Experiences with Radiance in Daylighting Design, Part VII

14th International Radiance Conference
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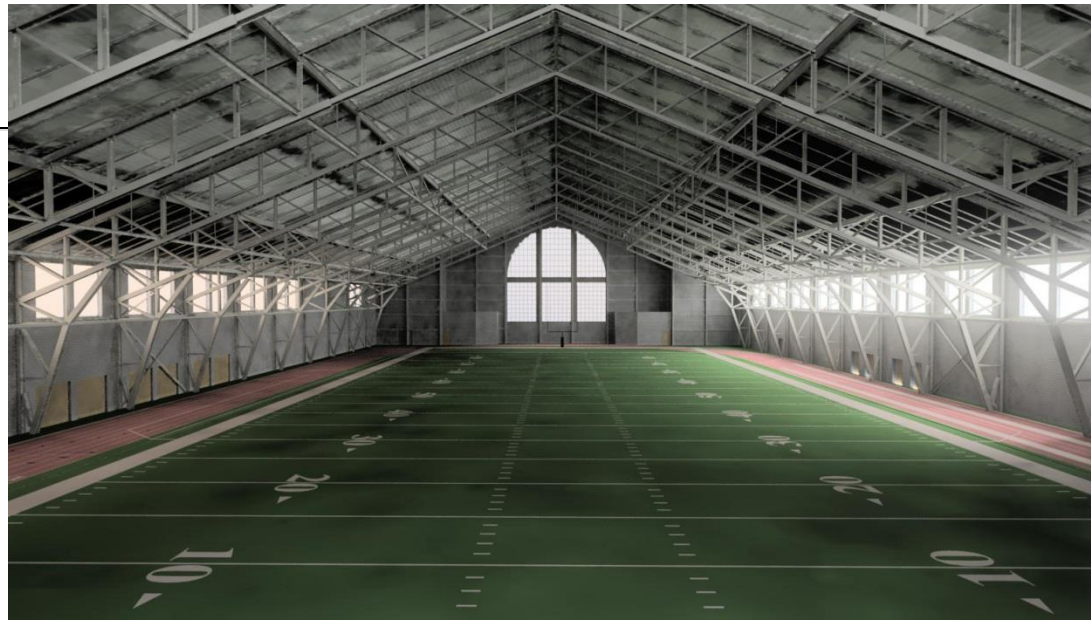
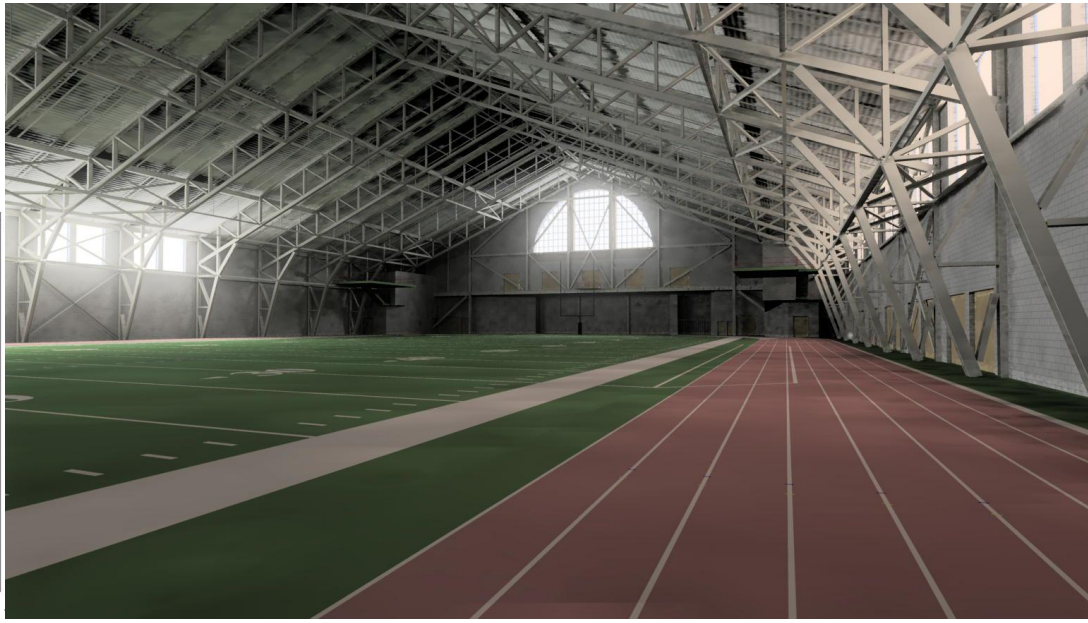
Presentation Outline

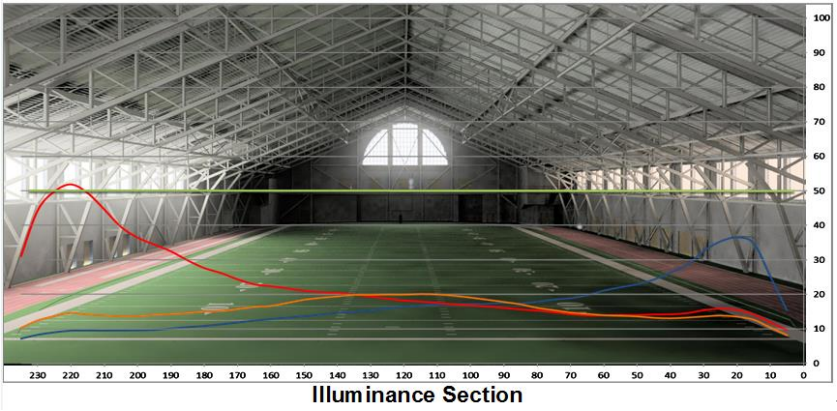
- CU Indoor Practice Facility
- Office building shading facade
- High School project
- CU Atrium Design
- Exterior Scene Mapping

Base Case Clerestories

- CU athletic expansion project - LEED silver goal
- Designed for a 50fc target
- Practice facility to house full size football field



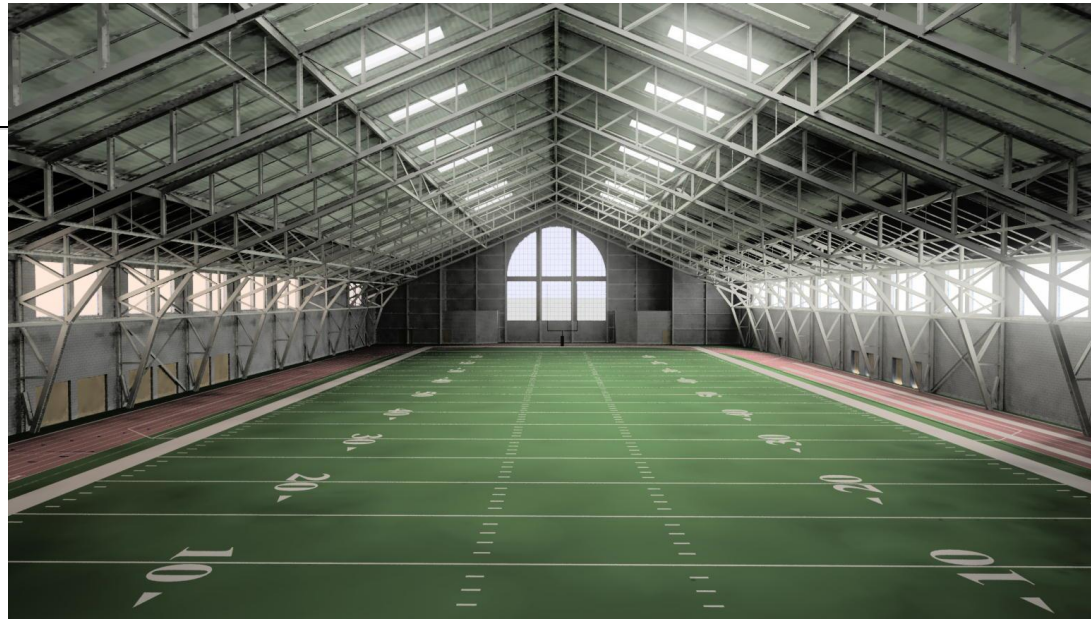


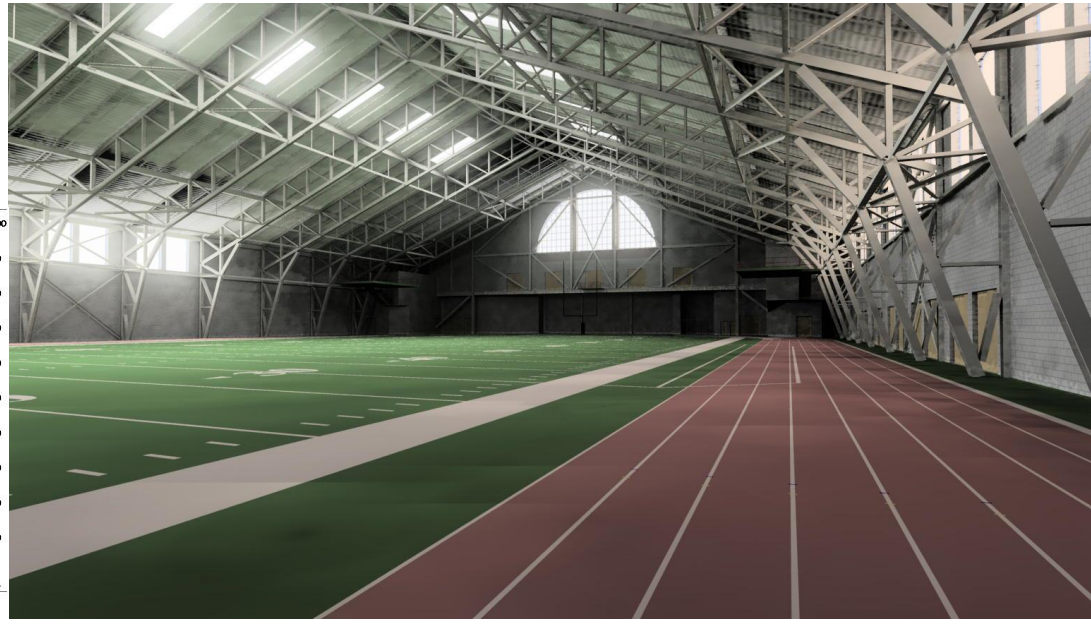


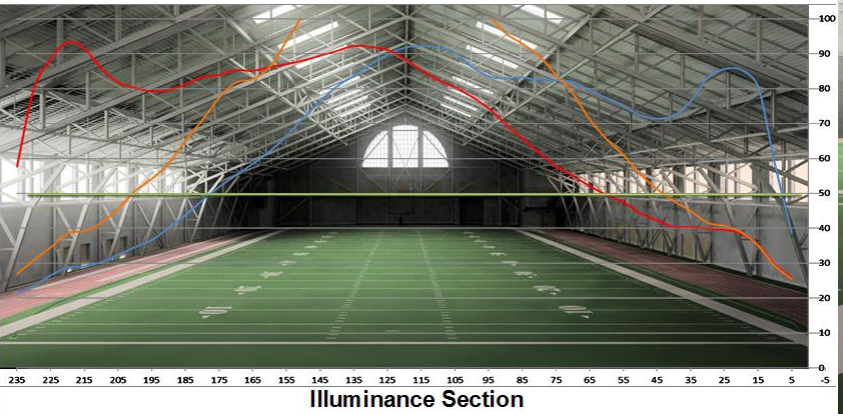
Illuminance Section

Skylight Array

- Array of 3’x10’ skylights added



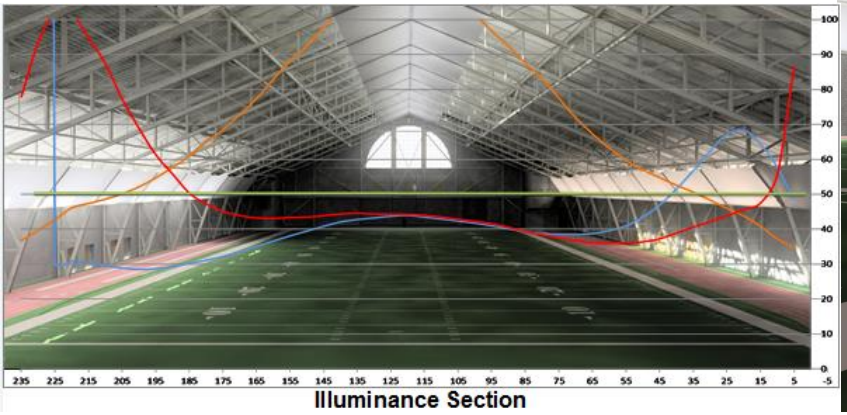




Illuminance Section

Linear Slot Skylight

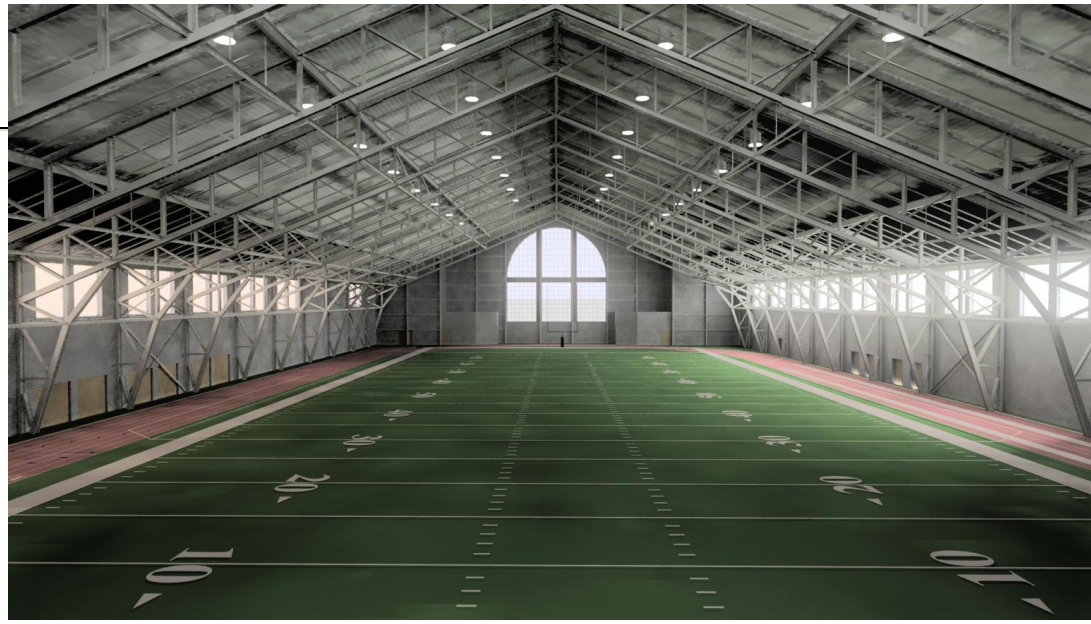
- Linear slot skylight down spine
- Operable for natural ventilation
- Translucent panels to diffuse/distribute clerestory light
- Louvered panels for direct sunlight control

