

George Washington University School of Business and Public Management

Technical Report I
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Lighting / Electrical
Dr Moeck
October 5th 2005



The purpose of my first technical assignment is to evaluate the existing conditions within the new George Washington University School of Business and Public Management. Taking advantage of the rendering capabilities of AGI 32 and the plans and specifications provided for me by Smith Group, I have modeled a few of the more interesting spaces that I would like to examine for the possibility of redesign.

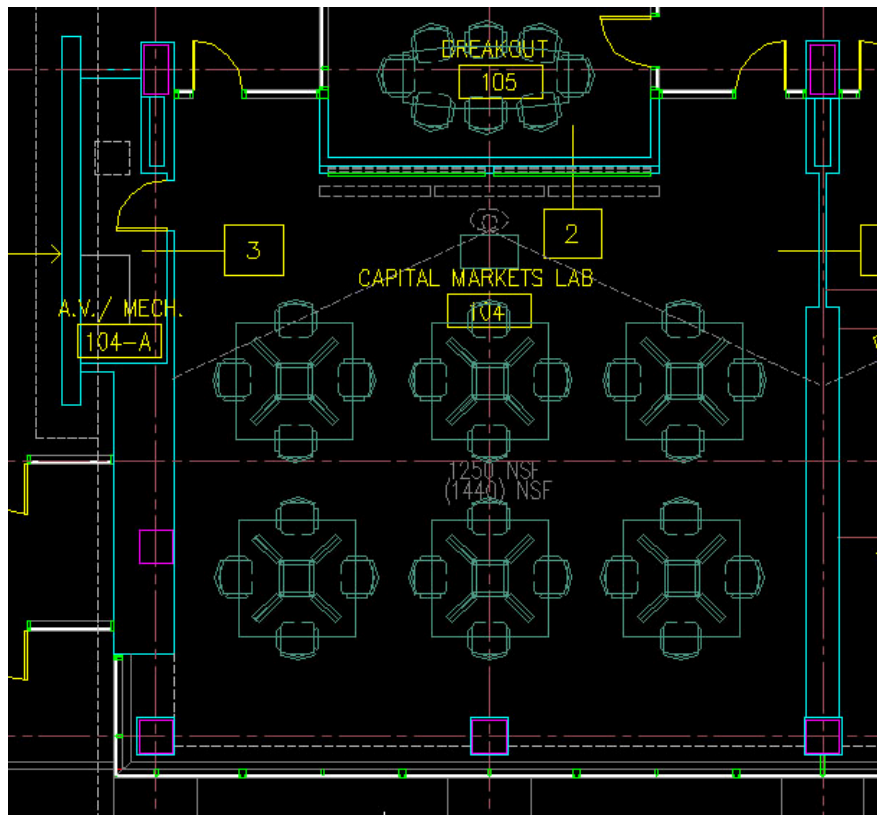
However, before I began my renderings of the existing spaces, I consulted the IESNA Lighting Handbook to determine lighting criteria for the various spaces. Using the handbook to help interpret “acceptable” lighting design, I created a standard for each space that I hoped to achieve as a lighting designer. With the building being a school, lots of variables needed to be considered in my standard, including important factors such as glare, VDT use, and lighting levels. Also taken into careful consideration were power densities, which were set according to ASHRAE 90.1 standards.

Basically, all the spaces adhere to the standards that have been set due to the IESNA Lighting Handbook, and all the spaces are acceptable to my standards as well. The few mistakes that were found will be adjusted according to the codes, and the other spaces that do not have issues dealing with code will be redesigned to accent the features that I have found to be important in my analysis of the spaces.

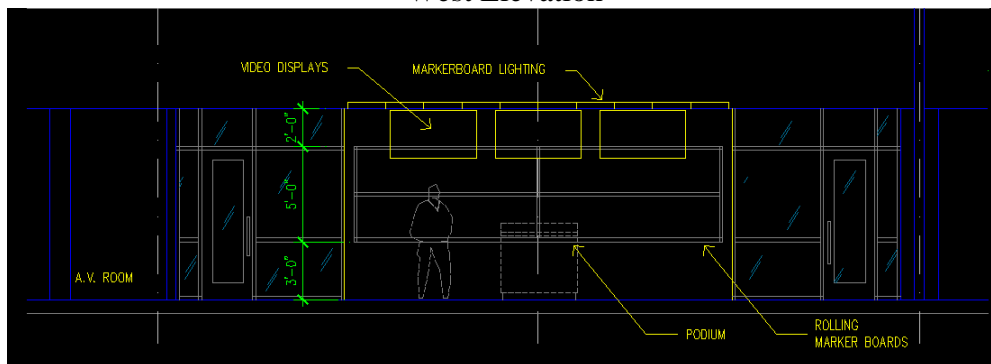
The criteria that I have set forth to be the standard I work in achieving with my design will not be etched in stone, and it is subject to change as I spend more time exploring the spaces. Having set forth my design criteria, I have taken the first step in my design by creating a standard I hope to implement.

