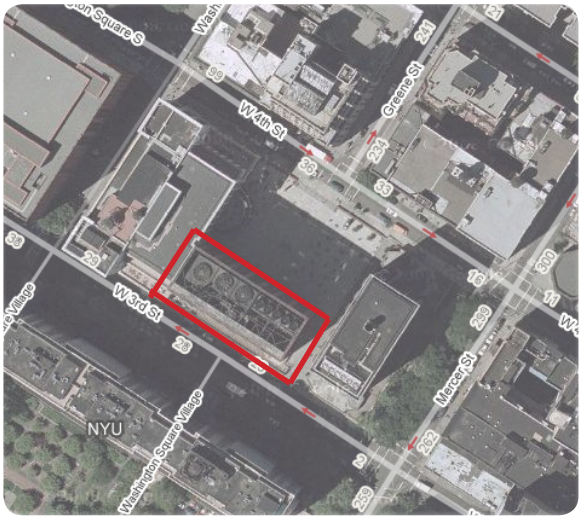
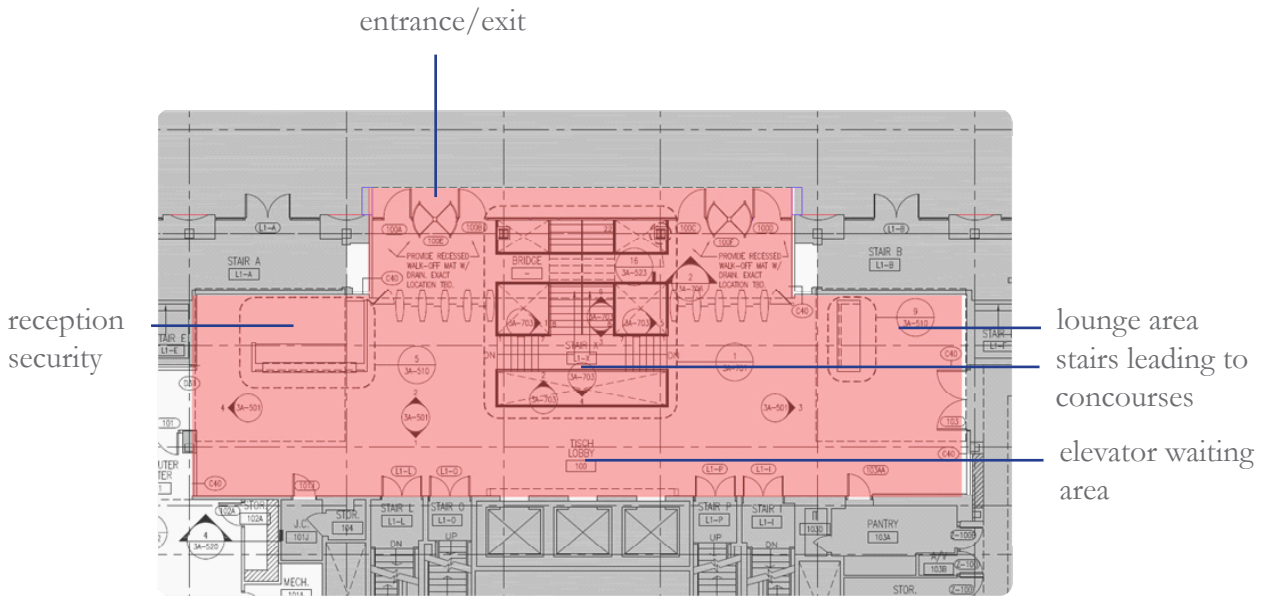
Master Depth Study: Daylight Delivery System for Tisch Hall Lobby

The master depth study analyzes the daylighting conditions in the Tisch Hall Lobby. A photosensor-based control system will be integrated with the lighting system. Energy saving calculations will be calculated to determine the effectiveness of the daylighting system.



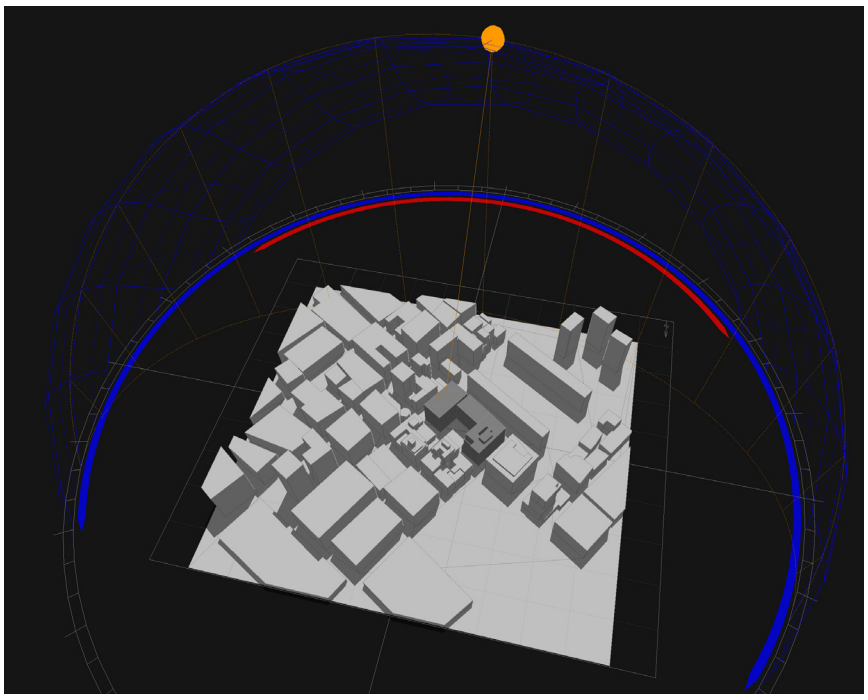
Tisch Hall, between west 4th and west 3rd st

