ENVIRONMENT DESIGN GUIDE

PROTECTING AGAINST SOLAR UVR

John Greenwood

This note GEN 35, originally published in November 2000, was reviewed by John Greenwood in September 2005. This summary page includes recent updates to the topic since publication.

SUMMARY OF

ACTIONS TOWARDS SUSTAINABLE OUTCOMES

Environmental Issues/Principal Impacts

- Australia has the highest rate of skin cancer in the world.
- Reducing exposure to solar ultraviolet radiation can significantly reduce skin cancer.
- Effective shade can provide excellent solar protection, utilising both natural and built solutions.
- The design profession and local government have important roles and responsibilities in achieving increased solar protection and urban design outcomes.

Basic Strategies

In many design situations, boundaries and constraints limit the application of cutting EDGe actions. In these circumstances, designers should at least consider the following:

- Ensure that shade is effective:
  - in the required place at the right time
  - minimum 94 per cent protection against direct UVR
  - protection against indirect UVR
  - provide summer and winter comfort.
- Combine a number of different elements to maximise solar protection rather than relying on a single element.
- Modify usage patterns of outdoor spaces to optimise access to existing shade.
- Reschedule outdoor events to avoid times of peak UVR levels.

Cutting EDGe Strategies

- Undertake a shade audit before commencing shade planning at any site.
- Increase effectiveness and comfort of shade structures by a 'spectrally specific' design approach.

Synergies and References

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This paper examines the issue of solar ultraviolet radiation (UVR) and its impact on public health in Australia, which has the highest rate of skin cancer in the world. It sets out factors affecting UVR levels and methods of protecting against solar UVR using environmental strategies, both natural and built. It considers the important roles and responsibilities of the design profession and local government in achieving significant improvement in solar protection and urban design outcomes.

1.0 INTRODUCTION

The design professions and local government have key roles to play in an important public health and urban design issue to be faced over the next decade, that of protecting against solar ultraviolet radiation (URV).

Public education campaigns over the last twenty years have achieved significantly increased awareness of the dangers of over-exposure to the sun. Increasingly, communities are expecting that shade be provided in outdoor spaces, and litigation has confirmed the legal liability of employers to provide solar protection for outdoor workers.

The result has been a proliferation of 'shade projects' with a diverse range of solar protection and aesthetic outcomes. If solar protection is to be effective and enhance the urban fabric, the active and considered participation of both local government and the design professions is essential.

2.0 WHY UVR PROTECTION IS AN ISSUE

Skin cancer is a major health problem in Australia - 1281 people died of skin cancer in 1996. This figure represents the highest rate of skin cancer in the world. As many as two out of three people who live in Australia their entire lives, will get skin cancer at some time. It is estimated that the direct cost of treating skin cancer in Australia exceeds $100 million annually.

The factors contributing to high rates of skin cancer in Australia include high levels of UVR, a predominantly fair-skinned population and our outdoor lifestyle.

Over-exposure to solar ultraviolet radiation (UVR) causes skin cancer as well as sunburn (erythema) and skin ageing (solar elastosis). In addition to the effects on skin, UVR can damage eyes, causing growth over the cornea (pterygium), cloudiness of the lens (cataract) and eye cancer. Reducing exposure to UVR can significantly curtail these negative health effects.

On a clear sky day, at solar noon in summer, UVR levels in Australia are sufficient to cause skin damage and sunburn in less than 15 minutes.

3.0 DIRECT AND INDIRECT UVR

Solar UVR is part of the spectrum of electromagnetic radiation emitted by the sun. Other forms of solar radiation include visible light, and infra-red radiation which is felt as heat. Unlike these other forms of radiation, UVR can be neither seen nor felt.

