# Shippensburg University
# Ceddia Union Building
## Daylight Analysis Report

H2L2

sevengroup

# Summary

This analysis is based upon the design of the project and the issues discussed at the day lighting meeting on February 9, 2009. This analysis should be shared with everyone in the project team.

The goal of the analysis is to establish the configuration, materiality, and geometry of exterior shading devices, glazing, and materials in the project. The recommendations in the report are to provide guidance to the project team to meet the daylight performance parameters, provide the best quality of daylight, and reduce energy consumption.

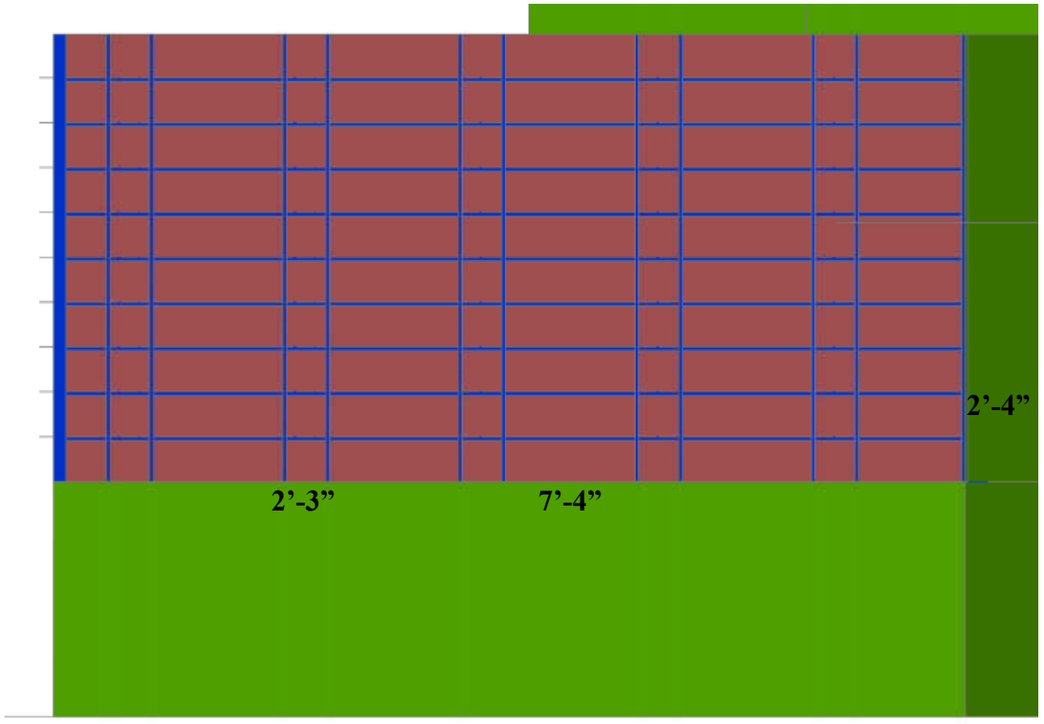
This analysis used the Daylight Autonomy Ratio and the metric to establish daylight performance in the lounges and dining area. The reason that the DAR is being used is that it looks at a complete year worth of sky conditions. Since the building will be used year round, DAR is the best metric for analysis. Due to the complexity of the double facade, AGI-32 was used to analyze the meeting rooms and the 3rd floor lounge.

3D models were built in AutoCad, imported into Ecotech, then into Radiance and Daysim. Results from Radiance and Daysim were then imported back into Ecotech to provide the graphic results. AutoCad models were also imported into AGI-32.

# Table of Contents

# Lounges

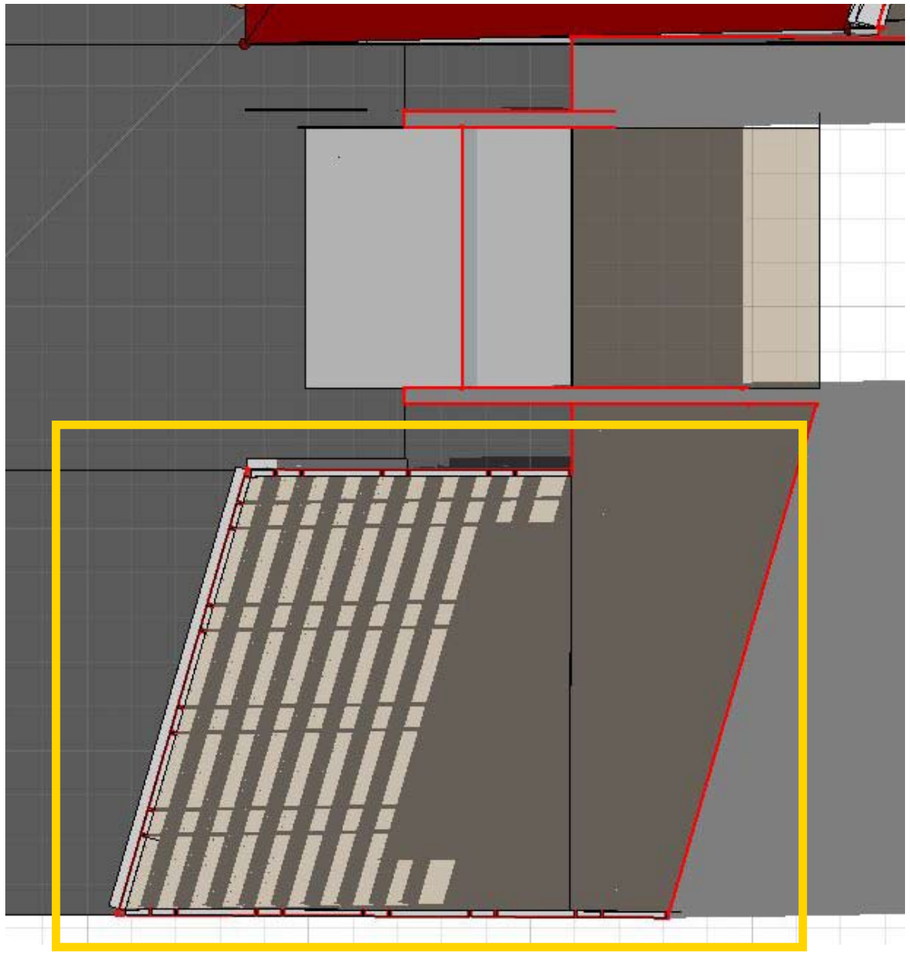
The lounge space analyzed was the two story Lounge 200.  The elevation shows the geometry of the store front frame used. These dimensions were taken from the most recent elevations. If the spacing dimensions change, then another analysis will be required. The recommended shading device geometries are solely based upon these dimensions and will have to change if the spacing increases to provide adequate shading.  The space will receive plenty of daylight, the goal is to provide the right amount, reduce glare, and solar heat gains.




Recommended exterior shading device on the east side of the space should be on a every horizontal frame member, 1’-0” in length, and should have a transparency, or openeness factor of 30%.

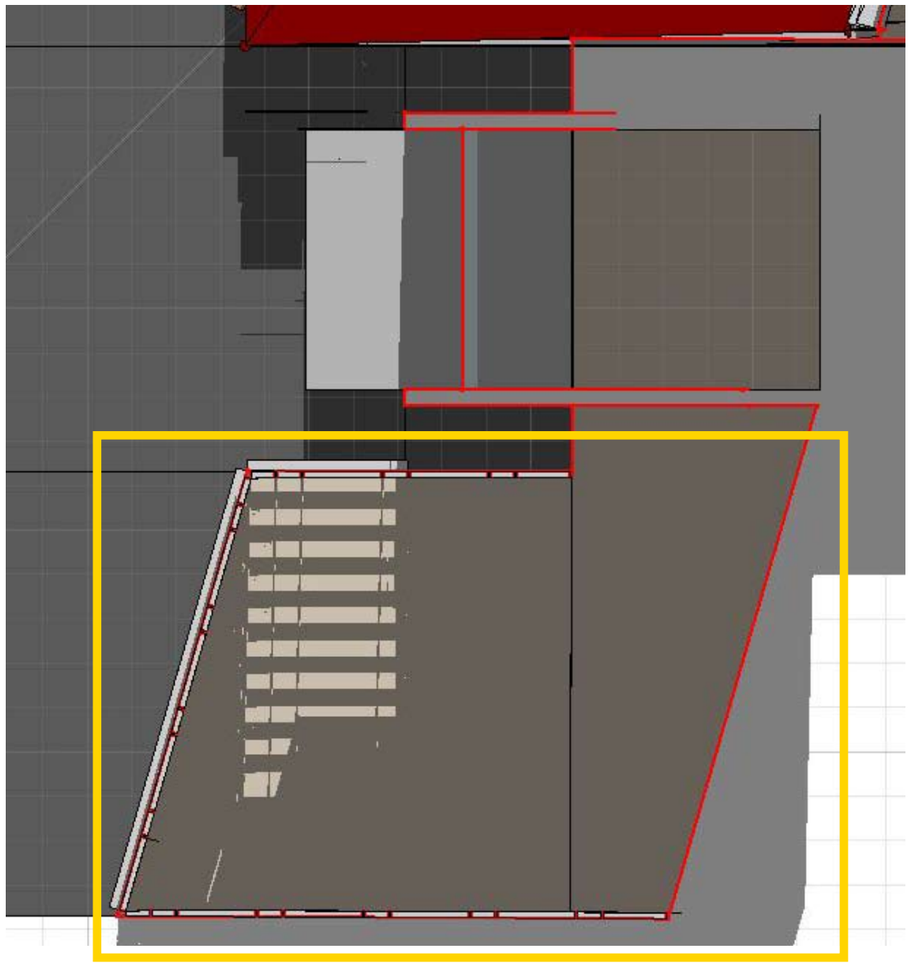
The image below shows the lounge at 10am  on March 21st.  Due to the orientation, increasing the length or angling the exterior shading devices on this side will be ineffective. The horizontal shades are to reduce solar heat gain as the heating period of the day increases.