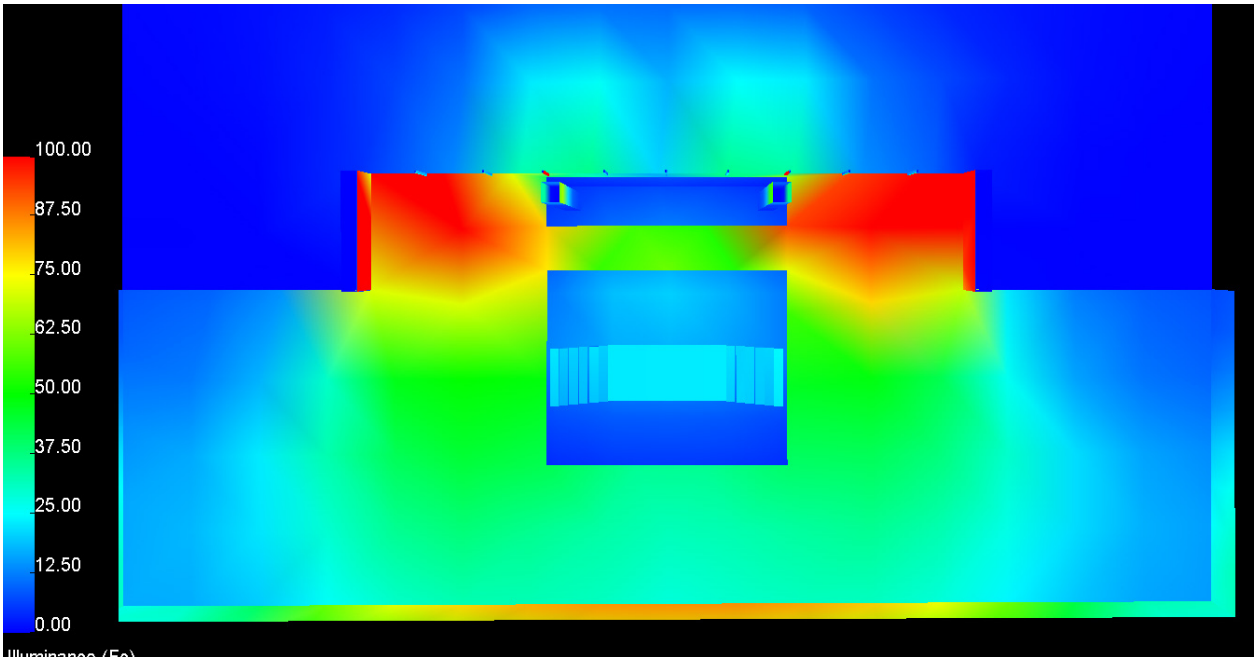


Tisch Hall Lobby, ground level

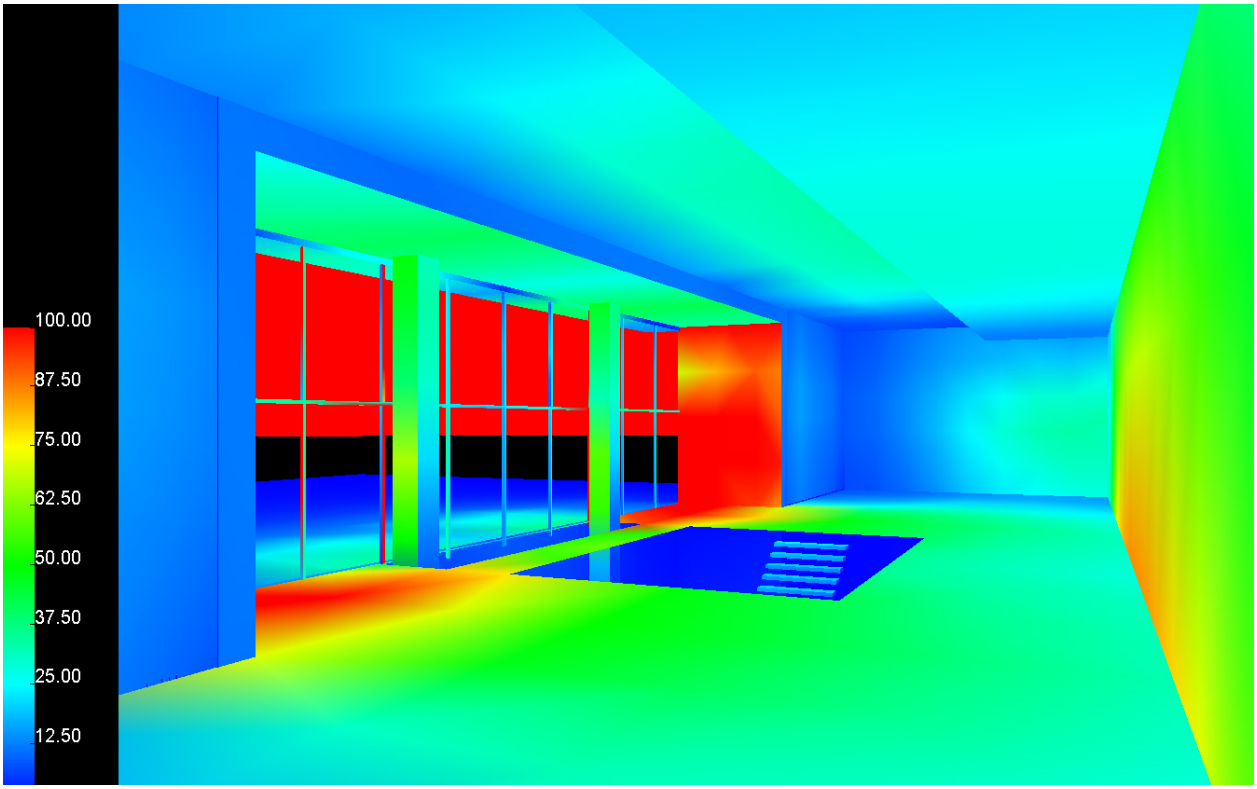
Location

Tisch Hall is located at the heart of New York City. The building faces northeast; thus, throughout the year, the building receives mostly northern light. The surrounding buildings of Weaver Hall and KMC shade Tisch Hall.





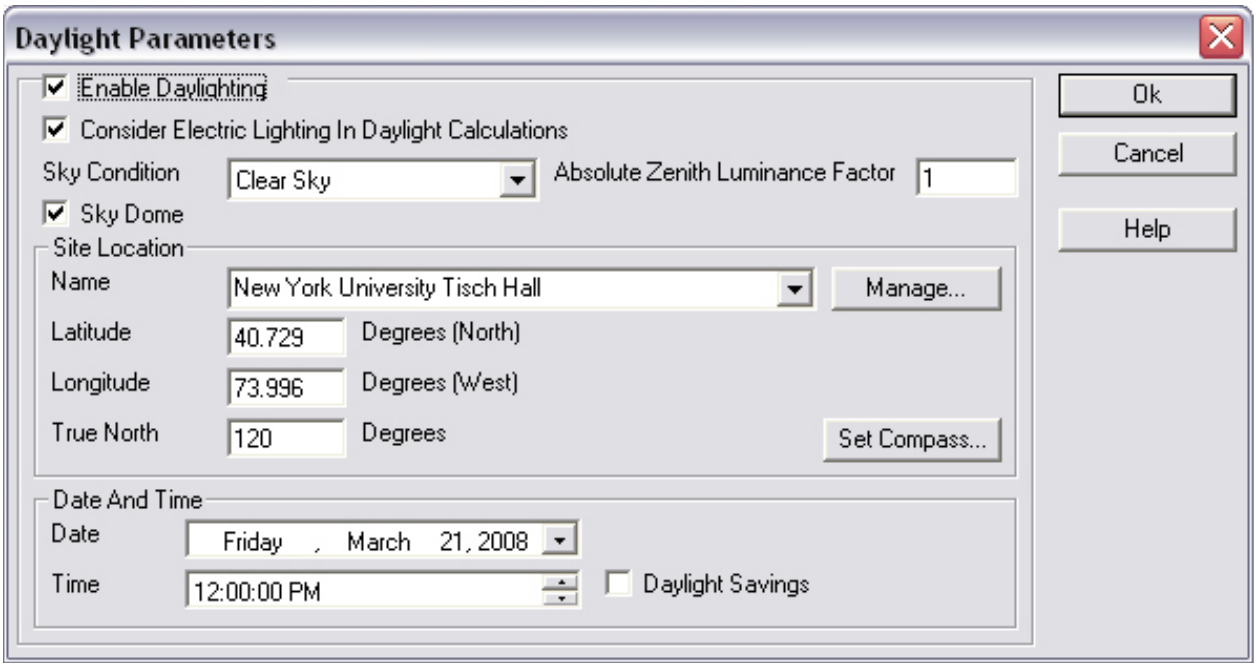
AGI Psuedo Rendering (Top View)

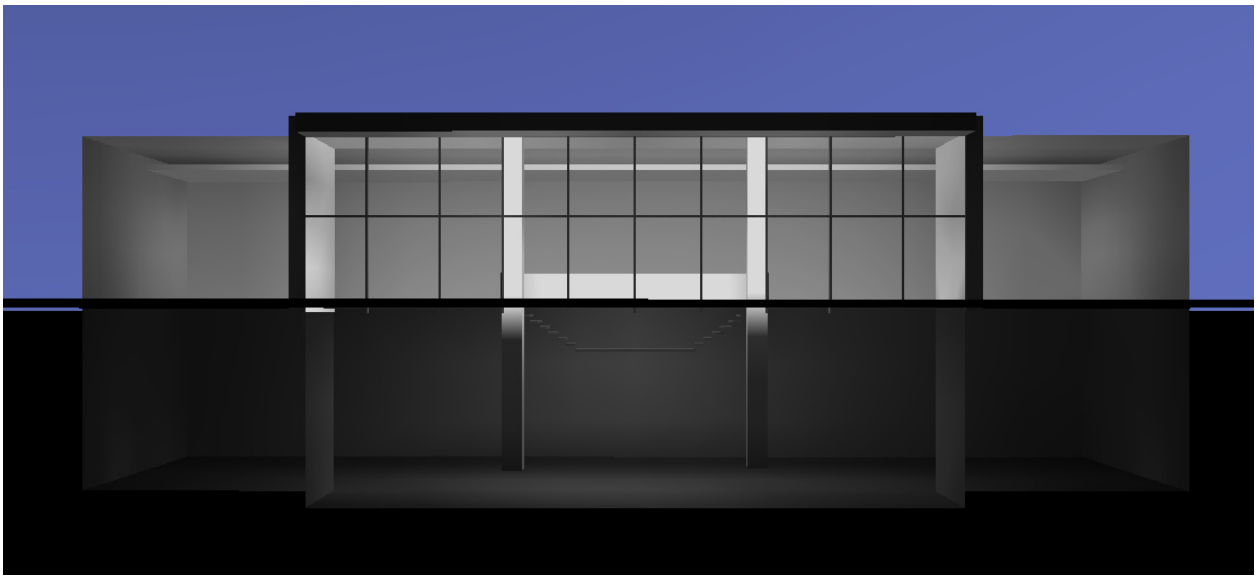


AGI Psuedo Rendering (Interior)

Daylight Simulation

The Tisch model is constructed in AGI32. The mesh sizes are increased to 4.2 for accurate computer calculations. The mullions are constructed as separate objects to fit with the window to help make the readings more accurate. The canopy to the front entry of Tisch Hall and Gould Plaza are also constructed. The surface of Gould Plaza will help reflect light into the Tisch Lobby.





