

# 3 Protecting against solar UVR

## Environmental strategies for controlling solar UVR

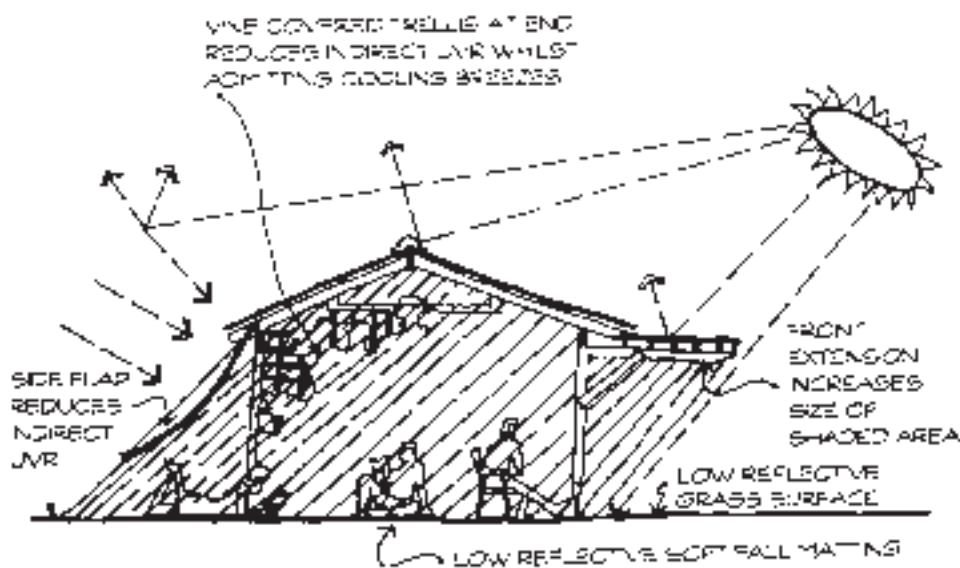
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Maximum protection from solar UVR can be achieved through a combination of personal and environmental strategies.

The most effective personal protection strategy is to minimise sun exposure between 11am to 3pm daylight saving time (10am to 2pm eastern standard time). When people are outdoors, especially during this time, it is important that they protect themselves from the sun by wearing protective clothing, sunhats, sunscreen and sunglasses, as well as using available shade.

Environmental strategies seek to support personal protection strategies by creating outdoor spaces that provide protection from both direct and indirect UVR. Examples of environmental strategies include:

- placing UVR protective barriers above, and to the side of the designated area
- reducing reflection of UVR from nearby surfaces into the designated area
- increasing the size of the shaded area to allow people to use the centre of the area rather than its edges.



Environmental strategies for protecting against solar UVR

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## Environmental strategies

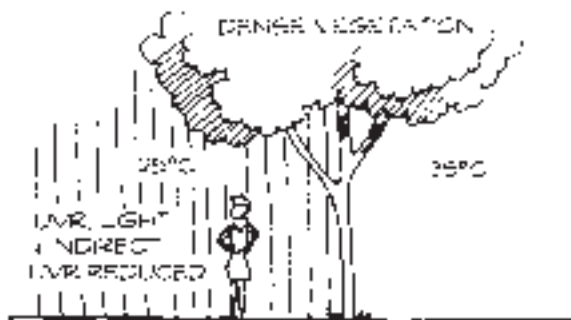
### Control of direct UVR

The most common method of controlling direct UVR is to place a barrier so that it intercepts the sun's rays, thus creating 'shade'. Such barriers can include both built items and natural barriers such as trees and other vegetation. For the barrier to provide effective protection during the required period, it should:

- be of sufficient size, and
- be located in the right place.

