Baseline Design – Daylight Strategy

Good quality daylight within the learning environment is essential. The aim of the baseline designs was to ensure sufficient levels of balanced glare-free light to all teaching spaces.

Climate Based Daylight Modelling (CBDM) – a different approach to daylight design in schools[1]

The PSBP Output Specification has a very different approach to daylight design compared with previous building programmes and school design guides. In the past, designing for daylight within the learning environment has been a numerical process based on a static overcast sky. The ambition was to deliver a certain percentage of diffuse light into the space (daylight factors) and achieve a degree of uniformity. The Baseline schools have been designed using Climate Based Daylight Modelling (CBDM) which takes account of the quality and quantity of sunlight and daylight.

Using CBDM in place of daylight factors provides far greater detail about light distribution and intensity which allows the building design to be adjusted to maximise the use of sunlight and daylight. Real weather data are used to calculate lux levels and targets can be set which are relative to user needs.

For the PSBP Output Specification two criteria have been established, Useful Daylight Index (UDI) and Daylight Autonomy (DA).

UDI is defined as the annual occurrence of illuminances across the work-plane that is within a range considered "useful" by occupants – 100 to 2000 lux. This is subdivided:

- UDI-a (100 to 2000 lux) where electric lighting is acceptable and electric lighting wouldn't be needed for the majority of the day. Achieving a high UDI-a percentage signifies the space is predominantly daylit throughout and glare is controlled.
- UDI-e (above 2000 lux) where the amount of light would be considered excessive and a source of glare and the blinds would be closed.
- UDI-s (below 100 lux) where the light would be considered insufficient without electric lighting.

The output specification sets a minimum target of 80% UDI-a for each learning space, sports hall and exam area.

DA is the amount of time a space can expect to reach a target illuminance level on the working plane. This criterion is aimed at delivering an energy efficient space. The output specification sets a minimum target DA of 50% for each learning space, sports hall and exam area.

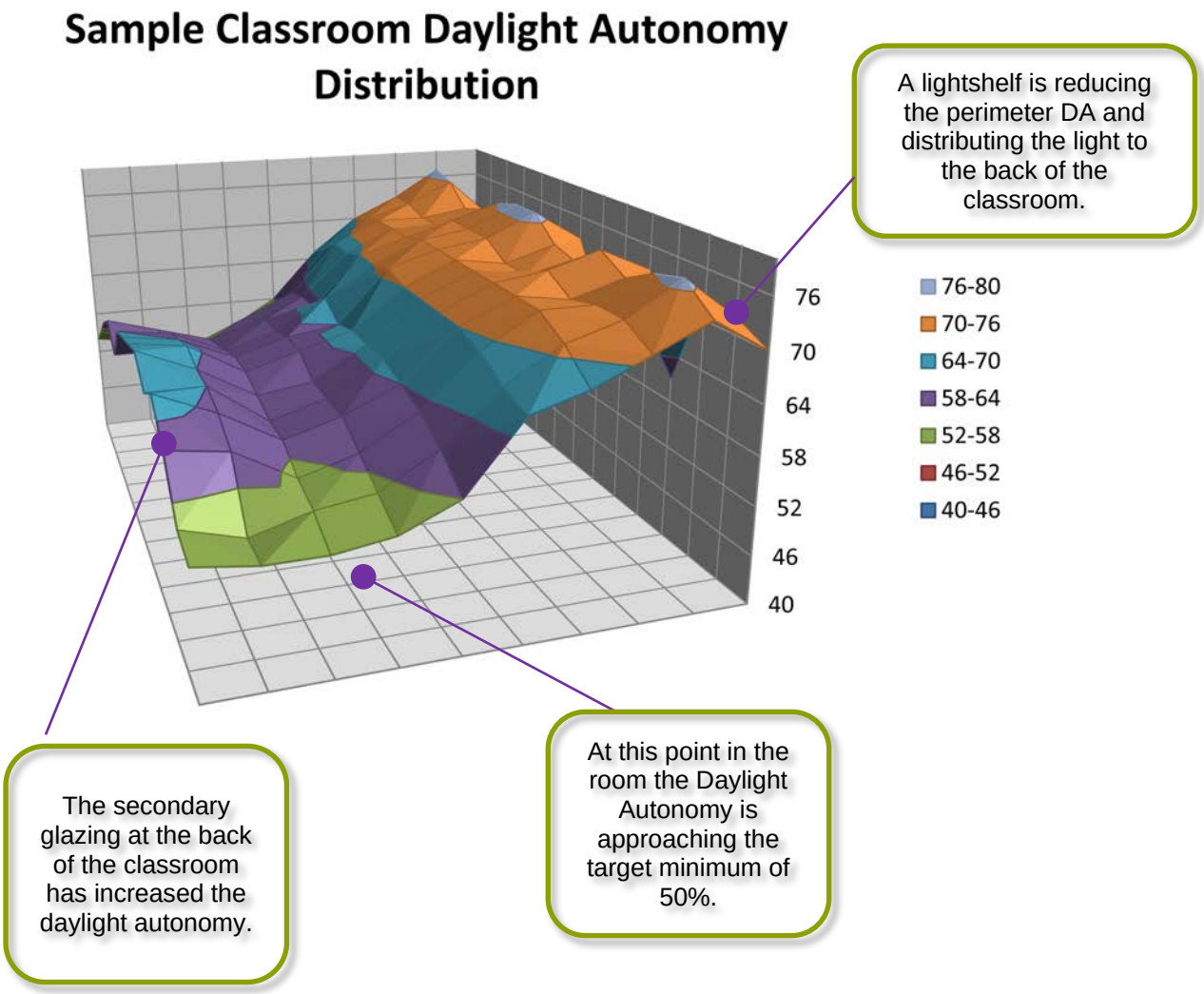
When undertaking UDI and DA analysis, the calculation grids must relate to the use of the space and, where known, the furniture layout. If a space is flexible then the

