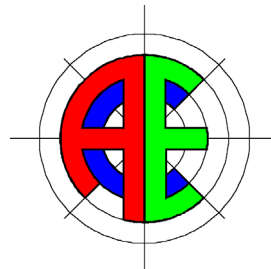


Melbourne City
Council

North Façade Analysis

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design advice

passive systems

design analysis

low energy services

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1 INTRODUCTION

This investigation of the performance of the proposed façade for Melbourne City Council Offices continues on from the work in an earlier AEC report, titled "Façade Shading Analysis", issued 14 March, 2003.

The earlier report made some recommendations about the level of shading required for full shading of all glazing in summer, and partial shading in during mid-season and in winter. These recommendations are assumed in this report as the base upon which further alterations to the design will be carried out.

A full daylighting and initial glare analysis of this initially recommended "base" option is also included. Some of the factors investigated in this analysis include:

- Natural light levels on levels 2, 5 and 8 of the office building under various sky conditions,
- The degree of solar penetration at various times of the day and the year,
- The degree of glare likely under this "base" configuration.

The overall aim of this report is to identify how the shading of the façade may be relaxed or altered further to optimise the comfort and natural light of the offices whilst working in the other constraints of the building design and budget. These recommendations will lead into a third report on the façade shading and daylight, investigating the possibilities raise here.

1.1 Limitations

The daylighting results provided in this report are very specific to the shading structure and façade provided. The results should not be carried across to other designs.

All of the daylighting analysis in this report assumes that a clear glass will be used for all facades. Any tinting on future glass types will significantly affect these results.

2 APPROACH

The study used the recommendations from the Façade Shading Analysis report to develop a base option. The shading recommendations from the earlier report are summarised in Figure 1 below. Note that the values represent the proportion of the façade that needs to be the relevant shading element to provide the required shading.

	Level 1		Level 9	
	Vertical	Horizontal	Vertical	Horizontal
North (Summer only)	0.8	0.8	0.8	0.8
North (All year)	2	2	2	2
South	0.5	0.35	0.5	0.35
East	0.25	0.25	0.65	0.65
West	2.3	1.9	2.3	1.9

Figure 1: Summary of recommendations from earlier report

This report mainly seeks to address the north and south facades, and as current plans indicate that the east and west facades will be broken by lifts, core and toilets, these sides are not significantly addressed at this stage.

2.1 Shading Design

Two separate shading designs addressed both the shading requirements of the north and the south facades.

2.1.1 North Façade Shading

The shading design to fit to the above conditions required the use of multiple vertical and horizontal shading elements on the north façade.

The horizontal shading included a 1m balcony for each level and a 2.1m deep light shelf (extruding outwards 1.6m from the façade and 0.5m into the interior), 2.1m above floor level.

The vertical shading included the two proposed planting mesh on either side of the window, each assumed to extrude 1.2m from the façade, and vertical, 1.2m deep opaque shading elements spaced no more than 1.5m apart across the face of the window. The mesh holding the eventual planting was assumed to be 80% opaque.

It was also assumed that a balustrade for the balcony would be included, 1m high and 50% transparent.

The north façade shading as described above is shown in Figure 2, Figure 3 and Figure 4.