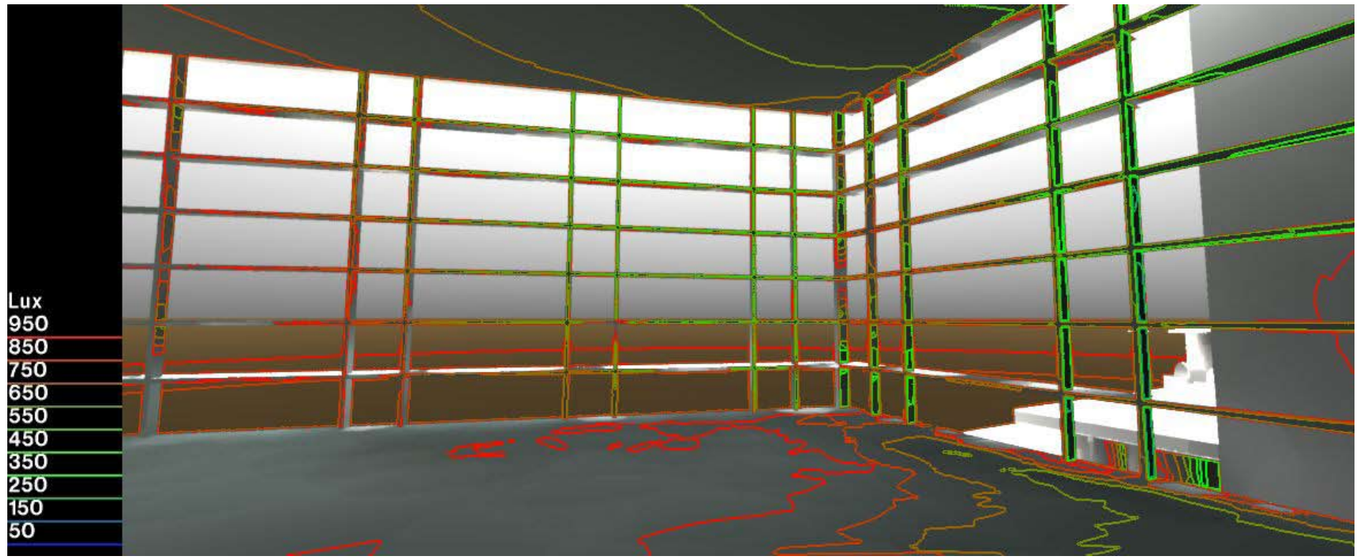
Solar shades, such as Meco shades will be needed  to control the direct solar impact from low sum angles throughout the year.

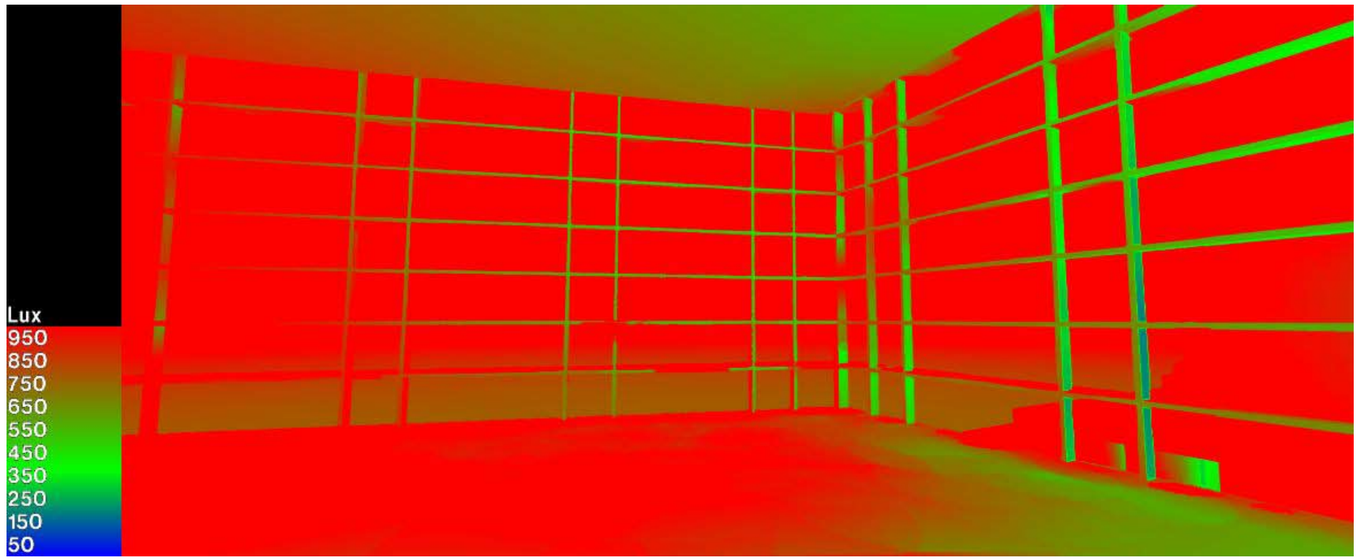


Below is an image of the lounge at 2:30 pm on March 21st. The section of the space that is not in line with the wall at the entry should have horizontal shading at 16" in length, 30%  tranparency,openenss factor, and placed at an angle of 15 degrees.

This side of the space will also need solar shades like Meco shades. Sun angles in the winter months will be at an angle that makes horizontal shading useless. Solar shades will reduce glare and allow the occupants to occupy this area of the space.

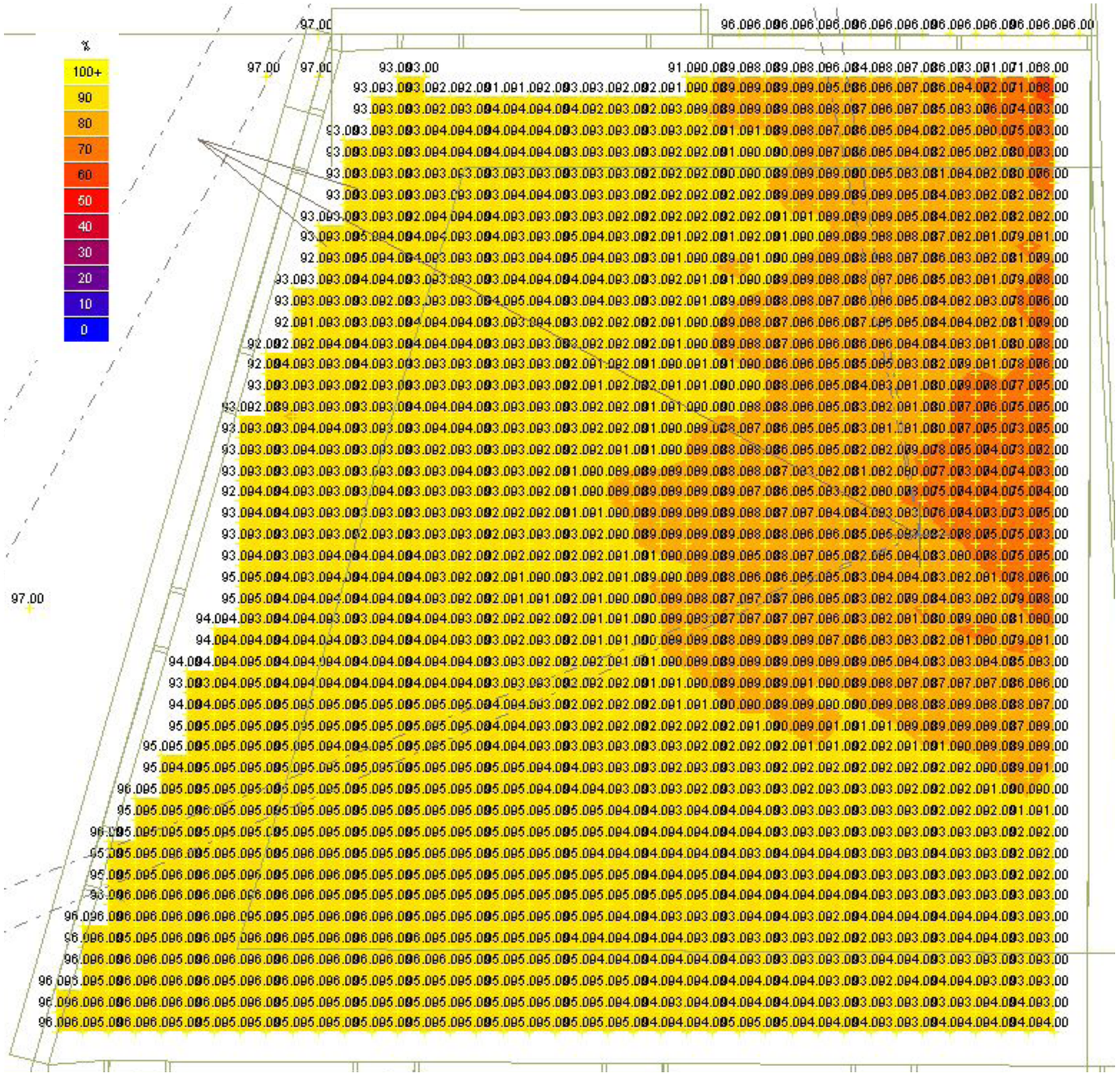





The images are from Radiance and are on March 21st at 12pm  under cloudy skies. The VLT for the glazing is 45%. The scale is in lux, therefore .09 lux =1 fc. The illuminance levels at the window wall and on the surfaces is about 88 fc.  The target illuminance for this space was set at 35 fc.

A reduction in the VLT is not the answer since it will create a unnaturally lit space and lights will have to be used on some winter days. It is recommended that the amount of glazing be reduced. This will provide better day lighting and reduce the effects of heat loss and heat gain.




The plan on the left is the daylight autonomy for the space. As shown, the minimum illuminance goal of 35 fc will be achieved 90% of the time throughout the year. However, the following page shows that there is still too much daylight in the space based upon the performance parameters.

The plan on the right is the daylight autonomy max. What this shows is the percentage of the time throughout the year when the illuminance levels would be above the visual comfort range (glare) and direct solar issues. The setting for this was 3880 lux or 350 fc.

Half of the space is about 15% DAmax. The area in red and purple is on average about 40%. This is mostly due to direct solar penetration but glare is an issue.

# Recommendations

-A VLT of no more than 50% with a low SHGC close to or below .30.

