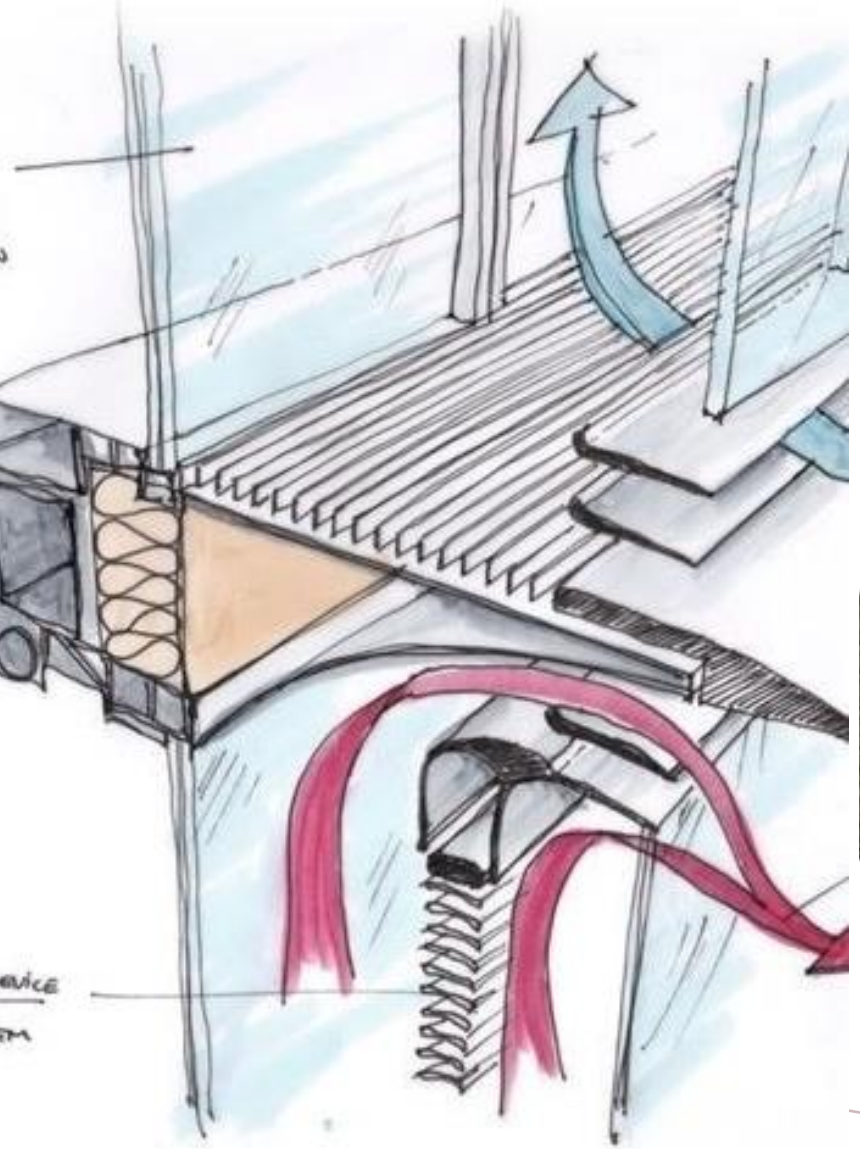
REFLECTING SURFACES

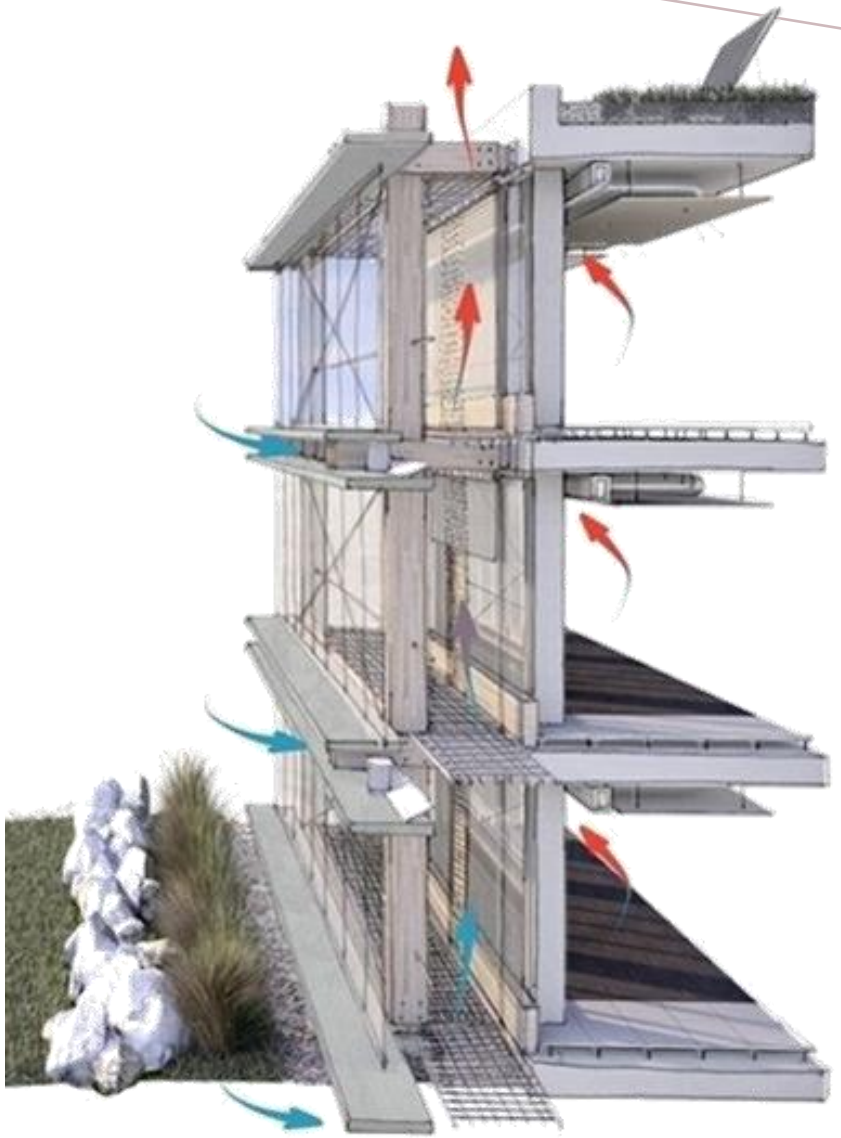
The descending order of importance for reflecting surfaces is: ceiling, back wall, side walls, floor, and small pieces of furniture.