Materials for Tisch Lobby

Finishes for Tisch Lobby			
Type	**Description**	**Finish**	**Reflectance (assumed)**
Wall			
ST-2	Batek Diamante Limestone (smooth)	Grey	0.5
WD-2	Bamboo Patina panel	Light Brown	0.3
P-1	White finish	Eggshell	0.9
Wall Base Finish			
ST-2	Batek Diamante Limestone	Grey	0.5
CT-5B	Gateway Ceramic Flooring	Sterling Grey	0.3
Flooring			
CT-5A	Gateway Ceramic Flooring	Sterling Grey	0.3
Ceiling			
ST-2	Batek Diamante Limestone	Grey	
ACT-5	Bamboo Patina panel	Light Brown	0.9

Tisch Hall is made up of several materials. The AGI model is simplified to make the walls and ceiling have one reflectance value.

In the study for the daylighting model, the reflectance for the wall is 0.5 (since most of the wall is covered with limestone), the reflectance of the floor is 0.3, and the ceiling is 0.9. The transmittance of the glass is 0.6.

Proposed Photosensor System

A photosensor based daylighting system can help Tisch Hall save energy. The operation hours of Tisch Hall will assume to be from 8 am to midnight. The lobby can utilize the consistent northern light to help illuminate the space. At certain times throughout the year, the corners of the lobby does not obtain the 10 fc recommended by the IES. For the proposed photosensor system design, the proposal is to recommend 15 fc throughout the lobby. With the increase of lighting, it would provide a brighter space which can help make the space feel larger and comfortable for occupants.

The lighting in the lobby will be divided into three zones. Zone 1 lights will be based on an astronomical clock. Zone 1 lighting will not need to be turned on for the majority of the day (8am to 5 pm) due to the ample daylight coming through the window. Zone 2 lighting be part of a photosensor based system. The lighting will dim to achieve the 15 fc proposed design for the corners of the lobby. Zone 3 are lights that will always be turned on - these include the recessed fluorescents in the wall and the pendants of the security desk and stairs.

A model was constructed in agi32 and ecotect to analyze the daylighting conditions throughout the year. The photosensor designed is based on the time of the year when the lobby receives the least amount of daylight. Calculations were run three times a day at 9:00 AM, 12:00 PM, and 3:00 PM on the equinox, summer and winter solstice. The calculations show that during the winter solstice, Tisch Hall receives the least amount of light.

The photosensor will be based off of the winter solstice at 3 pm. The dimming level was determined by finding the critical point, a single point within a space that establishes the contribution from the dimmed lighting zone that will required to make up for the difference between the target illuminance and the illuminance from daylight and non dimmed lighting.

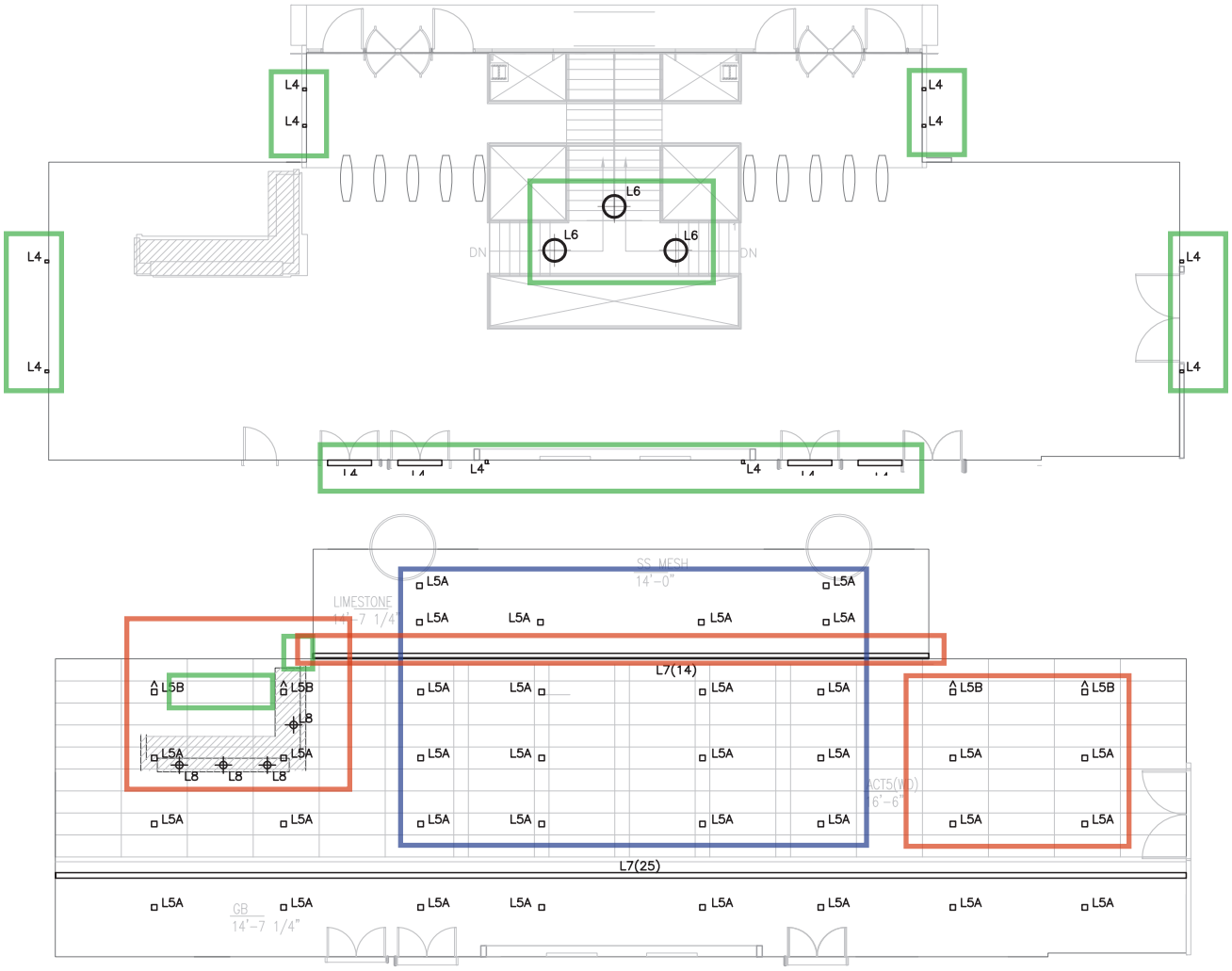
The photosensor location will be imported into the ecotect model of Tisch Hall and analyzed in daysim for energy analysis.