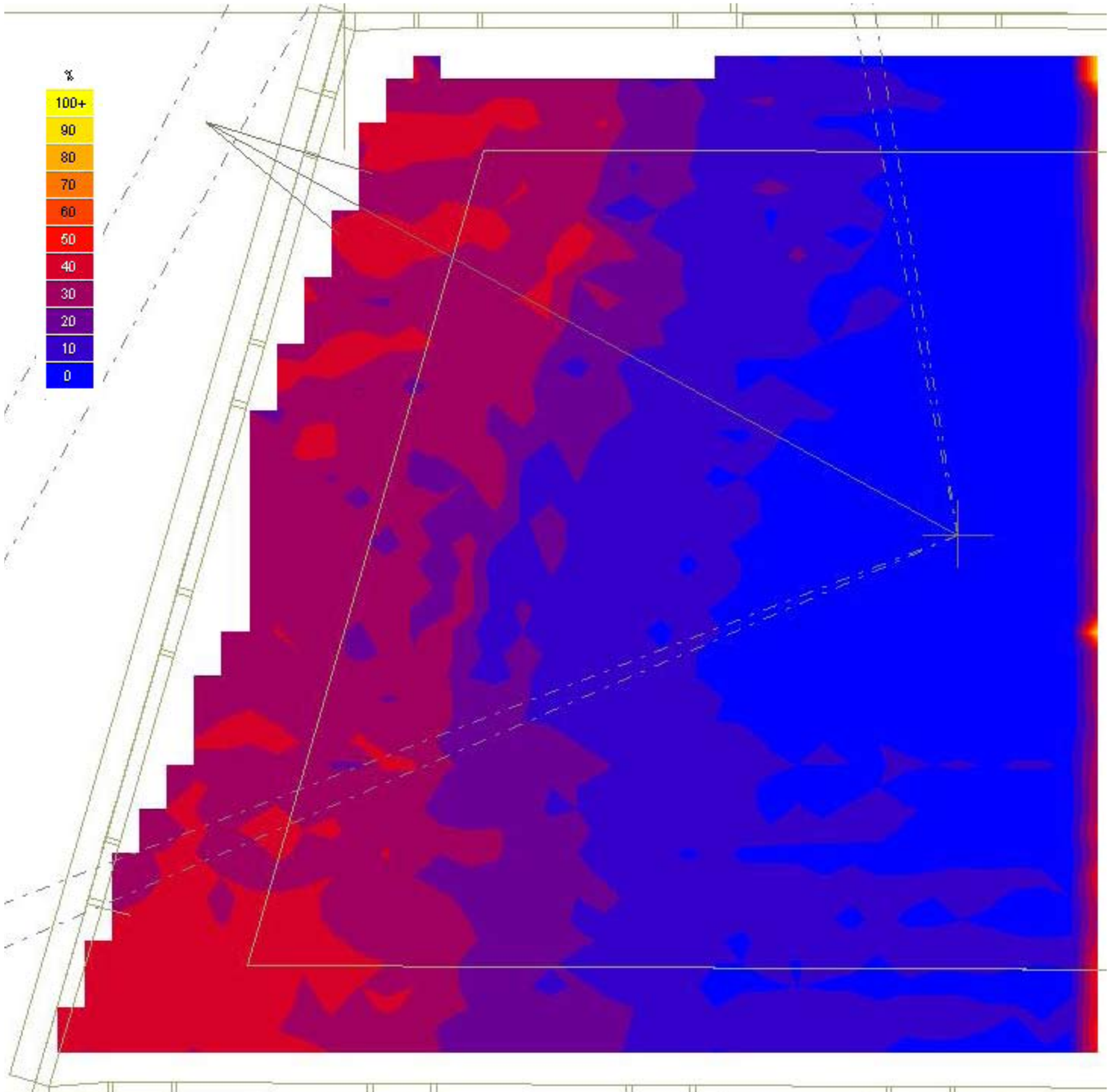
-1'-0" perforated horizontal exterior shading devices on the east side of the space with a 30% openess factor.

-1'-6" perforated horizontal exterior shading devices on the south side of the space with a 30% openess factor and at a 15 degree angle.
(This is based upon modeled geometry)

-Meco shades will be needed on the east and south sides.

-Reduce the amount of glazing.

-Internal reflectances of 70% for walls, 40% for floors, and 80-90% for ceilings should be followed as closely as possible. Floors in the space should not have a glossy finish. This will increase the glare issues in the space.



# Great Hall

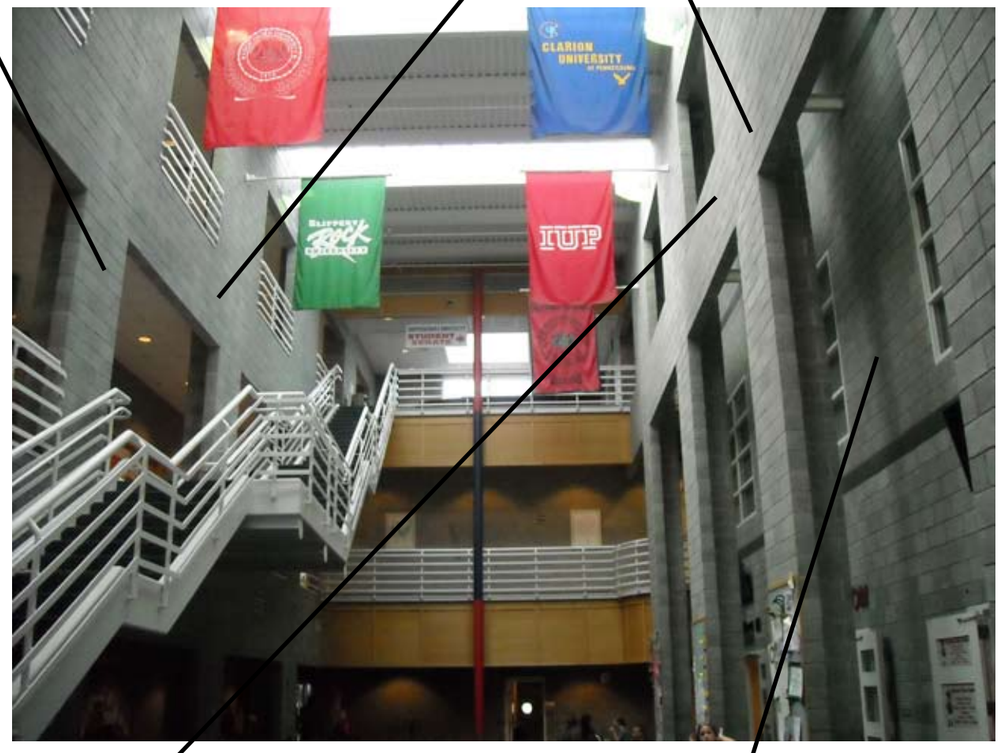
A daylight analysis was not performed in the great hall at this time because the existing skylights will not change.

This section does include suggestions for changes in materials in the great hall to improve the daylight qualities of the space.

Above is an image of the salon at the College of Architecture at UNC Charlotte. There is a balance of light and dark materials in the space.  The darker materials are in align with the occupants vision. If the space was completely white, it would be visually uncomfortable with lots of glare.

The horizontal elements of the space could match the wood color of the space. This would brighten the space, reduce shadows, and keep any glare issues at a minimum. Further, any direct solar penetration would not be a large glare spot due to the contrasting materials.

Vertical elements should be light in color. All sides should be light in color.




Both sides of this wall should be similar. One, it stays true to the language, two, it reduces glare  and contrast issues in the spaces on the second and third floors spaces that look into the great hall space.

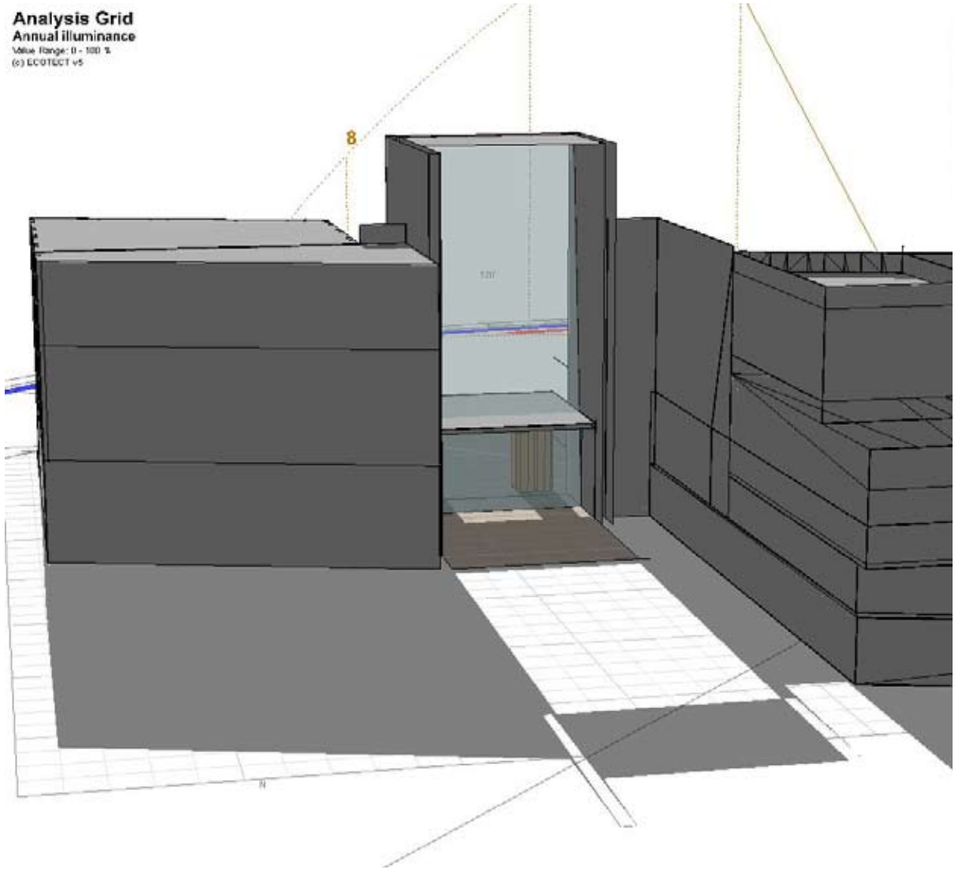
This wall could be white since it will be in shadow, It would also help reduce the contrast in the space.