1. Ceiling
2. Back wall
3. Side walls
4. Floor
5. Small pieces of furniture

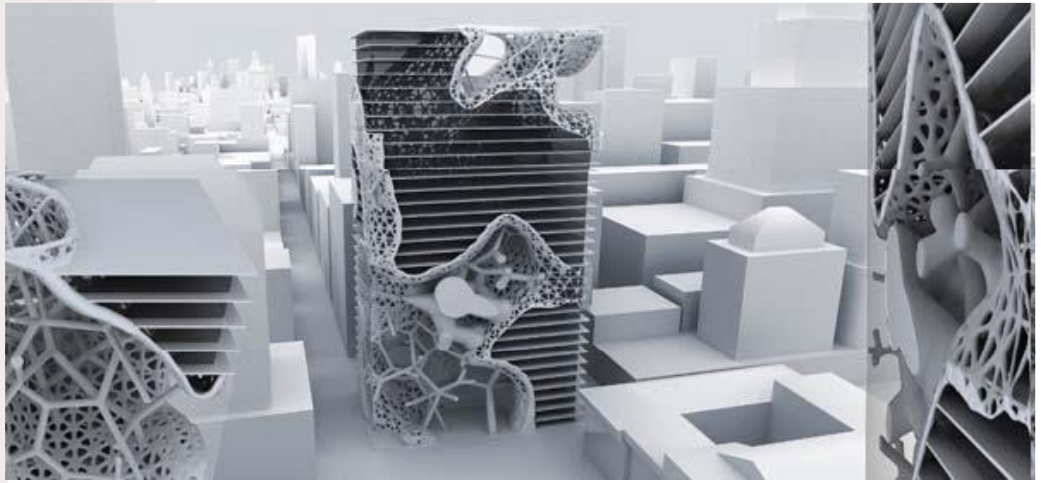


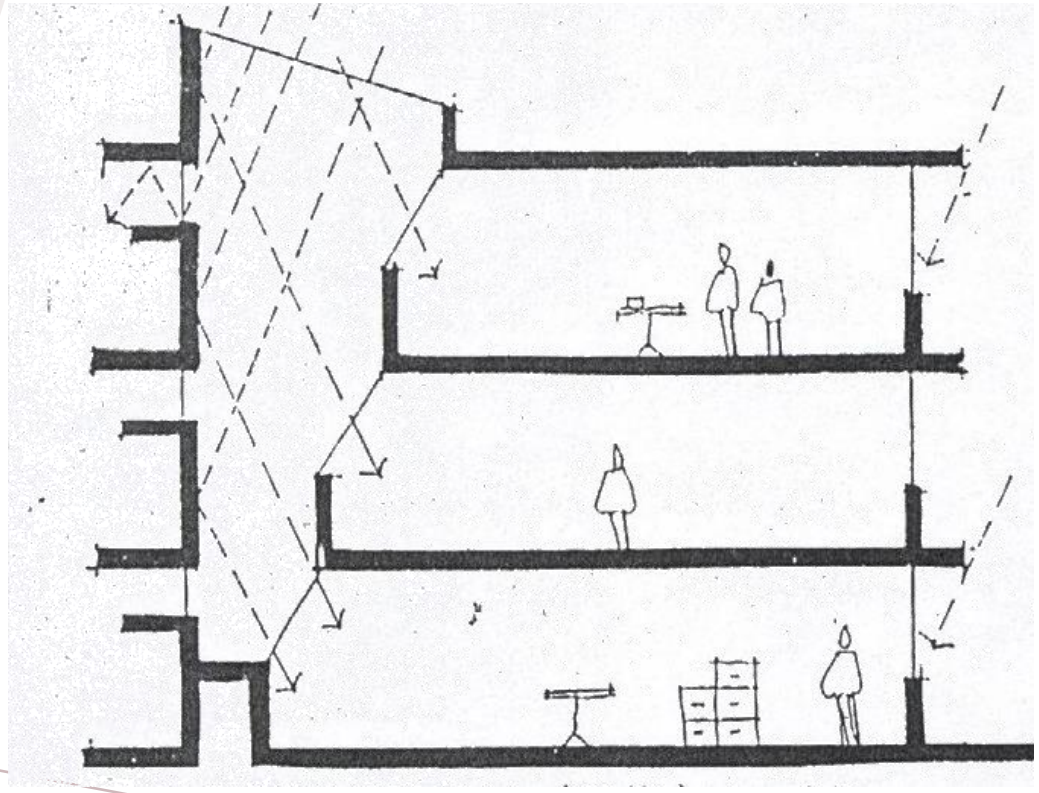
DOUBLE SKIN



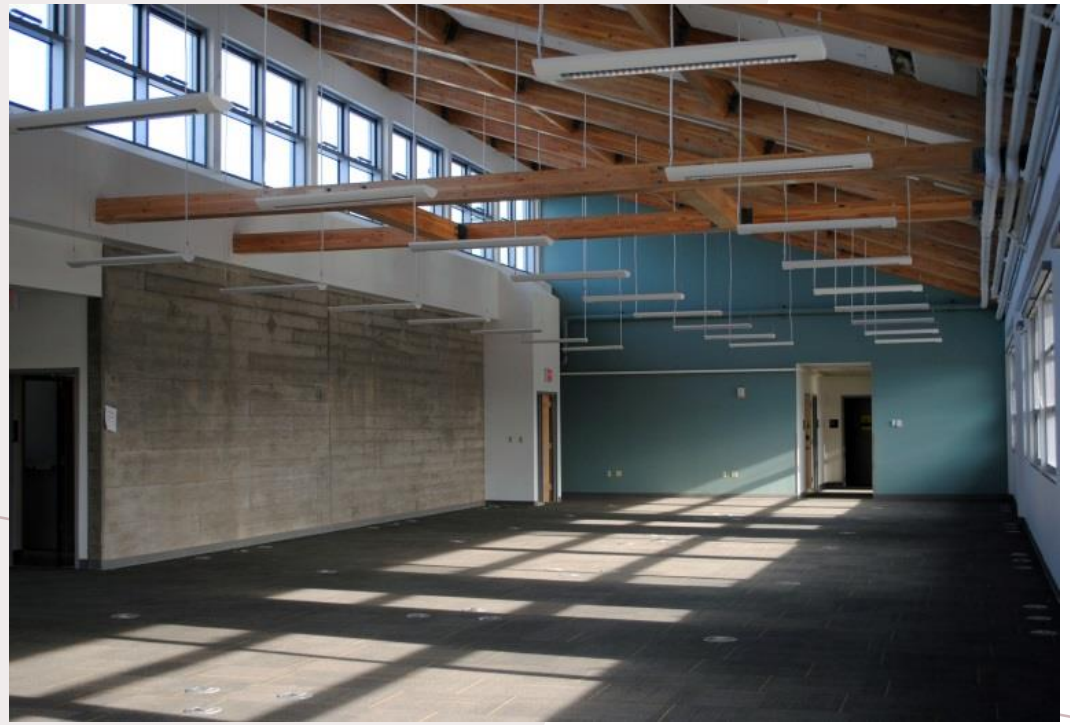