Proposed Photosensor System

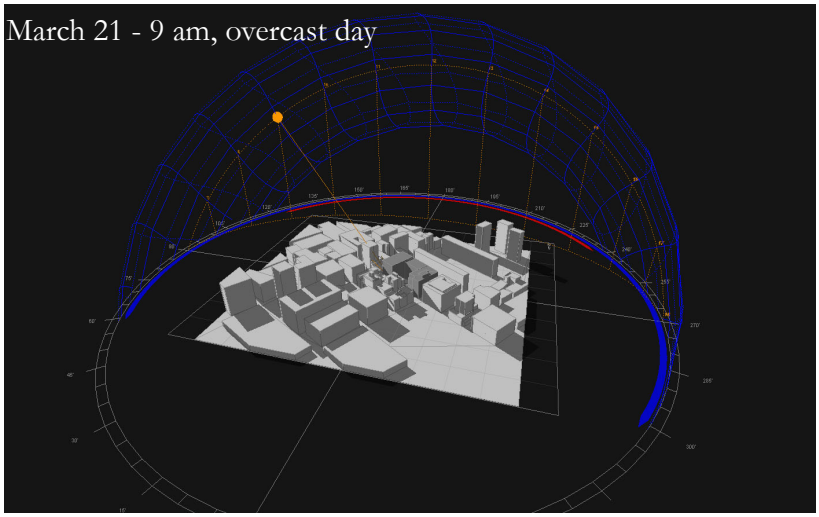
Zone 1

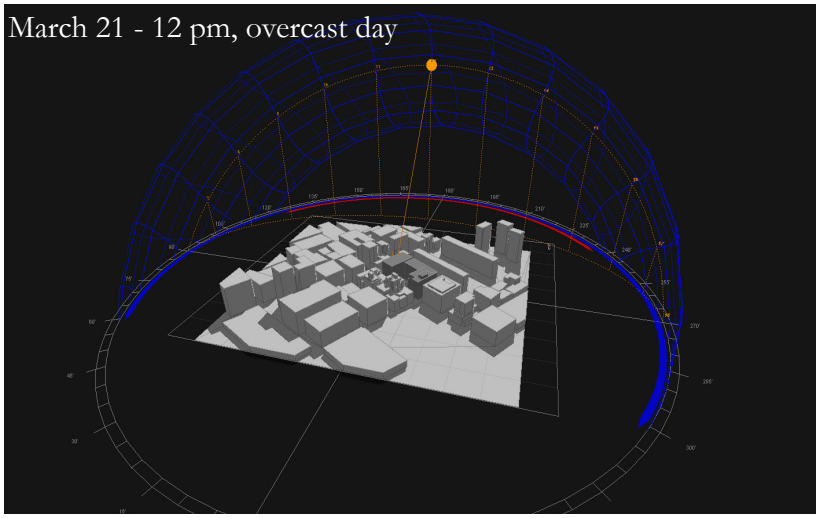
Zone 2

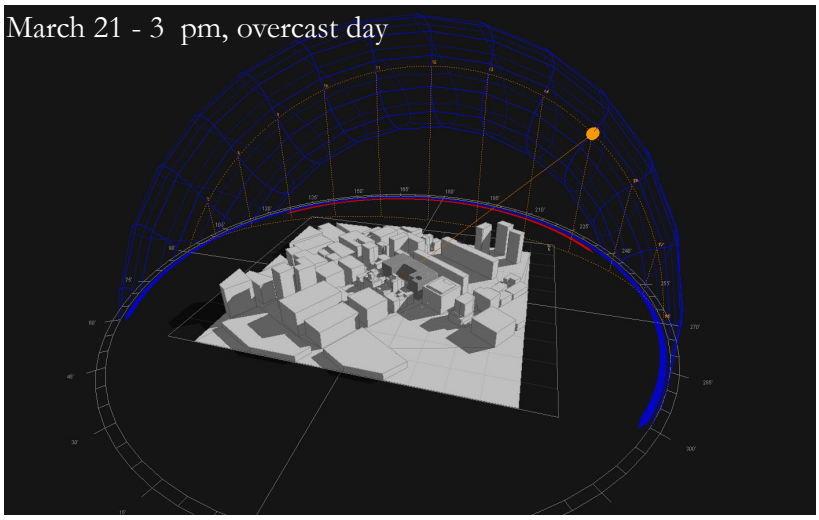
Always on



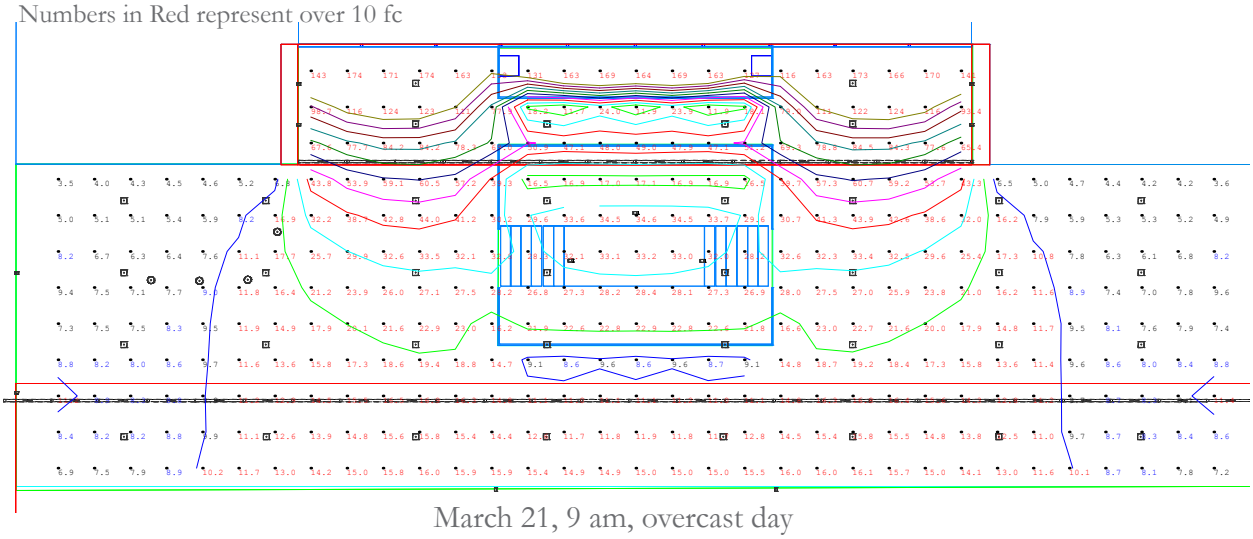
Tisch Hall Lobby, ground level


March 21 - 9 am, overcast day

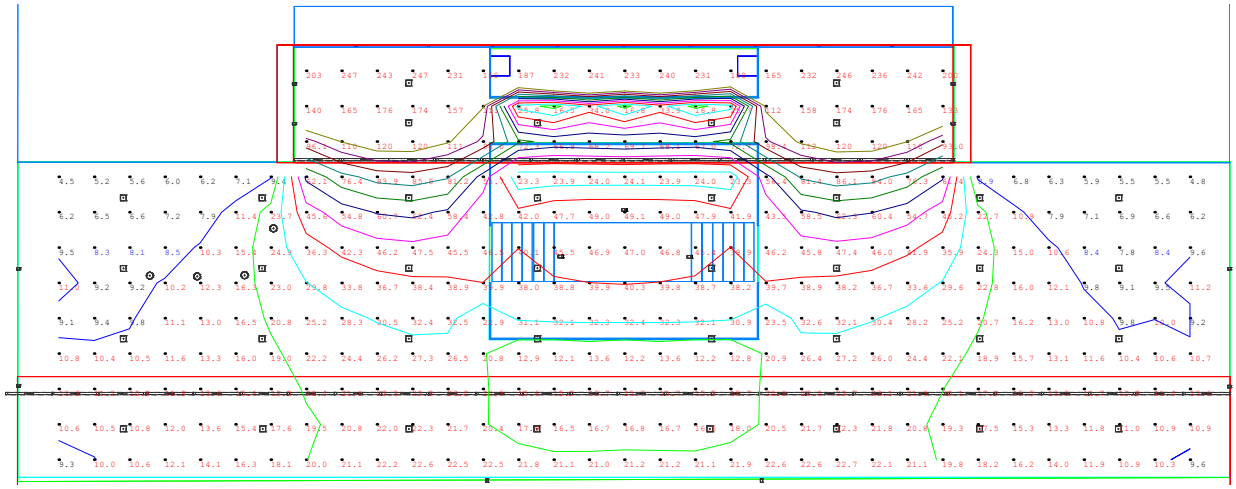

March 21 - 12 pm, overcast day


March 21 - 3 pm, overcast day

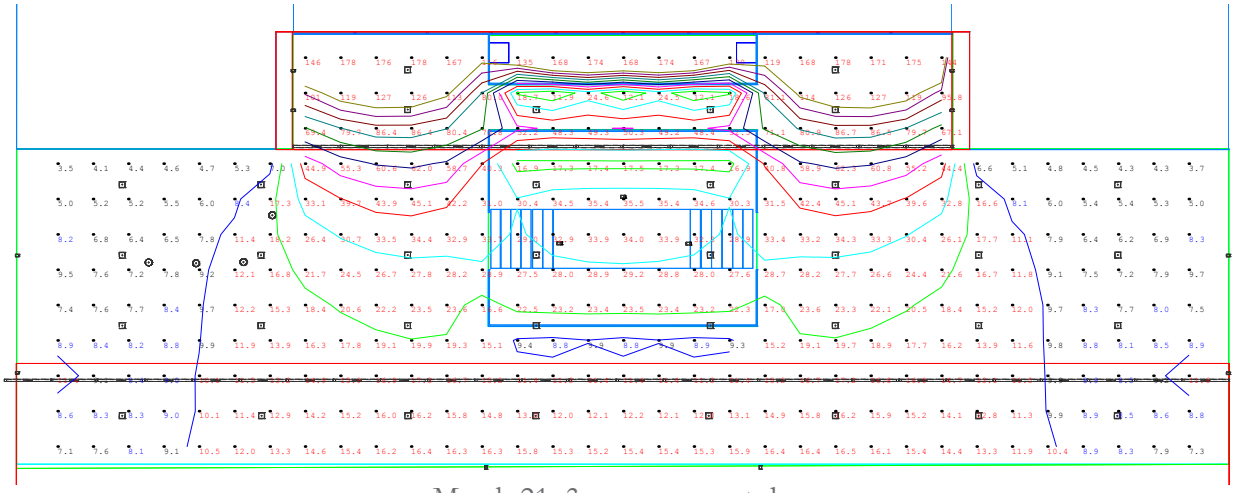
Numbers in Red represent over 10 fc



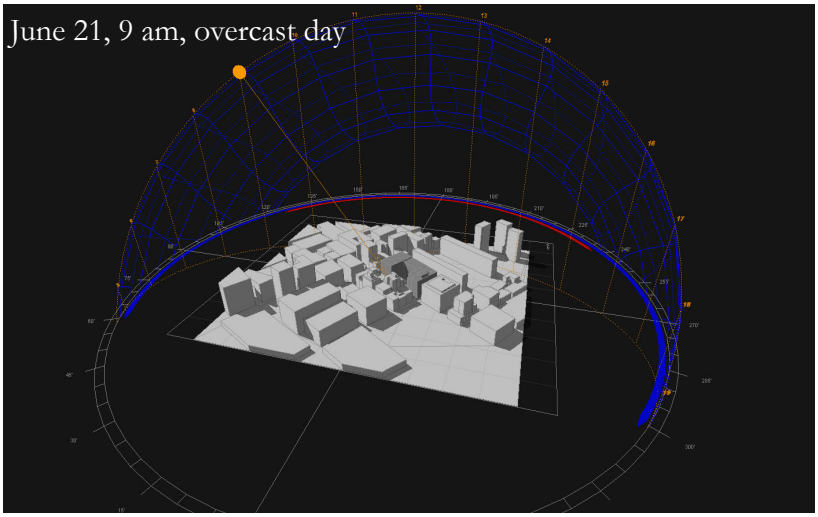
March 21, 9 am, overcast day

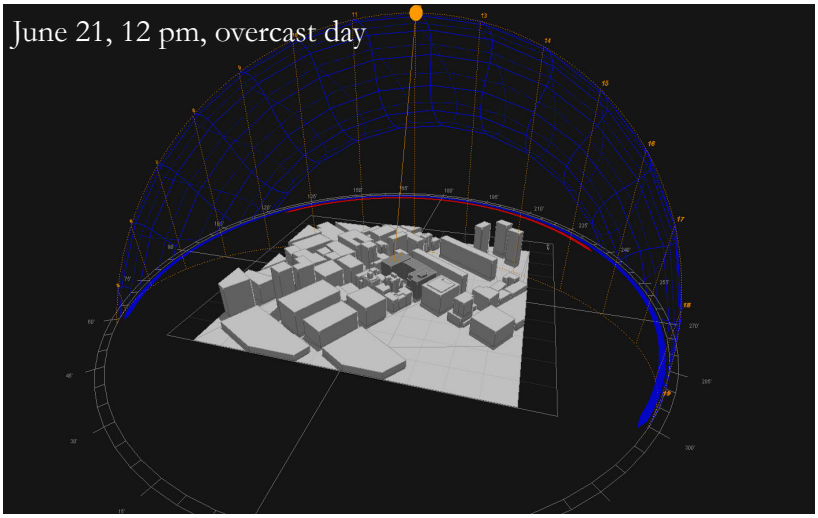


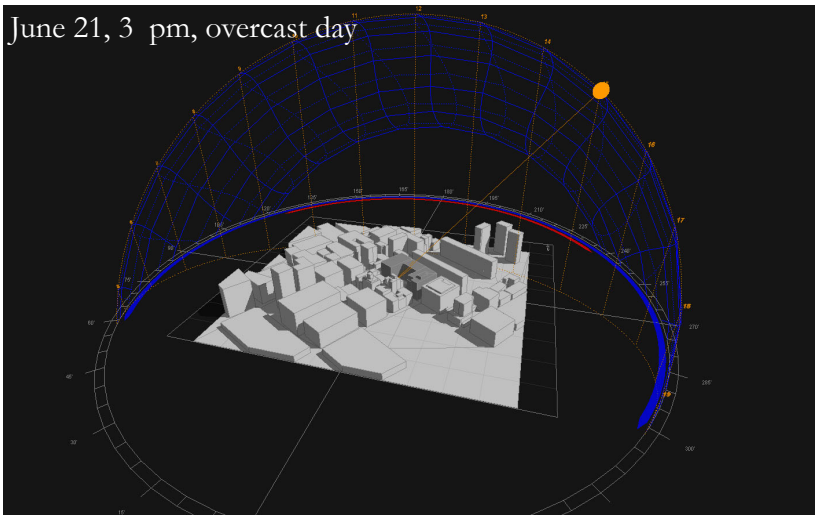
March 21, 12 pm, overcast day



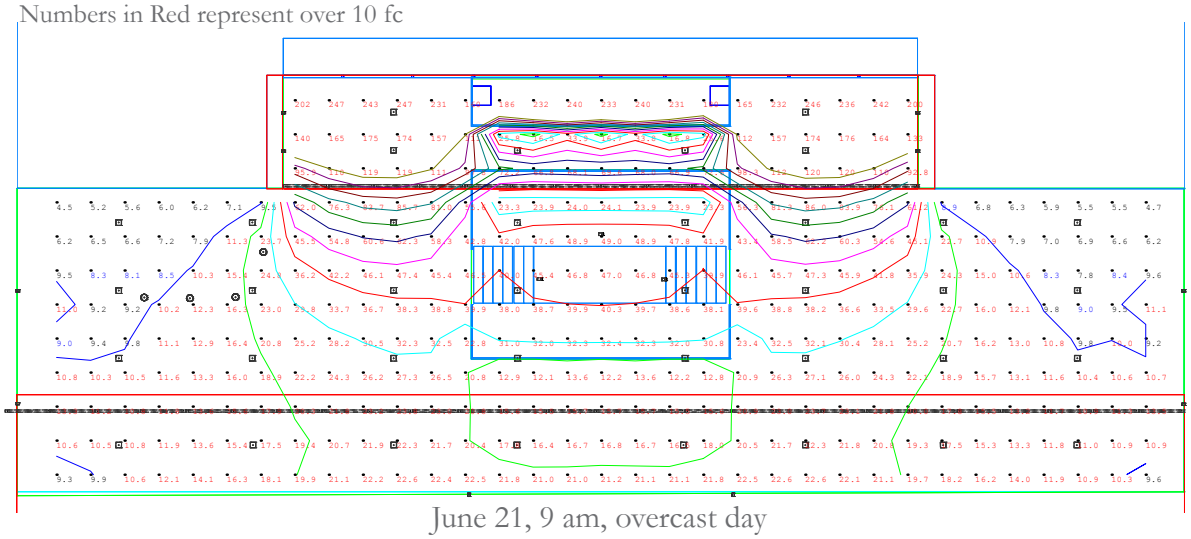
March 21, 3 pm, overcast day


June 21, 9 am, overcast day

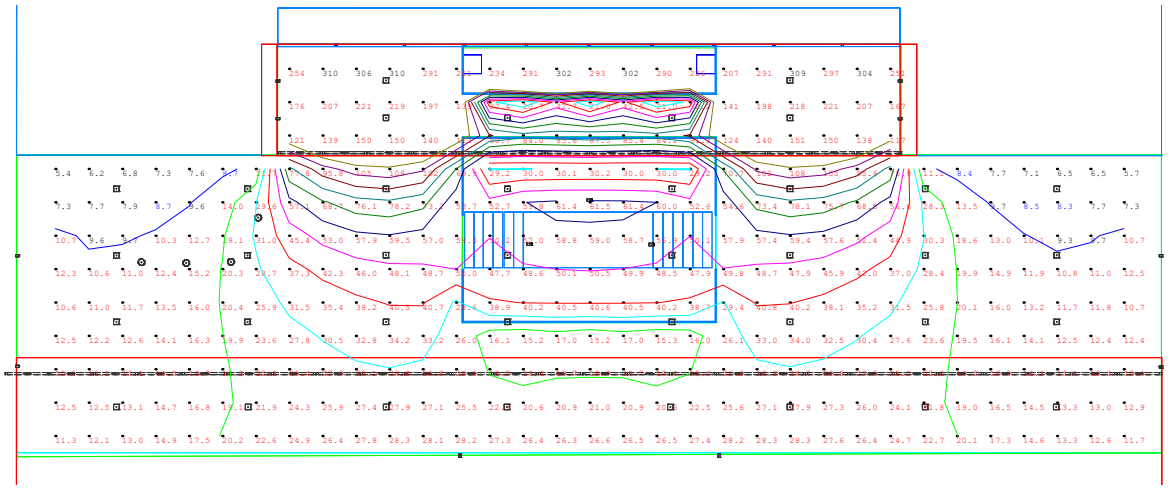

June 21, 12 pm, overcast day


June 21, 3 pm, overcast day

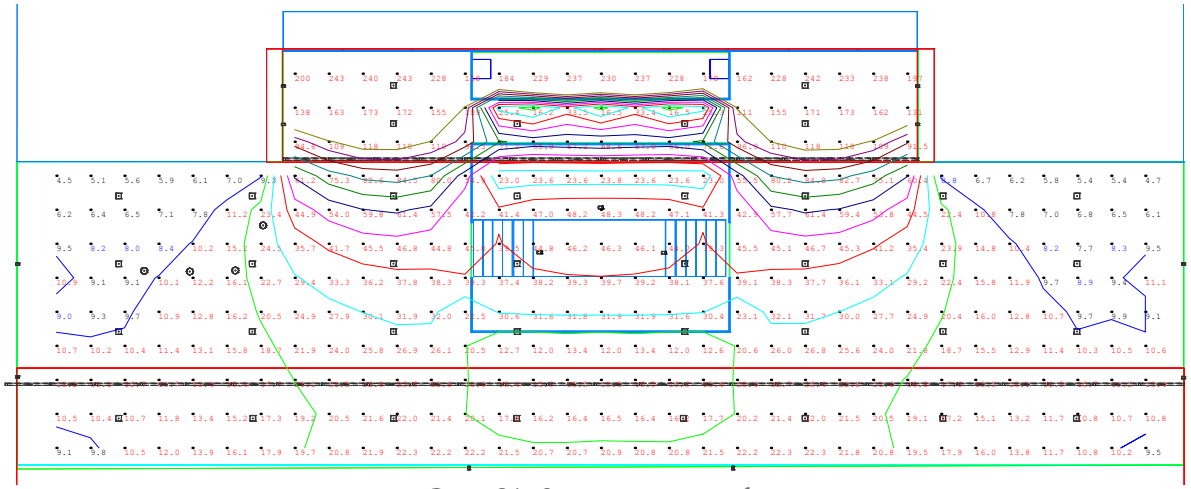
Numbers in Red represent over 10 fc



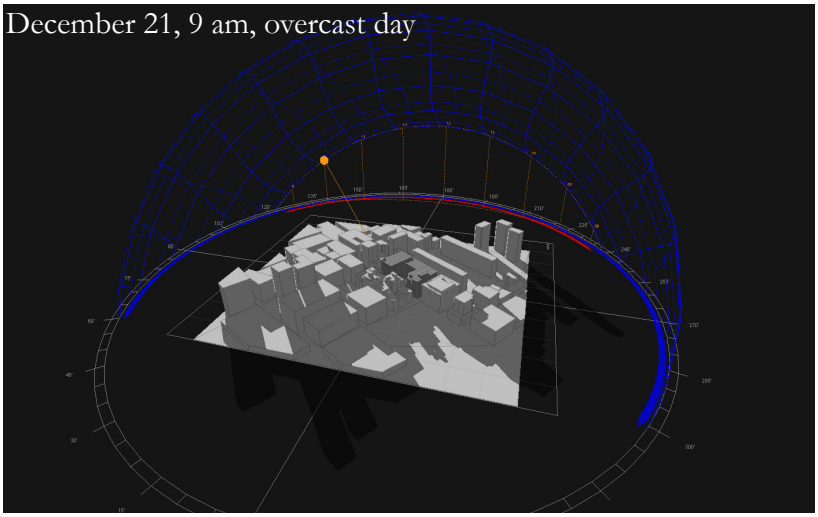
June 21, 9 am, overcast day

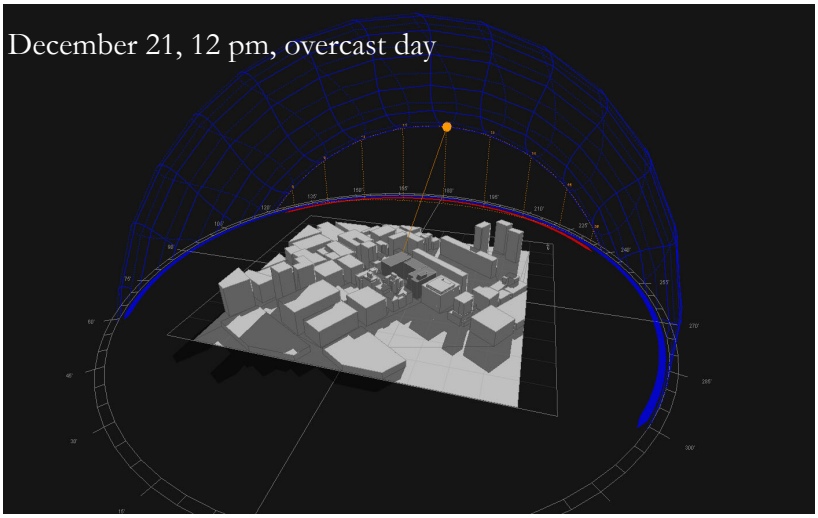


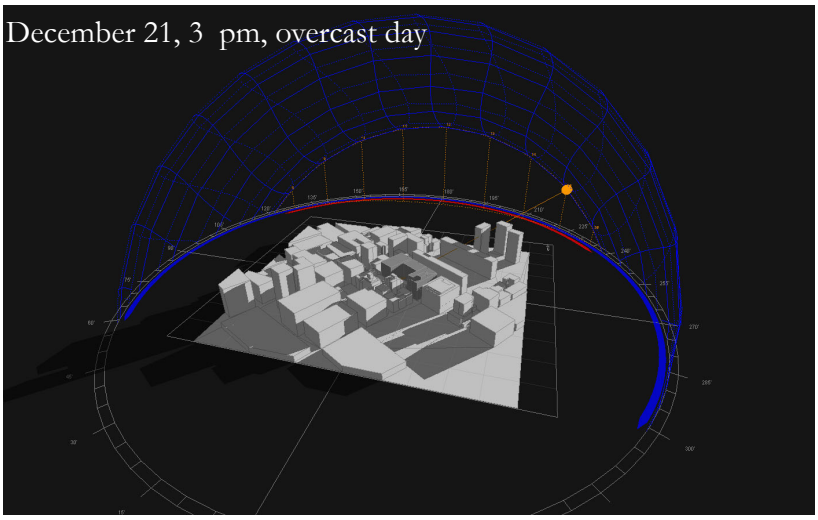
June 21, 12 pm, overcast day



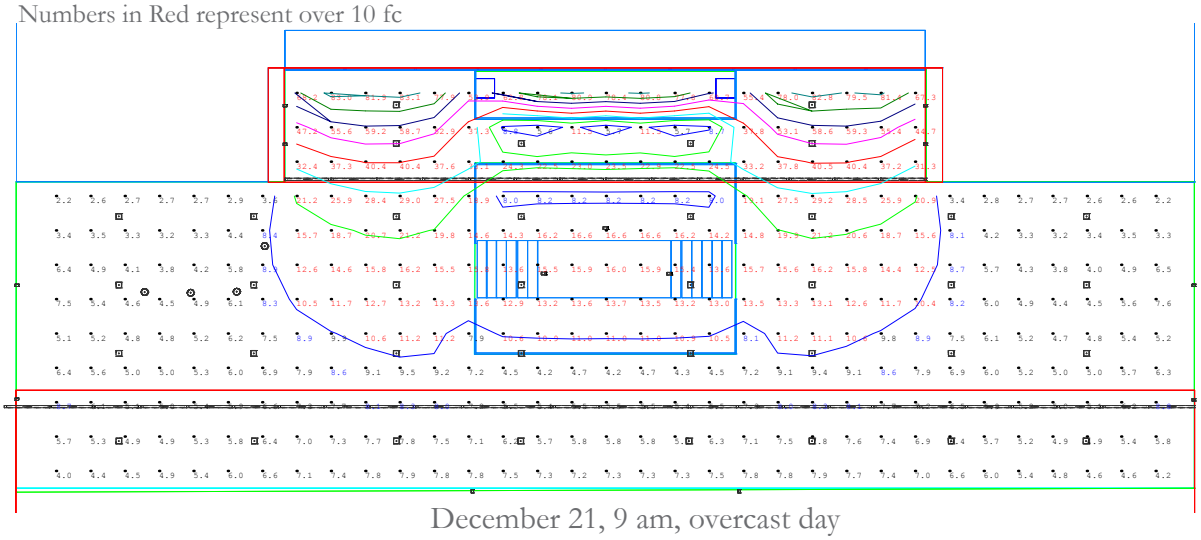
June 21, 3 pm, overcast day


December 21, 9 am, overcast day