Classroom – Capital Market Lab

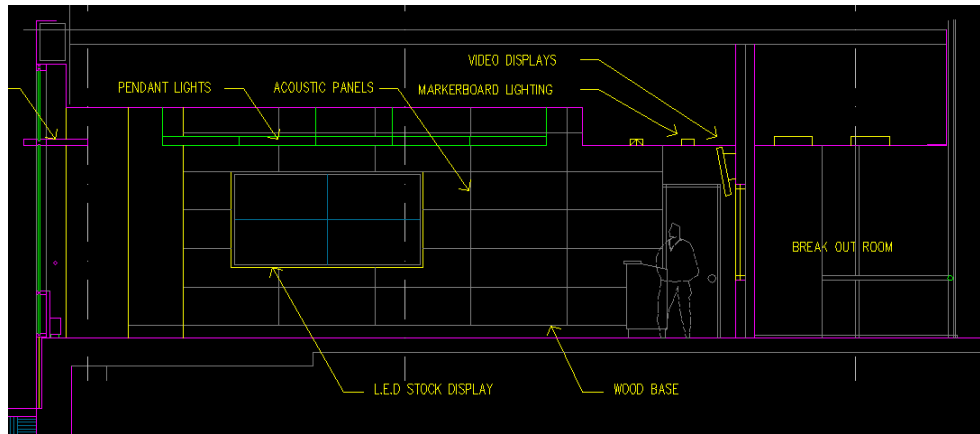
When designing systems for educational facilities, it is important to take into account the visual comfort of both the students and the instructors while also creating an environment that will be supportive to the learning process. To add complication, the addition of VDT use to any classroom or facility provides yet another accommodation to be accounted for. As important as it is to provide proper illuminance on the task planes, it is also imperative to create an environment that sets forth a proper psychological atmosphere. Creating a space that is dark and gloomy, constricted and confined will often inhibit the learning atmosphere, where a spacious and attractive space can support an atmosphere that is imperative to the academic space.



West Elevation



South Elevation

*Spatial Overview*

The Capital Market Lab seats 32 people. In the center of the classroom there are four sets of four desks set side to side so they face in the center. Along the three sides of the room that do not hold the black board are three rows of chairs, two rows with five seats and one row with six. There is one teacher's station on the north side of the room near the door.

In addition to the typical furniture, there are a few unique furnishings in the Capital Market. The room contains two LED screens that are meant to monitor stocks, and will help assist in the study of the stock market, which is the true purpose of the room. The room also contains a motorized project screen for projection and motorized blinds to help adjust the amount of daylight within the room.

Finishes

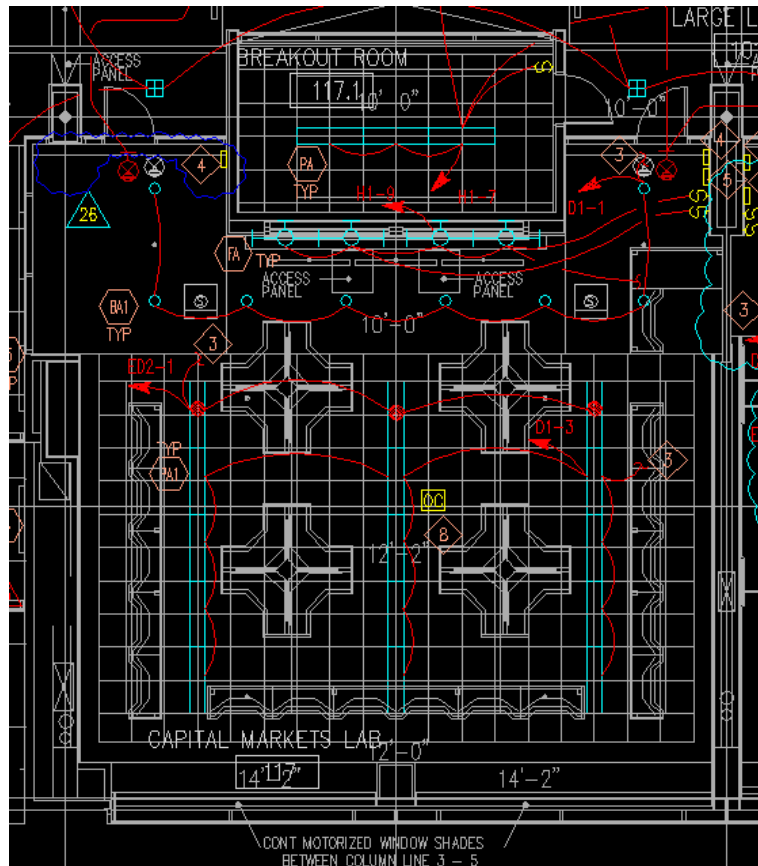
The floor of the capital market is clad in carpet designed for classroom use by Monterrey. It is a custom color from their knightswood line. This is an all loop small-scale texture that looks and feels like a fine woven carpet. Knightswood is eager and equipped to take on the toughest of environments. A custom color is being used, and the exact color is not available. The assumed reflection value is .25.

