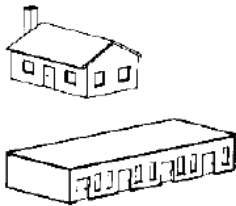
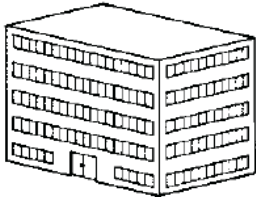




Lecture 12: Shading Design

9.5 Shading periods of the year

Table 9.5A Comparison of Envelope-Dominated and Internally Dominated Building Types

		
Characteristic	Envelope Dominated	Internally Dominated
Balance point temperature	60°F (15°C)*	50°F (10°C)
Building form	Spread out	Compact
Surface-area-to-volume ratio	High	Low
Internal heat gain	Low	High
Internal rooms	Very few	Many
Number of exterior walls of typical room	1 to 3	0 to 1
Use of passive solar heating	Yes, except in climates with no winters	No, except in very cold climates
Typical examples	Residences, small office buildings, small schools	Large office and school buildings, auditoriums, theaters, factories

*Superinsulated buildings tend to have a balance point temperature of about 50°F (10°C) even though the other characteristics are those of an envelope-dominated building.

9.6 Overhangs



Figure 9.6c Wide strip windows make efficient use of the horizontal overhang.

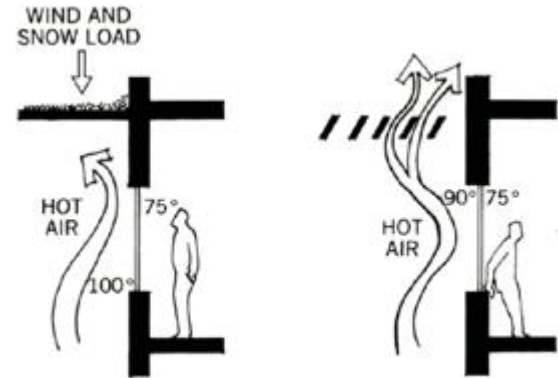


Figure 9.6a Horizontal louvered overhangs both vent hot air and minimize snow and wind loads. Also, their smaller-scale appearance is often desirable.

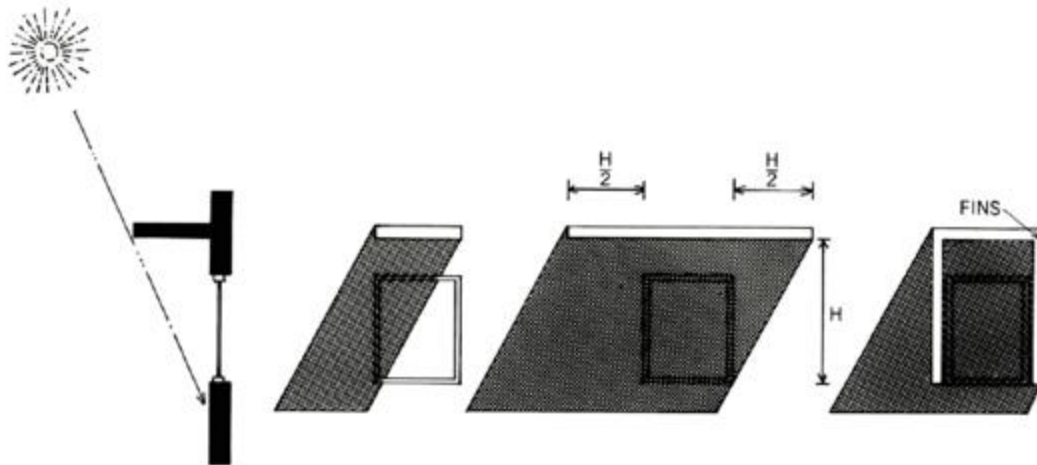
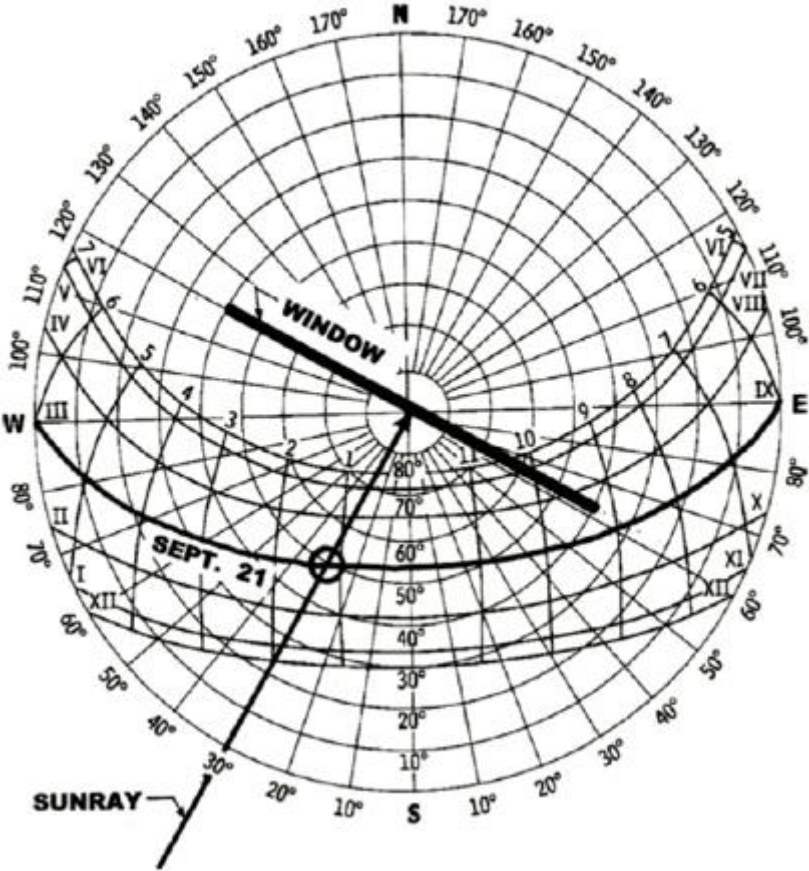