# South East Entry

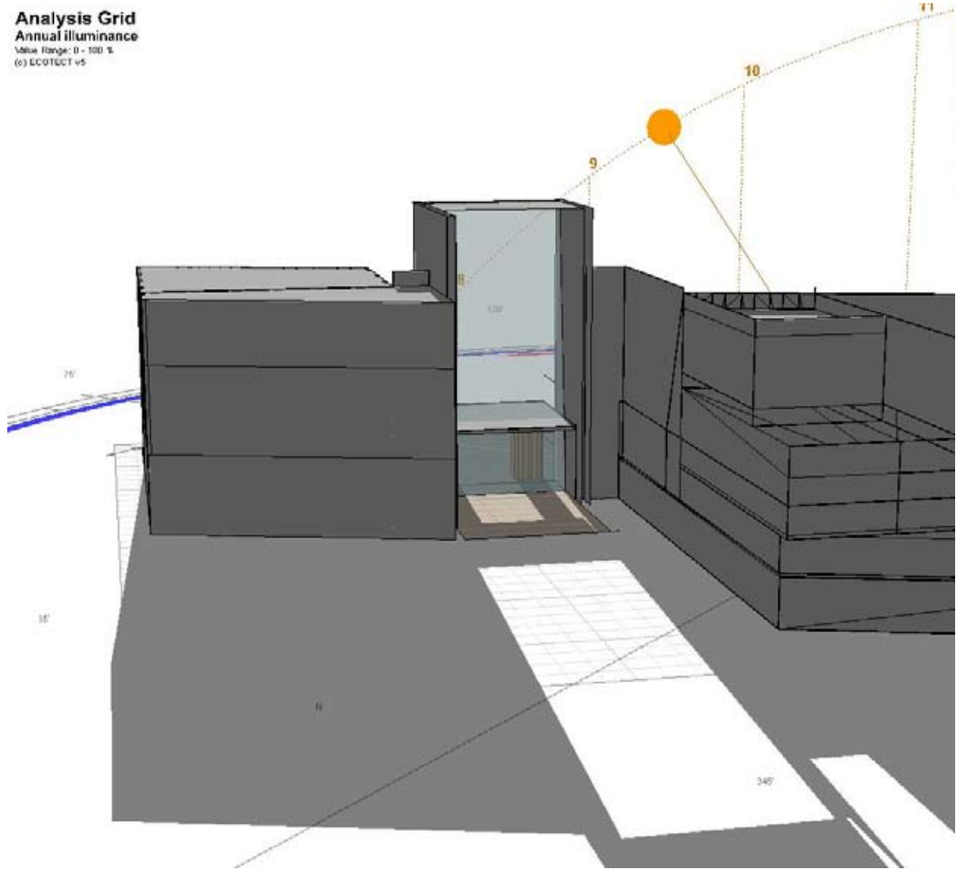
The large amount of glass at this entrance will allow a lot of direct solar penetration from October to March in the morning hours until about 10:30 am.

Realistically, less than half those days in those months will have clear sky conditions. The direct solar penetration is not a bad thing into such a large space and is some ways like passive heating.

However, for the third floor lounge, the direct solar penetration will be an issue. It is suggested that there is some type of sun control device such as shades for this space that will allow occupants to use it in these conditions.




February 10am



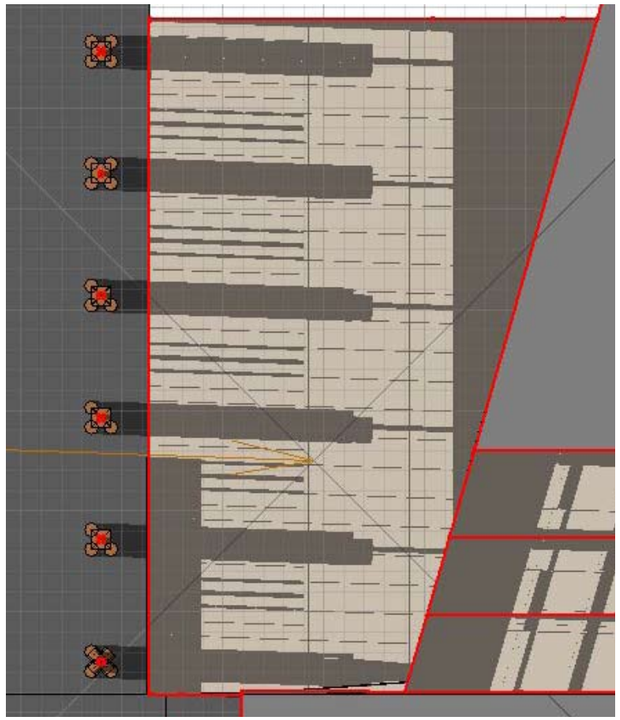

January 9:30am

# Dining

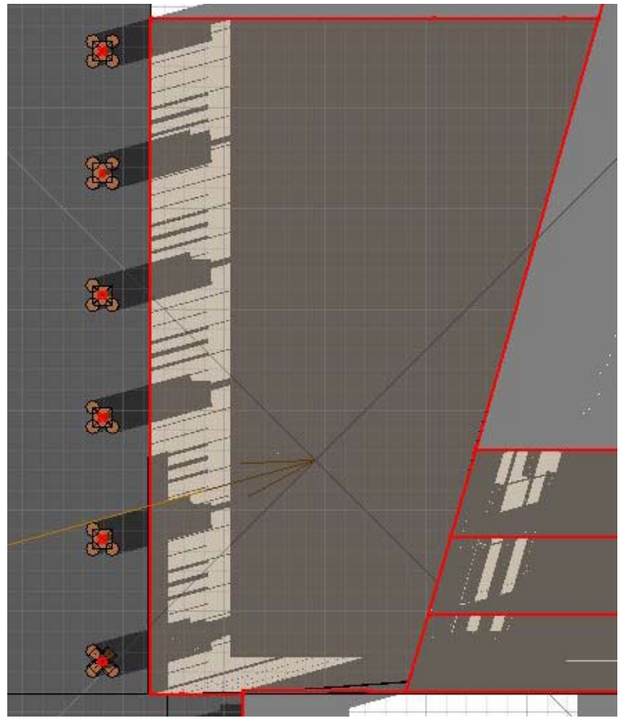
Direct solar will be an issue into the dining space year round. From April to September, from sunrise till 9am and from October to March from 8am till 10:30 am.

The area enclosed by the yellow rectangle is where a 3'-0" high wall was inserted. This will help reduce some of the direct solar issues and improve the thermal characteristics of the wall,

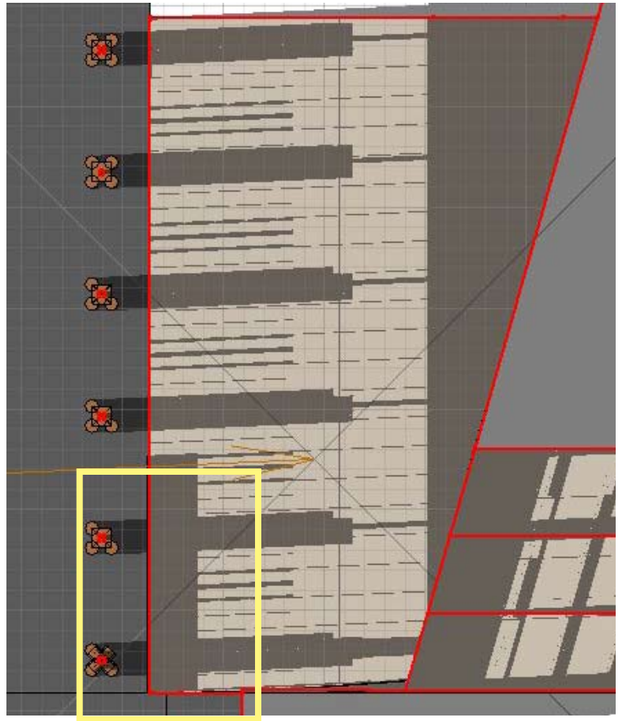
Shades will be required along this window wall to control the direct solar impact. Without shades, glare will be a very large issue.