The base of the wall is stained to match maple wood, assumed reflectance is .40.

The wall has three different claddings. Paint from Benjamin Moore that is mixed to be an off white named Balboa Mist. Its assumed reflectance is .6. It also has acoustical wall panel made by Knoll Textile which has an assume reflectance of .6 as well. There are also wood claddings that are also stained as maple to match the floor board running around the room. This reflectance was also assumed to be approximately .6.

The ceiling is set at two separate heights and uses two separate systems. The lower portion of the ceiling is Gypsum wall board at it houses the recessed lights with an assume reflectance of .8. The other portion of the ceiling that has the indirect fixtures hung below it, is an acoustical ceiling tile. I assumed a .7 reflectance for this.

The exact window information is not available, so it was assumed to have a transmittance of .9 for all windows.



Luminaires

Type	Description	Lamp	No. Lamps	Ballast	Mounting	Voltage
BA	Compact Fluorescent Down Light	42W TRT	1	Elec.	Recessed	277
FA	Wall Wash for Chalkboard	54W T5HO	1	Dim	Wall	277
PA	Pendant Direct / Indirect	28W T5	3 / 4'	Dim	Pendant	277

Light Loss Factors

Type	BF	Cleaning	Maintenance	LLD	LDD	RSDD	LLF
BA	.95	12 Months clean	III	.85	.9	.95	.72
FA	.95	12 Months clean	V	.85	.88	.95	.71
PA	.95	12 Months clean	II	.85	.94	.93	.74

Controls

All class rooms have been provided with a six zone Lutron Grafik Eye system. The Lutron 3000 series allows the user to program up to 4 scenes with 6 zones, and can

be expanded to 16 scenes with 48 zones. The pre-programmable lighting scenes make changing lighting for different settings as easy as touching a button. Other advantages of the graphic eye includes the possibility of linking multiple Grafik Eyes together, 16 accessory controls for 24 control points, and build in infrared receiver/optional infrared wireless remote control.

In the Capital Market Lab there are two on and off switches at either entrance to the room, with the four zone control panel being located on the side where the teacher's station is. On the ceiling, is an occupancy sensor. The occupancy sensor shuts off the lights if no movement is detected after a programmed amount of time.

Power Density

$$BA - 8 \text{ luminaires} * 1 \text{ lamp} * 42 \text{ watts} = 336W$$

$$FA - 4 \text{ luminaires} * 1 \text{ lamp} * 52 \text{ watts} = 208W$$

$$PA - 15 \text{ luminaires} * 3 \text{ lamps} * 28 \text{ watts} = 1260W$$

$$\text{Total Wattage} = 1804W$$

$$\text{Area} = 1500 \text{ sq ft.}$$

$$\text{Wattage per square foot} = 1804/1500 = 1.2 \text{ W/sq ft.}$$

$$\text{ASHRAE 90.1 Standard} \rightarrow 1.4 \text{ to } 1.6 \text{ W/sq ft.}$$

The capital market meets the power per square foot requirements that are set up by ASHRAE standard 90.1. If VDT use was considered common and each desk was provided with a computer, an additional .35 W/sq ft. could be added onto the 1.6 W/sq ft. maximum value.

Design Considerations

Ratios

A classroom has a variety of visual tasks that should be accommodated when lighting systems are being designed. With primary tasks such as reading and writing, it is important to provide the user with enough light on the tasks plane; however, the user is not confronted with those simple tasks. The user must also be able to quickly adjust his sight to the blackboard or the professor, so the eyes must continually adjust and readjust their focus from the varying tasks. Because of these issues, proper illumination and illumination ratios are very important for the spaces in the classroom. It is important to maintain an illuminance level around the room of no greater than one third that of the black board and the surrounding areas.

Glare

Glare is very important in a space with reading and writing tasks, and in spaces that will have to accommodate VDT use. Blinds should be provided to scatter incoming daylight, and other systems such as a light shelf can be implemented to help reduce the amount of direct light that reaches the work plane. Highly specular surfaces and finishes should be used as little as possible as they add to the amount of directly reflected light. As specular finishes affect the glare on objects, color affects the specularity as well.

Certain colors reflect more light than others, and colors of high reflectance should be used carefully in such spaces. Just as too much light in a space can hinder visual comfort, the lack of light plays to the same affects. Placement of light should be done carefully to avoid the possibility of excessive shadows, particularly on task planes.

Reflectance

As mentioned in reference to glare, the reflectance of surfaces can have a very distinct affect on the light in the space. With the use of us indirect systems, and cove systems, using non specular matte materials that are highly reflective is very important as it gives a nice even distribution of light into the spaces. Though the floor should be as reflective as possible, it is important that the floor remains matte and provides ambient light. This ambient light can have a profound impact on the room.