Figure 9.6b The sun easily outflanks any overhang the same width as the window. Use a wider overhang or vertical fins on each side of the window.

9.7 Design of Horizontal Overhangs

36°N LATITUDE



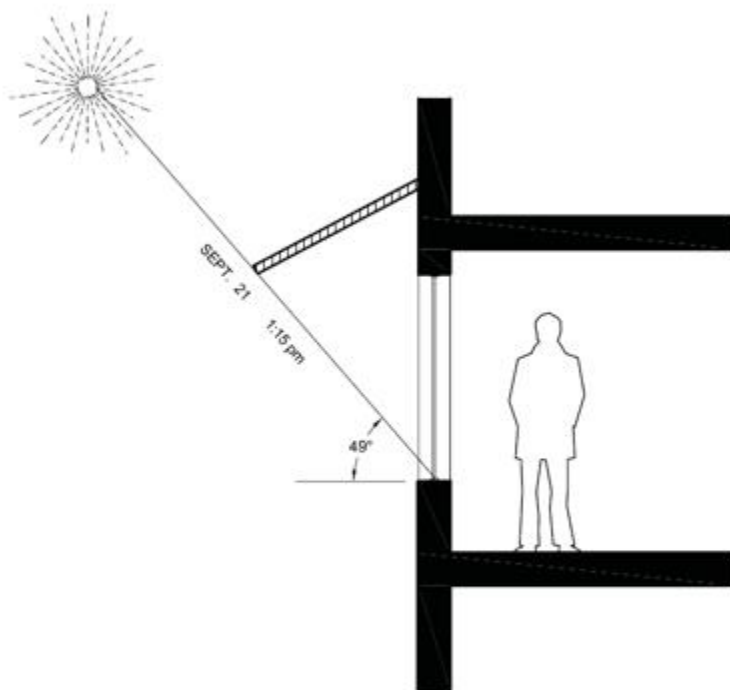


Figure 9.7c On a section draw the sunray from the windowsill. Any overhang that reaches this sunray will shade the window effectively the whole overheated period of the year.

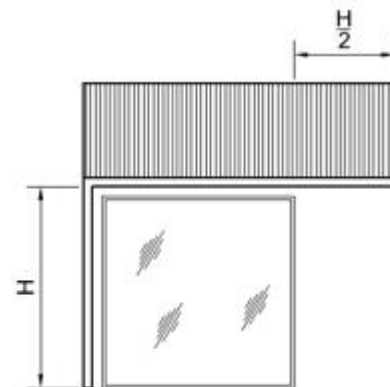


Figure 9.7d To prevent the sun from outflanking the overhang, in this example a vertical fin is used on the northwest side of the window and an overhang extension is used on the southeast side. This solution is asymmetric because the solar geometry is asymmetric in relation to this window.