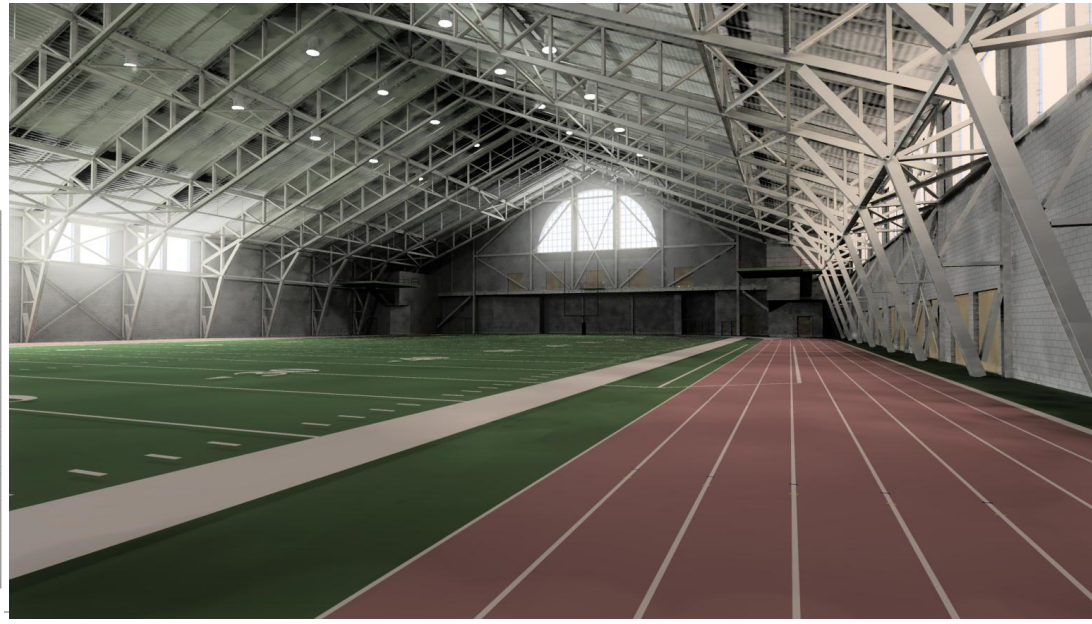


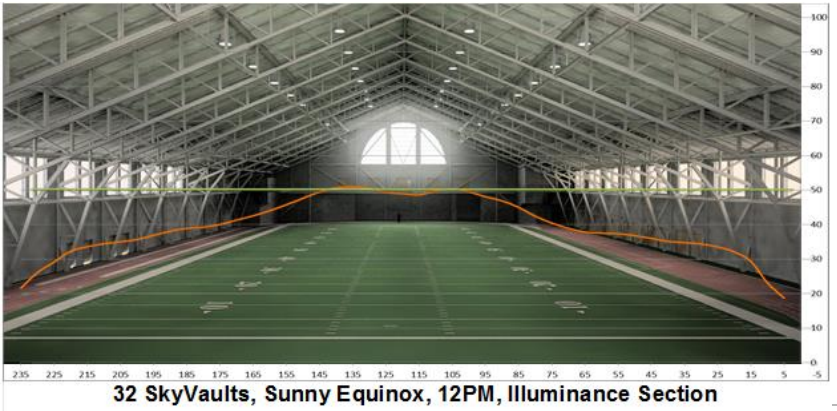
Illuminance Section

Tubular Skylights

- Series of 29” tubular skylights



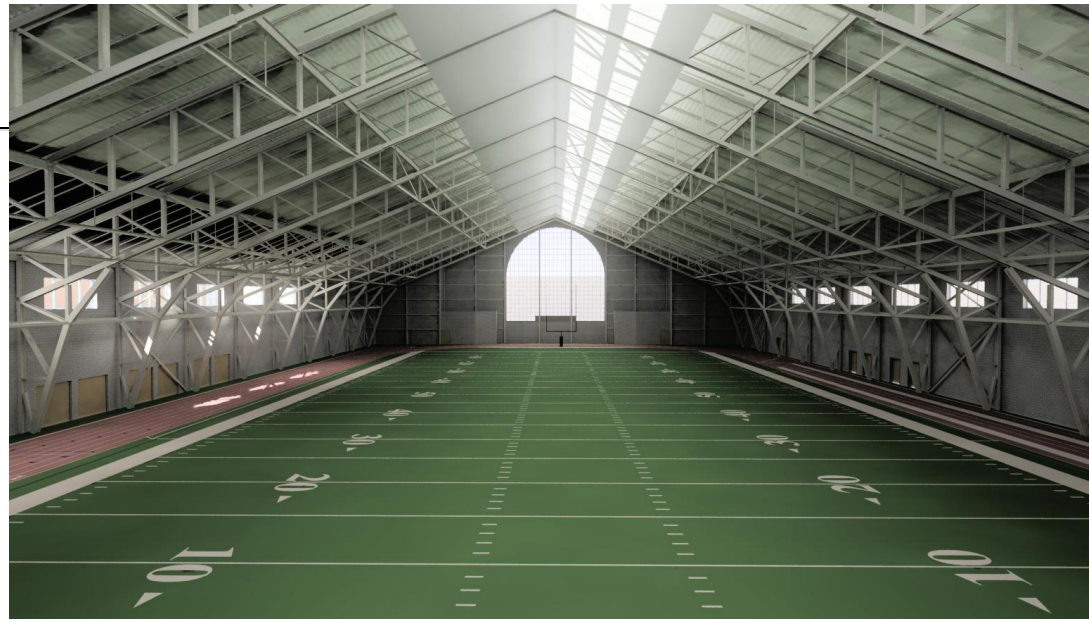


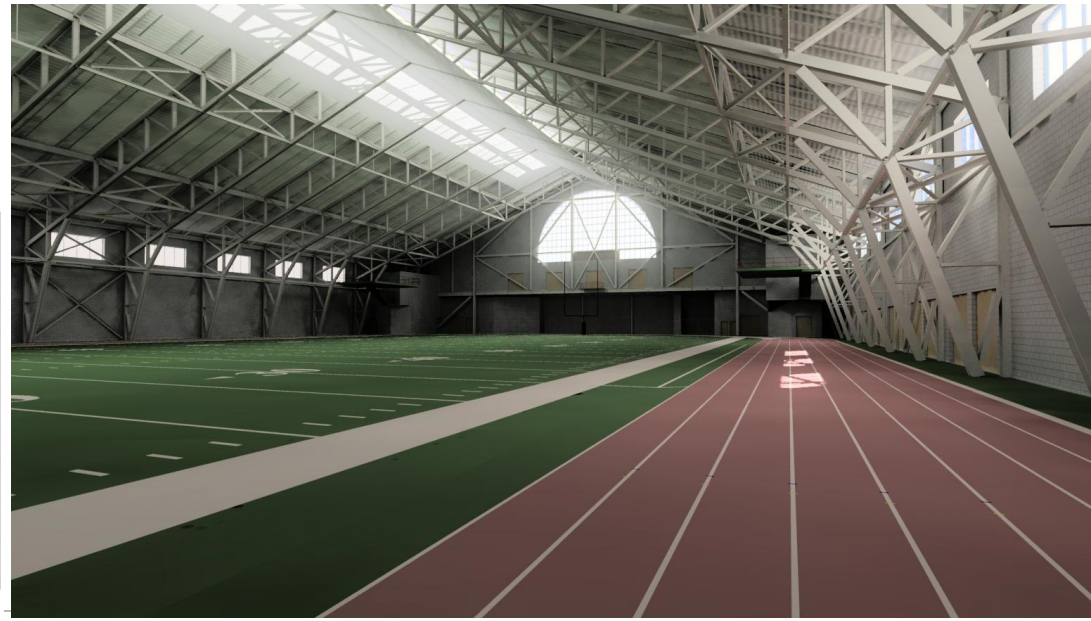


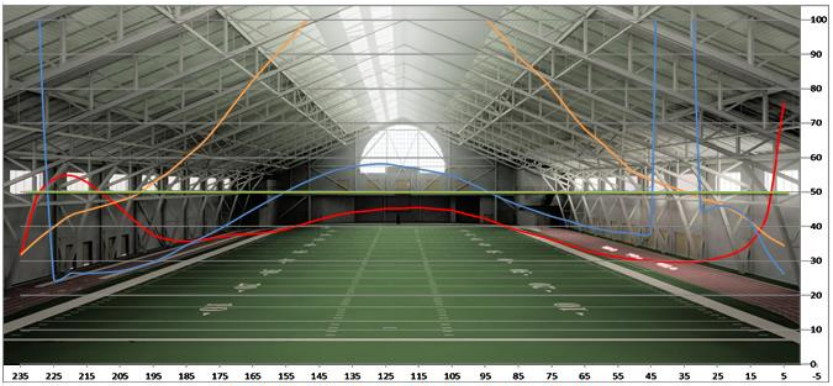
32 SkyVaults, Sunny Equinox, 12PM, Illuminance Section

Final Slot Skylight

- Linear slot skylight
- Diffusing fabric mounted on the bottom of 10’ trusses
- Diffusing clerestories with several clear panes for viewing
- No integration with natural ventilation



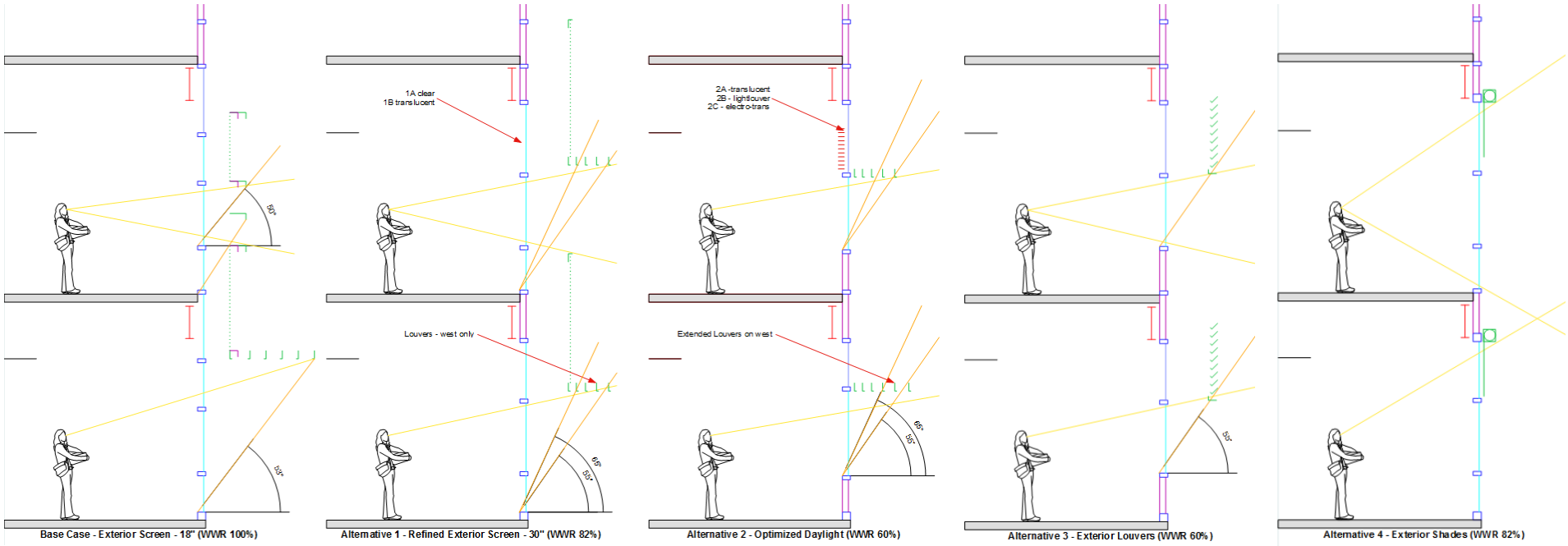




Illuminance Section (looking south)