LIGHT WELL

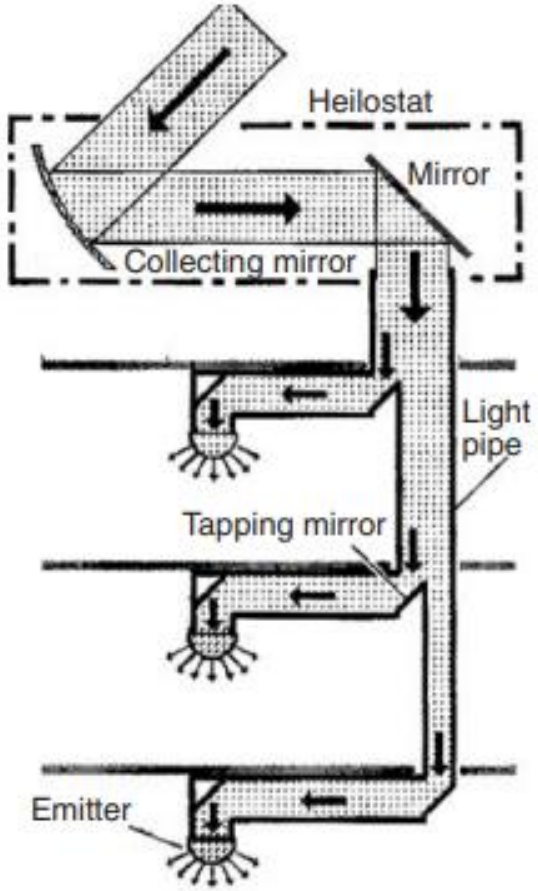


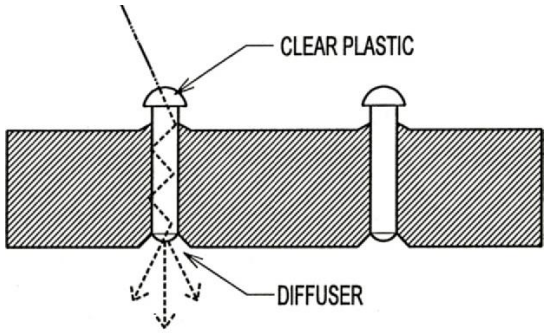


CLEAR STORY WINDOWS



LIGHT TUBES


Heilostat
Mirror
Collecting mirror
Light pipe
Tapping mirror
Emitter