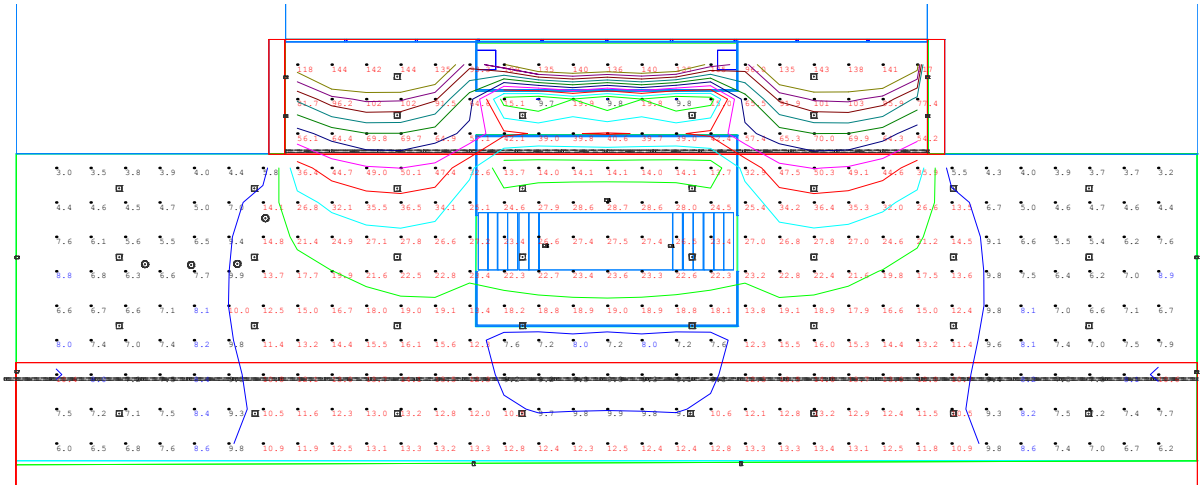

December 21, 12 pm, overcast day


December 21, 3 pm, overcast day

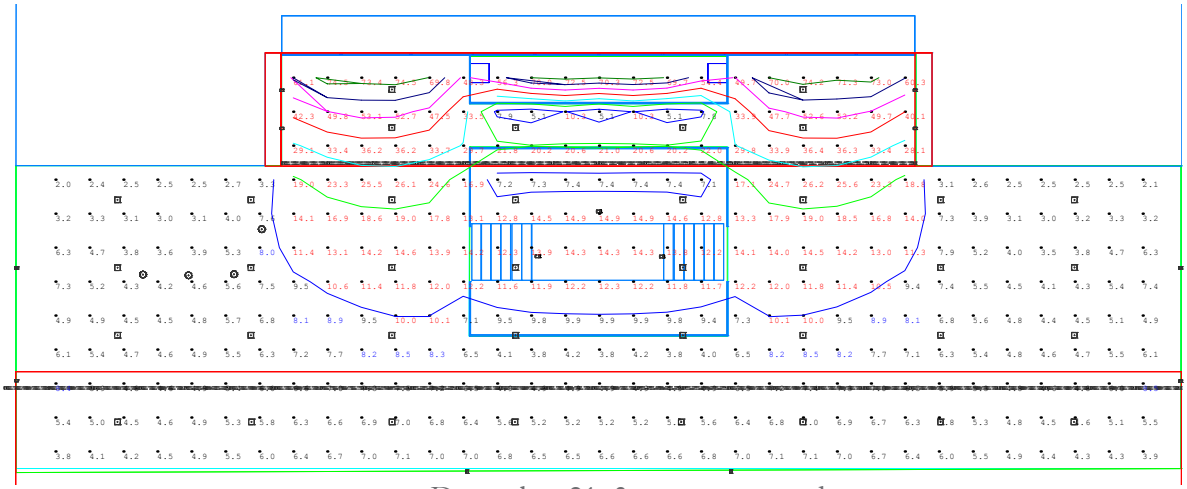
Numbers in Red represent over 10 fc



December 21, 9 am, overcast day



December 21, 12 pm, overcast day



December 21, 3 pm, overcast day

Critical Point

$$\text{Critical Point} = \frac{\text{(Desired Lighting - Daylight and non dimmed lighting)}}{\text{Zone 2 Lighting}} = 0.42$$

57.2	560.2	563.2	566.2	569.2	572.2	575.2	578.2	581.2	584.2	587.2	590.2	593.2	
8	-6.35802	-6.51613	-6.66667	-7.16279	-8.60526								
664	-2.57391	-3.39316	-3.70085	-4	-4.31959								
224	-1.44961	-1.74627	-1.89706	-1.97015	-1.87402								
898	-0.75833	-0.95683	-0.97902	-0.89655	-0.65734	0.394161	1.017241	1.130841	1.19802	1.284211	1.430233	1.666667	2.
733	-0.20833	-0.41606	-0.42553	-0.33103	-0.14189	0.191781	0.676259	0.863636	0.92	1.017391	1.105769	1.252747	1.
313	0.007752	-0.08333	-0.08088	-0.00709	0.114865	0.28	0.540541	0.699301	0.788321	0.858268	0.896552	0.910891	1.
451	0.106195	0.113821	0.132813	0.183824	0.258741	0.358108	0.510067	0.62585	0.704225	0.759398	0.795082	0.757009	0.
842	0.371134	0.256637	0.275	0.314961	0.362963	0.41844	0.517483	0.605634	0.666667	0.717557	0.760331	0.841121	1.