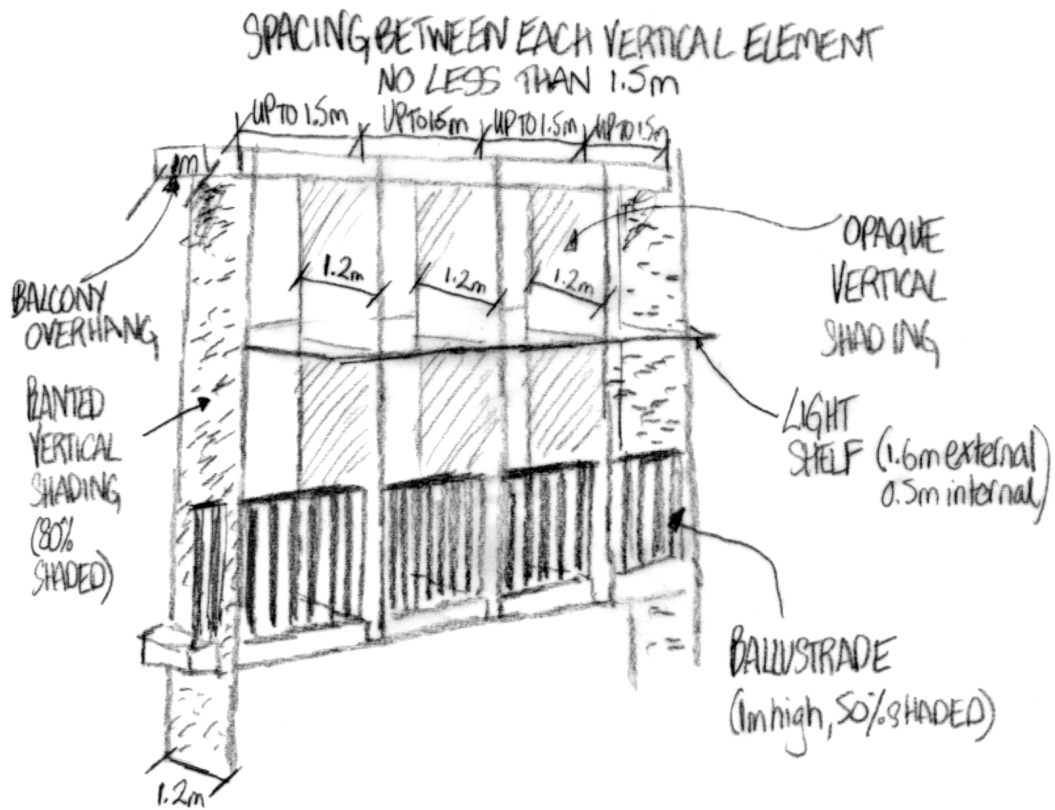


Figure 2: Sketch showing typical shading of north façade



Figure 3: Image showing layout of north facade shading

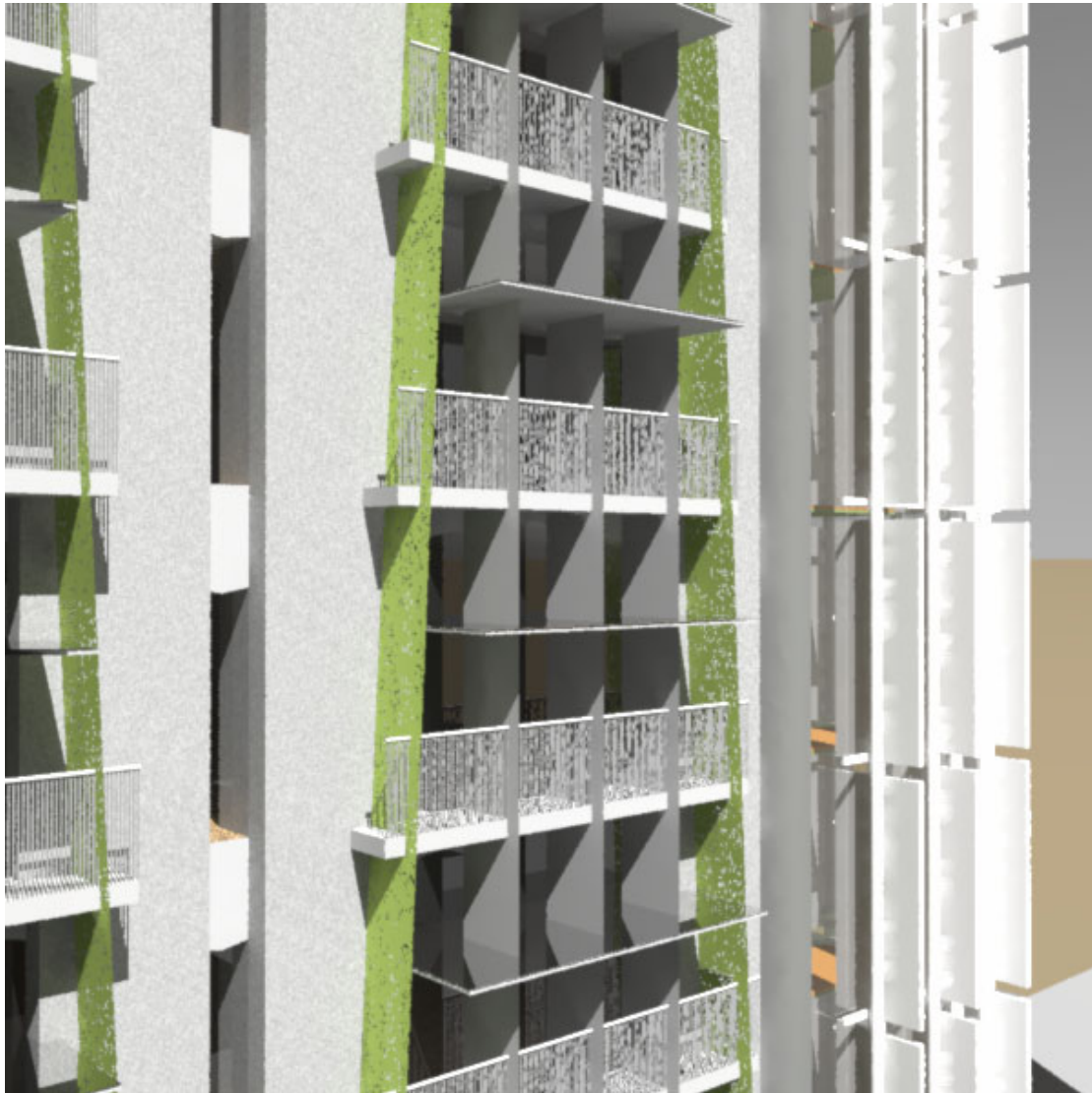


Figure 4: Detail of north façade shading

2.1.2 South Façade Shading

The shading for the south façade included vertical shading elements only, as the slight overhang inherent in the building design was assumed to be sufficient for the horizontal shading of the south-facing windows in summer.