Façade Shading

- East and West open office facades
- Architectural and client desire to create a static exterior shading solution that maintains plentiful views
- Analyzed a variety of shading options and more aggressive daylight and automated options



Base Screen

- Floor to ceiling glass
- Incomplete and redundant shading

Modified Screen

- Improved shading geometry but still not adequate to eliminate direct sunlight glare

Screen with Diffuse

- Diffuse glass to reduce glare
- Direct sunlight control becoming redundant

Dedicated daylight

- More intentional harvesting and redirection of daylight with diffuse glass

Screen with Louvers

- More intentional harvesting and redirection of daylight with LightLouver
- Ceiling alignment issues

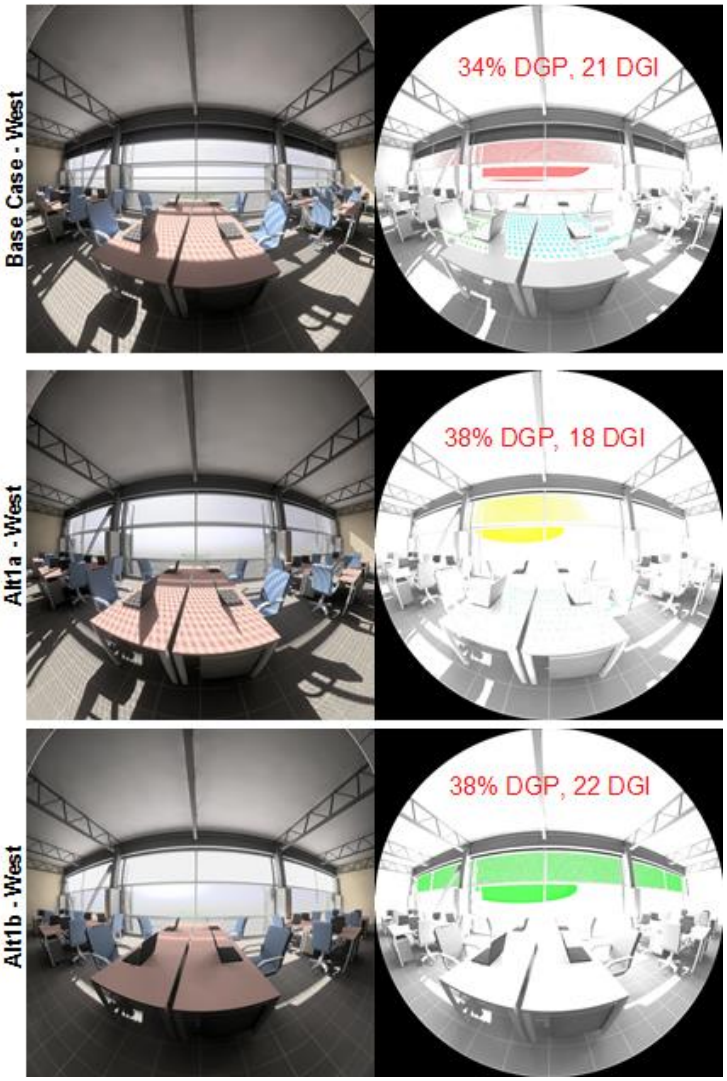
Exterior Louvers

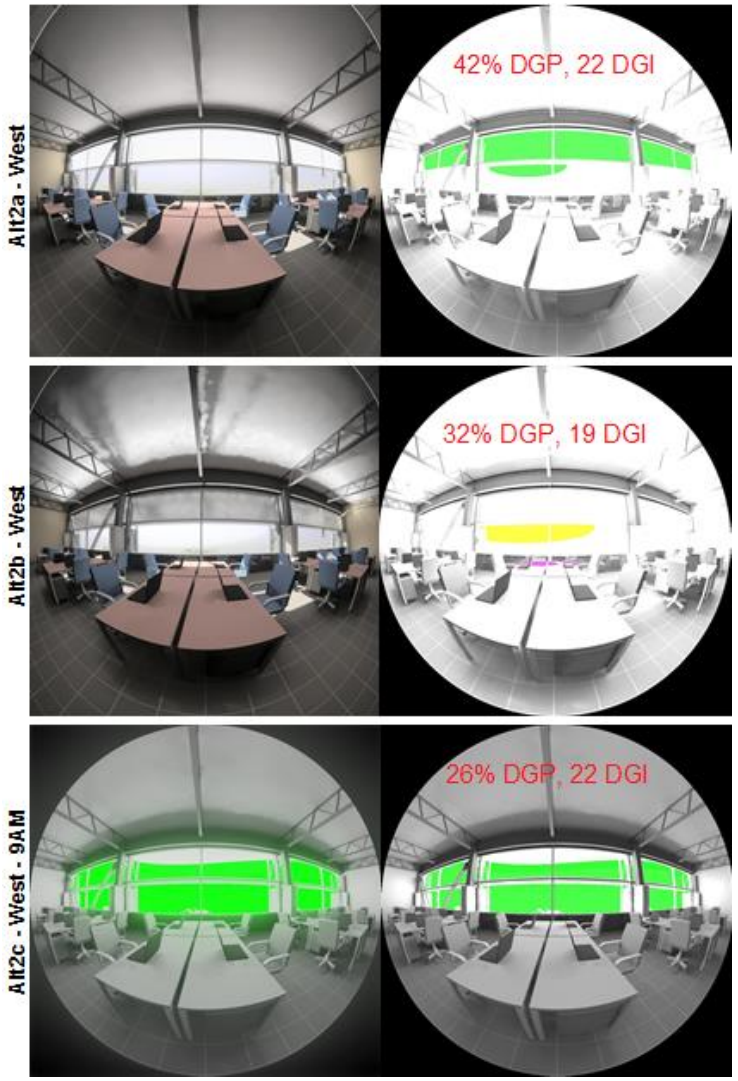
- Exterior screen louvered daylight redirection

Exterior Shades

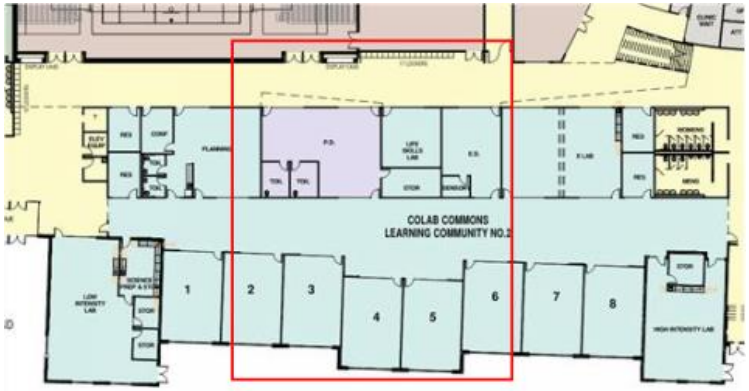
- Most reactive to East / West orientation
- Significantly reduces daylight when sun is present

Glare Comparisons

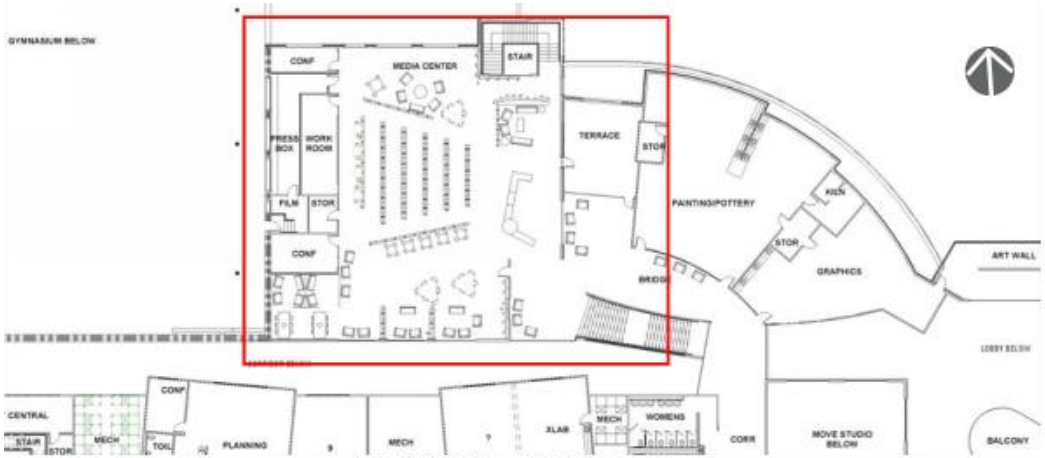




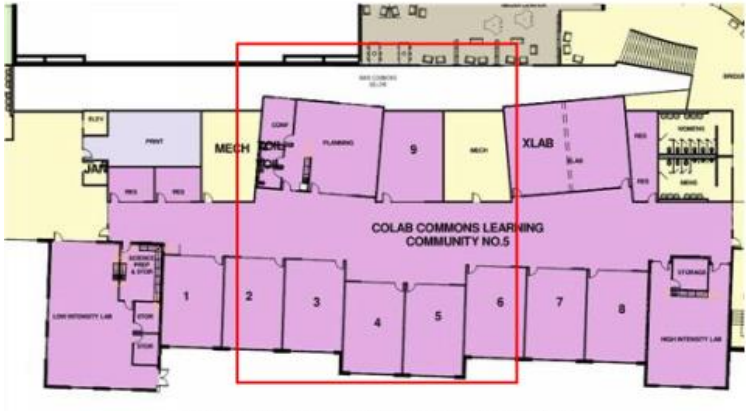
High School Critical Analysis Areas



Classroom Community First Floor Plan

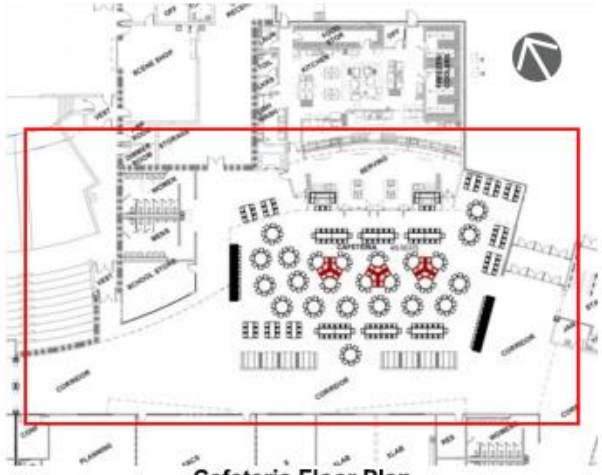


Media Center - 2nd Floor Plan



Classroom Community Second Floor Plan

Entry Lobby - 1st Floor Plan



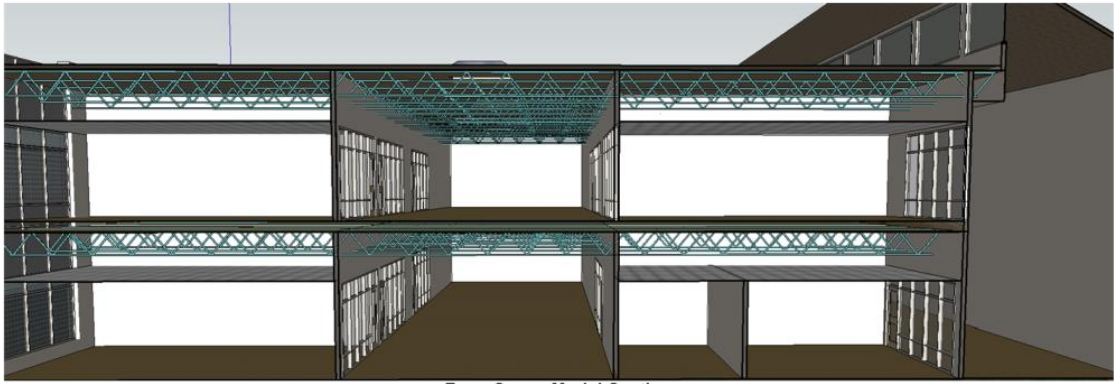
Cafeteria Floor Plan

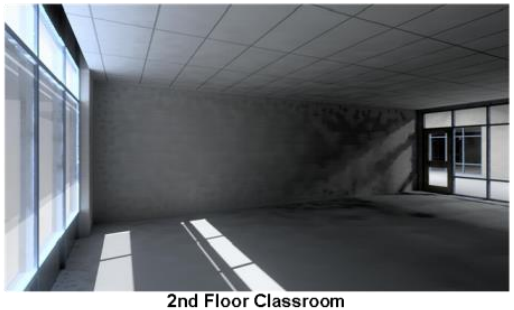
Skylights and Clerestories

Base Case Renderings
The base design shows us a base potential for using the perimeter windows and the borrowed daylight from the daylit commons and main hall to daylight the classrooms. With the exception of the southern half of the classrooms, the classroom spaces will have some connection to the climate via daylight but are under daylit and will not have useful daylight illuminance.