[1] *The concept of CBDM has been around for a number of years and has been used on other types of buildings, the concept was also introduced in the Society of Light and Lighting (SLL), Lighting Guide 5 – Lighting for Learning.*

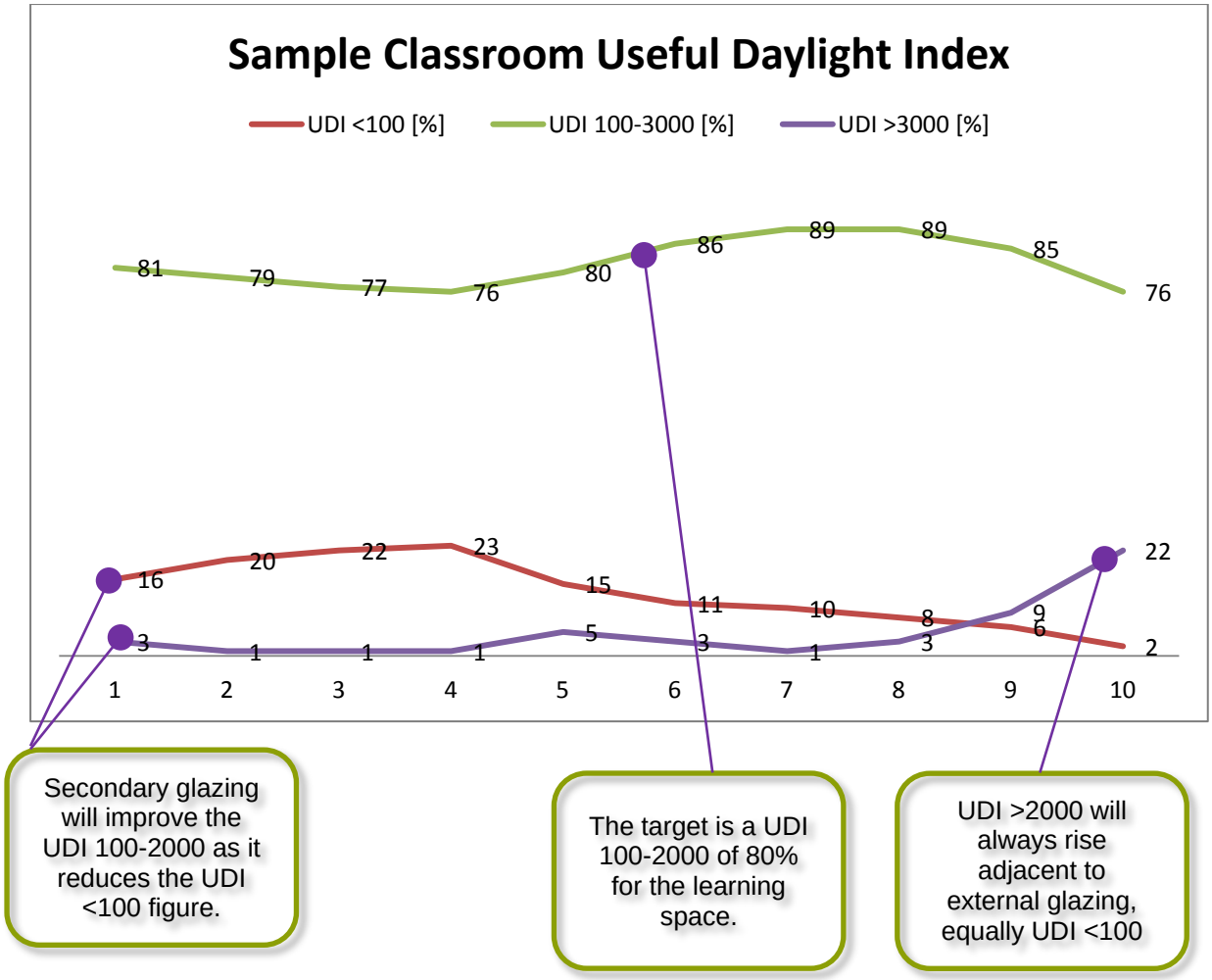
calculation grid must reflect that. Where it is known that desks or working areas will not be directly against walls then a 500mm perimeter zone in each room can be eliminated from the calculation area.