9.9 Design Guidelines For Fixed South Overhangs

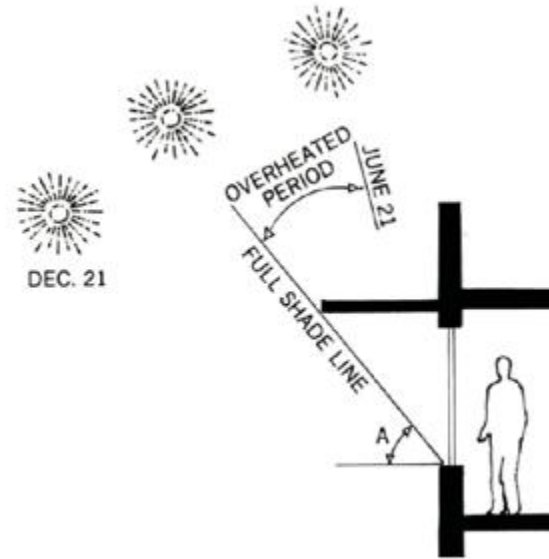


Figure 9.9a The full shade line determines the length of overhang required for shade during the overheated period.

9.11 Shading For East And West Windows

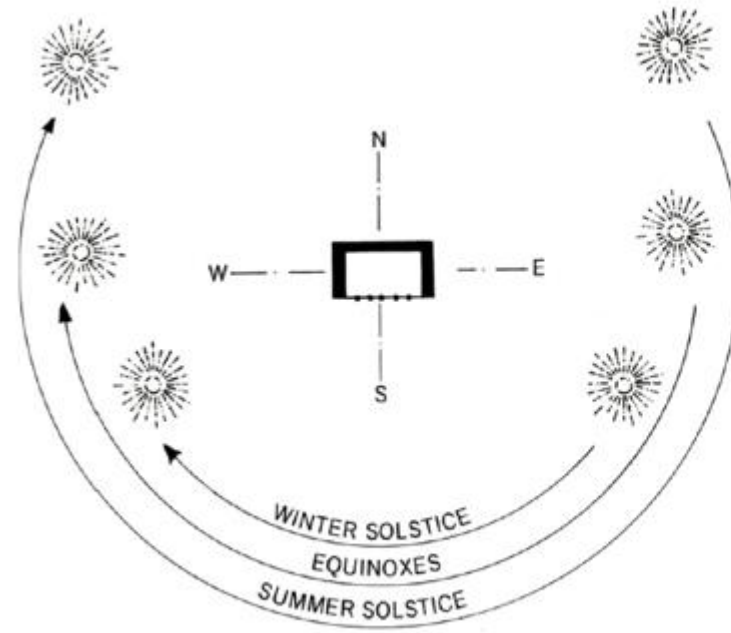


Figure 9.11b This plan view illustrates the sweep of the sun's azimuth angle at different times of the year from sunrise to sunset.

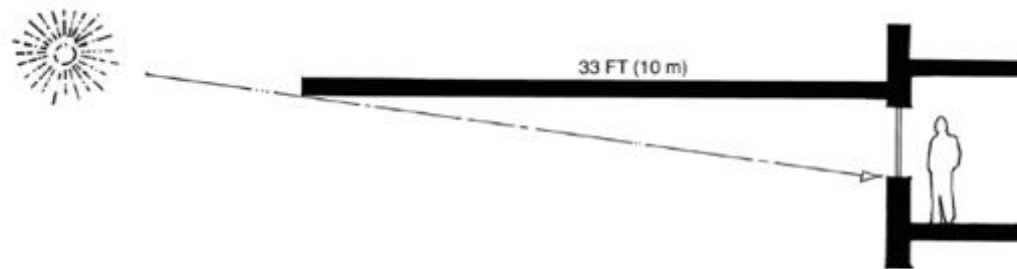


Figure 9.11a The 33 ft (10 m) overhang needed to shade a 4 ft (1.2 m) window on August 21 at 6 P.M. at 36° N latitude illustrates the futility of trying to fully shade east and west windows with fixed horizontal overhangs.