CLEAR PLASTIC
DIFFUSER

LIGHT SHELVES

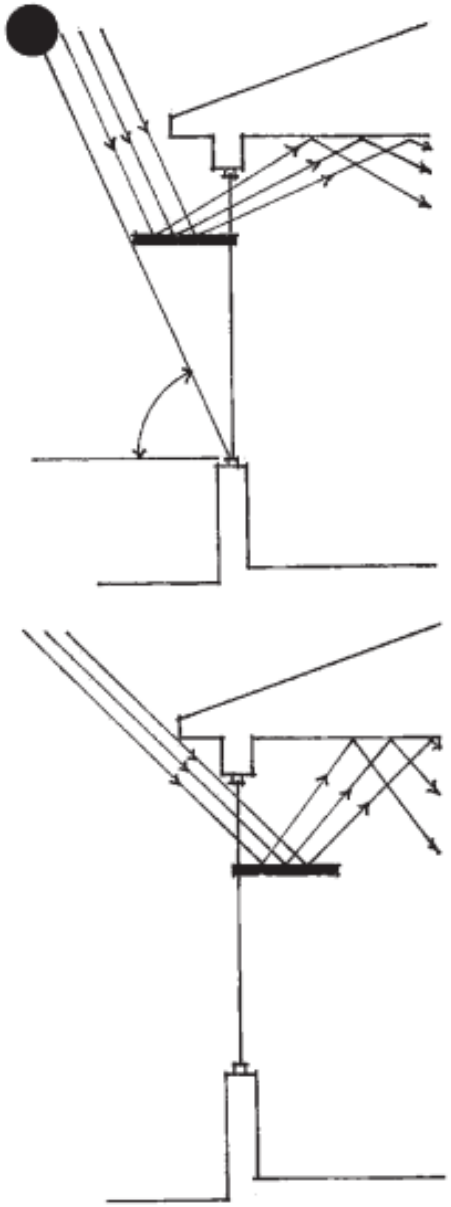
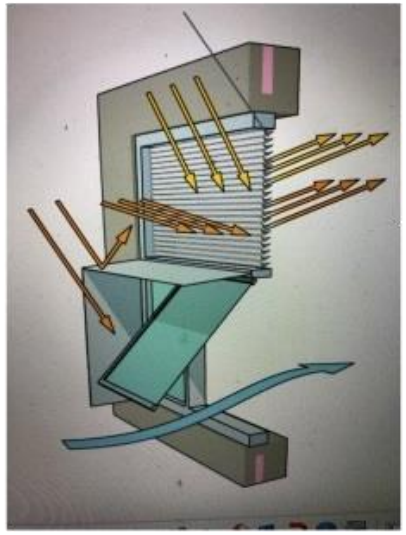
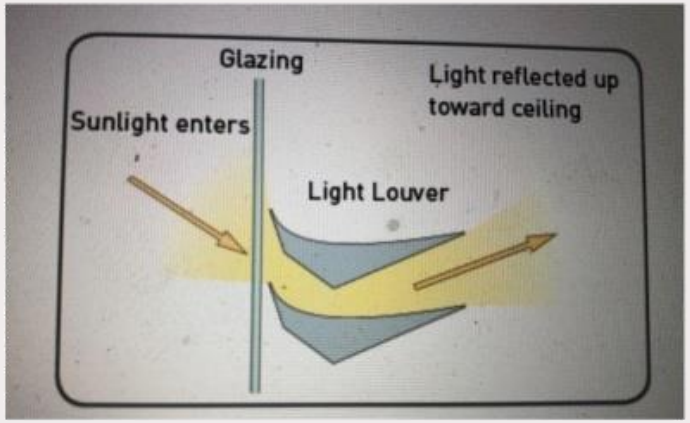


Fig. 2.36
External and internal light shelves.