Vertical shading fins 0.8m deep on the east side of each window were included as vertical shading elements. Although these elements would not provide total shading of the façade, the south façade glazing would be fully shaded during office hours.

2.2 Interior design

The interior architecture was based on the sketches provided by Design Inc and Mick Pearce. It includes the undulating ceiling, internal columns and medium-coloured finished. Some examples of the internal architecture used are included below in Figure 5 and Figure 6.

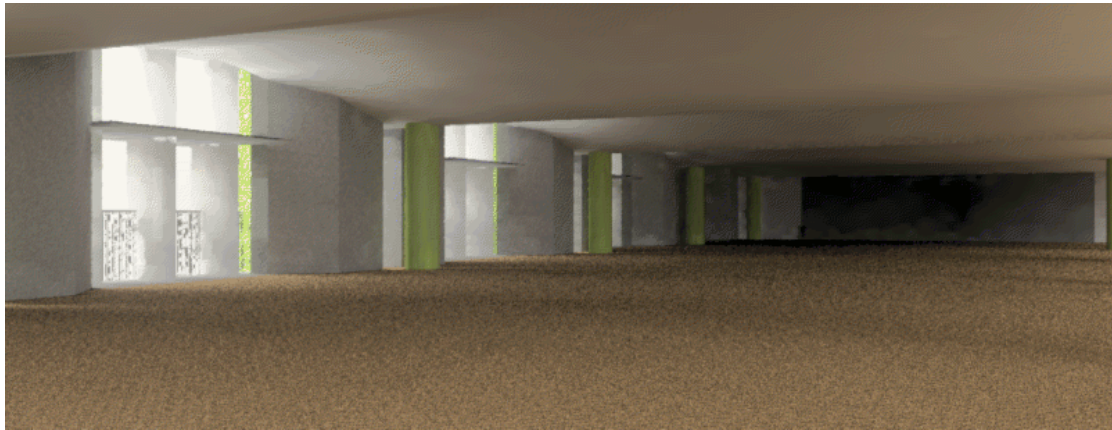


Figure 5: Interior architecture, looking NE

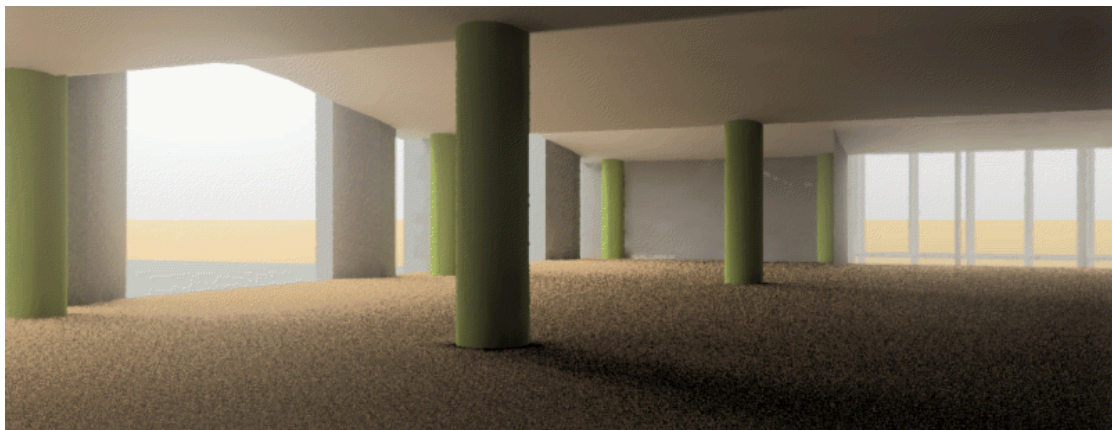


Figure 6: Interior architecture, looking SW

2.3 Modelling Software

Radiance was used for all the modelling for the results provided.

3 RESULTS

The daylighting analysis of the north façade shading investigated three key issues.

- Natural light levels on levels 2, 5 and 8 of the office building under various sky conditions,
- The degree of solar penetration at various times of the day and the year,
- The degree of glare likely under this “base” configuration.

The results for each are explained below.

3.1 Natural light levels

The natural light levels on the floor for levels 2, 5, and 8 were estimated for a number of sky conditions. These sky conditions included:

- Diffuse sky – totally cloudy representing light levels that will be exceeded for 85% of the year
- March sky – sunny midday sky to show light levels for a typical sunny day

The contour lines displayed on the images show the Lux levels on the floor. It is important to note that as these models do not include furniture, the light levels shown may be slightly higher than that in reality.