A 5% openness shade was modeled on the south facade to provide glare control for both windows. A 60% VT daylight glass was used and a 35% VT view glass. This strategy can work ok if the blinds are controlled fairly ideally but it can also lead to excessively glary conditions (if left up under direct sunlight) or dim conditions (if left down). Studies have shown that manual shades without occupant education tend to be misused and often left closed. The other design alternatives explore more reliable daylight strategies for the south facade.

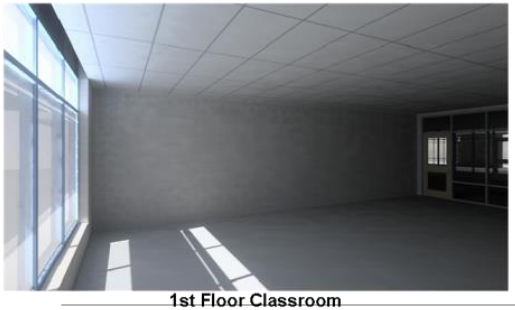

View of South Facade


Base Case - Model Section


2nd Floor Classroom

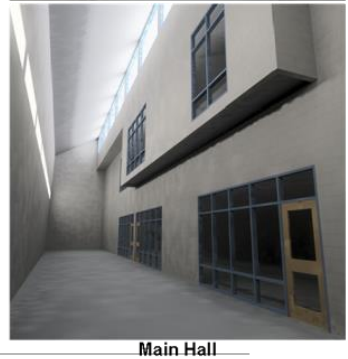

2nd Floor Commons


2nd Floor Teachers Lounge


1st Floor Classroom


1st Floor Commons


1st Floor P.D.


Main Hall

Louvered ceiling and Tubular skylights

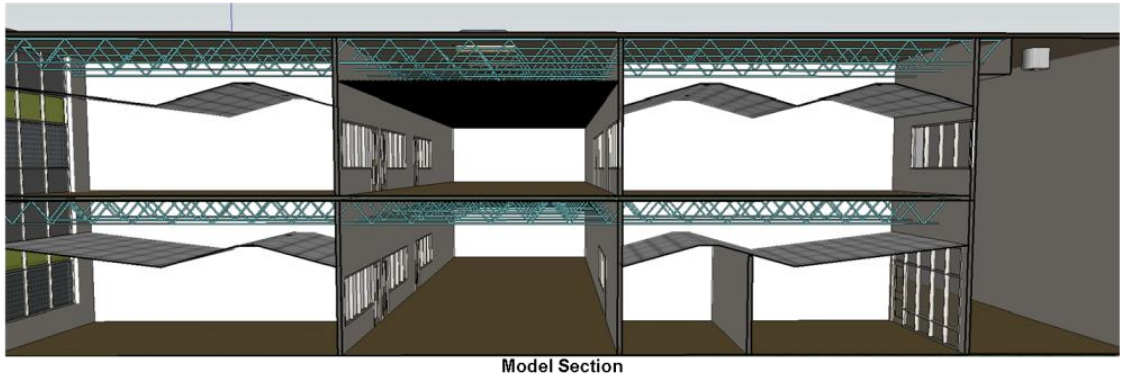
Solartube Renderings

The Solartube design shows better daylight coverage throughout the classrooms, as intended. They help balance the core of the south classrooms but still get a bit overpowered by the south glass. A refinement would be to reduce the south glass area, particularly the view window, to a Window-to-wall area ratio (WWR) closer to 30%, while keeping the same upper translucent (25%VT) windows.

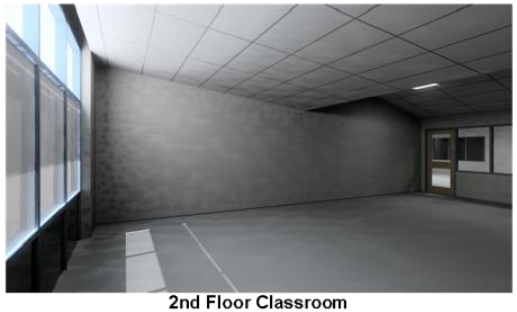
The central teacher room appears brightly daylit and uniform. The 1st floor PD room does not appear to balanced with the contribution from the main hall. Addiitonal refinements could be considered to boost this with either Solatubes or reflectors in the main hall.

No attempts were made to daylight the first floor commons as the commons is seen as a lower priority than the classrooms, in general. However, if desired, several Solatube runs and dropped ceiling could be employed to match the daylit 2nd floor commons.

View of South Facade

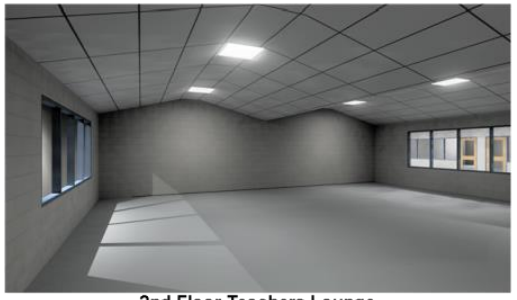


Model Section

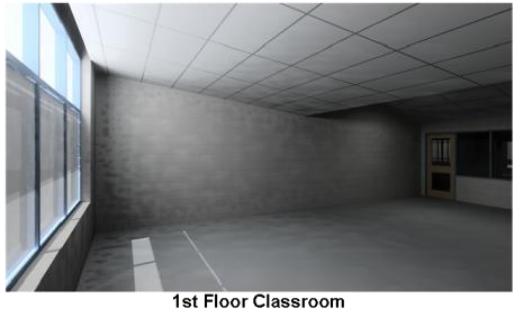


2nd Floor Classroom

2nd Floor Commons



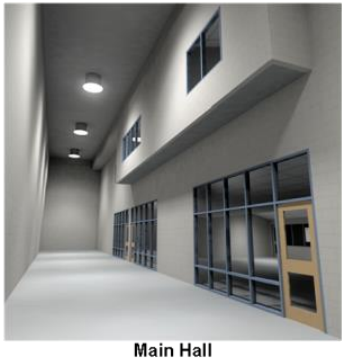
2nd Floor Teachers Lounge



1st Floor Classroom

1st Floor Commons

1st Floor P.D.



Main Hall

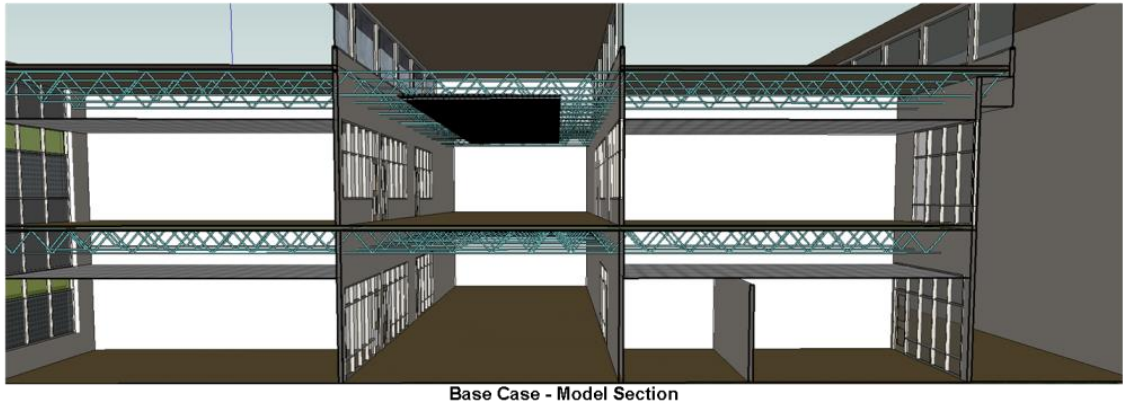
Pop-up Monitor Clerestories

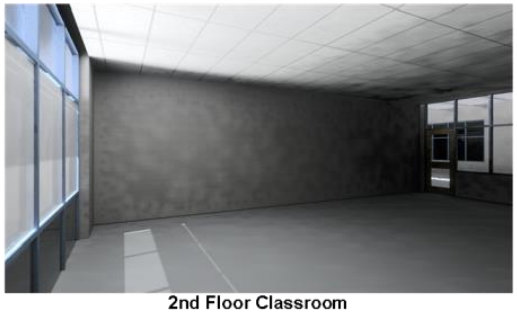
Monitor Renderings
The monitor design creates very nice and bright commons and main hall spaces with the higher ceiling and large clerestories. The south classrooms are nicely daylit via the LightLouver daylight system in the upper windows. These do not need to be as large as the translucent windows and provide deeper daylight distribution and better glare control.

Consider refinements to boost the borrowed daylight contribution from the monitor such as reducing the open grid size to give the south classrooms a better connection to the monitor's north clerestory

This solution could be used in combination with the Solatube solution,using Solatubes to bring daylight to the teachers office and PD classroom along with the monitors to create nice, tall and brightly daylit common spaces.

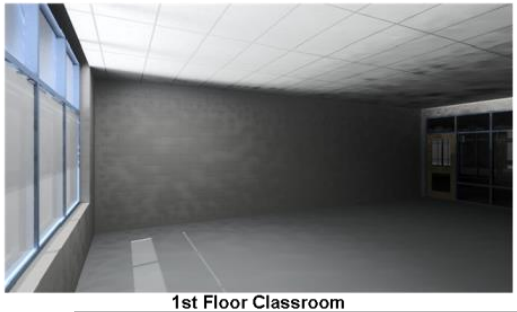

View of South Facade


Base Case - Model Section


2nd Floor Classroom


2nd Floor Commons


2nd Floor Teachers Lounge


1st Floor Classroom


1st Floor Commons


1st Floor P.D.


Main Hall

Stepped Roof and Clerestories

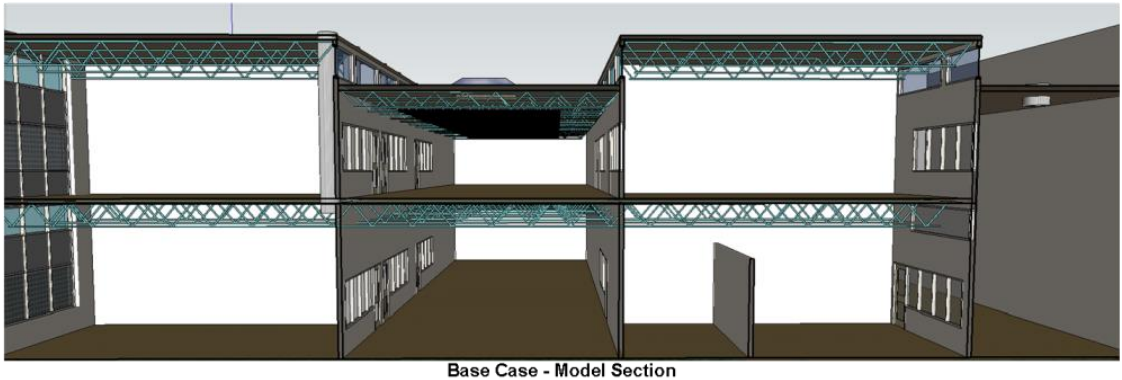
Stepped Roof Renderings

The stepped roof design, like the Solatube design, focuses on daylighting the classrooms as a first priority. Translucent (40% VT) glazing is used for the high clerestory windows. With the high open structure ceilings, the classrooms feel well daylit and more uniform than some of the other low ceiling strategies. Even the 1st floor classrooms feel nicely balanced and airy given the higher ceilings.

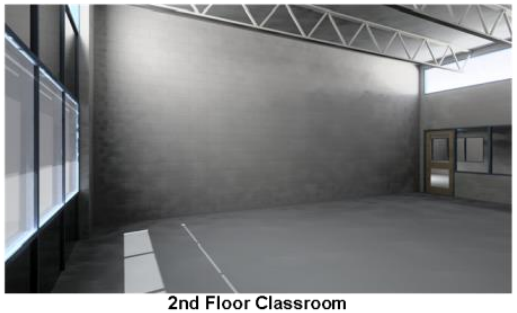
Ductwork will obviously cause some clutter but with some coordination it can have a minimal impact on the daylight transfer.

The commons is somewhat the odd space out in this design, but with an open ceiling and the skylights above the open grid ceiling it may not feel too squashed. Like the Solatube design, a monitor or clear skylight design is recommended for the main hall to make it brighter and more dynamic.