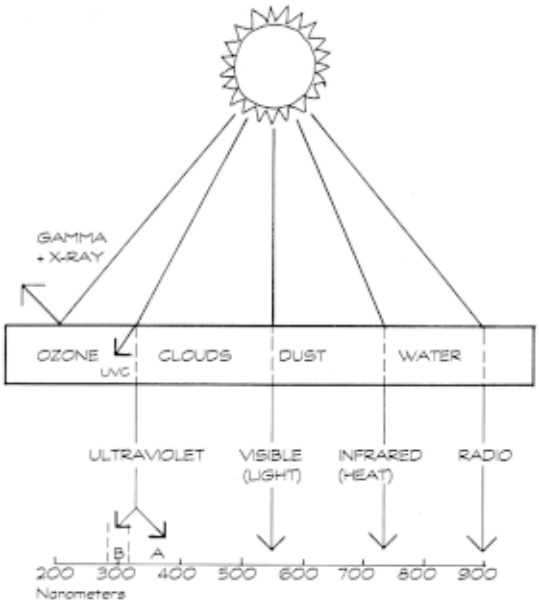

Figure 1. The solar spectrum

Ultraviolet radiation (UVR) is conventionally divided into UVA, which transmits freely through the earth's atmosphere, UVB about 85% of which is absorbed by the atmosphere and UVC which is completely absorbed by stratospheric ozone and atmospheric gases. UVB is the most biologically damaging form of UVR that reaches the earth's surface.

UVR reaches the surface of the earth in two ways – **directly** from the sun ('direct UVR') and **indirectly**, either scattered by particles in the atmosphere or reflected by surfaces such as walls, pavements, sand and snow ('indirect UVR'). Although indirect UVR is usually less intense than direct UVR, it can significantly increase total UVR levels. As a result, it is possible to suffer skin damage even when not in direct sunlight, due to the effects of scattered and reflected UVR.

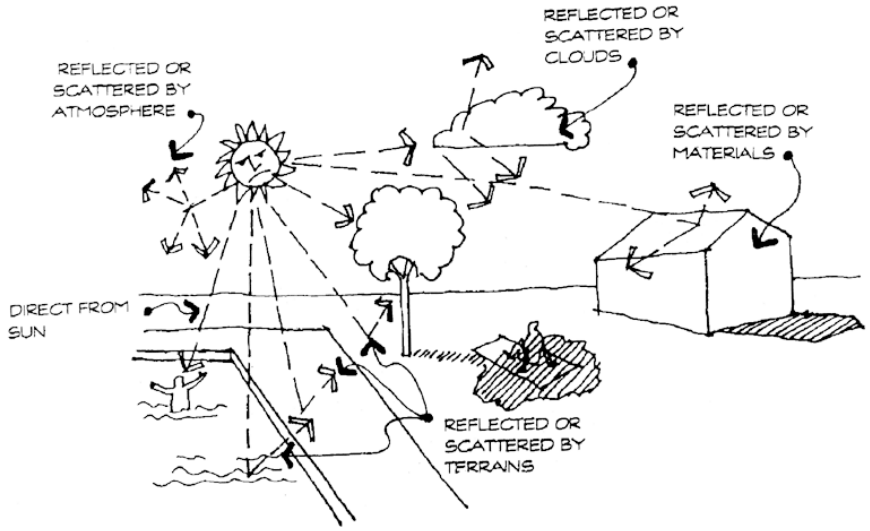

Figure 2. Direct and indirect UVR

4.0 FACTORS AFFECTING UVR LEVELS

There are four key factors affecting the intensity of UVR experienced on the ground:

- Season and time of day – the sun's position in the sky significantly affects the amount of UVR; the higher the sun in the sky, the higher the UVR levels. Accordingly, summer levels are higher than winter, with daily levels peaking at solar noon.
- Geographic location – the latitude of a location affects the intensity of radiation received. This is most relevant during the non-summer months, when UVR levels in the southern latitudes will be significantly less than those further north.
- Cloud cover – heavy cloud can reduce UVB levels to 5% of that present under clear skies. Scattered cloud has a variable affect with direct UVR levels rising and falling significantly as clouds pass in front of the sun.
- Surrounding environment – highly reflective natural surfaces (e.g. snow or sand) or smooth, hard built surfaces (e.g. concrete paths, metal cladding) cause increased indirect UVR and can significantly affect total UVR levels.