When considering the lux on the floor, there are two values which are particularly important.

Firstly, it has been noted that a level of 40 Lux is the first benchmark for ambient lighting required for circulation spaces. Therefore anywhere where 50 lux is exceeded on the floor, it can be assumed that ambient lighting will not be required.

Secondly, the Australian Standard for office lighting on a workspace is 320 lux. Therefore where ever the light levels exceed 350 lux, it can be assumed that task lighting will not be required.

With these in mind, the results are discussed below.

3.1.1 Cloudy 85% sky

The light levels represented in these images include light levels that will be exceeded for 85% of the year between 9am and 5pm. This is important because it shows us how often natural light will be able to supplement both ambient (50 lux) and task (350 lux) lighting, thereby indicating how much energy may be saved by linking the daylight with the artificial light levels.

Areas with light levels lower than 50 lux are shown on the images with dark blue shading. Ambient lighting will be required in these spaces for at least 85% of the year. Areas with light levels greater than 350 lux are shown with light green shading. These areas will have enough natural light to provide all work light requirements for 85% of the year. Unshaded areas will have enough natural light for ambient lighting, but not enough for task lighting, for 85% of the year.

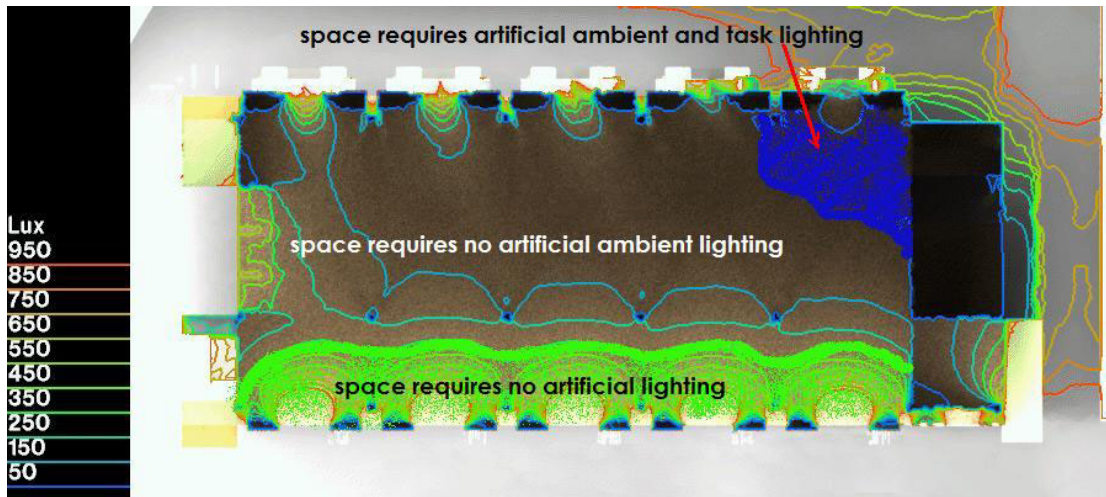


Figure 7: Lux levels on a cloudy day for level 8

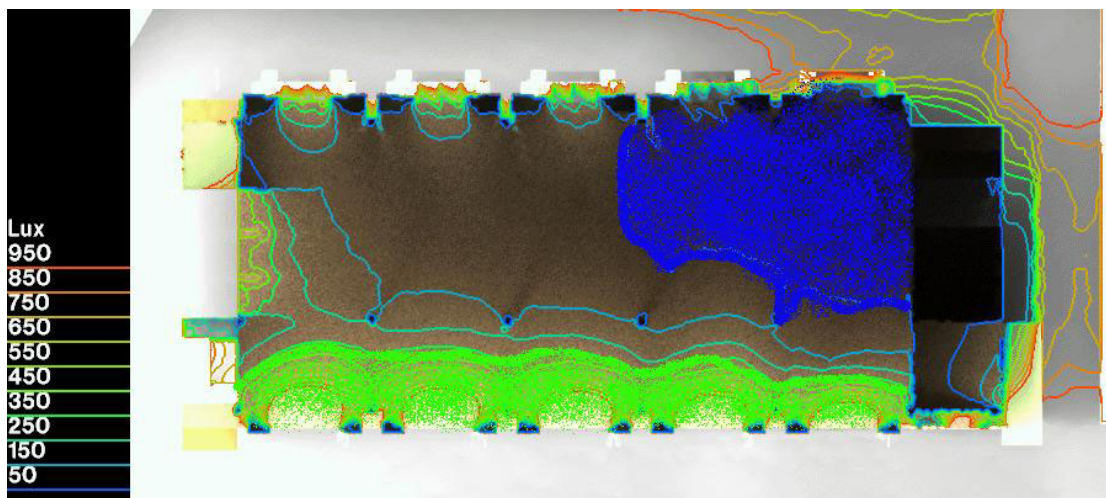


Figure 8: Lux levels on a cloudy day for level 5

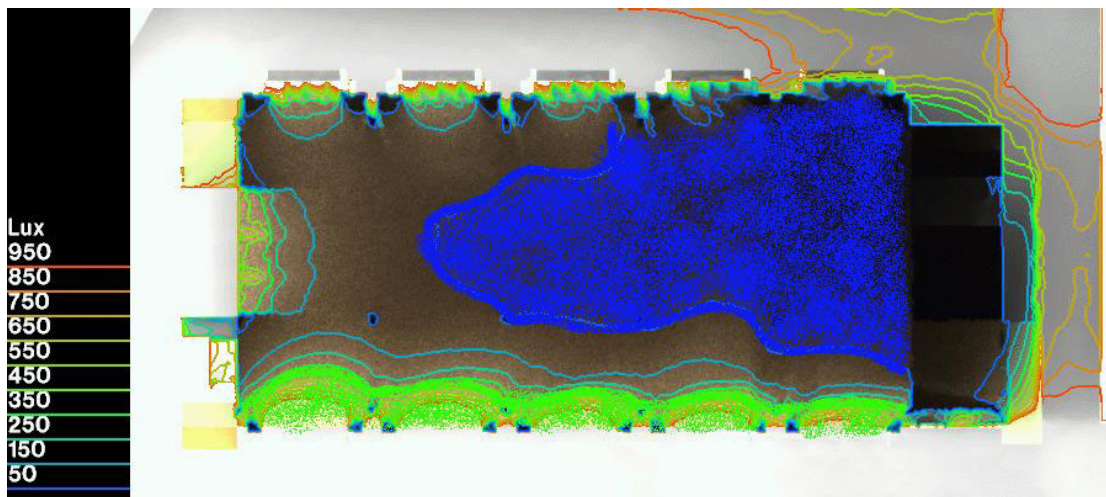


Figure 9: Lux levels on a cloudy day for level 2

3.1.2 Typical Sunny sky (March 21, 12pm)

The light levels shown in these images are less important than those for the diffuse sky and represent one single sunny sky condition. They have been included to give an indication of the difference in light levels between a cloudy sky and a sunny sky and to further track the effectiveness of the light shelf.

As in the diffuse sky images, areas with light levels lower than 50 lux are shown on the images with dark blue shading (ambient lighting will be required in these spaces) and areas with light levels greater than 350 lux are shown with light green shading (these areas will have enough natural light to provide all work light requirements). Unshaded areas will have enough natural light for ambient lighting.