View of South Facade



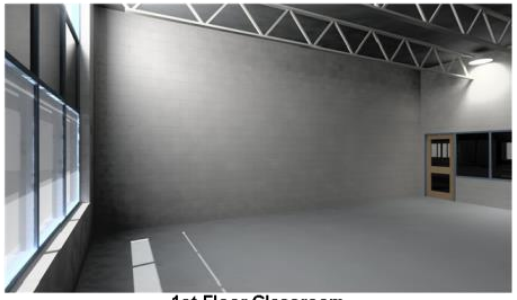
Base Case - Model Section



2nd Floor Classroom

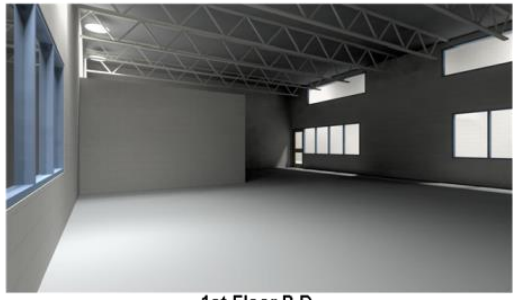
2nd Floor Commons

2nd Floor Teachers Lounge



1st Floor Classroom

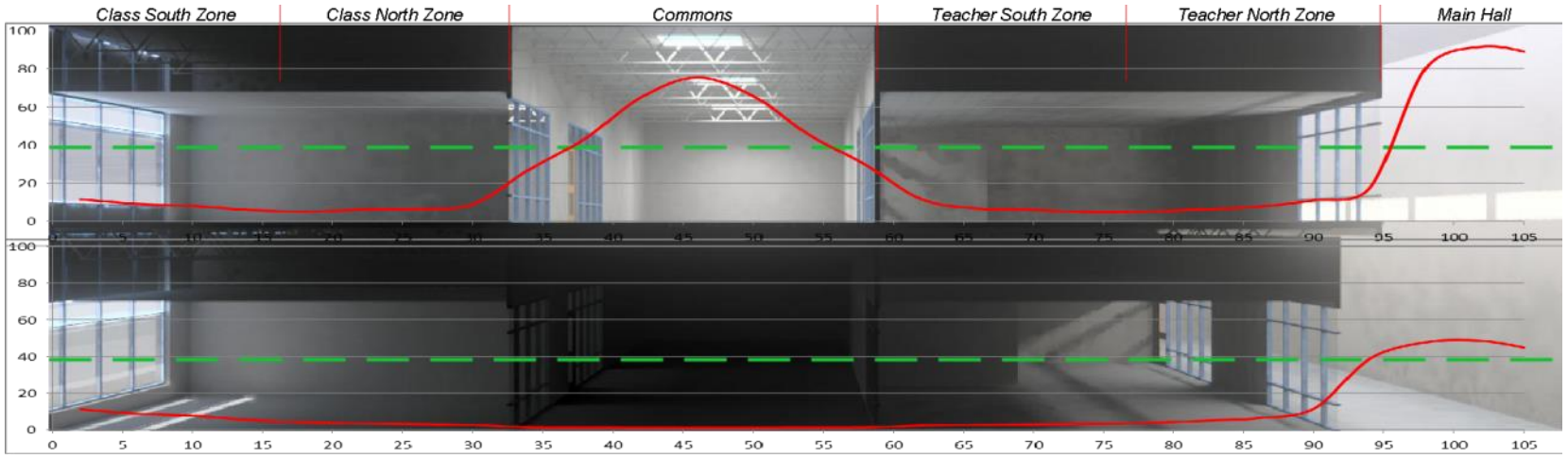
1st Floor Commons



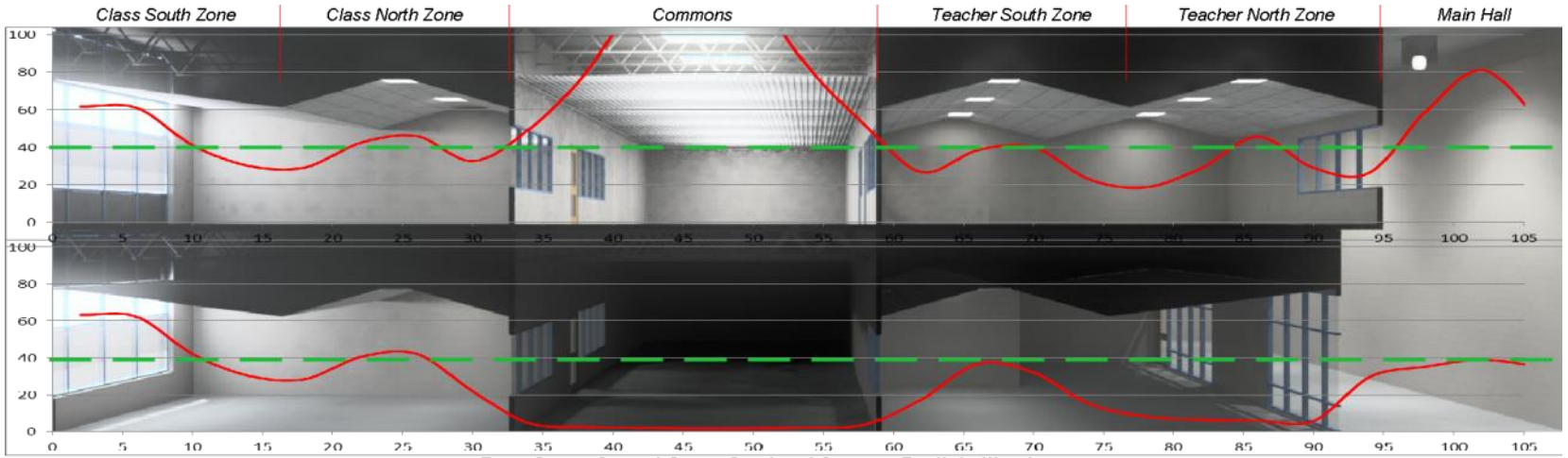
1st Floor P.D.

Main Hall

Illuminance Sections

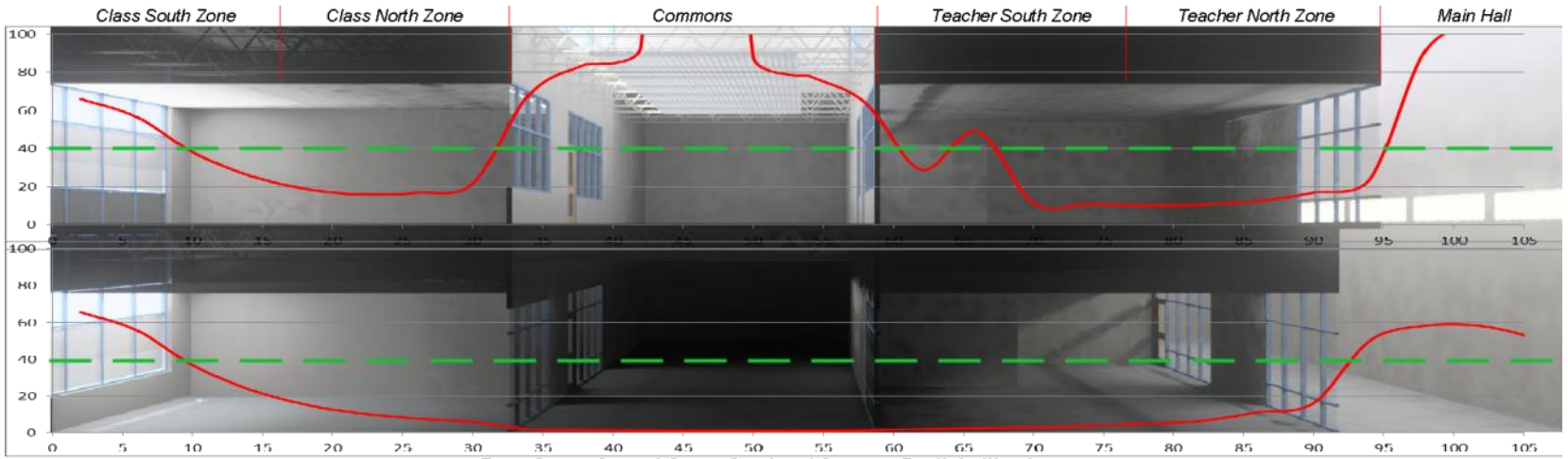


Annual Cross-Sectional Average Daylight Illuminance

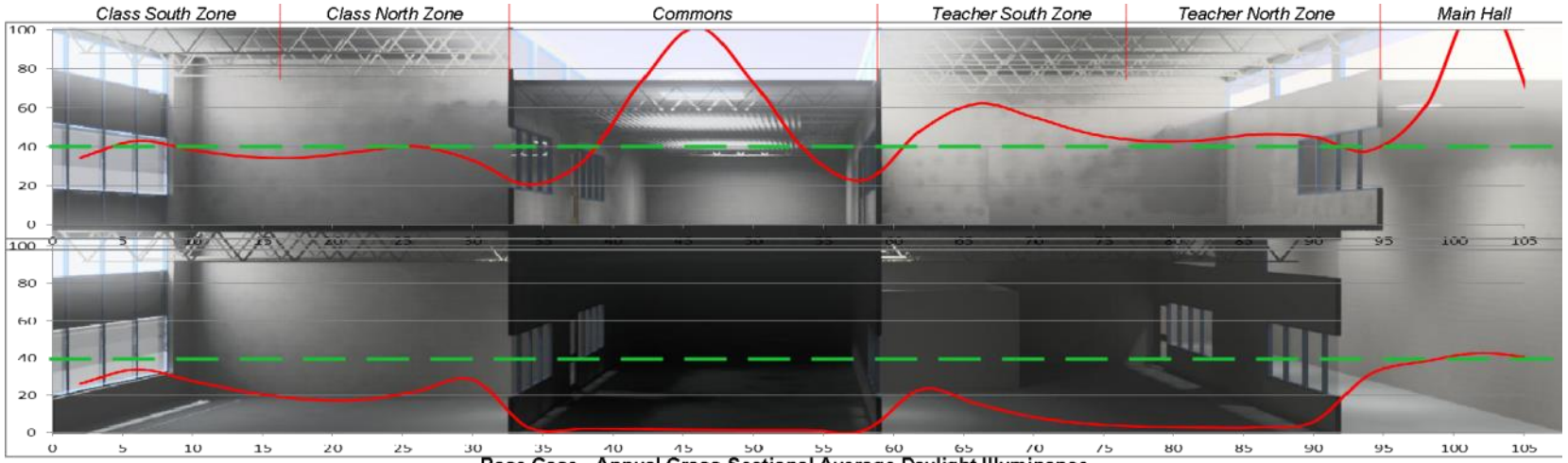


Base Case - Annual Cross-Sectional Average Daylight Illuminance

Illuminance Sections



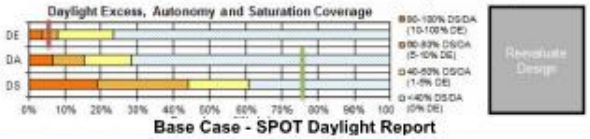
Base Case - Annual Cross-Sectional Average Daylight Illuminance



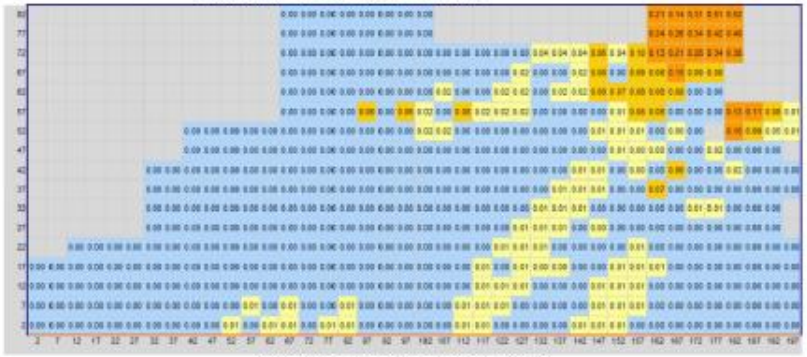
Base Case - Annual Cross-Sectional Average Daylight Illuminance

Commons base

Base Case - Perspective Renderings, Sunny Equinox, 12pm

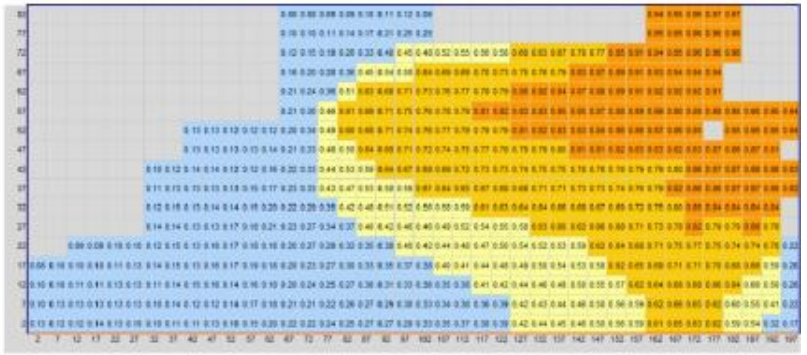


Base Case - SPOT Daylight Report



Base Case - Daylight Excess, 400fc

Base Case - Sectional Rendering, Sunny Equinox, 12pm

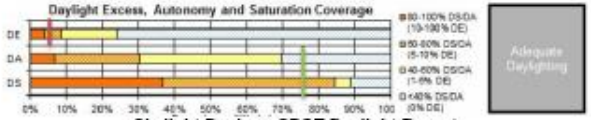


Base Case - Annual Daylight Saturation, 40fc target

Base Case - Daylight Autonomy, 40fc target

Balanced with Slot Skylights

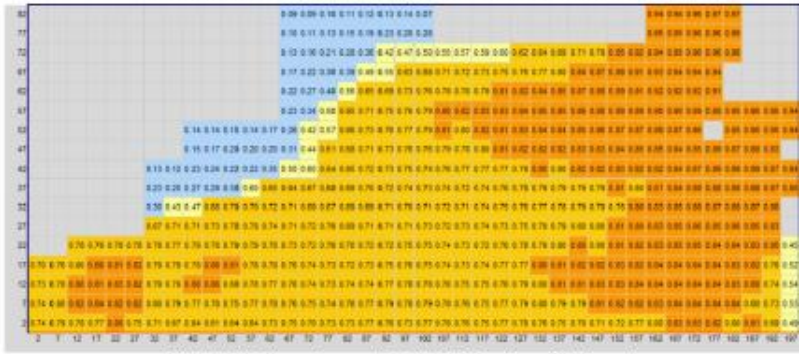
Skylight Design - Perspective Renderings, Sunny Equinox, 12pm