2	0.505263	0.378641	0.37963	0.412281	0.446281	0.484127	0.546875	0.617188	0.666667	0.714286	0.763636	0.79798	1.
541	0.571429	0.5	0.494505	0.510417	0.524752	0.561905	0.616822	0.672897	0.733333	0.78	0.797872	0.729412	0.
412	0.681159	0.647887	0.643836	0.653333	0.670886	0.719512	0.771084	0.841463	0.91358	0.987179	1.068493	1.121212	1.
852	0.818182	0.807018	0.810345	0.85	0.870968	0.920635	0.984375	1.078125	1.209677	1.355932	1.482143	1.745098	2.

Determined Critical Point

557.2	560.2	563.2	566.2	569.2	572.2	575.2	578.2	581.2	584.2	587.2	590.2	593.2
15	15	15	15	15	15							
15	15	15	15	15	15							
15	15	15	15	15	15							
15	15	15	15	15	15	15	15	15	15	15	15	15
15	15	15	15	15	15	15	15	15	15	15	15	15
15	15	15	15	15	15	15	15	15	15	15	15	15
15	15	15	15	15	15	15	15	15	15	15	15	15
15	15	15	15	15	15	15	15	15	15	15	15	15
15	15	15	15	15	15	15	15	15	15	15	15	15
15	15	15	15	15	15	15	15	15	15	15	15	15
15	15	15	15	15	15	15	15	15	15	15	15	15
15	15	15	15	15	15	15	15	15	15	15	15	15

Desired Lighting Level

557.2	560.2	563.2	566.2	569.2	572.2	575.2	578.2	581.2	584.2	587.2	590.2	593.2
0.1	8.1	9.3	9.3	8.6	7.6							
10.7	11.5	11.7	11.7	11.3	9.7							
9.8	12.9	13.4	13.6	13.4	12.7							
9.8	12	13.9	14.3	14.5	14.3	13.7	11.6	10.7	10.1	9.5	8.6	7.5