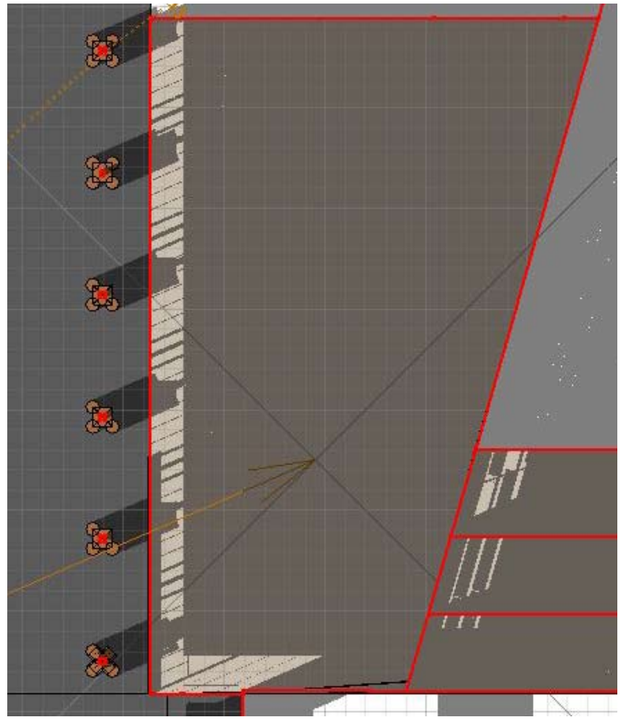
Dec 9am



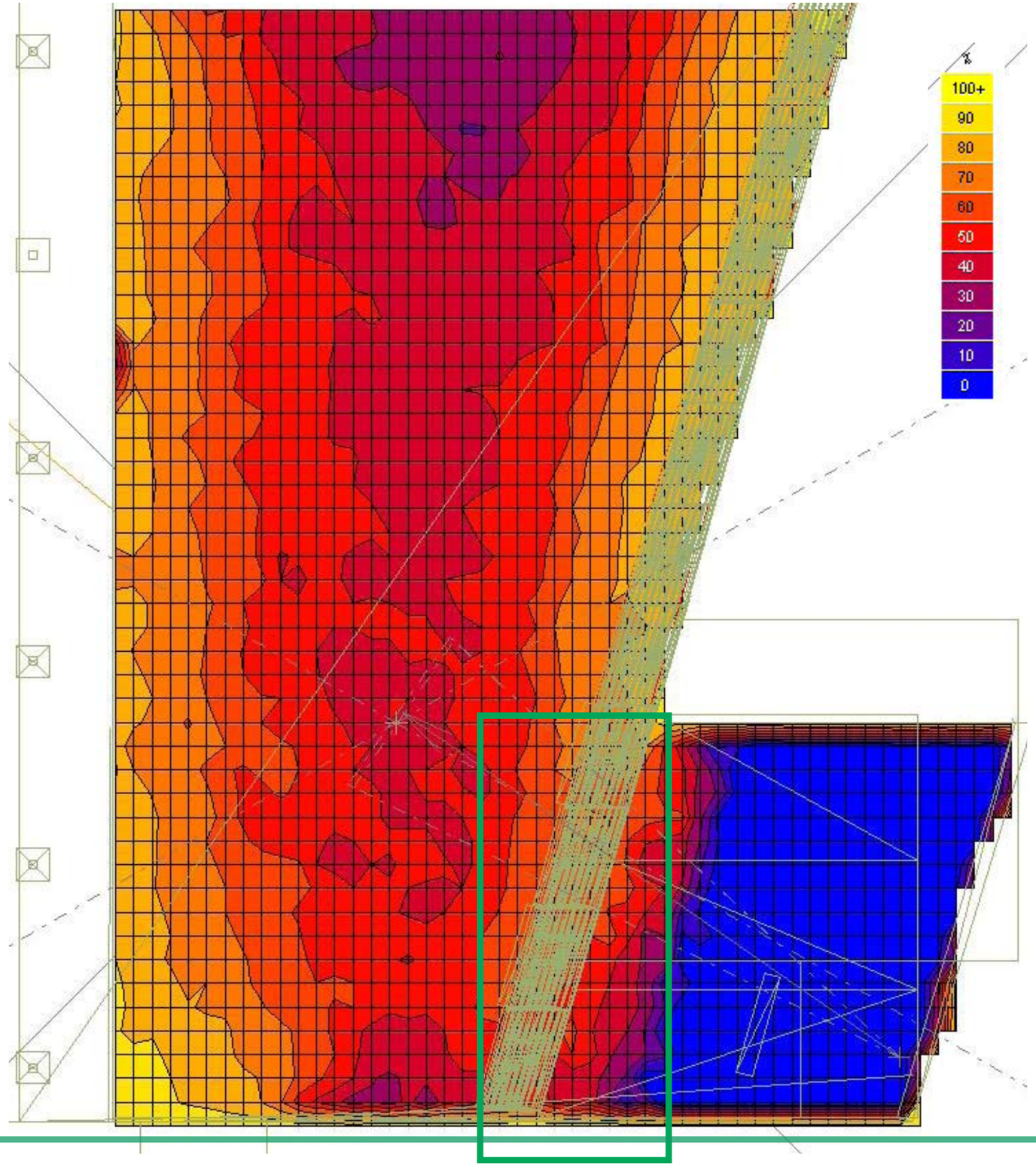
Mar 9am



Jan 9am



Apr 9am

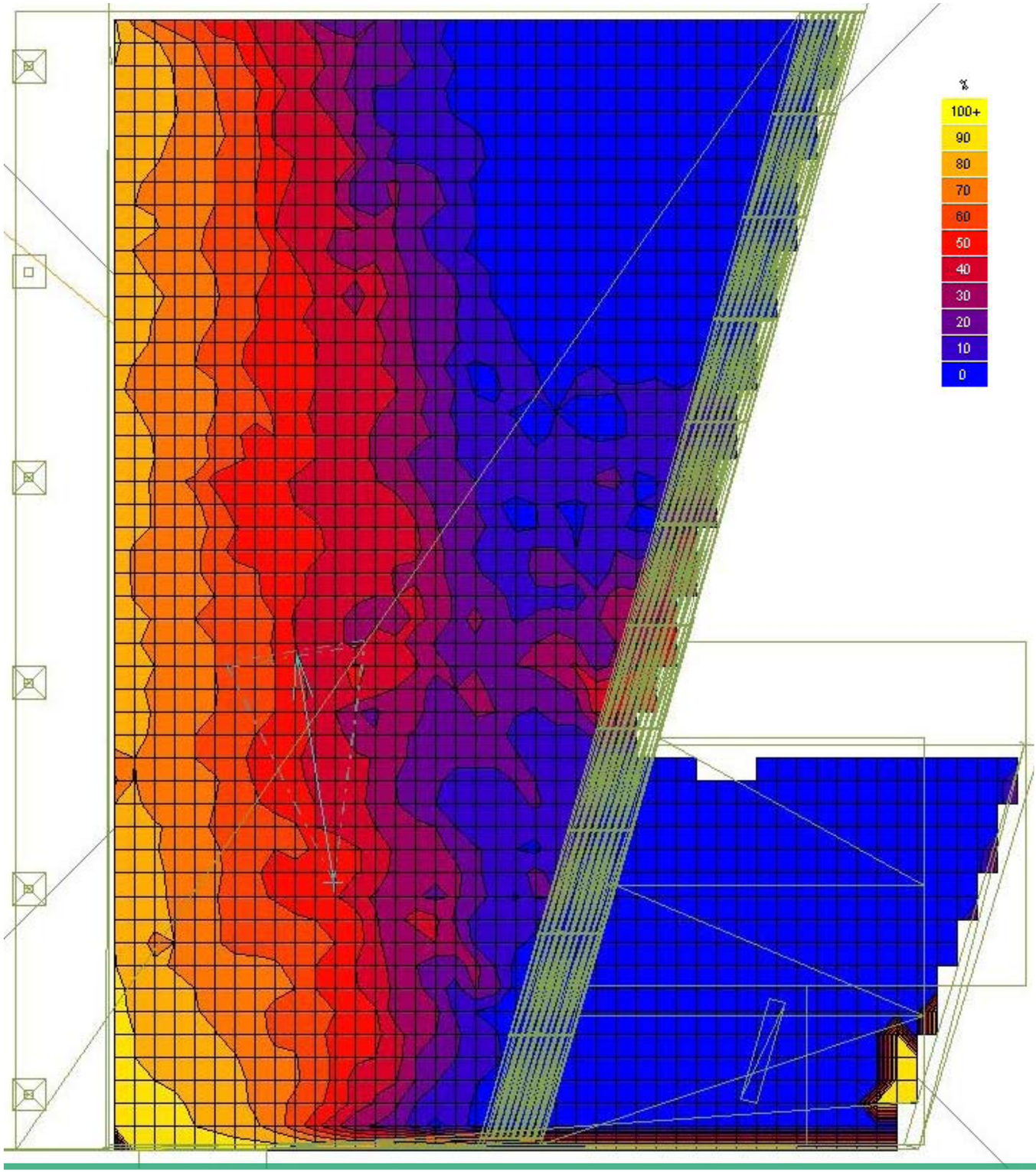



The plan on the left is the Daylight Autonomy ratio plan for the dining room with light well to the rear of the space. With a daylight performance parameter of 50fc and a goal of 60% daylight autonomy.

The model settings were 60% VLT for all glazing with the reflectances, of 80% for ceilings, 70% for walls, 40% for floors.

The area enclosed by the green rectangle is the only space on the light well were the double facade had any type of exterior shading device. The southern section of the light well with no shading had DA of about 80%.

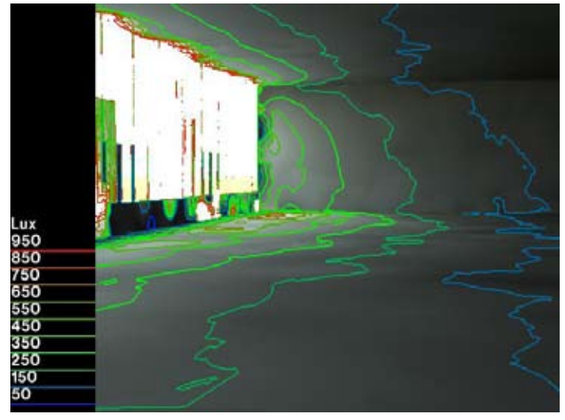
Overall, the light distribution is very good in this space.

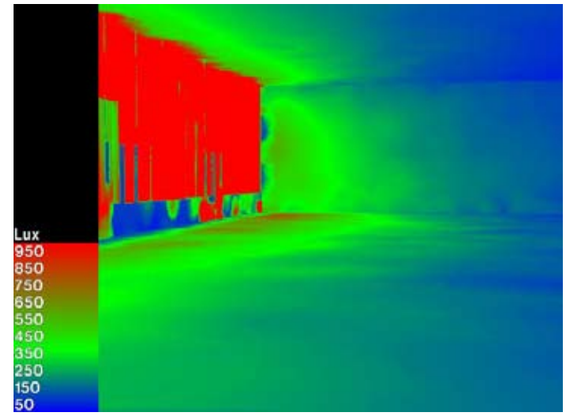



The plan on the left iis the Daylight Autonomy ratio pan for the dining room without light well to the rear of the space. With a daylight performance parameter of 50 fc and a goal of 60% daylight autonomy.

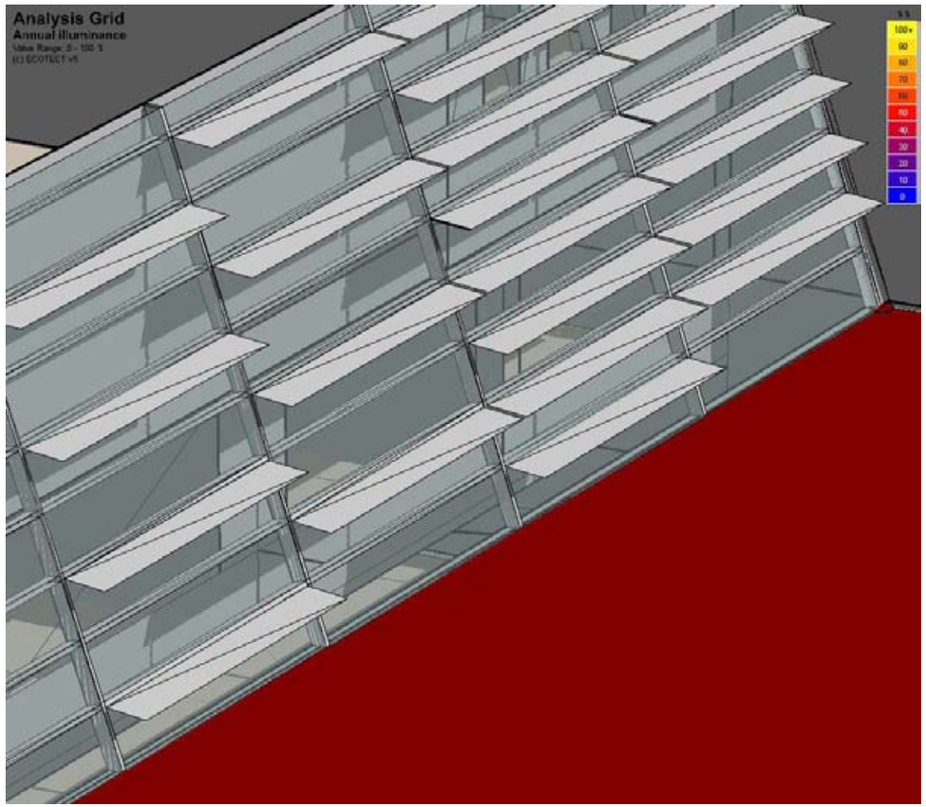
The model settings were 60% VLT for all glazing with the reflectances,of 80% for ceilings, 70% for walls, 40% for floors.