Light Source

The light source selected for the room plays just as big of an impact on the space as the other topics that have already been mentioned. Often times, the choice of the wrong lamp will greatly impact the other topics. The lamp should provide good color rendering and be of the proper color temperature to provide light that is not too warm or too cool. Fluorescent lights provide the best all around package for a class room. These lights can be found in varying color temperatures and of different color rendering index. Fluorescent lights are also very easy to dim, and provide this as another way to control the light with in the space.

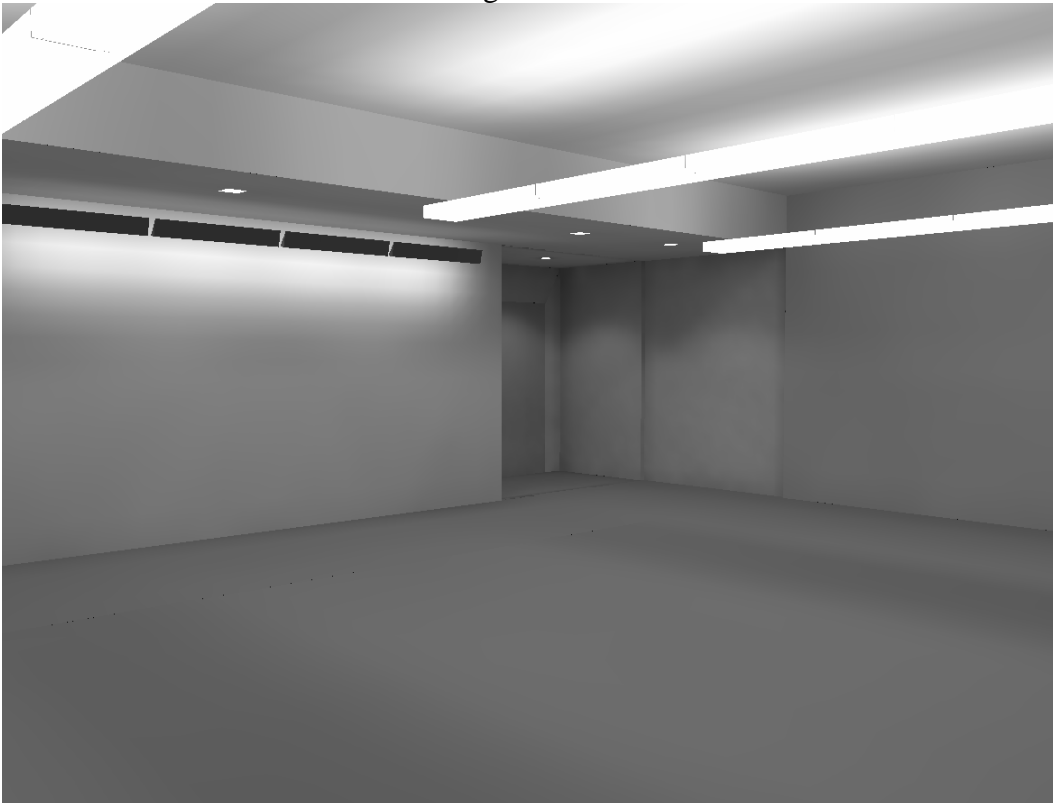
Lighting

In designing the lighting for a space such as the Capital Market, there were lots of considerations to keep in mind. In all technical sense and for its designed purpose, the Capital Market Lab is a classroom. However, its tasks and uses range beyond that of a simple classroom. The classroom is designed as a place for students to monitor stock, and explore the stock market in a more hands on environment. These extra tasks allow for special considerations and interpretations of the space.

