The Role of Built Environment in Modifying UV Exposure

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Abstract. Despite over a decade of international public programmes to promote environmental shade as a strategy to reduce overexposure to UV, the design and architectural professions have largely not responded to this call. This paper reflects on the case for designing our living environments to provide protection from UV over-exposure. Firstly, the history of the movement is considered. Secondly, key issues influencing the role of designed environments in modifying UV exposure are discussed. Several past initiatives to educate designers on shade design are critiqued and finally conclusions are drawn.

The urgency to take cover

It is important to remember that it was in response to expected increases in UV levels due to ozone depletion that led the World Health Organization (WHO), in 1992, to set up the Intersun programme [WHO, 2010]. This initiative complied with requirements of Agenda 21. New Zealanders will remember the alarming television advertisements showing of an elderly man and his grandson completely shrouded with sun-protective outfits on a deserted beach. The grandfather reminisced fondly of the time before ozone depletion changed the world. This disaster did not happen. Fifteen years later, because of the success of the Montreal protocol on ozone depletion, UV intensities in many places had levelled off or were declining [UNEP, 2007]. However, international research into understanding UV, associated health risks and human behaviours have been valuable in promoting sun-safe behaviours and role of environmental shade.

The role of shade

Studies of vernacular architecture across all cultures reveal a slow evolution of building design in response to both human needs and the local climate [Rudofsky, 1972]. In traditional Maori architecture, the mahau (or porch) of the whare was a living space orientated east to trap or store the warmth of the morning sun but also to shield the mid-day summer sun [Mackay, 2005]. Over the last two centuries, mass immigration around the globe has interrupted this slow natural adaption process. Dark-skinned populations in tropical zones have largely stayed put and continue to practice traditional lifestyles which acknowledge the daily high UV levels. However, notably waves of fair-skinned people from northern Europe have migrated to sunnier climes. With the advent of cheap air-travel, fair-skinned northern Europeans frequently travel southwards for short sunshine holidays. This is considered a significant factor in a threefold to fivefold increase in their melanoma rates in the last decades [Garbe *et al*, 2009]. In the case of destinations USA and Australasia, migrations have been permanent. New Zealand and Australia have twice the incidence of melanoma compared with countries in Europe and North America [Garbe *et al*, 2009][MOH, 2009]. For fair-skinned people, the impact on daily living of mid-summer UVI 12+ intensities (as found in Australasia) is significant in comparison with mid-summer maximums of UVI 6 common in northern Europe and USA. While clothing and sunscreen are suitable for active work and sport, shade is more appropriate for passive activities around the home and in public spaces. However, people must chose to avoid the sun. Long standing skin cancer researcher Prof Brian Diffey concludes 'the solar ultraviolet to which a person is exposed depends upon the local UV climatology and his or her behaviour,...'[Diffey, 2002].

The heliotherapy movement in 1920's Europe initiated a desire for tanned skin [Suren, 1925]. This fashion continues but the attraction of sun-bathing is not clear. A study of swimming pool sun-bathers suggested the warmth of sun, rather than its tanning effect, is desired [Mackay, 2006]. In New Zealand, sensible behaviour is not always intuitive. Commonly, cooling sea breezes force people to seek the warmth of the sun, even when UV levels are high [Mackay, 2005]. In this situation, laminated glass or polycarbonate can be used as shading materials to create UV protective 'warm shade'.

In New Zealand, some adaption of European traditional housing design has occurred to suit the sunnier climate. In 1947, European educated architect, Ernst Plishke, published a design for a model New Zealand house [Plishke, 1947]. Living areas opened onto a sun terrace with large sliding doors. The feature was economical in transforming the interior into a verandah. In winter, occupants can use the courtyard or enjoy and heat of the sun indoors. In summer, the indoor space, opened to exterior, provides shade. This strategy is common in new houses today. Other adaptions are laminated glass and polycarbonate verandahs and outdoor living spaces positioned in different locations around the building for use at different times of the day.