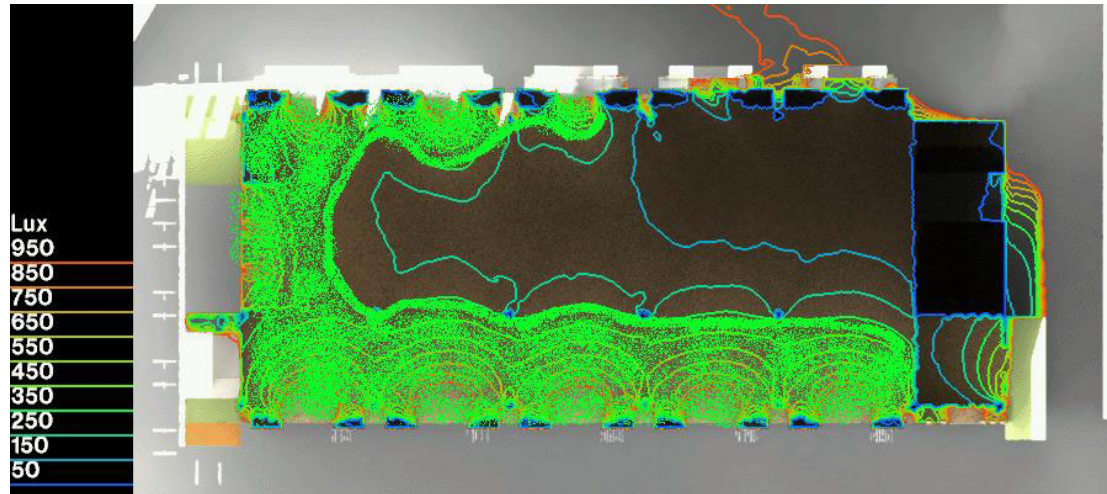


Figure 10: Light levels for a typical sunny March day on level 8

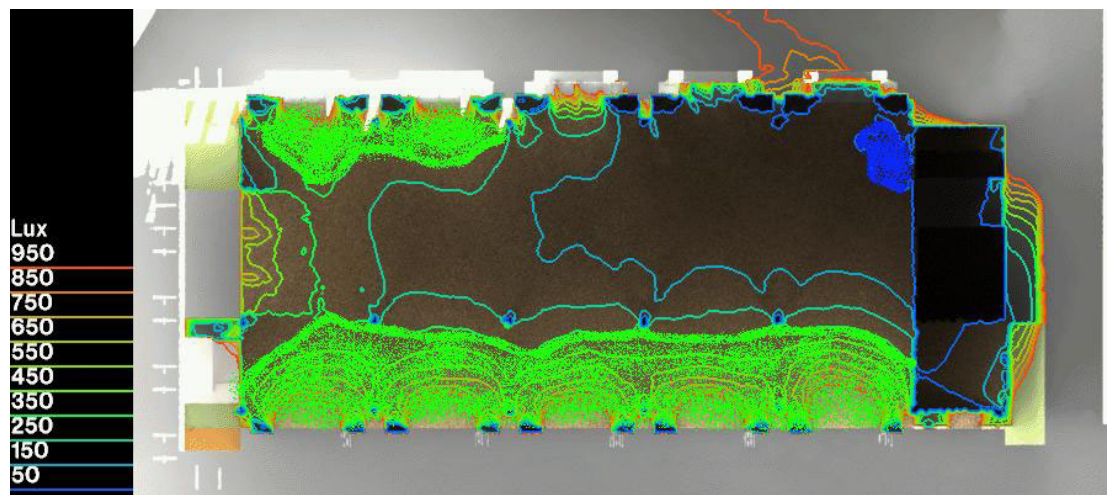


Figure 11: Light levels for a typical sunny March day on level 5

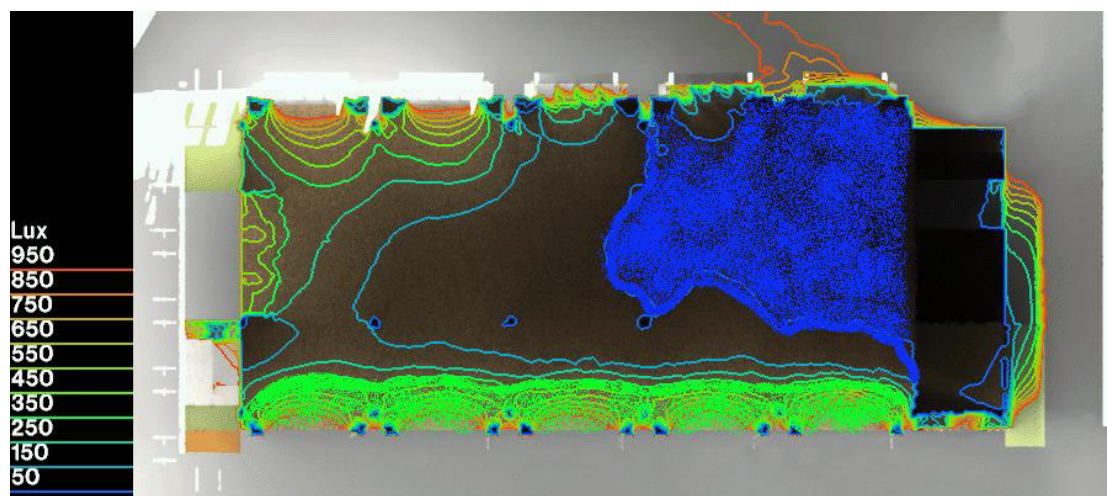


Figure 12: Light levels for a typical sunny March day on level 2

3.1.3 Objectives for future modelling

The daylighting results, particularly for the diffuse sky are significant.

Firstly, they indicate for the average floor (level 5) the ambient lighting will not be required for $\frac{3}{4}$ of the floor plate, 85% of the time. This means that daylight linking will allow a reduction of about 64% in the ambient lighting energy requirements.

Secondly, they indicate that, particularly for a diffuse sky, the availability of daylight on the southern side of the building is far greater than on the northern side. Even on a cloudy day, the perimeter zones on the south façade of the building will not require task lighting 85% of the time.

Thirdly, by comparing the light on the northern end of the building between areas overshadowed and in full sun, the images of a sunny day show how effective the light shelf on the northern façade is.

The first aim of future modelling will be to investigate whether these light levels can be improved, without losing the effectiveness of the shading. Particular note might like to be given to the eastern fringe of the north façade, which appears to be overshadowed by surrounding buildings for most of the year.

The second aim will be to confirm and possibly optimise the effectiveness of the light shelf on the north façade, including an investigation of light levels with and without the shelf, as well as some possible iterations into how deep the shelf may be.

3.2 Solar Penetration

The daylighting study sought to confirm that the base shading provided would shade the north façade during the summer months. The selected floor plate views provided show the level of solar penetration on the north façade of level 8 at a number of different times during the year. The images show that the base shading option satisfies the amended brief calling for full shading during summer.