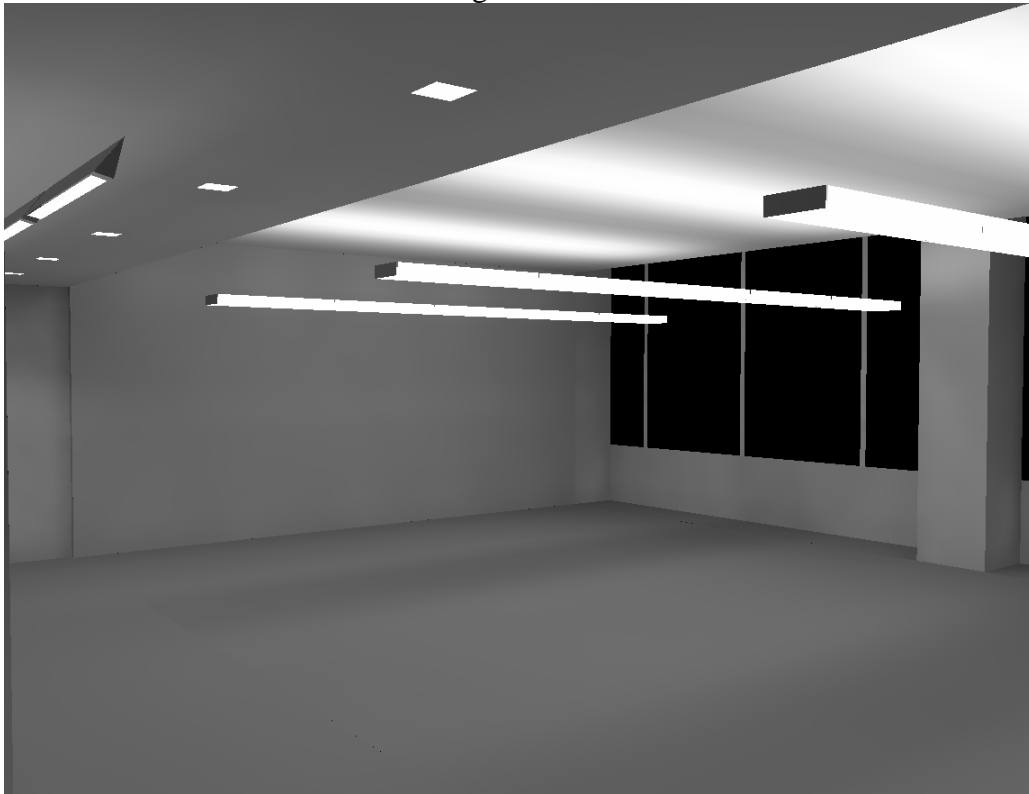
Like any classroom, the horizontal work plane is the most important surface in the room, and as the Capital Market is still a classroom, it is important to provide an illuminance level from 30 to 50 fc. The walls and vertical surfaces will play a very important roll in the use of the facility as well, and it is important that these surfaces provide numbers that are similar to the horizontal surfaces and never reach less than a third of their values.

The important design considerations are many of the issues that have already been described above. Reflectance, glare, luminance ratios are just a few of the items that must be accounted for in the design of this space. The importance of these different factors is magnified by the diverse needs of this room. The room requires VDT use, but it is also a classroom. It is a room where computers and writing tasks will take place, but it is also a lecture hall. The many different uses for this space require adaptability by the system, and the use of different lighting controls also becomes very important in the design of this space.

Rendering of Main Room



Rendering of Main Room



Calculation Plane at 2.5' off floor

25.6	30.2	33.1	35.7	37.1	37.4	38.2	39.5	39.2	39.4	40.1	39.9	39.3	39.3	37.9	35.1	31.3	25.5
24.4	29.5	33.4	35.6	37.5	38.1	38.8	39.8	39.9	40.0	40.3	39.7	39.5	38.9	37.2	34.6	30.3	24.7
23.3	29.2	33.3	34.9	37.8	38.9	39.6	40.3	40.8	40.8	40.6	39.9	39.4	38.6	36.7	34.1	29.9	24.0
23.3	29.2	33.6	36.4	38.7	39.7	40.5	41.6	41.7	41.7	41.6	40.7	40.0	39.0	36.8	34.1	29.8	24.1
24.1	30.1	34.7	37.5	40.0	41.1	41.9	42.9	43.0	43.1	42.9	41.9	41.3	40.1	37.7	35.0	30.5	24.7
24.8	30.7	35.3	38.1	40.6	41.8	42.6	43.6	43.7	43.7	43.5	42.6	41.9	40.7	38.3	35.5	30.9	25.1
24.7	30.5	35.1	37.9	40.4	41.6	42.3	43.3	43.4	43.4	43.3	42.3	41.6	40.5	38.0	35.2	30.7	24.9
24.0	29.7	34.1	36.8	39.2	40.3	41.1	42.0	42.2	42.2	42.0	41.0	40.3	39.2	36.9	34.2	29.7	24.0
22.5	27.9	32.1	34.7	36.9	37.9	38.6	39.6	39.8	39.8	39.5	38.5	37.9	36.8	34.7	32.1	27.9	22.6
20.3	25.1	28.9	31.3	33.2	34.2	34.9	35.9	36.1	36.0	35.7	34.7	34.0	33.1	31.3	28.9	25.2	20.3
17.4	21.3	24.3	26.3	27.9	28.9	29.7	30.8	31.2	30.9	30.3	29.3	28.7	27.9	26.3	24.3	21.3	17.4
14.0	16.6	18.8	20.3	21.6	22.4	23.2	24.8	26.2	24.6	23.7	22.9	22.3	21.6	20.3	18.8	16.6	14.0

Calculation Point on the Front Wall

41.2	59.4	66.4	67.4	67.0	69.2	70.1	69.0	67.7	69.5	70.1	68.7	66.9	67.6	65.5	66.1	65.8	
23.4	28.8	32.0	33.7	34.7	35.5	35.6	35.0	34.4	34.7	35.3	35.3	34.8	34.0	32.0	27.9	22.2	
20.5	20.7	22.5	25.1	27.1	28.0	27.2	25.7	24.0	24.4	26.1	27.4	27.7	26.4	24.1	22.2	21.0	
21.0	21.8	22.6	23.3	24.1	24.6	24.3	24.1	24.0	24.1	24.1	24.5	24.6	24.6	24.1	23.2	22.6	
20.9	21.3	21.9	22.4	22.6	22.7	23.0	23.1	23.0	23.1	23.2	23.2	23.3	23.3	23.1	22.7	22.4	
20.2	20.5	20.8	21.1	21.5	21.8	21.8	21.7	21.8	21.9	22.1	22.2	22.3	22.0	21.8	21.7	21.6	