Skylight Design - SPOT Daylight Report

Skylight Design - Daylight Excess, 400fc

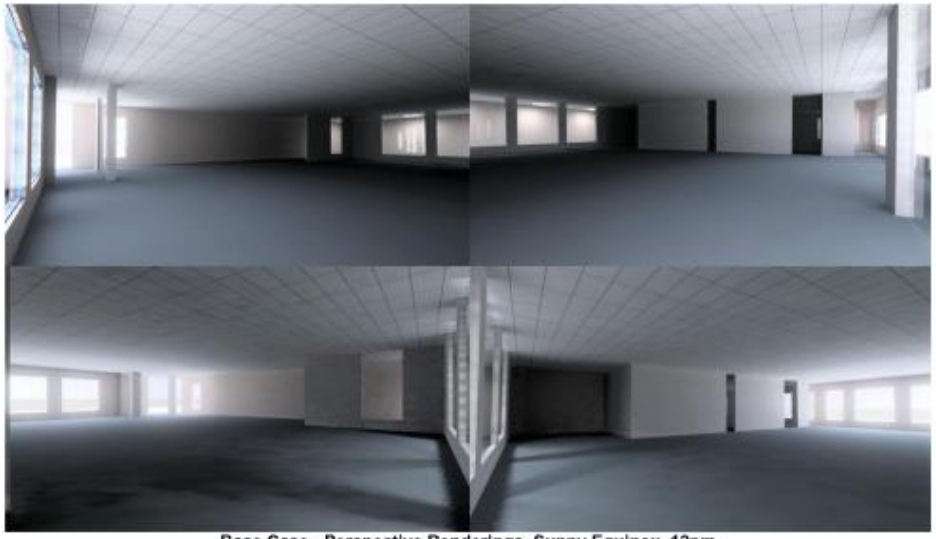
Skylight Design - Sectional Rendering, Sunny Equinox, 12pm



Skylight Design - Annual Daylight Saturation, 40fc target

Skylight Design - Daylight Autonomy, 40fc target

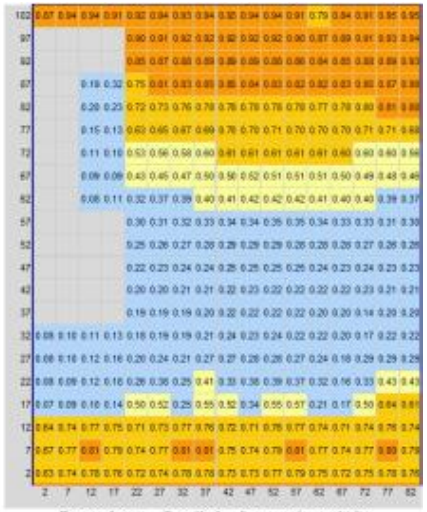
Media Center Base



Base Case - Perspective Renderings, Sunny Equinox, 12pm

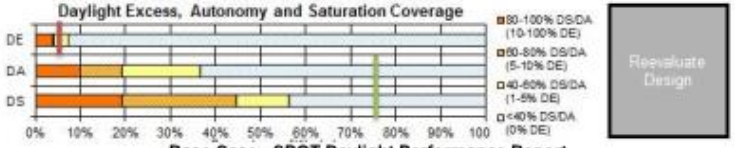
Base Case Daylight Performance

With just access to daylight via the north façade and the south daylit corridor the Media Center does not get adequate daylight throughout the year. The north 15 - 20' perimeter sees adequate daylight. The center of the space and the southwest nook are dim in comparison. This is perhaps intentional for the reading nook, though controlled daylight could make the space more attractive and comfortable.

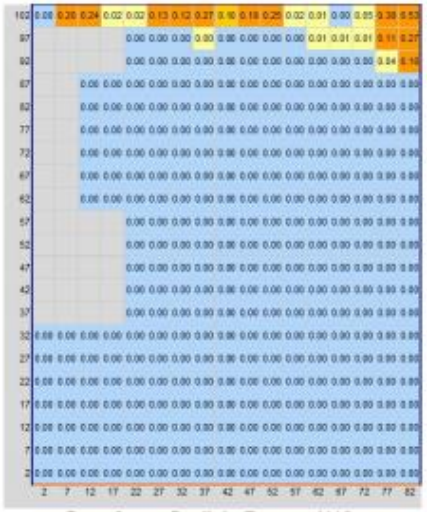


Base Case - Daylight Saturation, 40fc

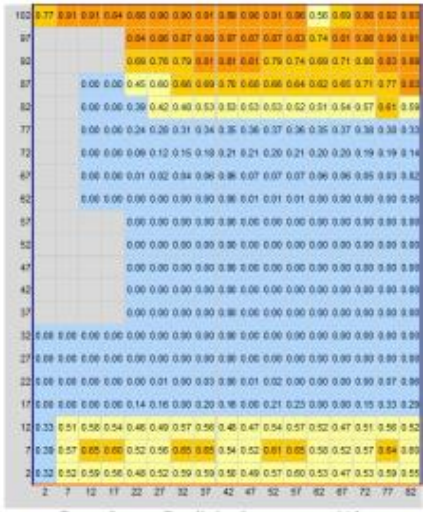
Base Case - Sectional Rendering, Sunny Equinox, 12pm



Base Case - SPOT Daylight Performance Report

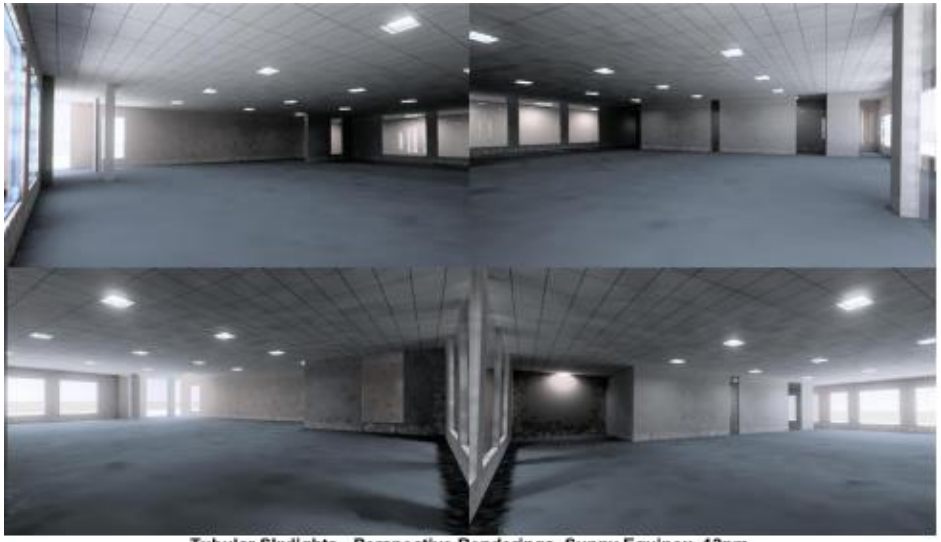


Base Case - Daylight Excess, 400fc



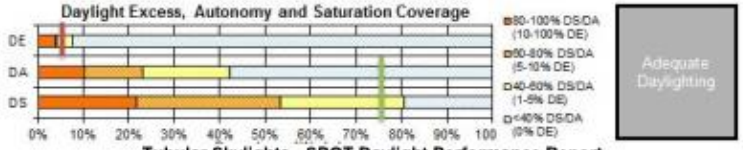
Base Case - Daylight Autonomy, 40fc

Tubular skylight option



Tubular Skylights - Perspective Renderings, Sunny Equinox, 12pm

Tubular Skylights - Sectional Rendering, Sunny Equinox, 12pm



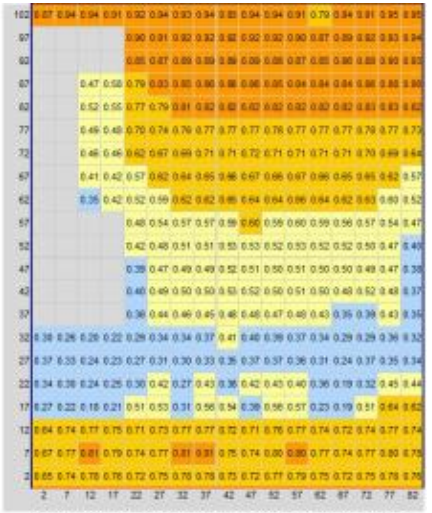
Tubular Skylights - SPOT Daylight Performance Report

Tubular Skylight Daylighting Performance

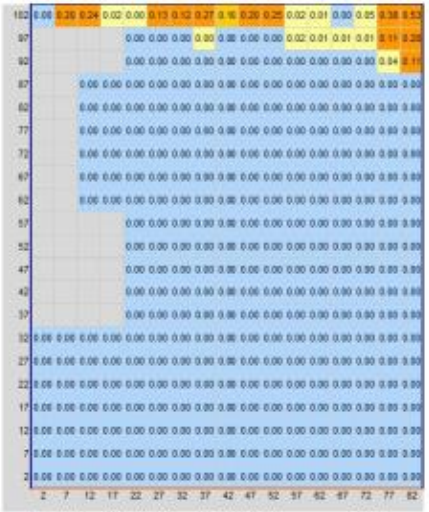
The tubular skylights do help balance the space and provide better annual daylight saturation. Another row of skylights would be recommended in the south side as there is limited daylight 'borrowed' from the corridor.

The model simulated just a high flat ceiling which gives similar workplane illuminance results but appears visually different. If possible, the undulated ceiling is recommended to help soften the high contrast between these lenses and a flat ceiling.

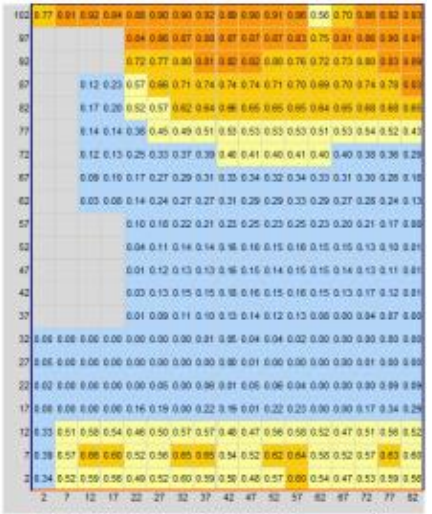
If it will be an open structure ceiling, the tubular skylights should be able to integrate well and it is recommended to locate the lens just a bit above the bottom chord of the trusses to minimize shadowing but to also high the lens a bit from view.



Tubular Skylights - Daylight Saturation, 40fc

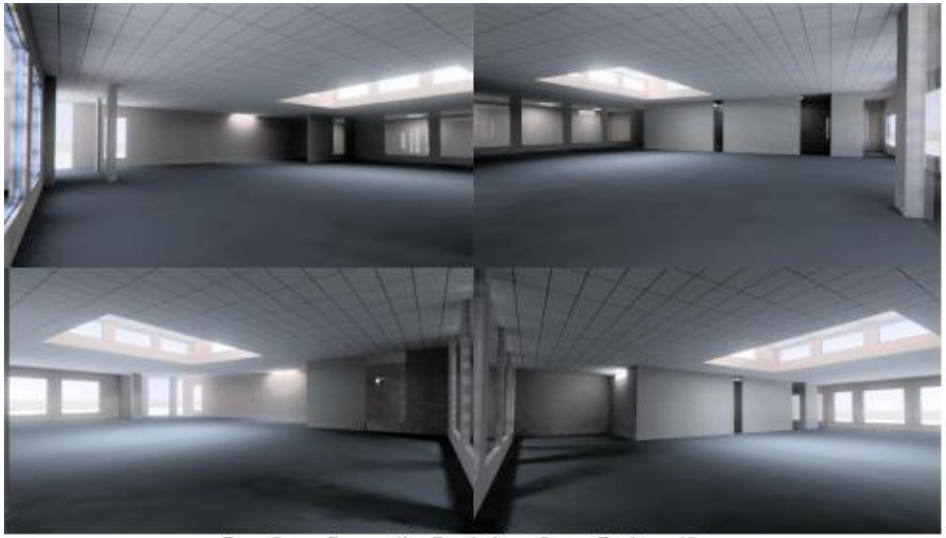


Tubular Skylights - Daylight Excess, 400fc



Tubular Skylights - Daylight Autonomy, 40fc

Pop-up Monitor

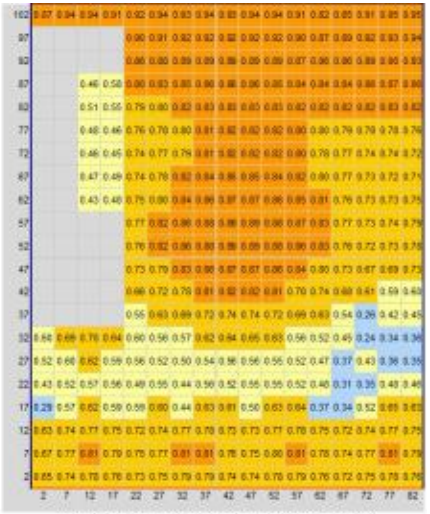


Base Case - Perspective Renderings, Sunny Equinox, 12pm

Central Monitor Daylight Performance
The central monitor does a nice job of opening and brightening the entire center of the space. The monitor provides nearly full daylight saturation in the space with the exception of the south edge which is still a bit low. The monitor could be shifted a bit this direction or additional linear skylights or tubular skylights could be used to further brighten the south edge.