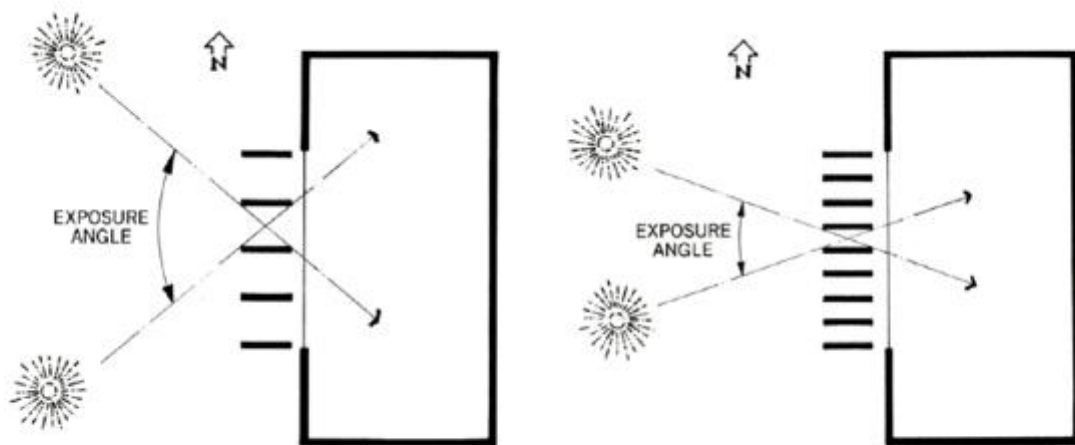


Figure 9.11c A plan view of vertical fins on a west (east) facade illustrates how solar penetration is reduced by moving fins closer together, by making them deeper, or both.



Figure 9.11d This photo of west facing windows was taken on a summer afternoon. The lack of shading by the vertical fins is proof of their impotence. Fins are not effective shading devices on east and west windows!



Figure 9.11f Since the depth of an overhang is a function of the height of a window, short window will require less deep overhangs.

9.13 Design Of Fins On North Windows

Table 9.13 Shade Line Angle for North Fins	
Latitude	Angle D
24	18
28	15
32	12
36	10
40	9
44	8
48	7

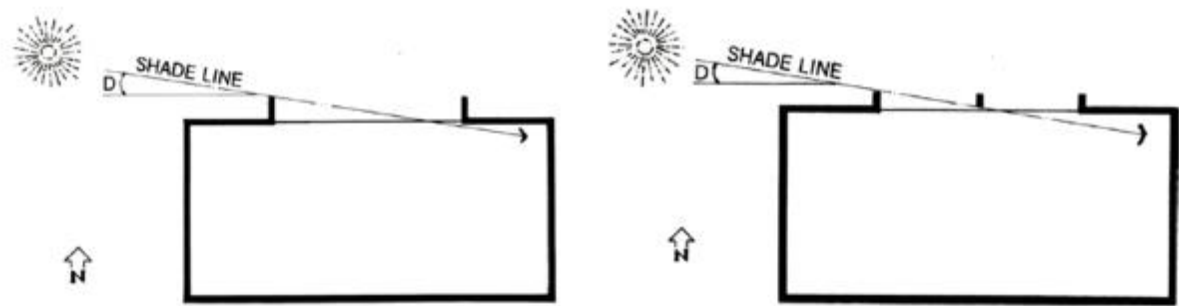


Figure 9.13 The shade line at angle D determines the vertical-fin design on north windows. An alternative solution is also shown.