Effective barriers to UVR must allow for daily and seasonal sun movement. Too often, shade canopies are erected or trees are planted on the assumption that they will provide the required shade, when the actual shadow pattern is quite different.<sup>1</sup>

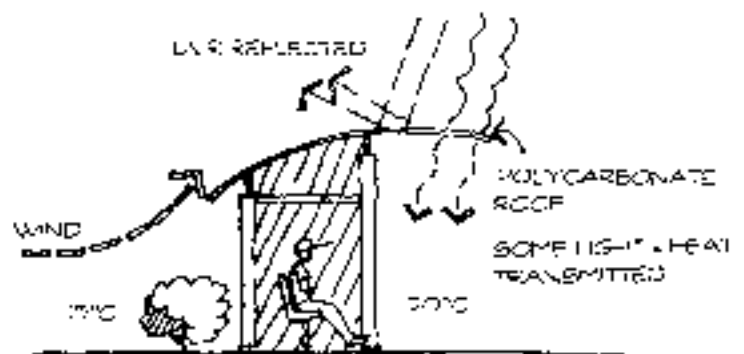
A decision on whether to use built or natural barriers to UVR will be strongly influenced by the specific shade needs and other site considerations. As built shade lends itself to greater design possibilities, this approach is often the most adaptable to the particular needs of a site.



#### summer protective shade

The high UVR levels experienced throughout Australia in summer mean that the provision of shade during these months should be a priority. Summer shade provision should minimise UVR levels, as well as reduce heat and light.

The aim is to create an environment which is shaded and cool. This may be achieved by tree planting, or by the use of materials which significantly exclude heat and light, as well as UVR.



#### winter protective shade

Winter shade provision should minimise UVR levels, while allowing for the transmission of sufficient levels of heat and light.

The aim is to create an environment that provides both warmth and protection from UVR. This may be achieved by the use of materials which exclude UVR but allow some transmission of heat and light, eg. polycarbonate sheeting. The control of winter winds is also essential.

<sup>1</sup> Oakman H. *Tropical and subtropical gardening*. Milton: The Jacaranda Press, 1981.

## Control of indirect UVR

The control of indirect UVR is an important consideration in any shade project.

Indirect UVR is reflected off surface materials or scattered by clouds or atmospheric particles. Therefore, it can come from any direction. Because of this, it is difficult to provide shade which completely excludes UVR. Nevertheless, control of indirect UVR will be more effective if the behaviour and sources of both reflected and scattered UVR are understood.

### reflected UVR

In most instances, reflected UVR will comprise only a small component of the total UVR present at a particular site. The notable exceptions to this general rule-of-thumb are locations characterised by the presence of snow or sand. Snow can reflect in excess of 80% of the UVR it receives, and sand up to 18%. However, the reflectance of most natural and artificial surfaces is usually less than 10%. Refer to the table on page 15 for the reflectivity of different ground surfaces.

The reflectance of a surface varies as the solar altitude angle, ie the height of the sun, changes. Most ground surfaces do not uniformly reflect UVR in all directions, but depend on the direction of incoming radiation. Accordingly, it is generally the case that higher levels of reflected UVR are experienced early and late in the day, while the highest levels of direct UVR are experienced at solar noon.

Reflectance of UVR should not be confused with the reflectance of light. While the amount of visible light reflected from a surface is influenced by colour, the reflectance of UVR is independent of colour. Therefore, a material that is good at reflecting visible light may not reflect much UVR. For example, the UVR reflectance of paint is low and is independent of colour.<sup>2</sup> Generally, the selection of surface materials to minimise reflected UVR should take into account:

- surface density—hard surfaces such as paving will reflect higher levels of UVR than softer surfaces such as grass or soil
- surface finish—smooth surfaces such as metal sheeting and smooth trowelled concrete reflect higher levels of UVR than coarse or varied surfaces such as timber cladding, roof tiles or brick paving.

### scattered UVR

Protection from scattered UVR is achieved by reducing exposure to the sky. Generally, a site receives as much scattered UVR from the sky, as direct UVR.<sup>3</sup> If a person sitting in shade is able to see a lot of blue sky, scattered UVR is able to reach them.

In many situations, the contribution of scattered UVR to the total UVR reaching a site will exceed that of the reflected UVR reaching the site. For example, this would occur when boating on open water because reflectance from open water is low.

## note

Built shade, natural shade and combined shade systems are discussed in detail in Chapter 4, Providing shade.