Other less significant factors are altitude, stratospheric ozone, atmospheric dust and air pollution.

5.0 PROTECTION AGAINST UVR

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 during the period of peak UVR levels between 11am and 3pm daylight saving time (10am to 2pm normal time). Whenever possible, outdoor activities should be re-scheduled to avoid this period; this is particularly relevant in the workplace, where environmental strategies are often difficult to

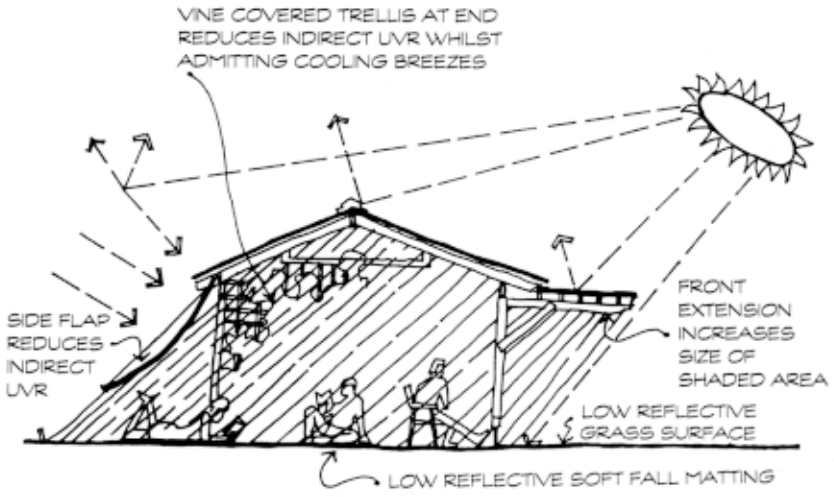

Figure 3. Environmental strategies for protecting against solar UVR

achieve. 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.

Effective environmental solar protection must provide:

- shade in the right place, at the right time - use sun angles to ensure that shadow is provided where protection is required
- at least 94% protection from direct UVR - shade with lower protection levels can create a false sense of safety
- protection against indirect UVR - minimise indirect UVR by increasing shaded area, providing side-screening and reducing reflectivity of surrounding surfaces
- summer and winter comfort - if a shaded space is not comfortable it will not be used; conversely, comfortable shaded spaces will be used by people seeking relief from heat, not UVR.

Due to the need to ensure these four aspects of protection, rarely will a single element provide the optimum solution – more often, it is necessary to combine a number of different elements in order to achieve effective solar protection.

For example, a roof over an outdoor café might be sheeted with polycarbonate, providing excellent direct UVR protection throughout the year but no cooling in summer. By adding deciduous trees on the northern side, replacing smooth concrete paths with coarse brick paving and side screening on the western side, the space would be cool in summer, warm in winter and experience lower indirect UVR levels.

