

## Shade in Schools – permanent not temporary?

Christina Mackay<sup>1</sup>, Louise Sandford<sup>2</sup> and Catherine Hall<sup>3</sup>

1. School of Architecture, Victoria University of Wellington, Wellington, New Zealand
2. Cancer Society of New Zealand Inc, Wellington, New Zealand
3. School of Architecture, Victoria University of Wellington, Wellington, New Zealand

**Abstract.** While purpose-built shade sails in New Zealand schools have appealed to and been used by students, in 2014, the Ministry of Education has elected not to support this type of shade canopy because of its limited life span and costly installation. The need for UV protection for fair-skinned children is long term, so more permanent shade structures are required. In New Zealand, covered out-door learning areas (COLA) must respond to different climatic zones to create UV protective and thermally comfortable spaces. This paper reviews designs of existing COLA in Australasia, and proposes shading materials to suit various sites in New Zealand.

### Introduction

In 2014, New Zealand schools lack effective shade. This is shade that provides effective protection from ultraviolet radiation (UVR) and is comfortable and desirable to use in New Zealand’s temperate climate. As part of the SunSmart Schools Accreditation Programme, the Cancer Society of New Zealand (CSNZ) is advocating to the Ministry of Education (MoE) for improved sun safety policy that can support practice in school settings. At a Ministry level CSNZ has been working with the Property and Infrastructure team to update the Property Toolbox on shade for schools. As this work progressed questions arose about shade that can enhance Modern Learning Environments in outdoor school settings.

Questions included:

1. What is the best shade design for covered outdoor learning spaces the in New Zealand climate?
2. When and where do we need warm shade? and,
3. What materials should be used to build effective shade with adequate UVR protection?

To investigate these questions, CSNZ worked with Christina Mackay and Catherine Hall in a jointly funded Victoria University of Wellington (VUW) Summer Research Scholarship project.

### Covered Outdoor Learning Areas (COLA)

A VUW 2003 New Zealand study of sixteen primary schools found several types of ‘communal’ shade areas including stand-alone structures, wide verandas and covered courtyards. They were covered in a variety of materials – shade-cloth, pvc and foliage. The areas were used for a variety of purposes – group assemblies, single class activities, lunch, class-room extension space, physical education and for free-play during breaks.

In Australia, COLA are evident in schools in several states. Many COLA are open sheds using profiled steel as the shading material. In New Zealand, previous VUW research found that in Paraparaumu, 69% of the time when UVI> 2 the air temperature was <18.1°C and users would

be likely to sit in the sun for warmth. In these situations, the use of transparent or translucent shading materials which transmit the heat of the sun while shielding UVR could create ‘warm shade’. This research analysed climate data to determine when ‘warm shade’ would be useful in schools in different locations around New Zealand.

### When do COLA need ‘warm shade’?

The study used readily available data from a previous NIWA study which analysed 2002 to 2007 UVI in five New Zealand locations: Leigh (Auckland), Paraparaumu (Wellington), Christchurch, Lauder (Central Otago) and Invercargill. This study selected the mean hourly UVI for each month.

This data was correlated against temperature data sourced from the NIWA Climate Database. For each site, 2004 temperature data was used as it provided an almost complete data set. Only Invercargill had some missing data which required extrapolation of available temperatures. Although the data sets were not a direct comparison, it could indicate monthly patterns. The comfort measure used was the ASHRAE Thermal Comfort Program which estimates that minimum air temperature of 18.1°C would create a cool but comfortable environment where the predicted percentage of dis-satisfied people (PPD) would be 10%. In the following hypothetical case, it is assumed that people (positioned out of the direct sun) would be slightly uncomfortable when the dry bulb temperature is less than 18°C.

An Excel spreadsheet analysis produced the following results for four scenarios.