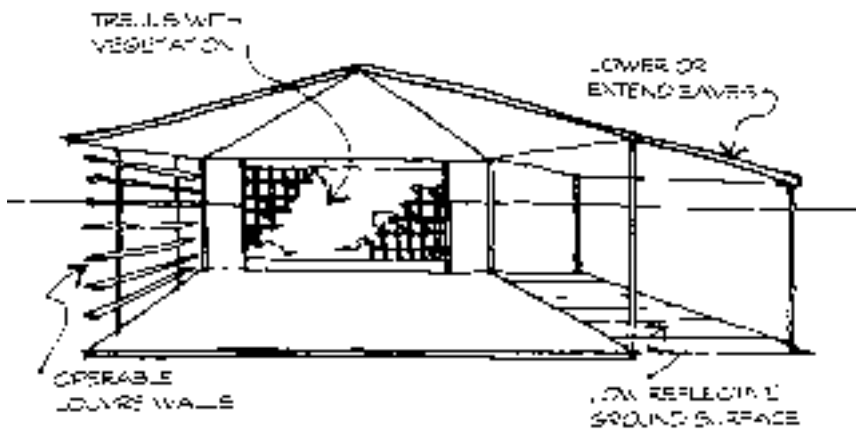
<sup>2</sup> Sliney DH and Wolbarsht ML. *Safety with lasers and other optical sources*. New York: Plenum Press, 1980.

<sup>3</sup> Gies PH, Roy CR, Toomey S and McLennan A. *Protection against solar UV radiation. Sun Protection Seminar Papers*. Australian Cancer Society, 1997.

## Environmental strategies

### Design strategies for the control of indirect UVR

There are a number of design strategies that can be used to reduce an area's exposure to indirect UVR (as well as direct UVR).



#### combining strategies to control indirect UVR

#### ensure shade structures are of an adequate size

The larger the shaded area, the greater the opportunity to avoid indirect and direct UVR. This is because UVR levels will be greater towards the edges of the shaded area.

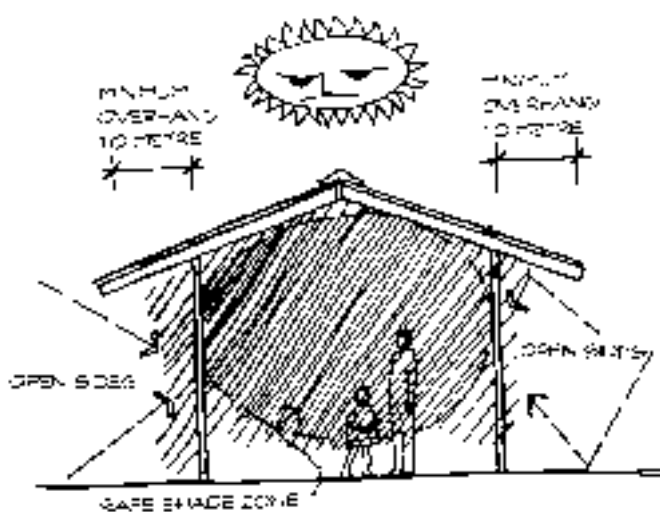
#### use barriers for side as well as overhead protection

Vertical screening with plants and trellises or a system of opaque louvres can provide a barrier to indirect UVR, while admitting ventilation and breezes.

#### choose materials that reduce reflectivity

Soft surfaces and those with uneven finishes will reflect lower levels of UVR than other surfaces. For example, vegetation absorbs and scatters UVR which decreases its intensity. Plant ground covers or grass in preference to the use of concrete paving.

Existing reflective surfaces can be altered to reduce indirect UVR. In a playground, concrete or bitumen surfaces can be treated to reduce reflectivity. Block the amount of direct UVR hitting the ground surface by overhead shading. Use coloured rubber matting (soft fall matting) or synthetic turf to reduce reflected UVR.



using an extended overhang  
to reduce indirect UVR

**extend overhead barriers past actual use areas**

A simple rule-of-thumb is to make sure there is at least a one metre overhang past the actual area of use. Laterally extending devices such as roller blind awnings can be useful for extending overhangs on existing structures.