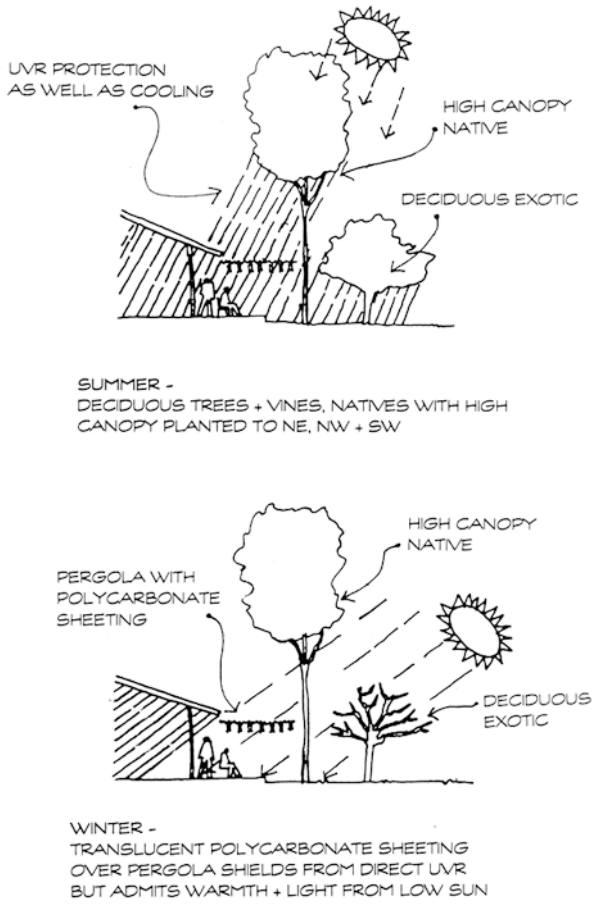

Figure 4. Passive solar cooling and heating principles

6.0 PROVIDING SHADE

Environmental solar protection can be created using natural or built shade solutions or a combination of both.

Natural shade can provide highly effective and aesthetically appealing shade, with significant environmental benefits. Natural shade is generally cooler than built shade as vegetation does not store heat and the evaporation of water through the leaves creates cooling. Vegetation provides colour, form, texture and scent as well as food and shelter for wildlife.

Environmental benefits of natural shade include:

- energy saved compared with built shade systems, which often have high embodied energy
- less need to use non-renewable resources used in many building materials
- fewer disposal problems, as plants generally act as nutrients during decomposition; and
- absorption of carbon dioxide in the atmosphere, potentially counter-balancing the 'greenhouse effect'.

Natural shade can have disadvantages that need to be allowed for at design stage, including:

- long lead times due to the slow growing nature of vegetation
- some unpredictability of shade outcomes, due to natural or seasonal variations
- potential detrimental affects to paths and services (above and below ground); and
- the need for relatively high levels of care and maintenance.

Built shade can take many forms and utilise a wide range of materials. Structures can be permanent, demountable or adjustable depending on the shade needs of the particular location. The range of materials available enables additional shelter benefits to be achieved. Spectrally specific design is possible, allowing transmission of heat or light whilst excluding UVR. Rain protection can be easily provided and, where appropriate, rain water can be collected for drinking or irrigation, and structures can support photovoltaic cells for the generation of electricity.

Other advantages of built shade include:

- shade outcomes are predictable in both quality and location
- shade can be quickly created; and
- maintenance requirements are generally lower than with natural shade.

In many situations, the advantages of built and natural shade can be optimised, and their disadvantages

minimised, by combining both forms into a single solar protection solution. This can be achieved by:

- using them as separate elements within an overall design solution, e.g. polycarbonate roof shaded by deciduous trees
- integrating the elements into a single structure, e.g. deciduous grape over a pergola structure; and/or
- overlaying one system with another, e.g. temporary shade structure in a park to provide solar protection until trees mature sufficiently.

7.0 SHADE PLANNING TOOLS

Two tools have been developed to assist in planning shade for outdoor locations.

The **Shade Audit** is a process for developing a strategic plan for shade provision at a particular site. This is achieved by establishing the usage patterns at the site, assessing the quantity, quality and usability of existing shade, determining the need for additional shade and identifying the preferred location and type of new shade. By assessing both summer and winter shade conditions, the Shade Audit ensures that effective solar protection is achieved whilst comfort levels at the site are enhanced (see DES 32).

The **Shade Inventory** is a process for prioritising a range of sites according to their need for protective shade and is most useful for organisations, such as councils, that are responsible for a large number of outdoor locations. It is also useful in situations where sites are so large that they may better be considered as a series of individual settings, each potentially requiring its own shade assessment. The Shade Inventory compares the solar risk of the sites and allows organisations to allocate funds and plan the provision of protective shade in an orderly and effective manner.