Key:

- UVI<2 + temp <18 C - requires warmth but not UVR protection
- UVI<2 + temp >18 C - requires neither warmth or UVR protection
- UVI>2 + temp <18 C - requires warmth and UVR protection
- UVI>2 + temp >18 C - requires UVR protection + maybe cooling

	Jan	Feb	Mar	Apr	May	Jun	July	Aug	Sept	Oct	Nov	Dec
7	2	2	1	1	1	1	1	1	1	1	1	1
8	2	2	1	1	1	1	1	1	1	1	1	1
9	4	2	1	1	1	1	1	1	1	1	3	3
10	4	4	4	3	1	1	1	1	3	3	3	3
11	4	4	4	3	1	1	1	1	3	3	3	3
12	4	4	4	3	1	1	1	3	3	3	3	3
13	4	4	4	3	1	1	1	1	3	3	4	3
14	4	4	4	3	1	1	1	1	3	3	4	3
15	4	4	4	1	1	1	1	1	1	3	4	3
16	4	4	4	1	1	1	1	1	1	1	3	3
17	4	2	2	1	1	1	1	1	1	1	1	1
18	2	2	1	1	1	1	1	1	1	1	1	1
19	2	2	1	1	1	1	1	1	1	1	1	1

**Figure 1.** Chart showing requirement for ‘warm shade’ in Leigh (Auckland)

	Jan	Feb	Mar	Apr	May	Jun	July	Aug	Sept	Oct	Nov	Dec
7	1	2	1	1	1	1	1	1	1	1	1	1
8	2	2	1	1	1	1	1	1	1	1	1	1
9	2	1	1	1	1	1	1	1	1	1	1	3
10	4	3	3	1	1	1	1	1	1	3	3	3
11	4	3	3	3	1	1	1	1	1	3	3	3
12	4	3	3	3	1	1	1	1	1	3	3	3
13	4	3	3	3	1	1	1	1	1	3	3	3
14	4	3	3	1	1	1	1	1	1	3	3	3
15	4	3	3	1	1	1	1	1	1	3	3	3
16	4	3	1	1	1	1	1	1	1	1	3	3
17	4	1	1	1	1	1	1	1	1	1	1	1
18	2	1	1	1	1	1	1	1	1	1	1	1
19	2	1	1	1	1	1	1	1	1	1	1	1

Figure 2. Chart showing requirement for ‘warm shade’ in Wellington.

	Jan	Feb	Mar	Apr	May	Jun	July	Aug	Sept	Oct	Nov	Dec
7	1	1	1	1	1	1	1	1	1	1	1	1
8	1	1	1	1	1	1	1	1	1	1	1	1
9	2	1	1	1	1	1	1	1	1	1	3	3
10	4	3	1	1	1	1	1	1	1	1	1	3
11	4	3	3	1	1	1	1	1	3	3	3	3
12	4	4	3	3	1	1	1	1	3	3	3	3
13	4	4	4	1	1	1	1	1	1	3	3	3
14	4	4	4	1	1	1	1	1	1	3	3	3
15	4	4	4	1	1	1	1	1	1	3	3	3
16	4	4	1	1	1	1	1	1	1	1	3	3
17	4	1	1	1	1	1	1	1	1	1	1	1
18	2	1	1	1	1	1	1	1	1	1	1	1
19	2	1	1	1	1	1	1	1	1	1	1	1

Figure 3. Chart showing requirement for ‘warm shade’ in Christchurch.

	Jan	Feb	Mar	Apr	May	Jun	July	Aug	Sept	Oct	Nov	Dec
7	1	1	1	1	1	1	1	1	1	1	1	1
8	1	1	1	1	1	1	1	1	1	1	1	1
9	1	1	1	1	1	1	1	1	1	1	1	3
10	4	3	1	1	1	1	1	1	1	1	3	3
11	4	3	3	1	1	1	1	1	1	3	3	3
12	4	3	3	3	1	1	1	1	1	3	3	3
13	4	3	3	1	1	1	1	1	1	3	3	3
14	4	3	3	1	1	1	1	1	1	3	3	3
15	4	3	4	1	1	1	1	1	1	3	3	3
16	4	3	1	1	1	1	1	1	1	1	3	3
17	4	1	1	1	1	1	1	1	1	1	1	1
18	2	1	1	1	1	1	1	1	1	1	1	1
19	2	1	1	1	1	1	1	1	1	1	1	1

Figure 4. Chart showing requirement for ‘warm shade’ in Lauder (Central Otago).