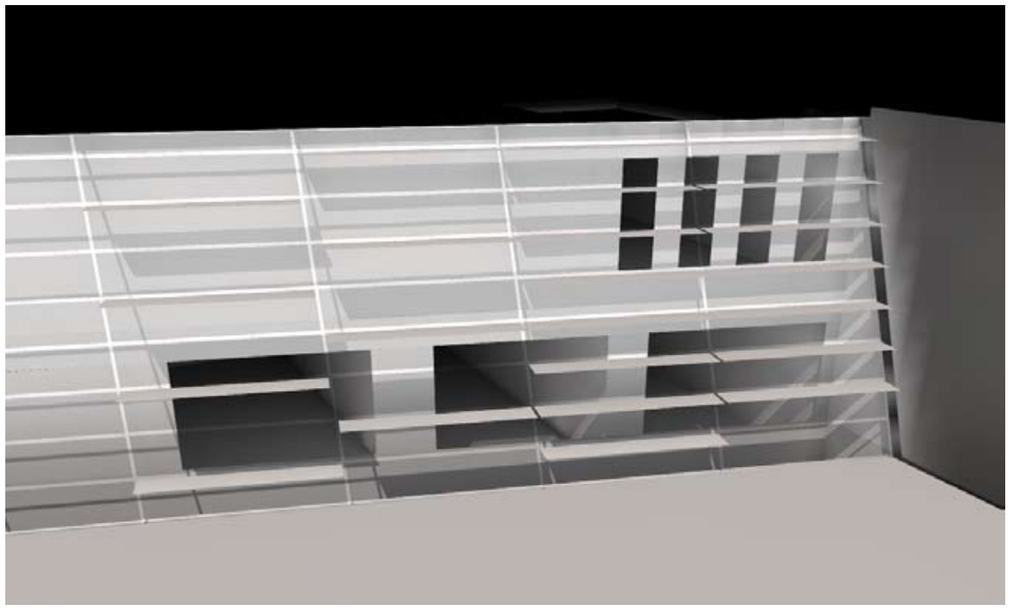
As shown, not quite 50% of the space will achieve the DA goal. The daylight is not evenly distributed and issue of glare and contrast will be more prevalent in this scenario.




The radiance images above show how dark the south wall will be and how the daylight decrease. This is glare and a dark wall will be an issue with contrast.  For occupants facing north, this will not be as much of an issue because of the glazing on that wall.



The image on the left shows the shading design used in the daylight analysis. The space of the frame is 12'10" horizontally and 3'0" vertically.

The horizontal shading is 2'-0" in length and at a 20 degree angle. The shading device has a transparency (openness factor) of 30%.

# Recommendations

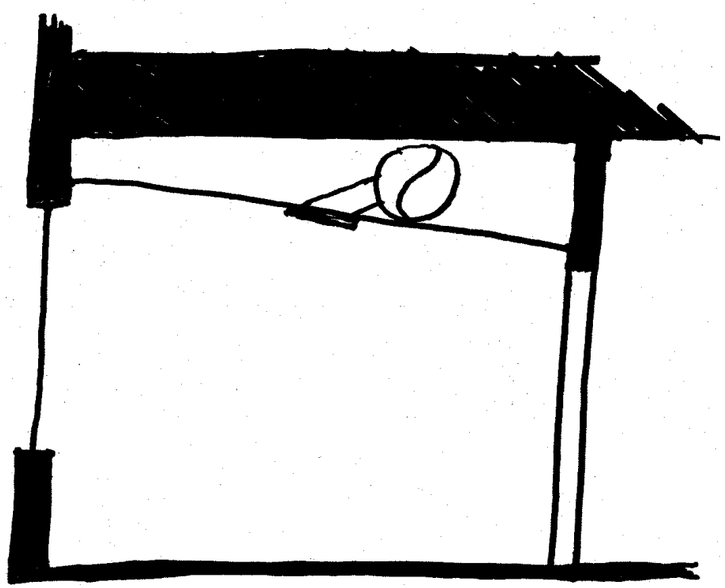
-The VLT of the glazing should be no more than 60% with a low SHGC. Energy simulation is needed to determine the effects of the double facade and a compromise is needed between daylight and cooling loads.

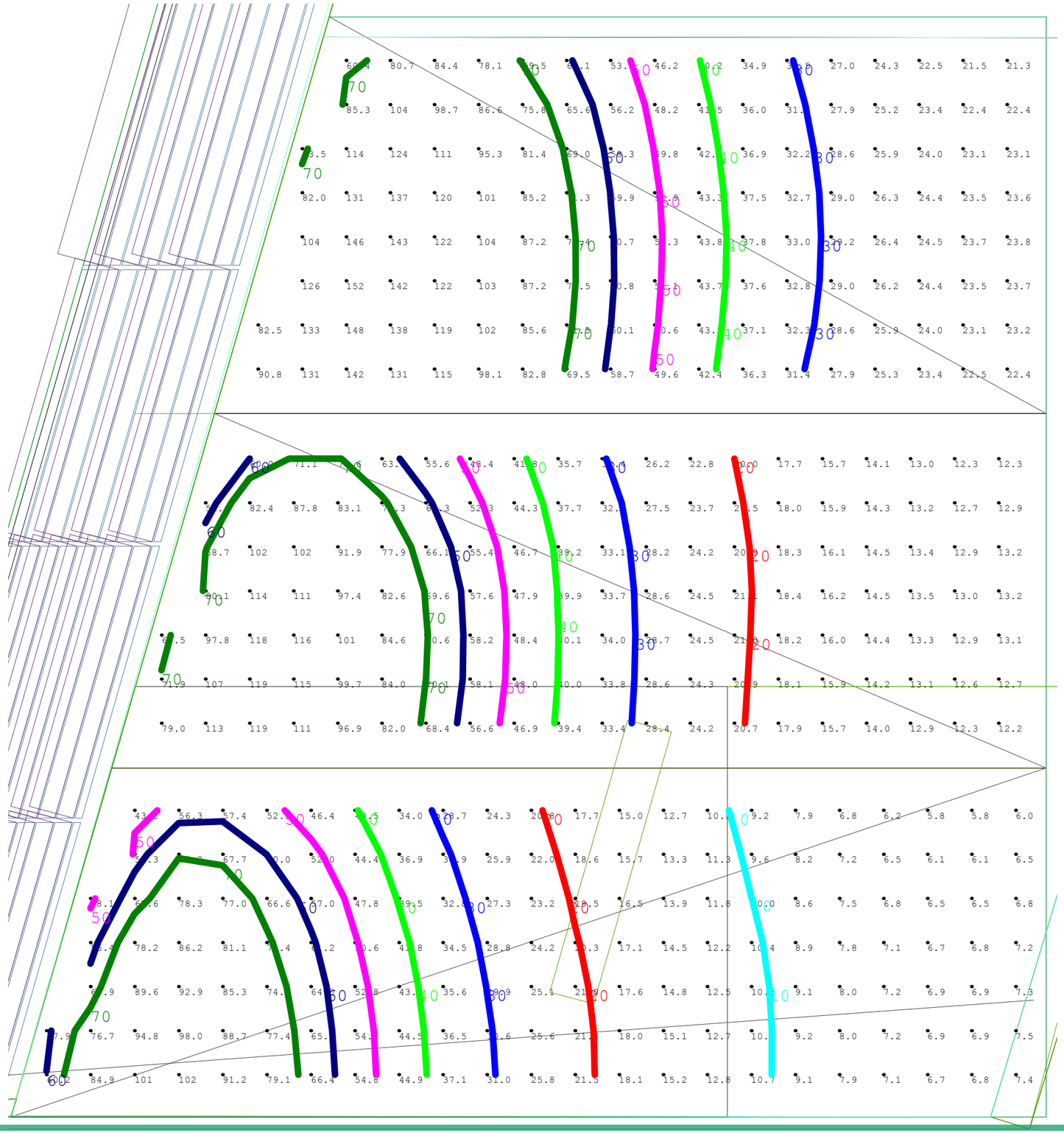
-The shading device geometry should be as noted above. Where are interior windows, a shading device should be placed on every horizontal member of the frame. Where there is no interior window, shading devices are not needed.

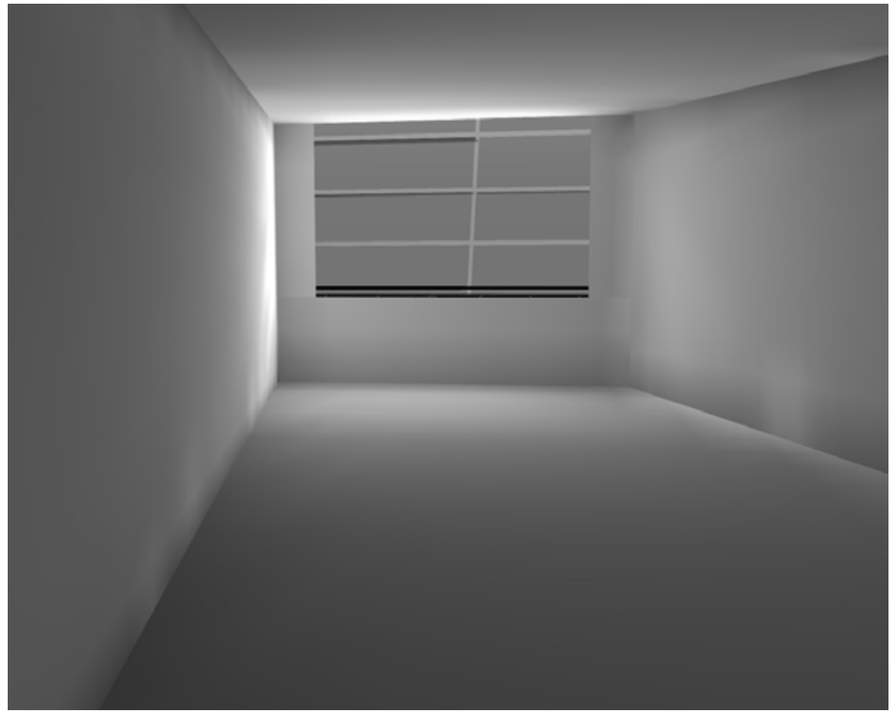
# Meeting Rooms

The luxor plans on the left show the illuminance levels for the second floor meeting rooms on March 21st under overcast sky conditions. The VLT of the outer envelope was 60%, the VLT of the glazing in the meeting rooms was 70%. Internal reflectances was 80% ceiling, 70% walls, 40% floors. The outer envelope had a horizontal shading device on every horizontal frame member. Window to floor ratio was 15% and the ceiling was sloped from the head of the window to 8'-0" in height at the entry wall.

As shown, about 45% of each space reaches 30fc. This would be a sufficient level of illuminance. Due to the depth of the space glare will be an issue, not only from direct sun but also from the lighting levels.







## Recommendations

-A minimum VLT of 70%. If the exterior envelope VLT drops to 50fc because of heat gain issues, then the VLT needs to be 80%.