**take account of external sources of reflected UVR from existing buildings and adjoining properties**

For example, if the property next door has a large, reflective wall facing your site, design a shade system that blocks the reflected UVR. Possible solutions may be to provide vertical screening using opaque louvres or a trellis. Avoid shade systems that reflect UVR onto other areas or adjoining properties.

## Designing shade for climate and comfort

# Designing shade for climate and comfort

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## Shade planning for specific climate zones

It is important to become familiar with the climatic elements of a location in order to design UVR protective shade which is comfortable for human use at the right time of the day and at the right time of the year. If a shelter does not address human comfort, it will not be an effective control against over exposure to UVR, because it will not be attractive for use.

The four elements of a climate which have a dominant influence on human comfort are:

- air temperature
- humidity, or water content of the air
- air movement (breeze)
- heat radiated from the sun and from the surroundings.

Each influences in some way the heat exchange processes between the human body and its environment. All must be considered together if the effects on people are to be predicted.

For example, when the weather is cold the effect of humidity is barely noticeable, but when it is hot, high humidity becomes less tolerable. Air movement at our body surface causes evaporation of perspiration and has a cooling effect. At higher humidities such evaporation is prevented or at least reduced. Wind does not change the air temperature but it makes us feel cooler. To some extent it can compensate for the effect of high humidity.

When climatic elements are understood, it is possible to design outdoor environments that provide increased levels of comfort by modifying the existing conditions.

For example:

- if it is hot and humid, provide shading to exclude the sun and allow cross ventilation to capture the breeze for cooling
- if it is cold and windy, provide wind breaks to exclude the breeze, and use north facing openings to collect the sun's warmth and light.

Shade offers the physical sensation of a change of temperature. Sheltered from the direct heat of the sun's rays, shady areas are perceived as cooler. Direct sunshine usually feels hotter, so shade is sought out on a summer's day to escape the heat as much as to escape exposure to UVR. On a cooler day in May or July, people prefer to be warmed by the sun and will tend to avoid shady spots, even though risk of UVR exposure is still present. For these times of year, it is necessary to create warm outdoor environments which also offer protection against UVR.

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### note

Effective shade systems address human comfort factors as well as control of UVR.

## Designing shade for climate and comfort

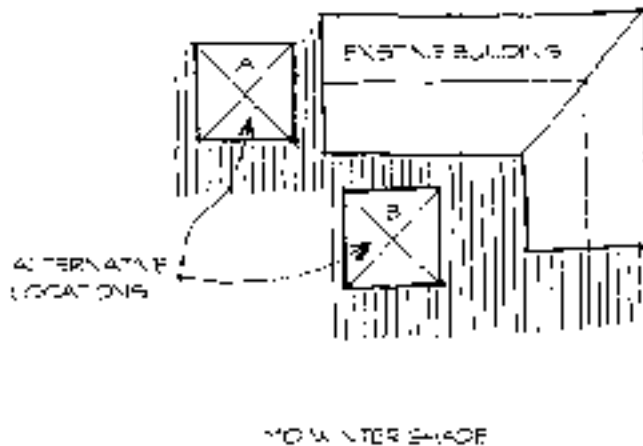
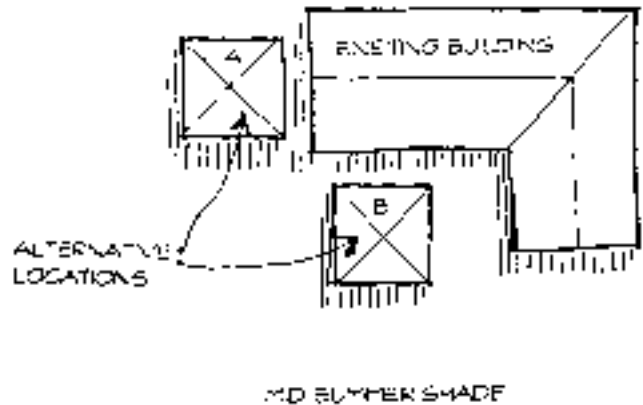
### Designing for comfort: general principles

In designing comfortable shaded outdoor areas that will be attractive for users, it may be necessary to adapt or modify the microclimate (local climatic conditions) of a site. Different strategies can be incorporated during the design stage of a shade project to counteract the negative effects of the microclimate (yet within the broad context of the prevailing climatic conditions).