8.0 THE ROLE OF LOCAL GOVERNMENT

Local government authorities are uniquely placed in that they have four distinct roles with regard to the provision of solar protection:

- Councils are directly responsible for the management of considerable areas of public open space, generally of a recreational nature. Many of these areas are used by young children who are at high risk of skin damage due to UVR exposure. Councils have an obligation to assist and enable the public to safely use and enjoy these areas of open space.
- Councils are employers with a relatively high number of outdoor workers. Occupational health and safety legislation obliges employers to protect the health and safety of their employees. In the case of outdoor workers, this clearly involves providing protection against excessive solar UVR exposure.
- Councils are consent authorities, with the obligation to assess applications with regard to design, amenity, safety and environmental impact. In this role, they could require applicants to address the issue of solar protection at the design stage and significantly influence the extent and quality of shade provision.
- Councils inform the community on a range of health matters and are active in programs aimed at increasing public awareness of important social issues. Given that skin cancer is preventable and that changing community behaviour is a key issue, councils could form powerful partnerships with public health authorities to bring about significant change.

Reasons for local government to act in the area of solar protection are two-fold. Social obligation to the community is a powerful motivator of most local government authorities at both the political and bureaucratic levels. Most would correctly perceive that the potential to 'do good' should be acted upon, rather than ignored.

Risk management practices require councils to consider existing liability issues relating to the workplace, and issues that may arise with regard to the general responsibility that local authorities have to visitors to their land and users of their facilities. Local authorities, reluctant to act on these issues, need to weigh the actual cost of implementation of comprehensive solar protection policies against the potential cost of litigation.

The initial task that local authorities must undertake is the preparation of a comprehensive shade/solar protection policy. Whilst many councils have recently initiated such policies, few consider issues other than those associated with protecting their employees. As outlined above, this represents only one portion of the scope of responsibilities that local authorities need to consider.

In general terms, issues to be included in a comprehensive solar protection policy for local government can be separated into workplace issues and planning issues. A key aspect to consider in the workplace is the management and planning of outdoor work so as to establish low solar risk work practices. These practices must then be supplemented by appropriate environmental and personal protection strategies in order to make unavoidable sun exposure as safe as possible.

The preparation and implementation of local regulation initiatives, setting out the development standards that the council believes appropriate for proposed projects, should address planning issues. This could define quantities of shade for particular development types, although a preferred course would be to establish performance standards and processes, such as the submission of a Shade Audit. Implementing these standards will involve the training of Council staff and education of design professionals and applicants to make them aware of the local shade requirements.

In addition to requiring applications to comply with the local standards, councils should apply the same

standards to the public open space within their local government area. This would be managed initially by the preparation of a Shade Inventory, providing the framework for a strategic plan that would allow funds to be directed, in the first instance, to sites having greatest need. A staged program of upgrading facilities would commence with Shade Audits for the sites most needing solar protection.

By being proactive in solar protection and implementing a comprehensive solar protection policy, local authorities will:

- assist in achieving long-term social, economic and health benefits
- minimise their exposure to potential litigation; and
- demonstrate that they are responsive, progressive public authorities and employers.

9.0 THE CHALLENGE FOR THE DESIGN PROFESSIONS

The issue of environmental solar protection poses both responsibilities and opportunities for the design professions.

It is arguable that a twofold 'duty of care' exists, which the design professions should recognise. This duty would apply to clients, who could expect designers to advise them regarding:

- potential liability issues arising from the failure to provide shade (e.g. in the workplace);
- Council requirements for shade provision (which are likely to significantly increase over the next decade); and
- potential amenity and economic benefits of providing protective shade, in appropriate locations.

A wider duty could be said to apply to the community, where the opportunity exists to significantly impact on the important issues of public health and the quality of urban design.