Design Standards***New Lighting Design***

The existing lighting design for the Capital Market is acceptable by both IESNA and ASHRAE 90.1 standards. Light levels may appear low around the edges of the room, and there may be other quirks that do not seem up to standards, but the models, reflectances, and IES files that were used were not necessarily the same ones that were used and this information is subjective to interpretation. I assumed that the design would be more than adequate for this space, and the suggestions I make below are my opinions on how improvements could be made to this space.

The Lutron Grafik Eye allows for numerous lighting settings, as it should in a room that has so many different uses. The indirect light among the work space allows for a minimal amount of glare and provides a softer light around the majority of the room. This also cuts down on potential glare for the possibility of glare use. To enhance this particular part of the space I would hope to be able to add a direct component along with the indirect component. Indirect lighting can become dull and boring; where a bit of direct lighting will add more character to the space.

This space has a lot of window space along the south wall, but takes no advantage of any day lighting capabilities. The blinds are already motorized; it would not be difficult to add a daylight sensor that would be able to adjust the lighting levels along with the daylight. Adding day light to the space saves on energy costs, especially if the space is used primarily during the day time. With rising energy costs, and new day light technology, these additions will be easy to make to the space.

A nice addition to the space would be the addition of good facial rendering capabilities in the front of the classroom. With a classroom of these unique characteristics, adding the possibilities of video conferencing would be very valuable to such a space. Video cameras don't necessarily have to be added to the space, as it is very easy to run a camera from a simple computer, but having good facial rendering would add significantly to the quality of the room if video conferencing would be used. The business school itself would gain a higher level of accreditation and the room would gain more use for allowing for just a little more design.

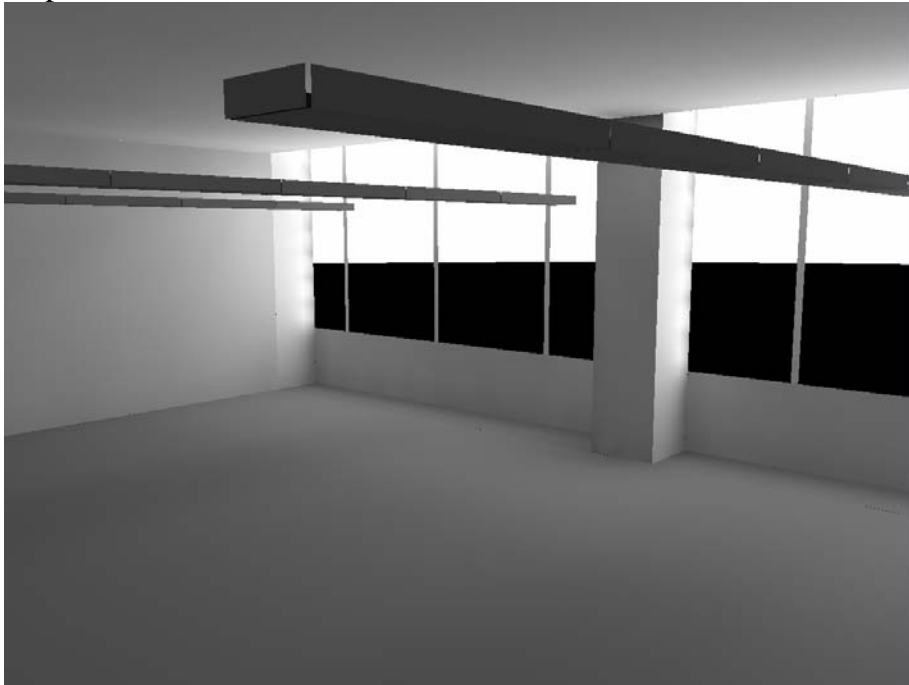
Daylighting
Washington DC → 38.9 Latitude, 77 Longitude