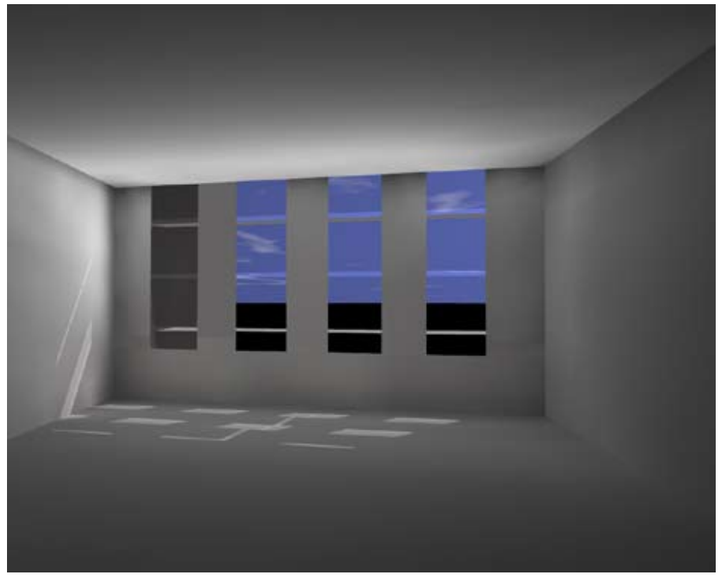
-Window to wall ratio of 10-15%.

-Slope the ceiling from the head of the window back to the entry wall.

-Solar shades are a must. Due to its orientation, direct solar penetration will be the greatest until about 11 am each day.

# 3rd Floor Lounge

The luxor plans on the right show the illuminance levels for the floor lounge under overcast sky conditions.



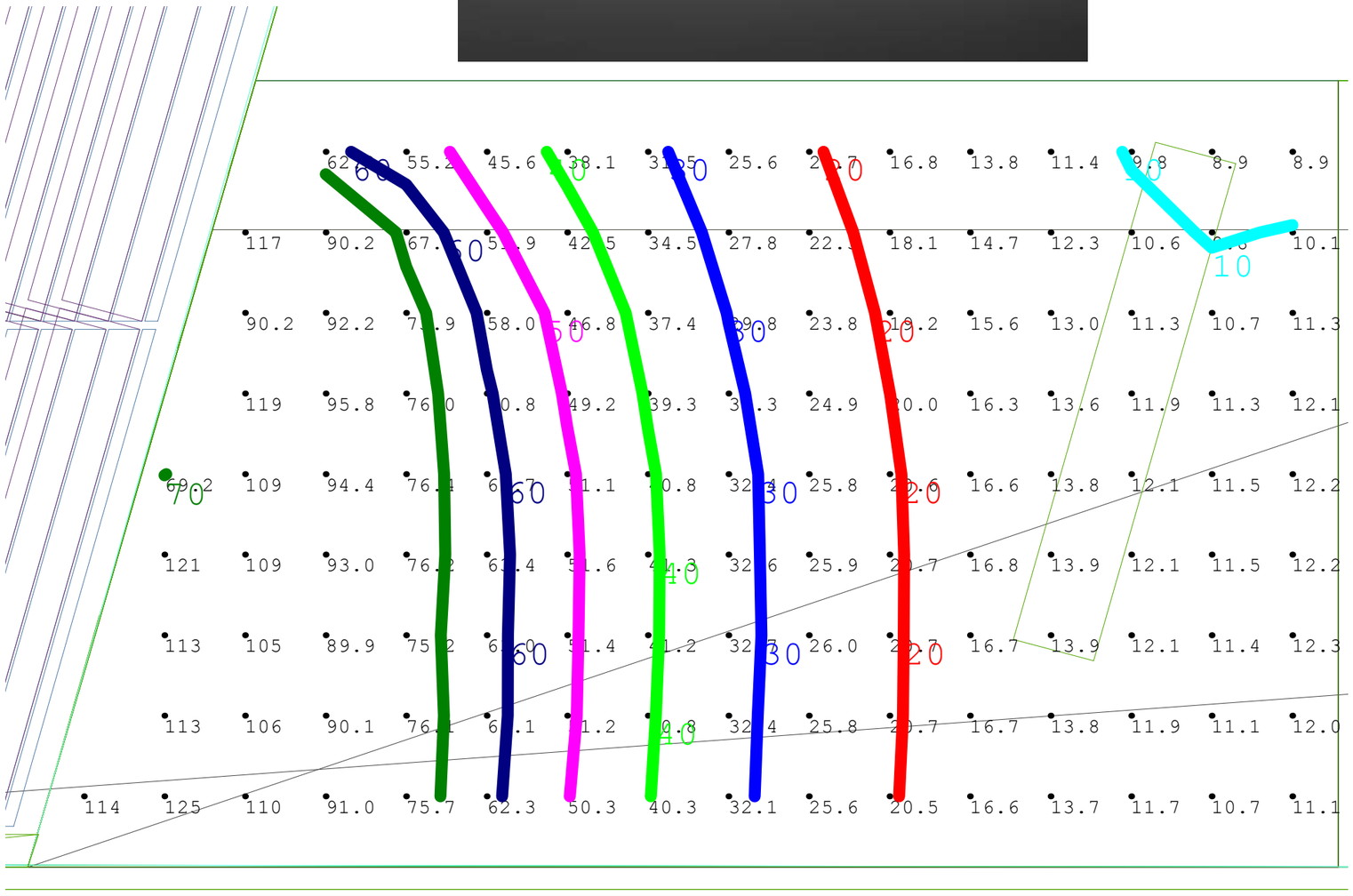
# Recommendations

-A minimum VLT of 70%. If the exterior envelope VLT drops to 50fc because of heat gain issues, then the VLT needs to be 80%.

-Window to wall ratio of 10%.

-Solar shades are a must. Due to its orientation, direct solar penetration will be the greatest until about 11 am each day.

-The back half of the space will be illuminated by the light from the great hall, so sloping the ceiling is not necessary.



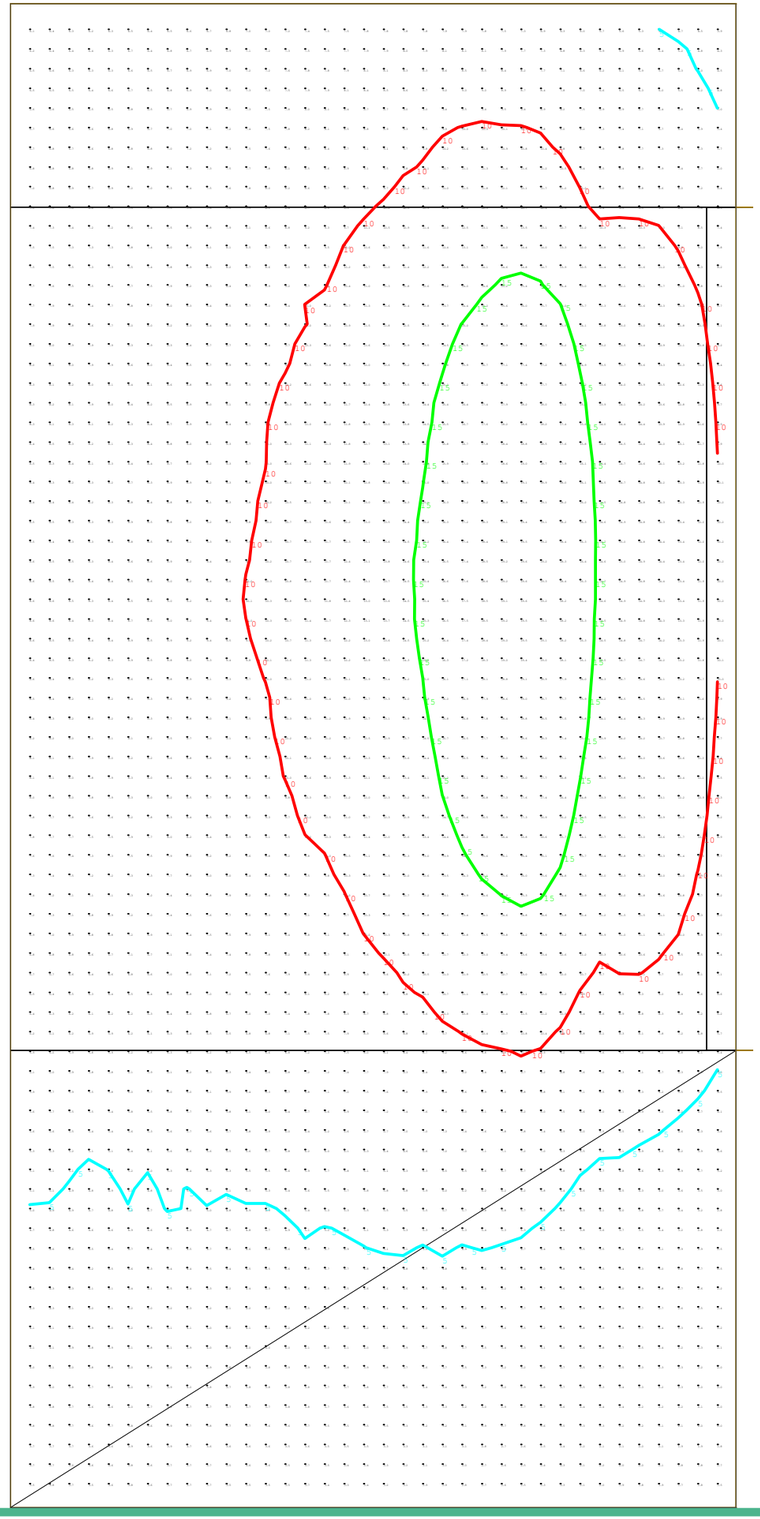
# Multipurpose Room

The luxor plans on the right show the illuminance levels for the second floor multipurpose room under clear and overcast sky conditions.

The amount of glazing is based upon the elevations.  A VLT of 70% was used in the simulation. Both scenarios do not provide adequate daylight nor distribute the daylight evenly.

There is a lot of glare and contrast due to the location of the windows, The north side of the space, receives no daylight, which causes the surface to be very dark creating unwanted contrast levels and glare.

The section on the proceeding page shows the means by which the surfaces can be manipulated to bring some light on the north wall, which in turn will reduce the controls levels and glare.