In addition to these responsibilities, shade planning represents a significant business opportunity for design professionals. The capacity to undertake Shade Audits and Inventories provides a new service to offer, in a market where demand for independent advice is strong. A sound knowledge of solar protection issues provides an additional area of expertise that can enhance all projects involving outdoor areas. In addition, undertaking Shade Audits for community groups or local councils creates significant opportunities, either through direct flow-on from the initial study, or through introductions and networking.

By being proactive with regards to solar protection, the design professions could:

- assist in achieving long-term social, economic and health benefits
- provide a higher quality of service to clients
- access additional business opportunities; and
- demonstrate that they are responsive, progressive and relevant.

10.0 CASE STUDY – OLYMPIC COORDINATION AUTHORITY

In 1998, the Olympic Coordination Authority (OCA) commissioned a shade study of the public domain at Olympic Park. The study was initiated to review and assess the shelter and shade strategy developed in accordance with the master concept design, and was an important recognition of the responsibility associated with designing and managing public open space.

The study assessed Olympic Park in 'legacy mode' – it's long-term role as a place of major sporting and other community events. Consideration of the site in Olympic mode was beyond the intended scope of the study. The study was specifically limited to the public domain – the scope did not include shelter assessment of venues other than at their interface with the public domain, being the entrances and exits.

In experiencing this extensive and complex site, the public undertake a wide range of pedestrian activities including walking, jogging, milling, queueing, sitting, resting, relaxing and general recreation. As the site is used year-round, the public is exposed, in varying durations, to a wide range of climatic conditions. Accordingly, an effective shelter and shade strategy is required to maximise the environmental safety and comfort of pedestrian visitors.

Despite the size and complexity of the site, shade assessment was able to be successfully undertaken, based on the Shade Inventory and the Shade Audit procedures. The site was assessed by venues, by precincts and on a site-wide basis. Six precincts were identified within the site and Shade Audits prepared for each precinct, to determine the particular usage patterns, existing shade provision, shade needs and the means for providing shade.

Assessment was made of the existing shade levels, as well as the projected shade at maturity of landscaping, say 2010. Shade needs were assessed with regard to both health, requiring protection from direct and indirect UVR, and comfort, where glare and radiated heat were major issues.

With regard to the provision of shade, three major goals were established, being:

- to provide shade at non-discretionary locations, such as queuing locations at venues and public transport nodes
- to provide shade in discretionary recreational areas; and
- to provide transit shade along major pedestrian routes.

The study contained specific recommendations as to how the goals could be achieved, which resulted in the

construction of some additional structures and the modification of structures already in planning stage. By working directly with the design architects and OCA staff, the shade consultants were able to assess and evaluate means by which greater levels of UVR protection could be achieved. In this regard, outcomes included:

- the construction of the Yulang structure, which combines areas of solid roof and open pergola with deciduous vine to create protective shade;
- design brief input for the Olympic Boulevard and perimeter bus shelters, where consideration of orientation, seat location and the use of UVR protective glass significantly increased solar protection outcomes; and
- confirmation of exisiting strategies for solar protection, particularly those relating to the extensive use of natural shade to provide recreational and transit shade.

However, perhaps the most significant aspect of the Olympic Park study is the demonstration, by a significant public authority, of the importance of protection from solar UVR in the planning and management of public open space.

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ACKNOWLEDGMENTS

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BIOGRAPHY

John Greenwood is an architect with twenty years experience in the design and construction of a wide range of residential, commercial and aged care projects. For the past eight years he has specialised in shade and shelter planning.

His designs have won awards in the 1992 Shade Ideas Competition, and in May 2000 his company Shelter Strategies was awarded the Small Business Award at the Inaugural 2000 Cancer Council Awards.

In 1998 he co-authored the Cancer Council of NSW publication *Undercover - Guidelines for shade planning and design*, highly regarded as the most comprehensive shade planning document in Australia, and has presented numerous workshops and seminars on shade planning.

In 1998, Shelter Strategies undertook a comprehensive shelter study of Olympic Park, Sydney, for the Olympic Co-ordination Authority and remains a consultant to the OCA, on shade and shelter issues.