10.1	12	13.7	14.1	14.5	14.8	14.6	13.9	13.2	12.5	11.5	10.4	9.1
12.8	12.9	13.2	13.6	14.1	14.8	15	14.8	14.3	13.7	12.7	11.6	10.1
10.2	11.3	12.3	12.8	13.6	14.3	14.8	14.9	14.7	14.2	13.3	12.2	10.7
7.6	9.7	11.3	12	12.7	13.5	14.1	14.3	14.2	13.8	13.1	12.1	10.7
7.5	9.5	10.3	10.8	11.4	12.1	12.6	12.8	12.8	12.6	11.9	11	9.9
7.8	8.4	8.8	9.1	9.6	10.1	10.5	10.7	10.7	10.5	10	9.4	8.5
6.8	6.9	7.1	7.3	7.5	7.9	8.2	8.3	8.2	8.1	7.8	7.3	6.6
5.4	5.5	5.7	5.8	6	6.2	6.3	6.4	6.4	6.2	5.9	5.6	5.1

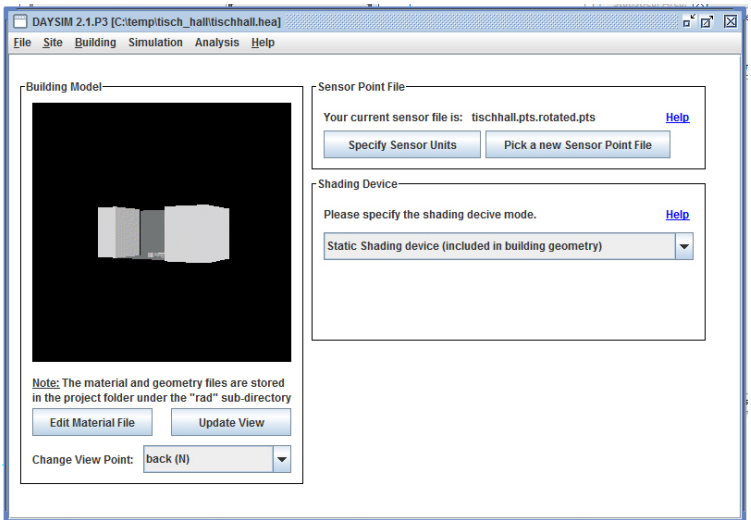
Zone 2 Lighting

557.2	560.2	563.2	566.2	569.2	572.2	575.2	578.2	581.2	584.2	587.2	590.2	593.2
1.2	66.5	75.6	77	76.6	80.4	0	0	0	0	0	0	0
7	44.6	54.7	58.3	60.2	56.9	0.1	0	0	0	0	0	0
25.9	33.7	38.4	40.8	41.4	38.8	0	0	0	0	0	0	0
7.7	24.1	28.3	29	28	24.4	9.6	3.2	2.9	2.9	2.8	2.7	2.5
11.7	17.5	20.7	21	19.8	17.1	12.2	5.6	3.6	3.5	3.3	3.5	3.6
14.1	14.9	16.1	16.1	15.1	13.3	10.8	7	5	4.2	4.1	4.6	5.8
13.7	13.8	13.6	13.3	12.5	11.3	9.7	7.4	5.8	5	4.9	5.3	6.9
9.4	11.4	12.1	11.7	11	10.1	9.1	7.6	6.4	5.8	5.6	5.8	6
6	10.2	11.1	10.9	10.3	9.6	8.9	8	7.1	6.6	6.5	6.6	7.1
9.1	10.2	10.6	10.5	10.1	9.7	9.1	8.4	7.8	7.3	7.2	7.5	8.8
9.7	10.3	10.4	10.3	10.1	9.7	9.1	8.6	8.1	7.6	7.3	7.2	7.6
10.4	10.5	10.4	10.3	9.9	9.6	9.2	8.7	8.1	7.5	7	6.7	6.1