9.14 Design Guidelines For Egg crate Shading Devices

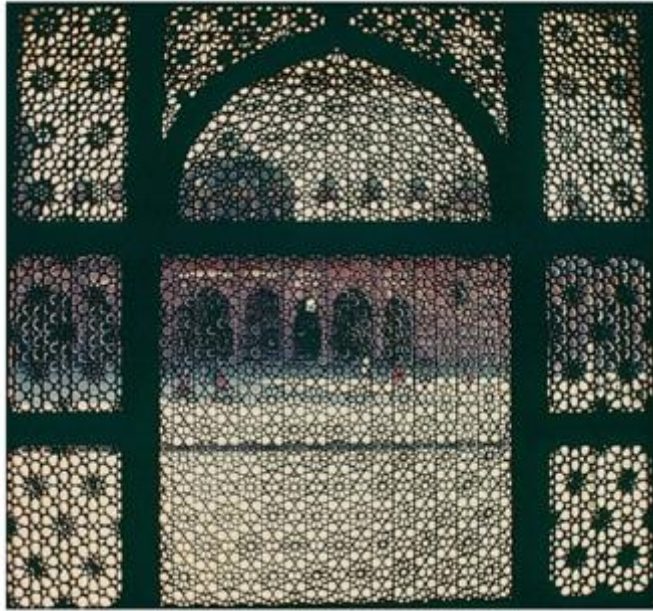


Figure 9.14a This marble screen, carved from a single piece of stone, is actually a miniature eggcrate shading device. The thickness of the slab is critical. The same pattern in a flat metal plate would be practically useless as a shading device. (Photograph by Suresh Choudhary.)

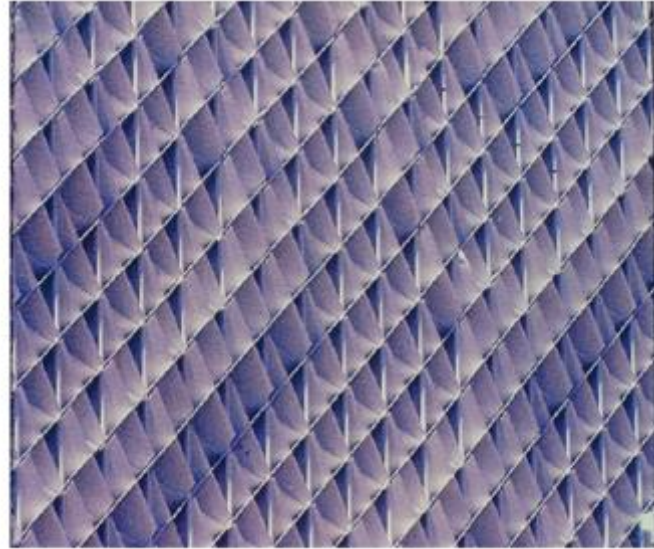


Figure 9.14b An eggcrate shading device made of metal. (Courtesy of Construction Specialties, Inc.)

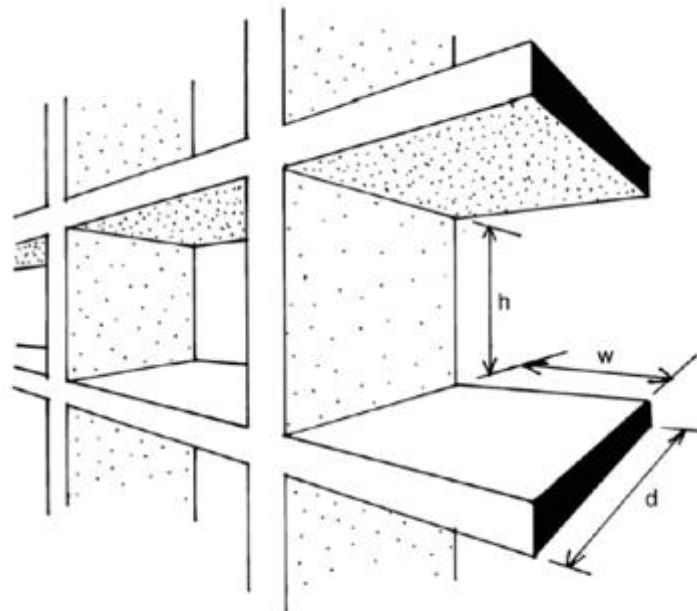


Figure 9.14d The shading effect is a function of the ratios h/d and w/d . It is not a function of actual size.

Figure 9.14c Small and medium-sized eggcrate shading systems severely block the view. Medium to large eggcrate systems are usually made of concrete, while small eggcrates are often made of masonry units.