March 21st 10 am



111	119	127	135	145	152	159	165	173	172	175	175	174	170	167	161	156	149
128	135	145	154	164	172	179	185	191	194	197	197	197	194	192	186	180	173
143	153	163	175	185	195	202	208	214	218	222	224	224	222	217	213	207	199
160	173	186	199	211	222	231	237	243	248	252	255	255	253	250	247	241	232
184	199	214	229	244	257	266	273	279	285	290	293	293	292	292	289	284	274
216	231	249	268	286	300	310	317	324	329	333	337	340	343	345	345	339	328
248	269	292	316	339	355	365	370	376	381	384	388	394	402	410	415	412	401
286	314	345	376	403	423	431	431	433	434	435	443	458	471	489	502	510	503
328	369	412	452	5144	5164	5168	5159	5153	5143	484	499	525	554	542	5272	5304	5343
378	436	496	5205	5244	5268	5267	5235	5209	528	533	563	606	5309	5352	5406	5487	5648
433	522	5258	5317	5358	729	5385	5315	5235	534	572	638	5355	5407	5466	5540	5664	5901
500	5286	5363	5411	807	5519	5560	5426	460	506	629	5379	5440	5491	5547	5642	5792	6050

March 21st 1pm



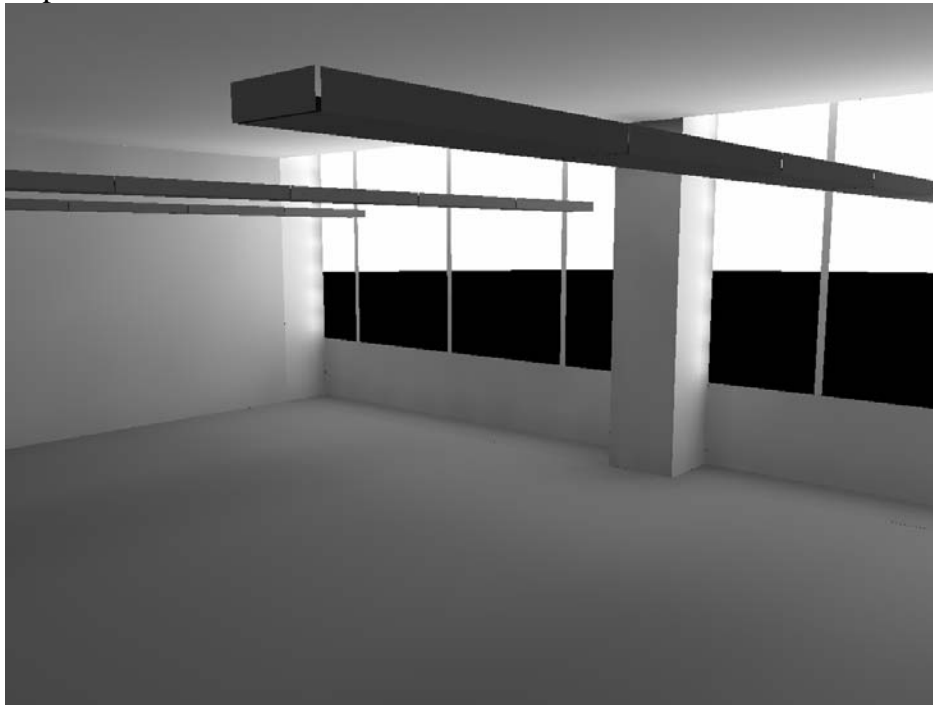
51.9	55.3	57.9	60.4	63.7	65.5	67.6	68.9	71.4	70.1	70.7	69.5	68.6	66.6	65.1	62.9	60.8	58.8
59.4	62.1	65.7	68.2	70.9	73.3	75.1	76.4	78.0	78.0	78.2	77.7	76.7	74.7	74.0	71.1	68.8	66.7
66.8	70.3	73.6	76.5	79.2	81.3	83.6	84.9	86.8	86.6	86.9	86.6	85.6	84.0	81.9	79.8	77.5	75.0
74.6	79.0	83.0	86.5	89.1	91.5	93.8	95.1	96.1	97.1	97.3	97.3	96.3	94.0	92.2	90.4	87.8	84.9
84.9	90.3	94.6	97.8	101	103	106	108	108	110	110	110	109	107	105	103	100	97.6
99.8	105	109	113	117	119	122	124	125	126	127	127	126	125	123	120	117	113
116	123	128	133	137	140	142	144	145	147	148	148	148	146	144	141	138	133
136	145	152	157	162	166	168	169	170	171	173	174	175	172	171	168	165	159
160	174	183	189	195	197	199	199	198	199	201	203	205	206	206	204	199	191
191	209	223	232	238	239	237	233	229	230	235	240	245	249	249	248	245	232
227	254	273	285	291	289	283	269	265	256	268	281	291	298	303	302	297	282
269	311	334	347	355	353	343	298	216	258	298	329	348	357	361	366	358	342

June 21st 10 am



107	115	122	128	135	141	145	148	154	152	152	150	148	144	140	134	129	123
124	132	140	147	153	160	163	166	170	170	171	170	167	163	160	154	148	141
141	151	159	167	175	180	185	187	190	192	193	192	190	187	181	176	169	161
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187	202	214	224	232	239	244	246	248	250	252	252	251	247	242	236	229	217
225	240	252	264	273	279	283	285	288	290	292	293	293	291	286	280	270	257
267	287	301	315	325	332	335	334	335	338	341	345	346	345	341	335	325	309
317	344	364	379	389	396	396	392	390	391	398	405	415	412	411	404	394	374
380	416	444	461	474	476	470	459	450	449	461	476	490	496	498	495	483	459
461	508	543	564	576	577	562	534	505	510	538	567	587	600	604	607	602	580
555	6951	6992	7016	7027	7025	7001	6940	534	561	6953	7001	7030	7045	7056	7064	7073	7085
6984	7074	7104	7124	7146	7150	811	7020	431	606	7051	7107	7140	7152	7159	7187	7212	7260