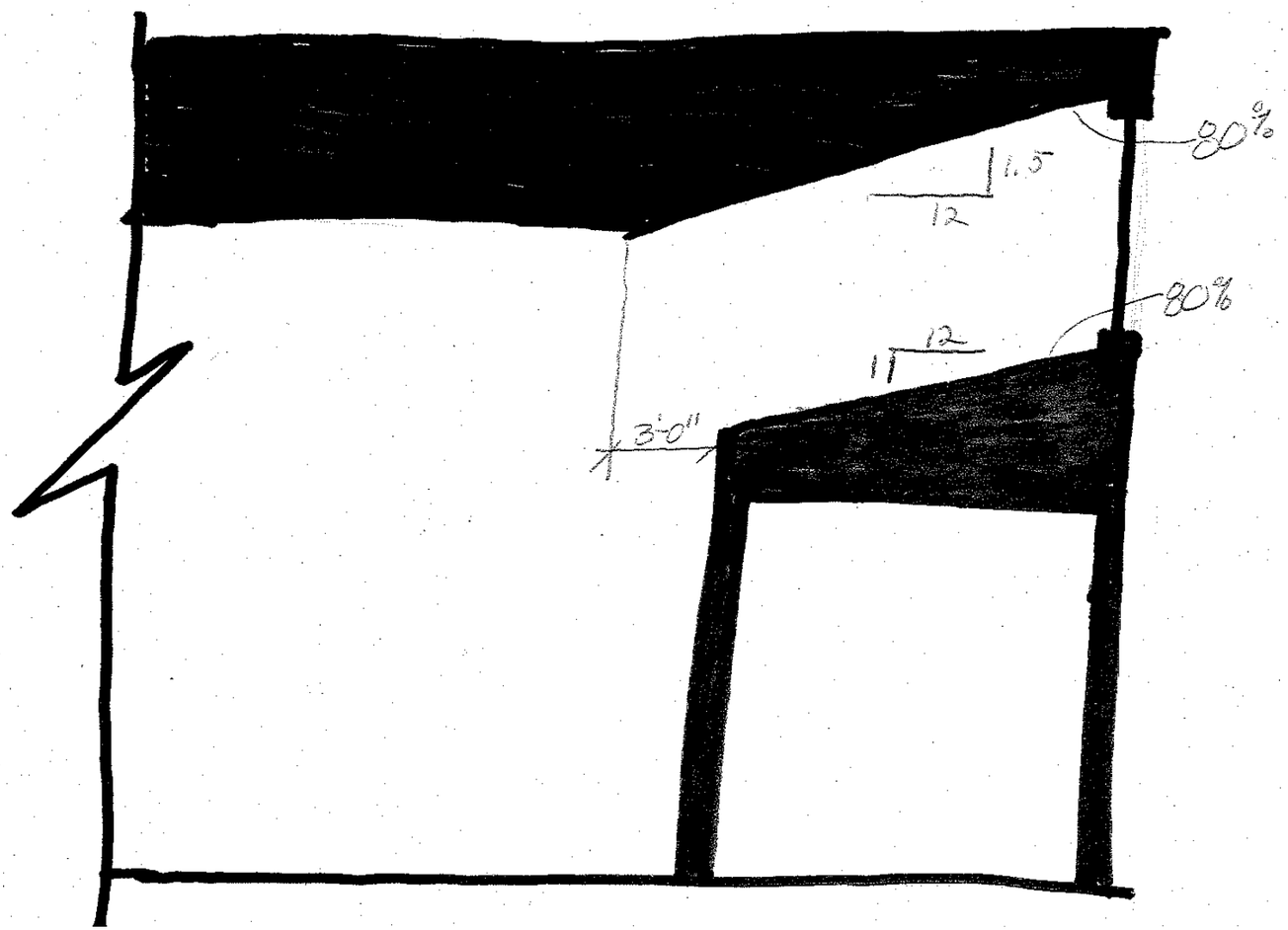
# Recommendations

-The only effective means to daylight the space evenly is with toplighting.

-Evaluation of the space's uses should be critically analyzed. The reason being is that the windows are not providing enough nor  a good quality daylight in the space.

-Blinds will be necessary  to darken the space.

-To reduce the glare issue, a lower VLT of 50% is recommended for any glazing placed on the north wall.

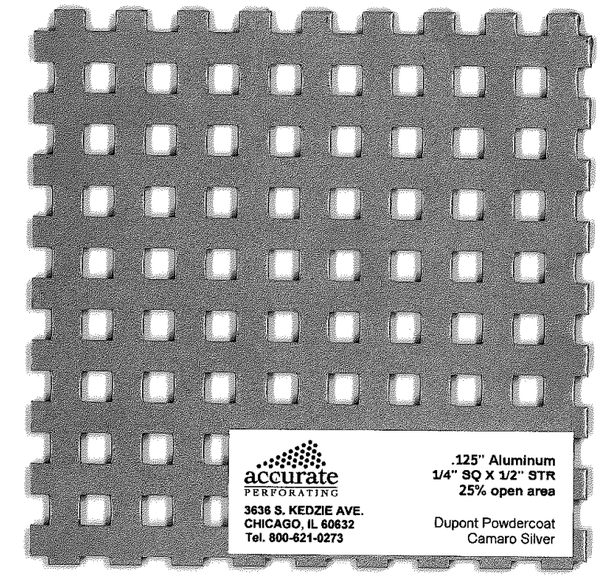



The ceiling and the bottom floor below the windows need to be sloped.  Both surfaces should not be angled to much, especially the top surface, the greater the angle, the less light that will impact the north wall.

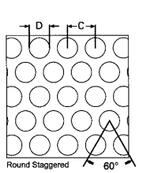
# General Recommendations

Here are some examples of shading device pattens and how to determine the openess factor. This information and one possible source of the material is through Accurate Metal Fabrication at www.accurateperforating.com

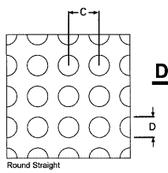
Some other manufacturers of shading devices.
http://www.c-sgroup.com/
http://www.levolux.com/index.htm
http://www.airolite.com/



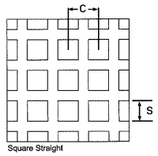

## Open Percent



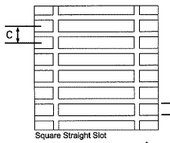

$$\frac{D^2 \times 90.69}{C^2} = \%$$



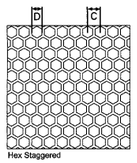

$$\frac{D^2 \times 78.54}{C^2} = \%$$



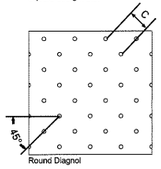

$$\frac{S^2}{C^2} = \%$$




$$\frac{L \times W}{C^2} \times 100 = \%$$




$$\frac{99.9 \times D^2}{C^2} = \%$$



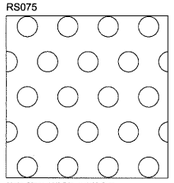

$$\frac{157.08\ D^2}{S^2} = \%$$

$$\text{H.P.S.I.} = \frac{\text{\% Open Area}}{78.54 \times D^2}$$

If you do not see the pattern you need, please contact us at 1.800.621.0273. We can easily create a custom tool for the job.



## RS075 - RS083

RS075

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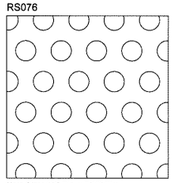
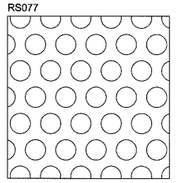
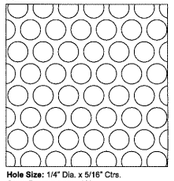
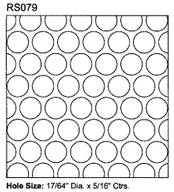
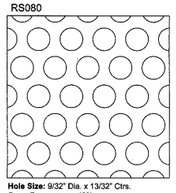
**Open Percentage:** 23%

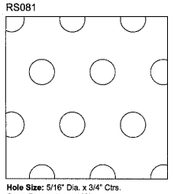
RS076

**Hole Size:** 1/4" Dia. x 7/16" Ctrs.
**Open Percentage:** 30%

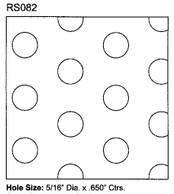
RS077

**Hole Size:** 1/4" Dia. x 3/8" Ctrs.
**Open Percentage:** 40%

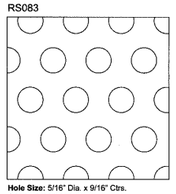
RS078

**Hole Size:** 1/4" Dia. x 5/16" Ctrs.
**Open Percentage:** 58%

RS079

**Hole Size:** 17/64" Dia. x 5/16" Ctrs.
**Open Percentage:** 66%

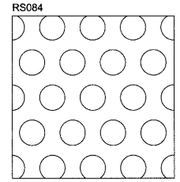
RS080

**Hole Size:** 9/32" Dia. x 13/32" Ctrs.
**Open Percentage:** 43%

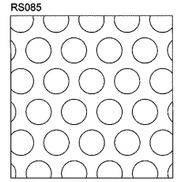
RS081

**Hole Size:** 5/16" Dia. x 3/4" Ctrs.
**Open Percentage:** 16%

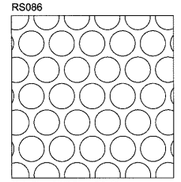
RS082

**Hole Size:** 5/16" Dia. x .650" Ctrs.
**Open Percentage:** 21%

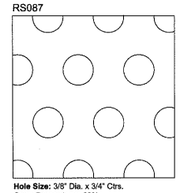
RS083

**Hole Size:** 5/16" Dia. x 9/16" Ctrs.
**Open Percentage:** 28%

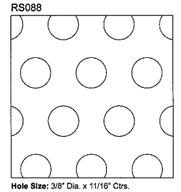
## RS084 - RS092

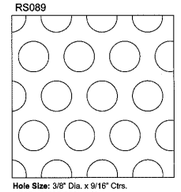
RS084

**Hole Size:** 5/16" Dia. x 1/2" Ctrs.
**Open Percentage:** 35%

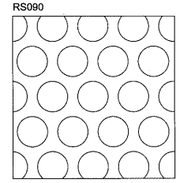
RS085

**Hole Size:** 5/16" Dia. x 7/16" Ctrs.
**Open Percentage:** 46%

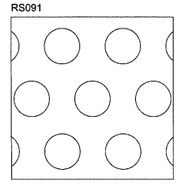
RS086

**Hole Size:** 5/16" Dia. x 3/8" Ctrs.
**Open Percentage:** 63%

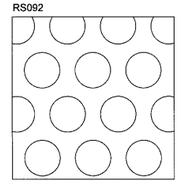
RS087

**Hole Size:** 3/8" Dia. x 3/4" Ctrs.
**Open Percentage:** 23%

RS088

**Hole Size:** 3/8" Dia. x 11/16" Ctrs.
**Open Percentage:** 27%

RS089

**Hole Size:** 3/8" Dia. x 9/16" Ctrs.
**Open Percentage:** 40%

RS090

**Hole Size:** 3/8" Dia. x 1/2" Ctrs.
**Open Percentage:** 51%

RS091

**Hole Size:** 7/16" Dia. x 3/4" Ctrs.
**Open Percentage:** 31%

RS092

**Hole Size:** 7/16" Dia. x 5/8" Ctrs.
**Open Percentage:** 44%

**Round Staggered**

Please refer to our website at www.accurateperforating.com to download detailed pattern drawings.

If you do not see the pattern you need, please contact us at 1.800.621.0273. We can easily create a custom tool for the job.