The graphs below show the modelling results obtained for the baseline design classrooms.

Daylight Analysis Results



Useful Daylight Index



Secondary glazing will improve the UDI 100-2000 as it reduces the UDI <100 figure.

The target is a UDI 100-2000 of 80% for the learning space.

UDI >2000 will always rise adjacent to external glazing, equally UDI <100

The sample graph here shows the results of a UDI analysis for a classroom. Each line represents the results as if a line had been drawn down the centre of the room from the external window to the back wall. A 3D graph would provide further detail.

The baseline design solutions
The aim of the baseline designs was to provide not only sufficient functional light but also a well-balanced and visually comfortable day lit space. Key features of the day-lighting design are given below.

- Secondary school teaching spaces are typically 7.8m deep with light entering from two sides of the room.

- Primary school classrooms are 7.2m deep; the daylight is adequate and meets the criteria in the Output Specification.

- Tall window openings ensure light travels deep into the room. To achieve this requires there to be no structural elements protruding below the structural slab along the building perimeter and small profile window frames are used.

- The floor to ceiling heights relate to the depth of the space to be daylit. 3m high in the 7.2m deep Primary classrooms and 3.3m high in the 7.8m deep secondary teaching spaces.

- Light shelves or other light redirection systems distribute light within the space and control high levels of daylight adjacent to the external windows.