	Jan	Feb	Mar	Apr	May	Jun	July	Aug	Sept	Oct	Nov	Dec
7	1	1	1	1	1	1	1	1	1	1	1	1
8	1	1	1	1	1	1	1	1	1	1	1	1
9	1	1	1	1	1	1	1	1	1	1	1	1
10	1	1	1	1	1	1	1	1	1	1	1	1
11	3	3	1	1	1	1	1	1	1	1	3	3
12	3	3	3	1	1	1	1	1	1	3	3	3
13	4	3	3	1	1	1	1	1	1	3	3	3
14	4	3	3	1	1	1	1	1	1	3	3	3
15	4	3	3	1	1	1	1	1	1	3	3	3
16	4	3	1	1	1	1	1	1	1	1	3	3
17	3	3	1	1	1	1	1	1	1	1	1	3
18	1	1	1	1	1	1	1	1	1	1	1	1
19	1	1	1	1	1	1	1	1	1	1	1	1

Figure 5. Chart showing requirement for ‘warm shade’ in Invercargill.

**Discussion**

During the school year (from February to December), the benefit of ‘warm shade’ (as illustrated in the light blue coding) is clear for Wellington, Lauder and Invercargill. During February and March, in Auckland and

Christchurch, commonly the air temperature is greater than 18.1°C and the radiant heat transmitted through a transparent shading material could make the COLA too hot for comfort. One mitigation strategy could be to position temporary additional solid shading material underneath. Alternatively, in coastal locations, sea breezes might provide sufficient cooling. At all sites, during the 3 or 4 months of winter UV protection is not required (as indicated by the dark blue coding) and any warmth from the low intensity sun would be welcome. At this times, impermeable clear sheet materials could transmit heat but the low angle of winter sun (at approx. 30°) would allow direct sun to penetrate deep under a COLA edge. On sunny winter days students could sit under the shelter of COLA roof in full sun. The specification of impermeable roofing material, rather than shade-cloth or trellis, would create a dry outdoor space that can be used all year round in all weathers.

**Clear shading materials**

There is a wide variety of translucent or transparent architectural products available. The New Zealand Building Code requires overhead glass to be laminated safety glass. The laminate layer is a 99% barrier to UV, creating an excellent but expensive warm shade canopy. In 2003, polycarbonate sheet was recommended. Its protective coating was a barrier to UVR. In 2014, suppliers recommend acrylic instead, because if the protective coating of polycarbonate sheets is damaged the UVR degrades the panel. However, acrylic does not have the same very high UV protection rating. Some low cost PVC sheeting provides low UV protection and quickly degrades. Fibreglass roofing is usually translucent, which means that it transmits less heat. ETFE is an unusual product which transmits both UV and infrared radiation. PVC membranes restrict both. In 2014, the Ministry of Education restrict the use of transparent roofing in schools. An underlay of steel mesh is required and maximum areas of transparent roofing are prescribed. These regulations compromise sensible design of COLA.

**Conclusion**

Analysis has confirmed the benefit of designing warm shade for COLA in New Zealand schools, but more research and development of COLA designs, including alternative cladding materials and systems, is required.

**References**

Gies, P., Mackay, C. 2004. Measurements of the Solar UVR Protection by Shade Structures in New Zealand Primary Schools. *Photochemistry & Photobiology*, 80: 334-3

Mackay, C. 2003. Designing safe and comfortable outdoor living spaces, PLEA 2003 Conference Proceedings, Santiago, Chile (2003), 321 -325.

McKenzie, R. (2008). A Climatology of UVI for New Zealand. Lauder, Central Otago: National Institute of Water & Atmospheric Research Ltd. Retrieved from <http://www.cancer.org.nz/Uploads/NIWA-client%20report-revisedapr08.pdf>

Ministry of Education, Modern Learning Environments, <http://www.minedu.govt.nz/NZEducation/EducationPolicies/Schools/PropertyToolBox/StateSchools/Design/ModernLearningEnvironment.aspx>