A brief discussion of the issues and strategies follows.

**In many locations, (particularly cooler ones) the penetration of the sun's warmth and light during winter will be necessary for thermal comfort.**

- Provide shade which excludes UVR but admits the sun's warmth and light. Translucent polycarbonate sheeting is ideal for this purpose (see Appendix C).
- Adjustable devices may suit year-round use.
- Deciduous trees and other plants will allow warmth and light to penetrate when they lose their foliage. Alternative UVR protection is needed for outdoor spaces during these periods.
- Provide alternative external spaces for use in different seasons. Where space is available, this may be an easier and more economical solution.
- Locate planned summer shade structures so as to not increase winter shade.
- Planting can be used to form north-facing courtyards or outdoor enclosures for social gatherings or outdoor activities. Plant shelter belts or wind screens to the south, south-west and west, leaving open sunny lawns to the north, adjacent to covered outdoor paving that is warmed by the low winter sun



#### optimum location of shade structures

Location B provides good summer shade without creating additional winter shade. Location A will increase winter shade.

## Designing shade for climate and comfort

- Introduce passive solar heating principles while excluding UVR. This can be done by using dark coloured external materials (with low UVR reflectance) to absorb heat, such as some paving materials. However, ensure full shading to paving in summer to prevent the radiation of heat to shaded areas.



SUMMER -  
SOLAR RADIATION -  
SOLAR RADIATION -  
SOLAR RADIATION -



WINTER -  
SOLAR RADIATION -  
SOLAR RADIATION -  
SOLAR RADIATION -

passive solar cooling and heating principles

### In all locations, cooling is recommended during the summer months.

- Design the space to capture any prevailing breezes.
- Provide shade to the openings of shade structures during summer.
- Projecting eaves attached to buildings will cool the indoor and outdoor spaces during the summer months. Eaves will also reduce direct UVR and indirect UVR, which could otherwise reflect and scatter off wall surfaces.

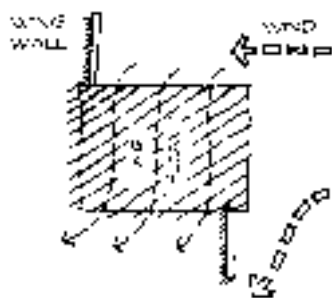
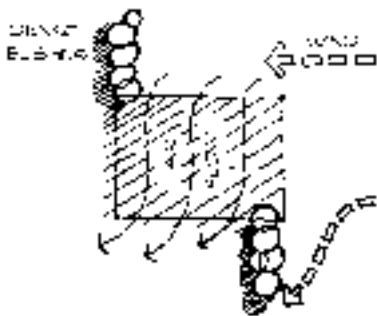
### Shading of walls and paved areas can significantly increase summer comfort levels

- When exposed to direct sun, walls and paved surfaces gain heat, which is 'stored' and re-radiated, increasing and maintaining the surrounding temperature. In summer, this can result in overheated, unpleasant outdoor spaces. By shading walls and paved areas, the heating of these surfaces can be significantly reduced and comfort levels enhanced.
- Glare caused by the reflection of bright sunlight from hard surfaces such as walls and paving can be unpleasant and increase the perception of heat. Shading of such surfaces reduces glare and results in more comfortable outdoor spaces.

## Designing shade for climate and comfort

Cross ventilation will provide relief from excessive humidity and prevent over-heating of spaces.