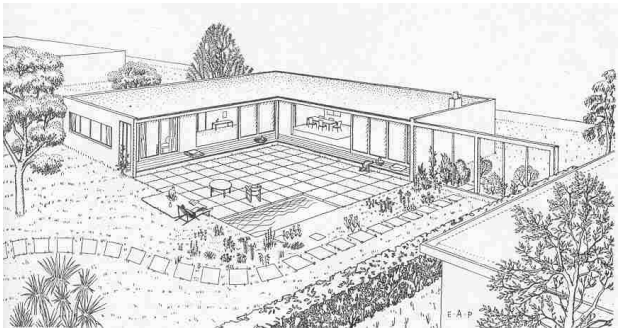

Figure 1. Model house proposal for New Zealand families in 1947.

Shade design education initiatives

Internationally, there have been several initiatives to encourage designers of the built environment to take responsibility for protecting the populace from UV over-exposure, but it is notable that in some countries the drive has not been sustained.

In 1997, the Health Education Authority (HEA) in Britain arranged for the prestigious Bartlett School of Architecture to host a design competition to design shade structures [RIBA, 1997]. The published designs were stand-alone sculptural objects situated in a park setting. The structures appeared to have no function other than providing various unspecified degrees of UV protection. In the same year, the HEA published a booklet, '*The Architecture of Shade*', and distributed it to all architectural schools and practices and local councils [New *et al*, 1997]. No reference to sun-shading for UV protection has been identified in UK architectural journals since. In 1998, *Under cover – Guidelines for shade planning and design* was published in Australia [Greenwood *et al*, 1998]. In 2000, a New Zealand edition followed and was promoted through a series of Shade Workshops organized by the Cancer Society of NZ (Inc). The presenter, John Greenwood, was a guest at the Canadian Design for Shade 2003 Conference, where 'a number of Toronto sites were re-imagined with a provision of shelter from damaging ultraviolet rays' [Andreae, 2003]. Again, there is no reference to UV protection in Canadian architectural journals since. Australasian Cancer Society's have continued to promote sun-shading, especially for schools via Sunsmart Schools programmes. After 2005, CDC published a web-based resource *Shade planning for American Schools* [CDC, 2009]. The guide is focused at a 'grass-roots' level to parents and school management rather than the architects and designers. In 2006, John Greenwood launched 'Web-shade', a computer based shade-audit and design tool.

The author has presented papers on shade research and design to PLEA (Passive Low Energy Architecture) conferences in Chile (2003), Geneva (2006) and Quebec City (2009) as well as to the Society of Building Science Educators in Seattle (2008). Feed-back confirmed that specific design of UV protection is only considered relevant in locations with fair-skinned populations and high levels of UV.

Shade design education recommendations

Education needs to be scientifically valid and use first principles rather than loose generalizations. Shade is useless in isolation and requires to be fully integrated into living environments. A 2009 design and teaching resource for architectural professionals offers an approach centred on assessing the protection factor (PF) of environments as follows [Mackay, 2009]:

$$\text{PF estimated (under shade)} = \frac{1}{\text{UV transmittance (of shading material)} \times 0.5 + \text{sky factor*} \times 0.5}$$

**'sky factor' is the proportion of the total hemisphere of the sky that can be viewed from a location under the shade.*

The suggested process for considering UV protection in a design project includes the following steps: understanding the science of UV protection and the local climate, researching shading precedents, assessing the out-door occupation requirements (time of day and duration) and the sun-protection needs of the users to determine the protection factor (PF) required for the space and, finally, exploring and testing of alternative designs and confirming estimated PF ratings.

Conclusion

Early initiatives to promote shade design were a response to predicted ozone depletion which has since been avoided. The role of shade in skin cancer prevention was over-emphasized and internationally the architectural professions have not recognised its relevance. In Europe, specific design may not be required (due to relatively low UV levels and static populations). However, inn Australasia and probably the southern states of USA (locations with relatively high UV levels and fair-skinned immigrant populations) the in-depth study and application of environmental UV protection has a place.

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