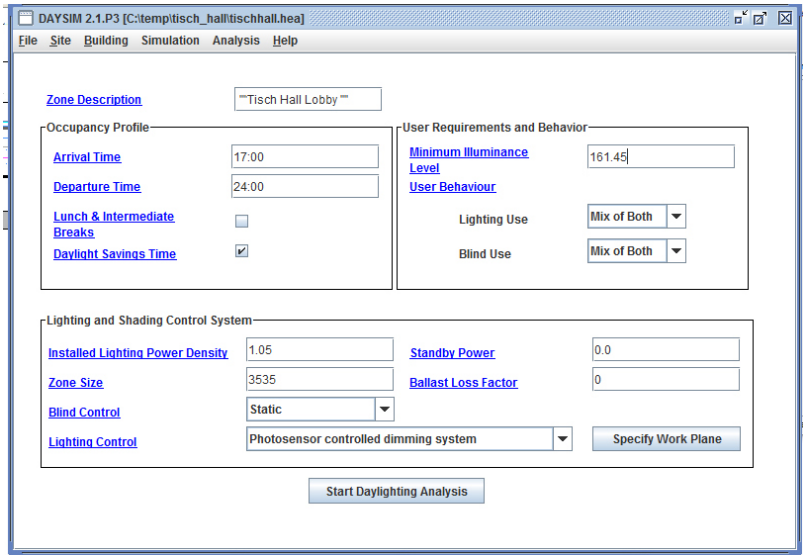
Daylight and non-dimmed Lighting

Daylight Simulation

A total of three daysim simulations will be computed. The first two simulations will take place between the hours of 8 am to 5 pm. The first simulation will calculate the energy used for full lighting output while simulation two will calculate the total energy consumed with the photosenor based zone 2 (zone 1 lighting will be off from 8 am to 5 pm). The energy savings will be determined by taking the difference of full lighting on and lighting with photosensor for zone 2. The last calculation will calculate the energy consumed for the rest of the night, from 5pm to midnight.

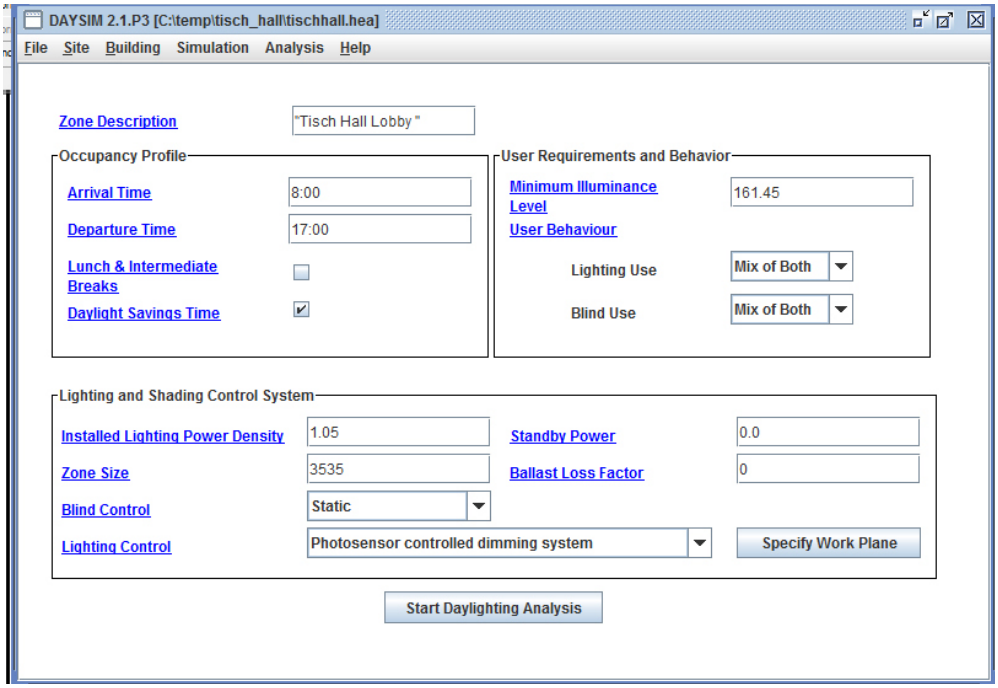


Daysim program parameter

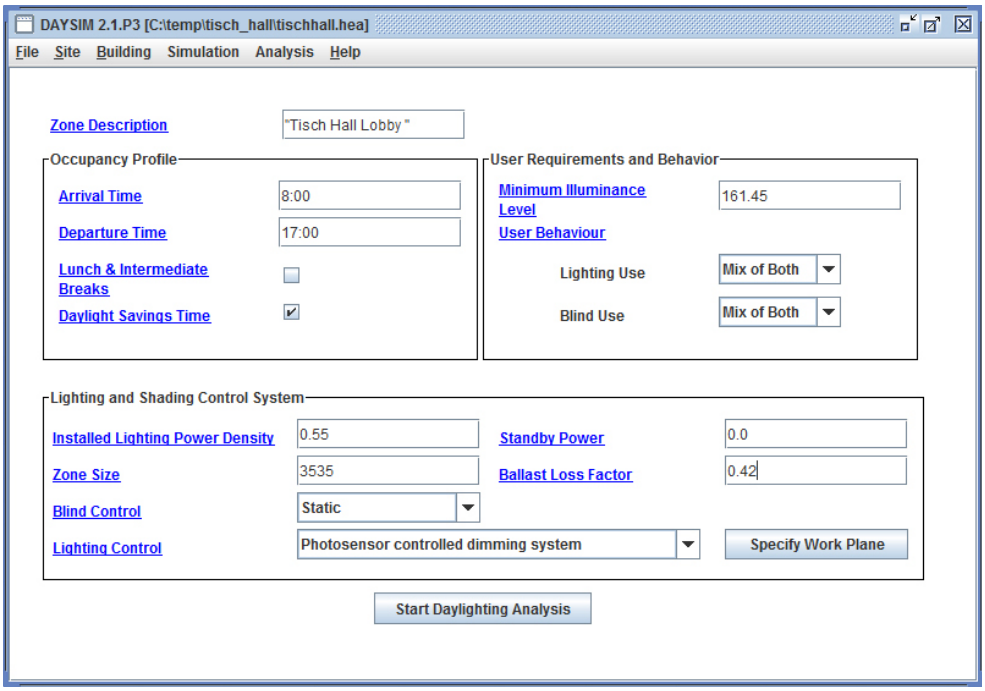


Daysim run 3 with all lights on for evening

Daylight Simulation



Daysim run 1 with all lights on



Daysim run 2 with zone 2 lights only

Photosensor Analysis

Daysim Simulations	Daylight Factor	Daylight Autonomy	Predicted annual electric lighting use (kWh/sq.ft)	Electric Lighting use (kWh)	Electric Lighting activated per year (hrs)	Maintain illuminance (fc)
Run#1: All Lighting on	31% of space 2% or higher	-	2.4	8647.3	2379	15
Run#2: Zone 2 on	31% of space 2% or higher	-	0.2	805.1	2379	15
Run#3: Evening Lighting	31% of space 2% or higher	-	2	6971.2	1828	15

Energy Savings with photosensor dimming (kWh)	7842.2
Con Edison Electricity Rate (kWh)- May 2008	$0.1274
Total money saved	$ 999

Overall, the proposed photosensor system helps the lobby save energy. Daylight conditions throughout the year provide enough illumination levels for the lobby. Only at certain times of the year, there are insufficient light levels at the corners of the lobby. The worst lighting condition in the lobby appears in March, during an overcast day. The critical point was determined with the march daylight condition. The required dimming level was 42%. By running three different simulations in daysim, the total energy savings can be calculated. The photosensor based daylighting system can help save 7842 kWh and $999.