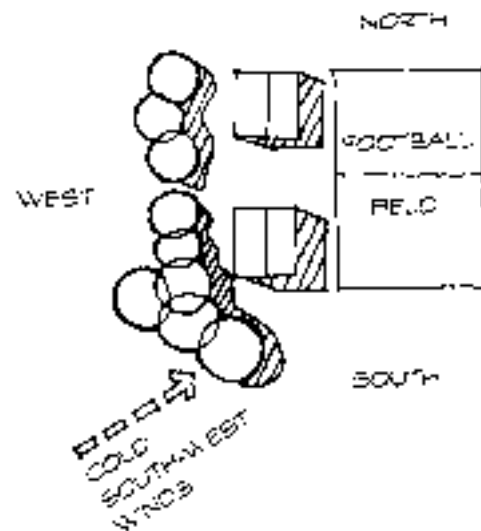
- If the cooling breeze is coming from the north-east, the obvious answer would be to orient openings toward the breezes. However, if the requirements of a particular activity do not allow for the ideal orientation, take measures to channel the wind and change its direction.
- Air flow through a structure is due to a pressure difference between the windward and leeward sides. Wing walls, baffles, or dense groups of bushes positioned on opposite sides of a structure will have the effect of inducing air flow.<sup>4</sup>



ways of encouraging cross ventilation

The exclusion of wind in the cooler part of the year should be considered.

- Observe the direction of any unwanted cold winter winds and provide suitable windbreaks.
- Dense tree and shrub 'shelter belts' to the south and south-west of the shaded area may be beneficial, especially in July and August.



<sup>4</sup> Szokolay SV. *Climate, comfort and energy — Design of houses for Queensland climates*. Brisbane: The Architectural Science Unit, The University of Queensland, 1991.

## Designing shade for climate and comfort

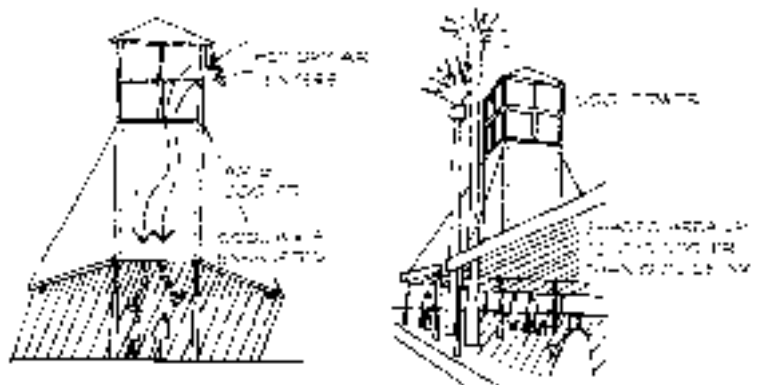
**In hot, arid areas, the radiation of heat into shaded areas should be reduced.**

- Align buildings close together, east to west, to provide mutual shading.
- Surrounding surfaces such as dry earth, paving or unshaded walls can reflect UVR, heat and light in the form of painful glare. Limit areas of bitumen and other solid pavements. Compacted, free-draining gravel paths and driveways reduce heat build-up and glare while allowing water penetration to the roots of nearby shade trees.
- Trees, plants and water (in an enclosed space) will cool the air by evaporation, help to keep dust down and give visual and psychological relief through the impression of coolness.<sup>5</sup> Place water features such as shallow pools where breezes will pass over them before reaching the shaded facility.
- Plant shade trees in groups with spacing to allow their canopies to overlap at maturity.

### A solution for hot arid climates

The climate characteristics of Australia's inland are not unlike other hot arid places such as the Middle East or Arizona USA. Some innovators in Arizona have taken a traditional feature of Middle Eastern architecture and developed a modern version of the malqaf and called it the 'Cool Tower'.

Typically towers are 8 to 13 metres high, more than 2.5 x 2.5 metres in area and can cool covered areas from about 20 to 30 square metres. The technology has been used in an outdoor transit centre in Tucson, Arizona, where summer temperatures can reach up to 45°C. Waiting passengers stand under or near the towers, which lower temperatures as much as 10°C. The cooling effects are amplified through landscaping, broad roofs, and screens.<sup>6</sup>



evaporative cooling and shade in hot dry climates

<sup>5</sup> Koenigsberger and Ingersol, 1974.

<sup>6</sup> Queensland Health and Department of Architecture, Queensland University. *Shade for sports fields*. Brisbane, 1995.