9.15 Special Shading Strategies

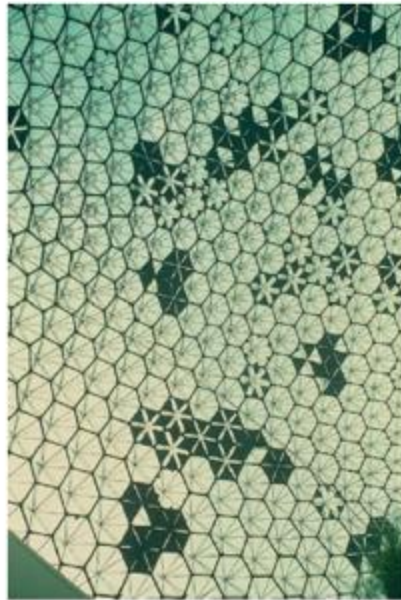


Figure 9.15a The U.S. Pavilion, Expo '67, Montreal, Canada, was designed by Buckminster Fuller. This view of the dome from the inside shows the vent holes and triangular roller shades that prevent overheating in the summer.

Figure 9.15c Architect Rolf Disch of Freiburg, Germany, has designed his home to track the sun. His Heliotrope house rotates to face welcoming windows toward the winter sun and a blank wall to intercept the summer sun. The PV panels on the roof rotate separately to always collect the maximum solar radiation. (Courtesy of architect Rolf Disch.)



Figure 9.15b The residence that architect Richard Foster built for himself in Wilton, Connecticut, in 1967 is round and rotates 360° to take full advantage of the panoramic view and passive solar heating. (Courtesy of Richard Foster, architect.)





Figure 9.15i This parasol roof in Singapore shades both the actual roof and the roof garden.

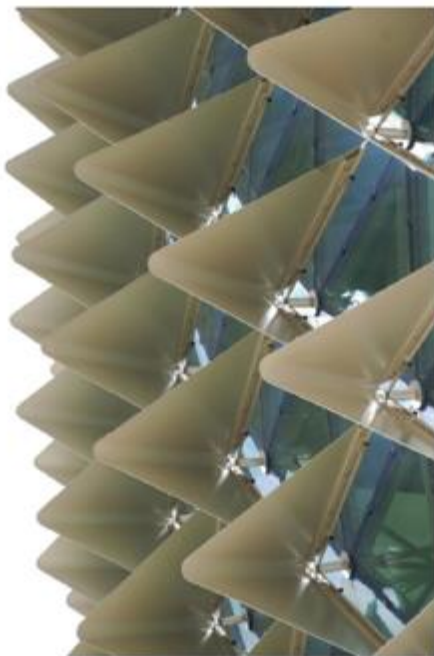


Figure 9.15h The glass dome of the Singapore Concert Hall is covered with aluminum caps to keep out the direct sun.

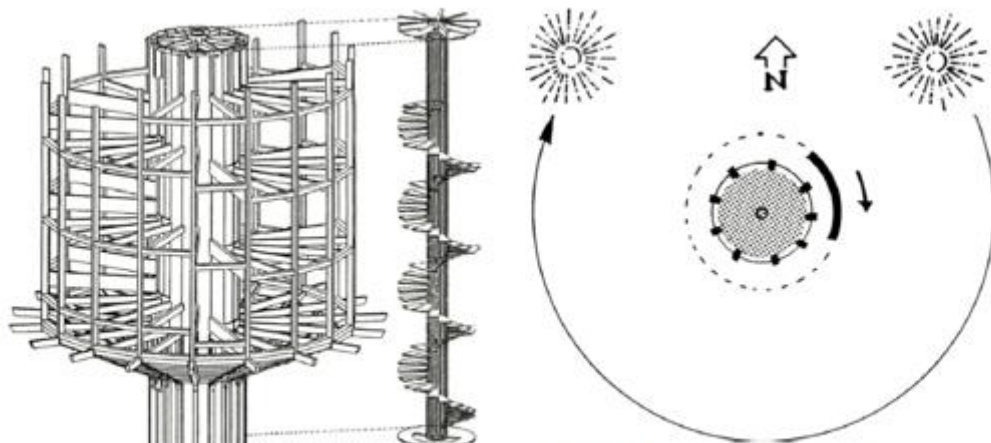
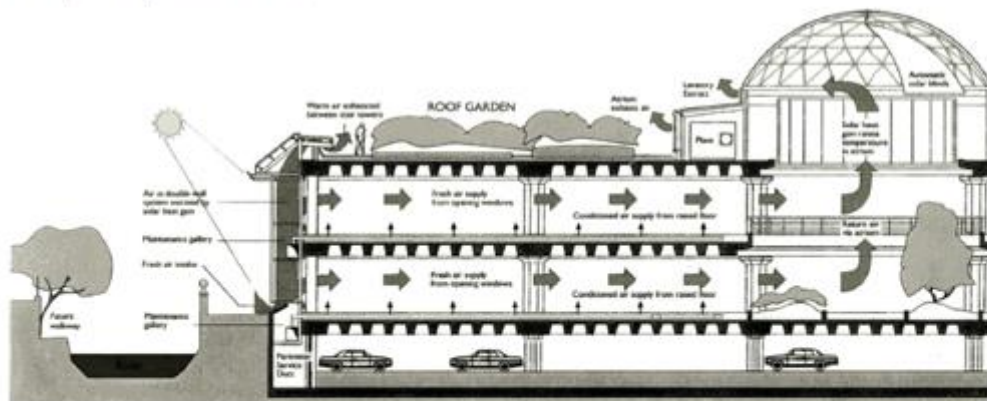