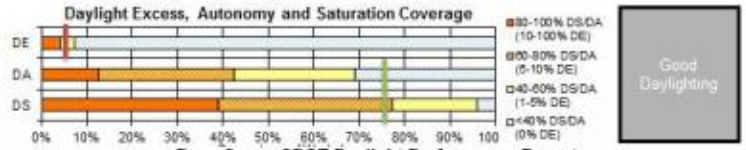
The monitor gives the space a more open feel as well with the higher ceiling. Artwork could be intregrated into this volume as well to provide some visual interest.

Tubular skylights with dimmers are recommended for the west side occupied spaces (conference rooms). They can be easily daylit with a couple of tubes and the dimmers will allow them to maintain a fully controllable visual environment.

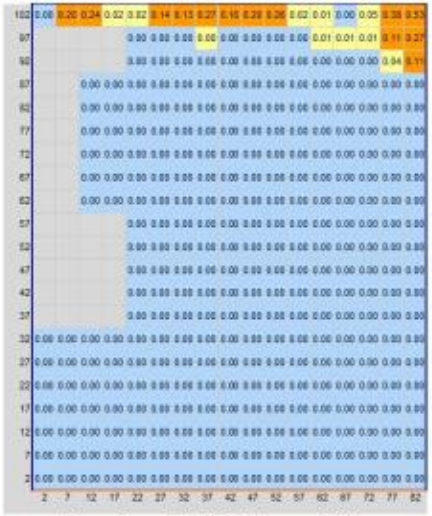


Base Case - Daylight Saturation, 40fc

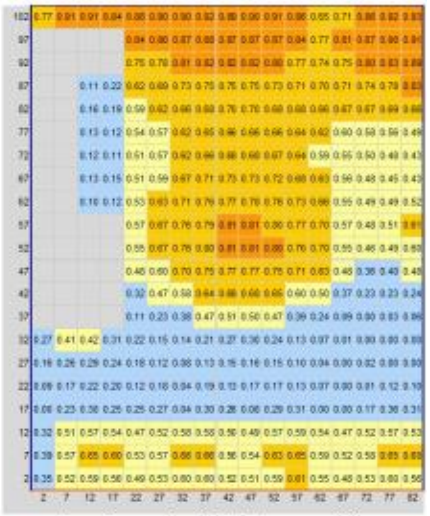
Base Case - Sectional Rendering, Sunny Equinox, 12pm



Base Case - SPOT Daylight Performance Report



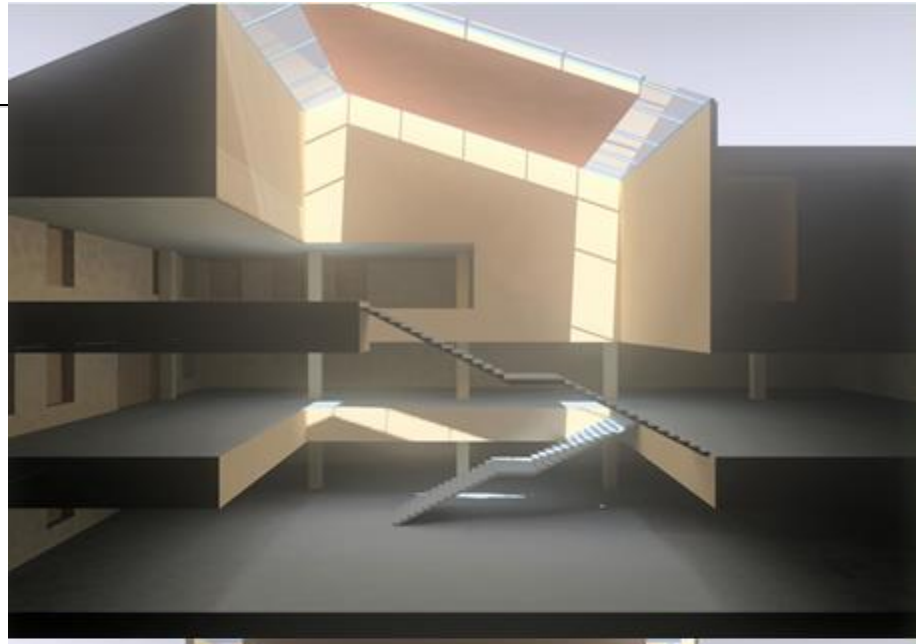
Base Case - Daylight Excess, 400fc

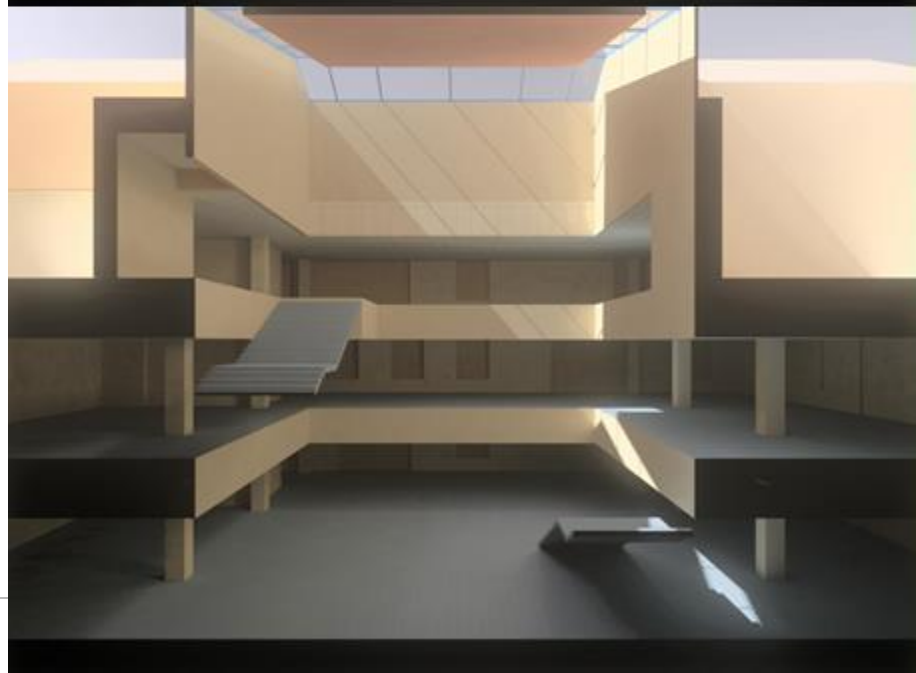


Base Case - Daylight Autonomy, 40fc

CU CASE Atrium Study

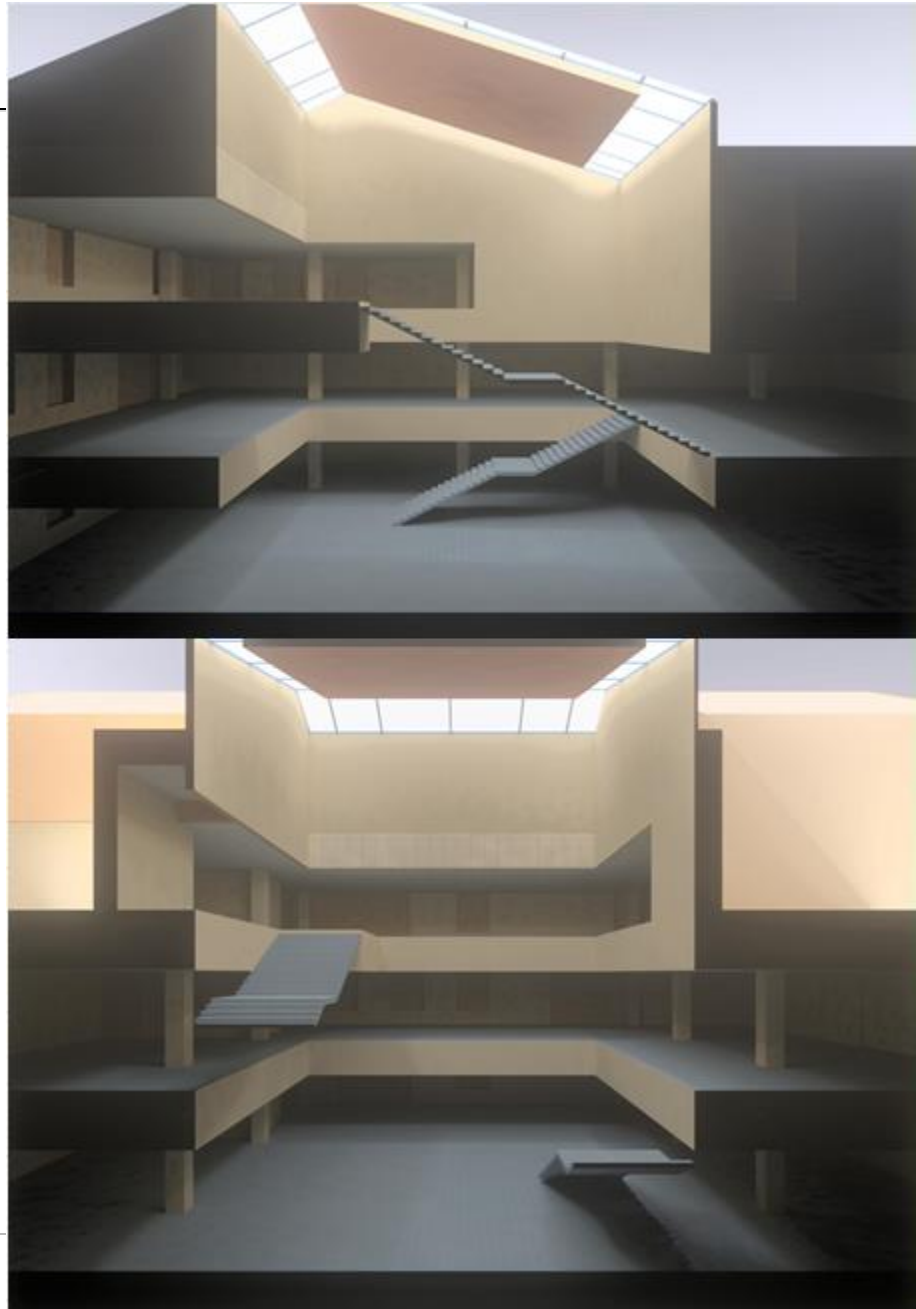
- Base design
- Perimeter skylights to wash surfaces
- Too much area, heat gain, and ‘sparkle’