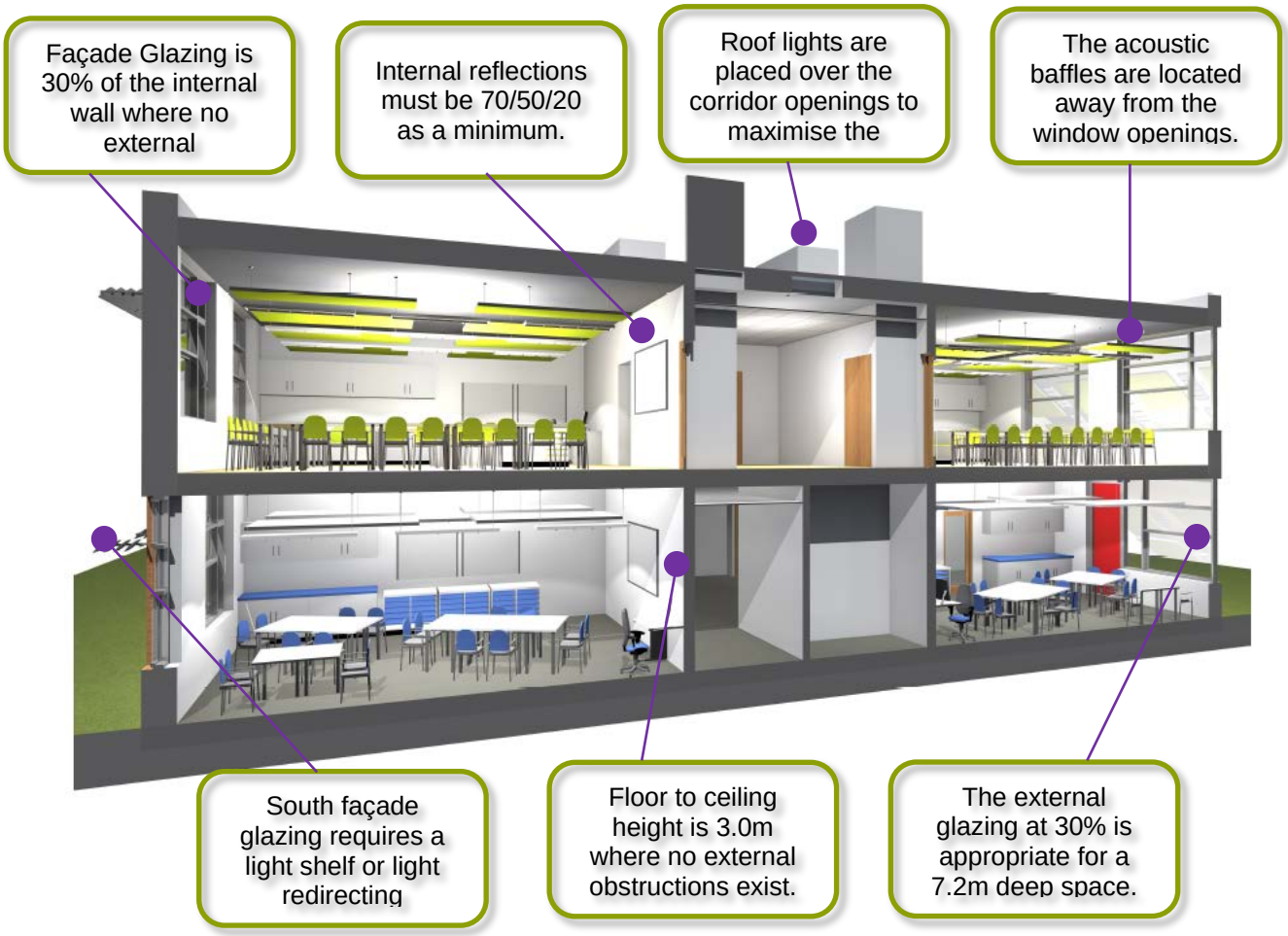
- A minimum of 30% external glazing is provided to achieve the CBDM criteria. This assumes no external obstruction.

- Because CBDM takes into account the sun and sky intensity and the sun angle, different day-lighting solutions are provided for the different facades.

- The lighting design is co-ordinated with other building elements and services so as not to restrict the distribution of daylight within the space.

The images below show these features applied to the baseline designs.

Baseline Primary School Design – Section through classrooms



Baseline Secondary school (superblock) – section through dining hall

South façade glazing incorporates a light shelf to redirect light into the room.

Roof lights provide daylight into the large halls and provide secondary light to learning spaces.

25% glazing required on the internal walls to deliver secondary daylight to the classroom spaces.

Open / translucent balustrade design allows light to distribute to the lower floors.

Internal reflections must be 70/50/20 as a minimum.

Floor to ceiling height is 3.3m assuming no external obstructions exist.

Baseline Secondary school (finger block) – section through teaching spaces

Floor to ceiling height is 3m assuming no external obstructions.

North Façade Glazing is 30% of the internal wall where no external obstructions exist.

The acoustic baffles are located away from the window openings.

Internal Glazing is 25% of the internal wall façade. This provides secondary light into the space.

The ground floor opening in the corridor is 1.2m wide to provide daylight to the ground floor

Roof lights are placed over the corridor openings to maximise the internal daylight.

Internal reflections must be 70/50/20 as a minimum.

South façade glazing incorporates a light shelf to redirect light into the room.

Open / translucent balustrade design allows light to the lower floors.

The first floor opening in the corridor is 1.8m wide to allow daylight to the lower floors.