Figure 9.15d A section of the rotating solar house called the Heliotrope. (Courtesy of architect Rolf Disch.)

Figure 9.15e A shading panel can rotate around the building in phase with the sun. If the panel is covered with PV, it also acts as a tracking solar collector.



Cross section showing air movement

Completion 1991

THE MICHAEL LAIRD PARTNERSHIP

Figure 9.15f The Tanfield House in Edinburgh, Scotland, designed by Michael Laird Partners, uses domes to daylight and ventilate the atria. To prevent overheating, triangular solar blinds rotate when needed on indoor tracks to block the sun. (Tanfield House, Edinburgh—Michael Laird Architects.)

9.16 Shading Outdoor Spaces



Figure 9.16a The public areas in this outdoor mall in Las Vegas are shaded by translucent membrane tension structures.



Figure 9.16b The Roman Colosseum, which was built about A.D. 80 and seated about 50,000 spectators, was covered with a giant awning for sun protection. (From *Lanfiteatro Flavio Descritto e Deliniato*, by Carlo Fontana, Vaillant, 1725.)

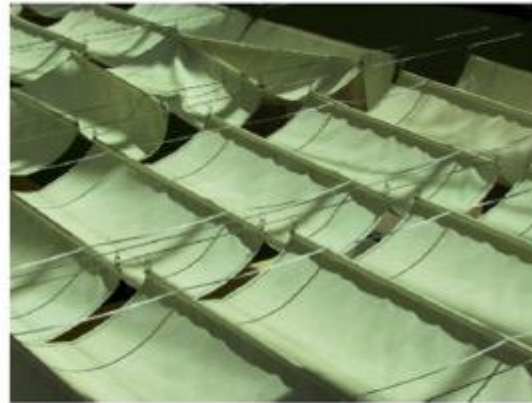


Figure 9.16c The toldo (pleated awning) is a beautiful and effective device for shading outdoor spaces. It can be easily retracted along its horizontal support cables at night, when it is cloudy or stormy, and when it is no longer hot.

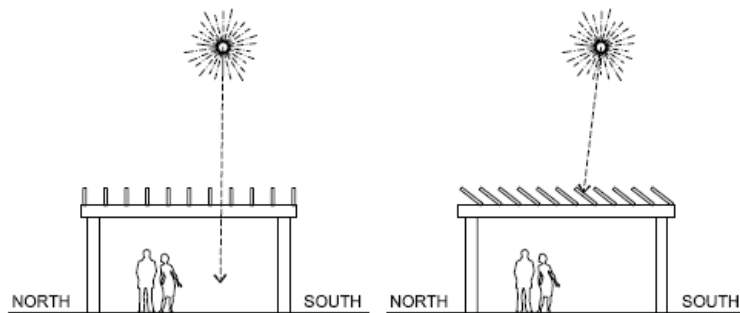


Figure 9.16i The typical pergola has shading elements that are on edge like joists. Such a design will provide little shade at 12 noon. Instead, the louvers should be tilted toward the north.



Figure 9.16g This pergola was designed so that most of the shade comes from the vine that it supports.



Figure 9.16h This arbor is located in the garden of the Governor's Palace, Colonial Williamsburg, Virginia. (Courtesy of Richard Kenworthy.)