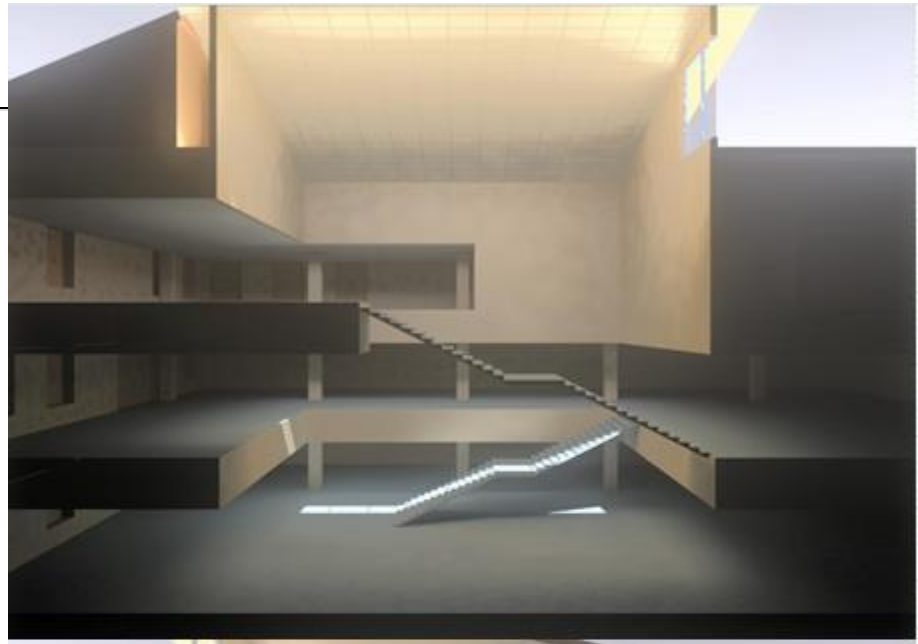


CU CASE Atrium Study

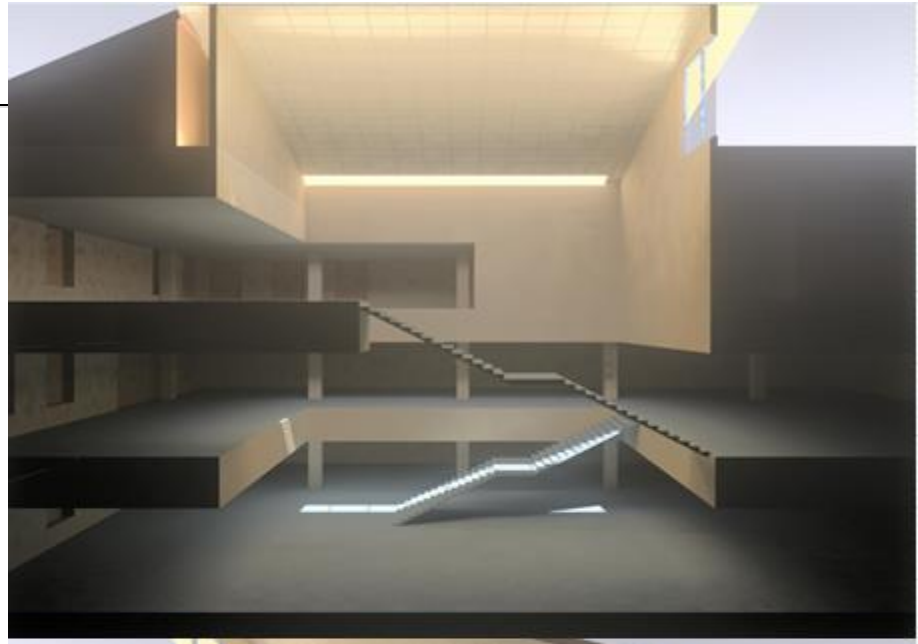
- Diffusing glass
- Better distribution to adjacent floors
- Minimal ‘sparkle’

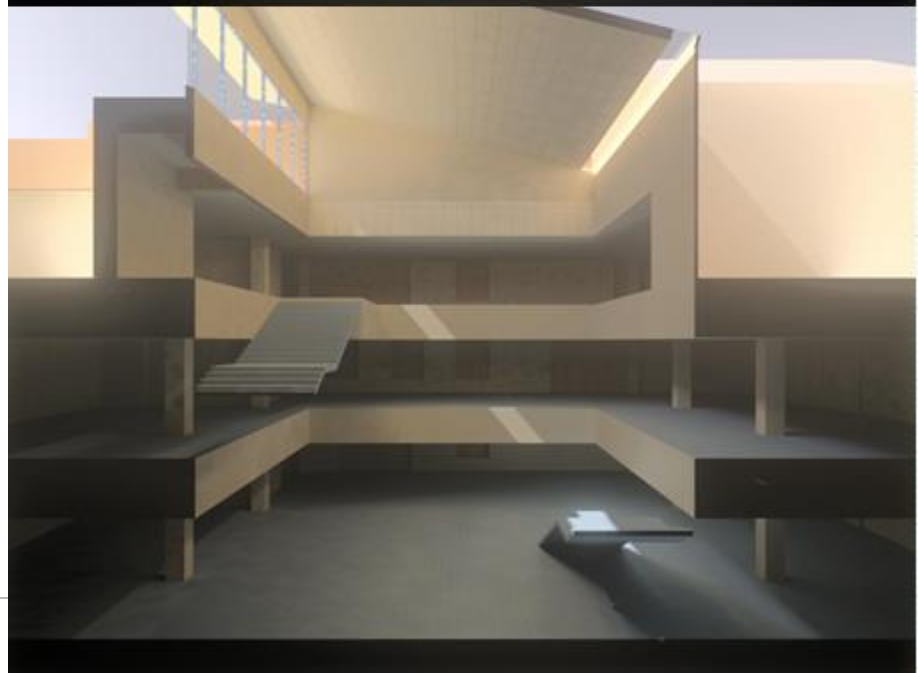


CU CASE Atrium Study



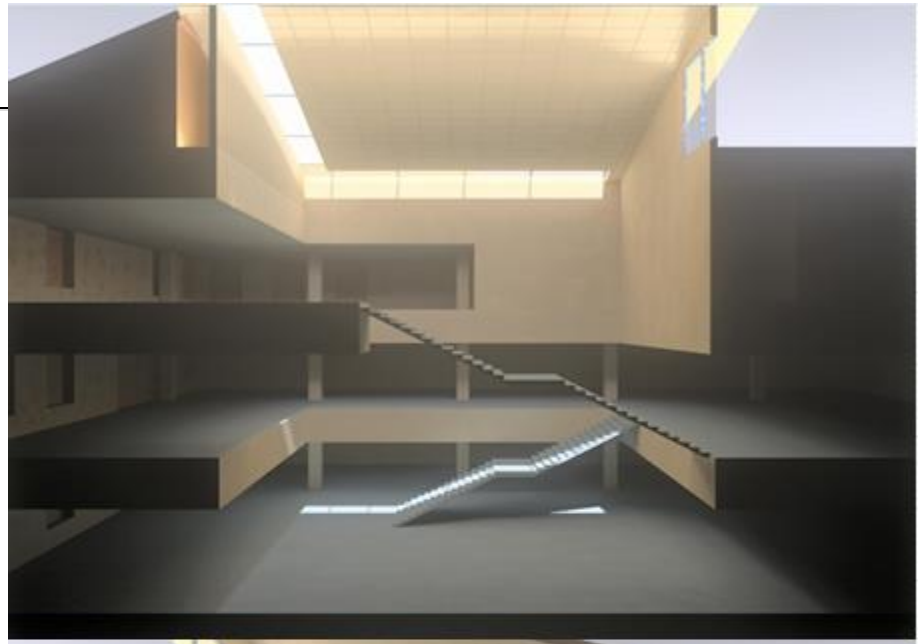
CU CASE Atrium Study

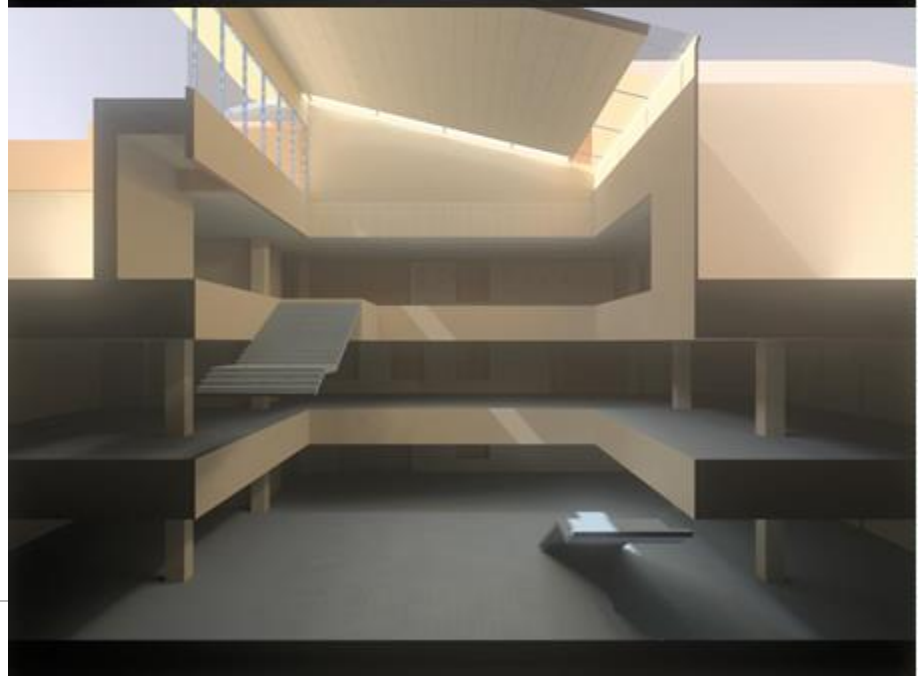




CU CASE Atrium Study

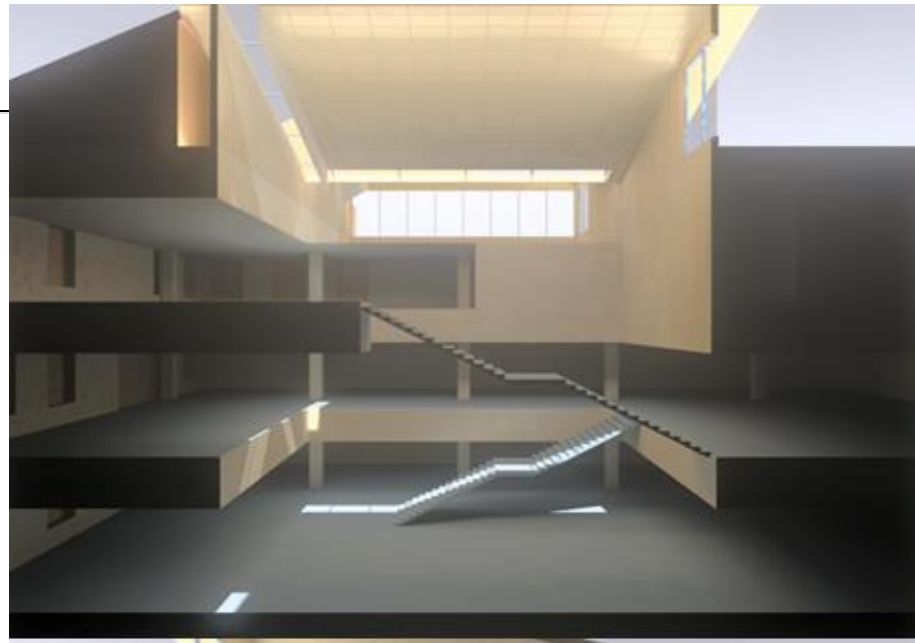
- South and east shaded clerestory
- Balancing skylights on north and west
- Good summer control
- Clear north skylight
- Winter sparkle and heat gain
- Summer sparkle stratified

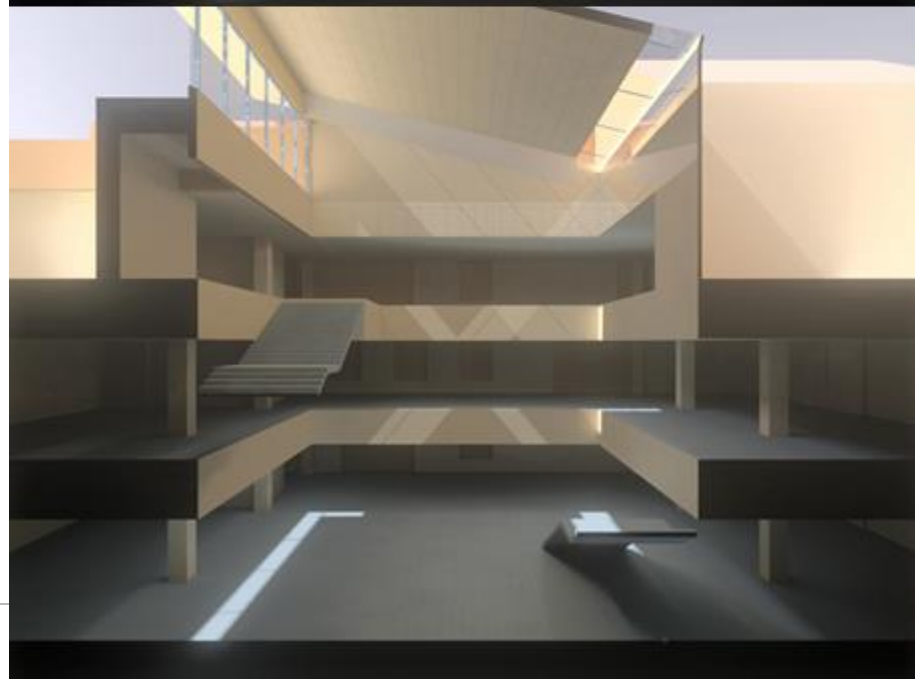




CU CASE Atrium Study

- Added specularity and louvers





Current Design Solution

- Roof orientation and height changes
- Managed solar heat gain
- ‘Sparkle’ limited to circulation areas and avoided in work areas
- Big Ass fan to compliment stratification effects

Current Design Solution

Questions?

Experiences with Radiance in Daylighting Design, Part VII

14th International Radiance Conference
August 18th, 2015

Zack Rogers, PE, LEED AP BD+C
Daylighting Innovations, LLC

DAYLIGHTING INNOVATIONS