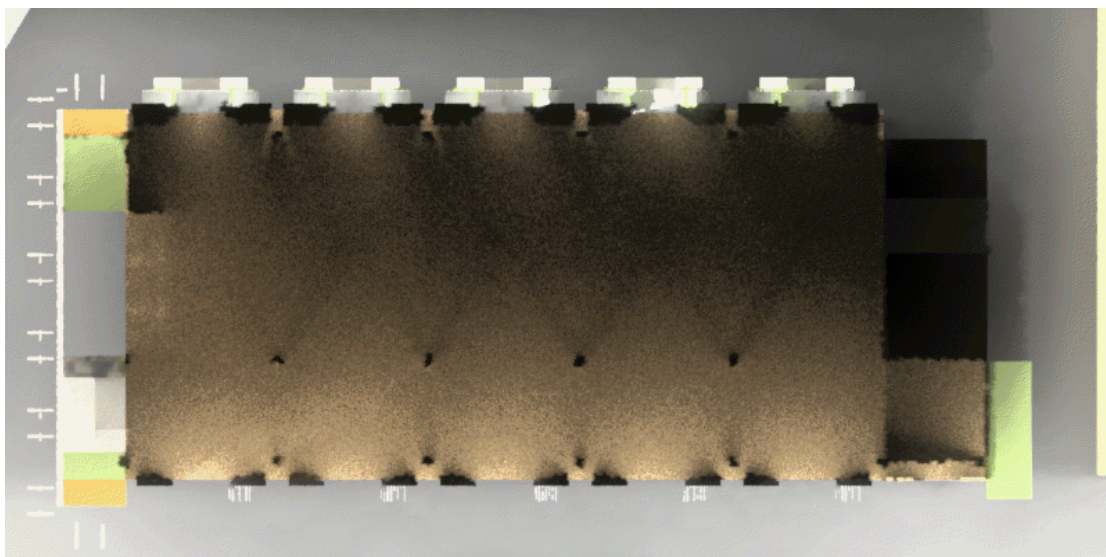


Figure 13: Solar penetration, 9am, December 21, level 8

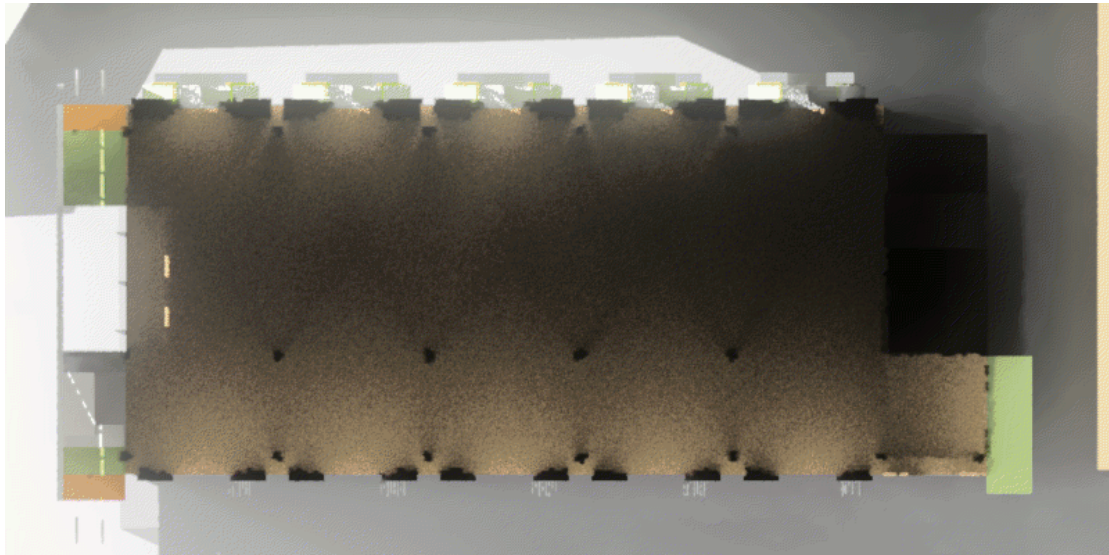


Figure 14: Solar penetration, 3pm, December 21, level 8

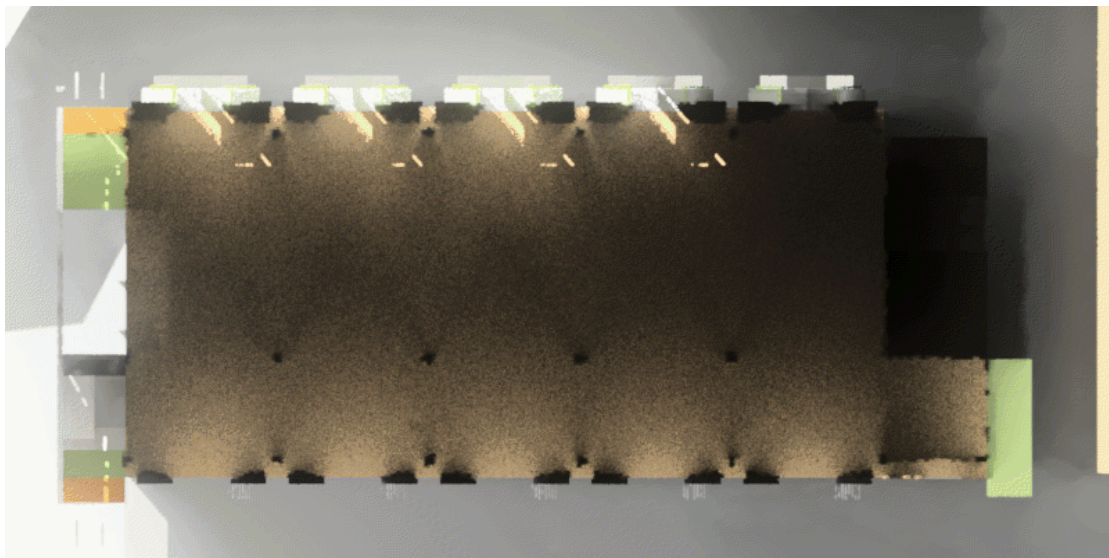


Figure 15: Solar penetration, 3pm, March 21, level 8

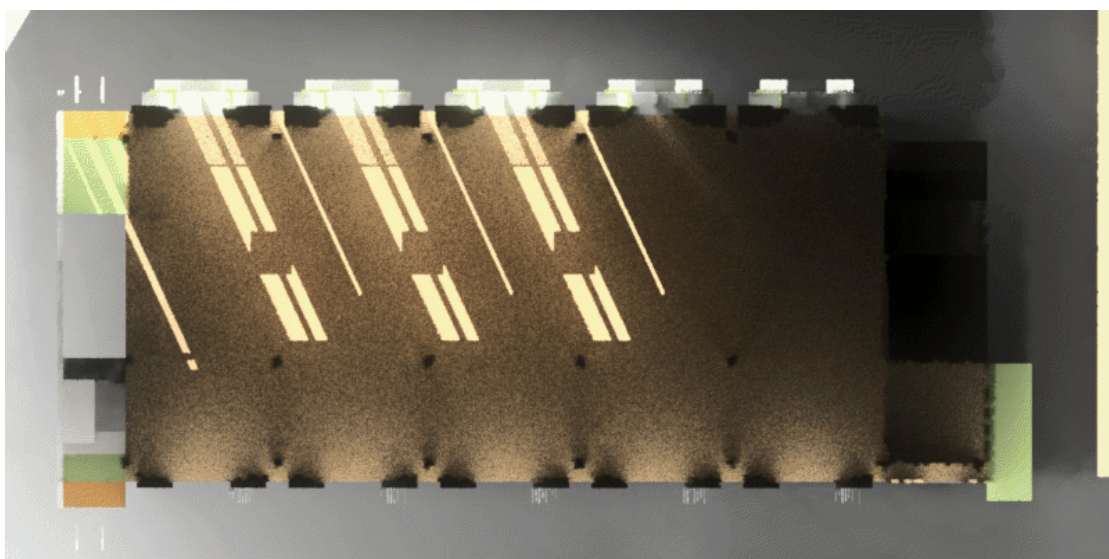


Figure 16: Solar penetration, 3pm, June 21, level 8

3.3 Glare

It is generally accepted that blinds will be included to control glare on the north façade. However an investigation into potential glare at times where there is no direct sun penetration is worthwhile in order to get an idea as to whether occupants are likely to want to close their blinds during this time.

Glare is usually caused by large differences in the luminance of various sections of the façade. Whilst blinds can be used to address the glare, the design objective is not to have the blinds permanently down. The façade shading design will need to continue to analyse glare as part of the process, including consideration of issues such as:

- level of glare caused by highly transparent “punch-out” windows
- energy benefits from the opaque façade elements
- energy and comfort benefits from the provision of daylight in the offices
- comfort benefits from minimising glare in the offices

A full glare analysis will be carried out by AEC to determine the optimum façade for the treatment of glare. This initial study does not properly investigate glare as an issue, because artificial lighting levels are not included in the study.



Figure 17: Glare looking north from level 5 on a sunny December afternoon

Looking at Figure 17, it can be seen that there are areas of glare at the façade in this model. However this model assumes that artificial lighting is switched off. A full glare analysis will be conducted by AEC to ensure that glare will be effectively controlled. This analysis will consider a number of options which may be utilised to prevent or reduce any glare.

4 ONGOING INVESTIGATIONS

This report has identified the outcomes for a base north façade design which aims to provide 100% shading during summer whilst optimising natural light throughout the office space. Further investigation into the north façade will be required. Some possibilities which may be considered include:

- changing the transparency of the vertical plantings and vertical shading elements,
- changing the location and size of vertical and horizontal shading,
- changing the depth and location of the light shelf or removal of the light shelf,
- changing the proportion of the façade that is transparent/opaque
- changing the depth of the balcony,
- adopting automated shading or location-specific shading for the north façade.

AEC will undertake further modelling of options arising from this report, as well as a full glare analysis of the façade treatment. Input will be sought from the rest of the design team with regard to how the façade shading nominated in this report may be changed to suit architectural aspirations.