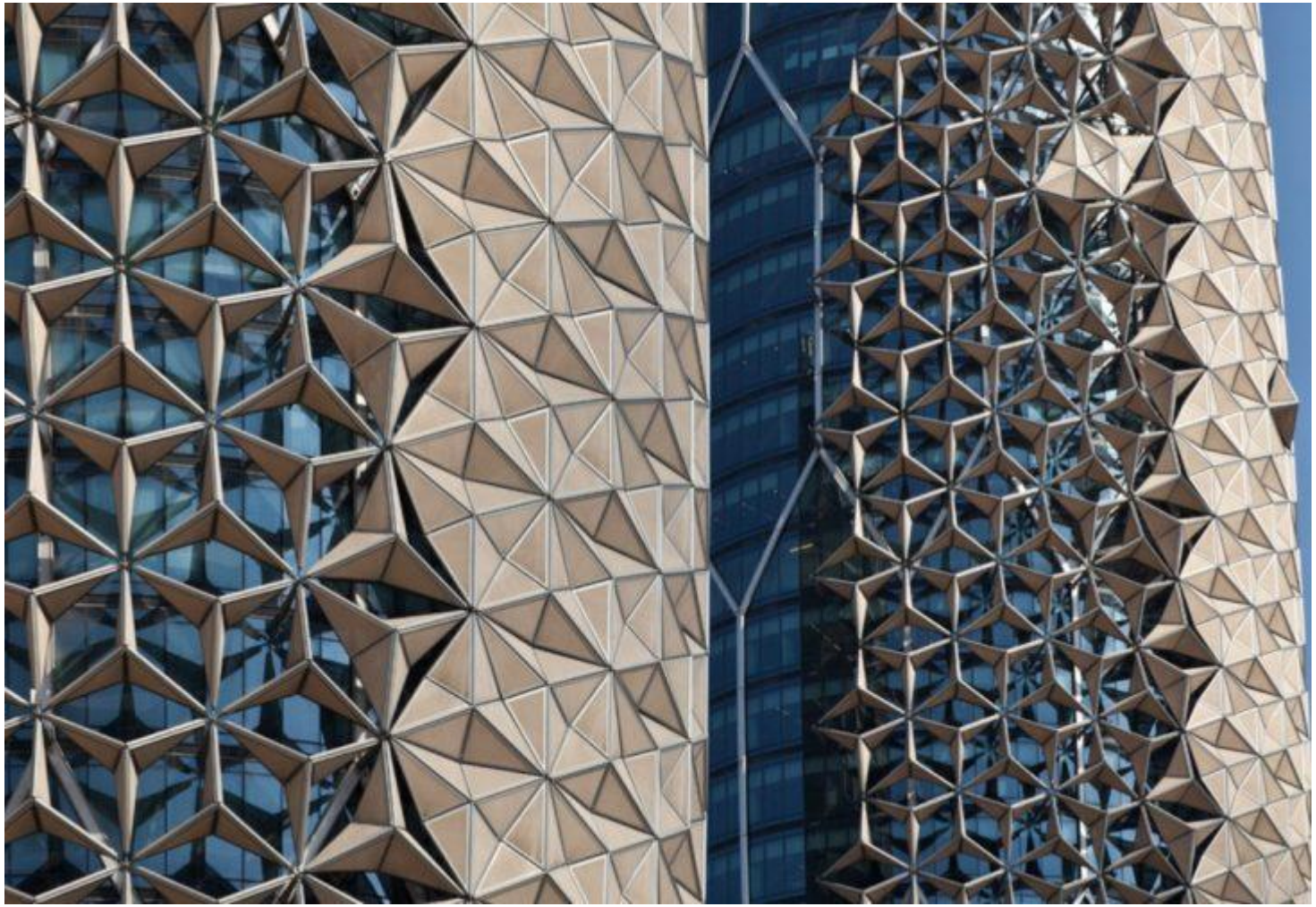
Daylighting: Light Louvers

A light louver daylighting system reflects sunlight to the ceiling, creating an indirect lighting effect. Fixed sunshades limit excess light and glare.





KINETIC FACADES



THANK YOU

Dr. Marian Nessim

Associate Professor at HBRC- Architecture Dept.