June 21st 1 pm



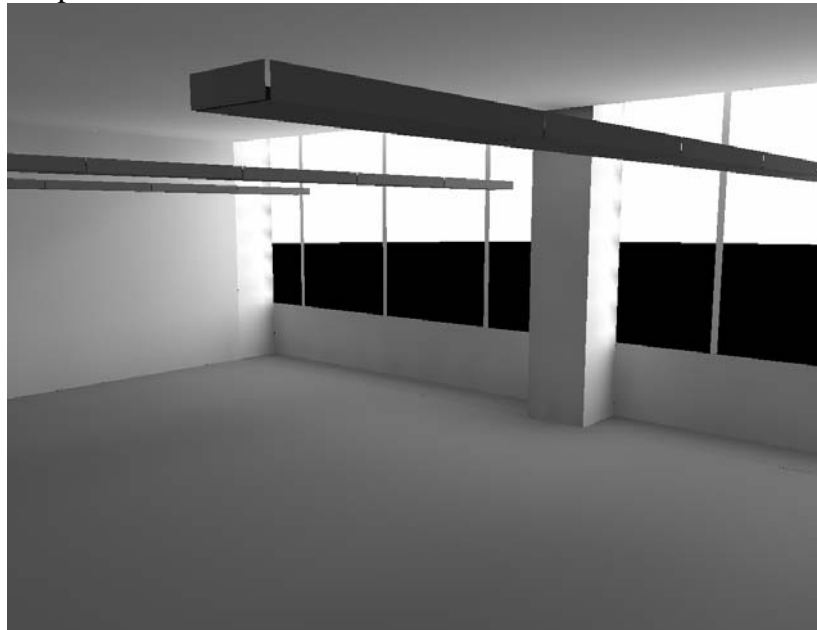
59.4	62.4	65.3	68.0	71.5	73.6	76.0	77.2	79.7	78.5	78.9	77.3	76.1	73.8	72.0	69.5	66.7	64.0
67.1	70.4	74.2	77.0	80.0	82.6	84.4	85.8	87.4	87.4	87.3	86.7	85.1	82.8	81.6	78.3	75.5	72.3
75.5	79.6	83.3	86.5	89.3	91.7	93.9	95.1	96.0	96.8	96.9	96.4	94.9	93.1	90.4	87.9	84.9	81.2
84.5	89.6	93.8	97.8	100	103	105	106	107	108	108	108	106	104	101	99.2	95.8	91.7
96.3	102	107	110	114	116	119	121	121	122	122	122	120	118	116	113	109	104
113	119	124	128	131	134	136	138	139	140	140	140	139	137	134	131	127	121
132	141	146	150	154	157	159	160	161	162	163	164	163	160	158	154	149	142
156	167	174	178	182	185	186	186	187	188	190	192	193	190	188	183	178	168
185	200	210	215	219	220	219	218	217	219	223	225	228	228	226	222	214	201
223	243	256	263	267	265	260	254	250	253	261	269	274	277	275	270	262	244
269	298	315	324	325	320	309	291	276	285	304	320	330	334	336	331	319	297
324	366	384	393	396	389	370	317	233	305	353	383	398	402	402	402	388	361

December 21st 10 am



98.6	92.9	97.5	93.4	100	106	112	119	128	131	137	140	143	143	142	140	137	132
99.0	92.8	98.4	104	111	118	125	132	139	146	153	158	162	163	166	162	158	154
			+					+						+			
98.1	103	109	116	124	131	139	147	155	165	173	180	184	187	187	186	183	179
108	115	122	131	139	148	157	165	175	187	197	205	211	214	217	218	215	211
			+					+						+			
122	130	139	148	159	169	179	189	200	213	225	236	243	249	255	258	257	252
142	150	160	172	184	196	207	218	231	245	259	272	283	295	304	312	315	307
			+					+						+			
162	173	186	201	218	232	243	254	267	283	299	314	335	357	382	412	403	407
185	200	218	239	260	278	299	297	309	324	338	353	374	397	421	456	441	449
			+					+						+			
210	233	259	288	317	338	349	349	335	334	345	360	379	403	434	490	512	493
241	273	312	354	392	421	447	434	427	428	438	456	468	524	600	709	711	670
			+					+						+			
274	324	381	437	486	552	561	499	458	435	447	461	518	590	713	839	833	831
313	393	465	552	612	678	741	807	882	951	1021	1093	1207	1280	1769	2906	3106	3409

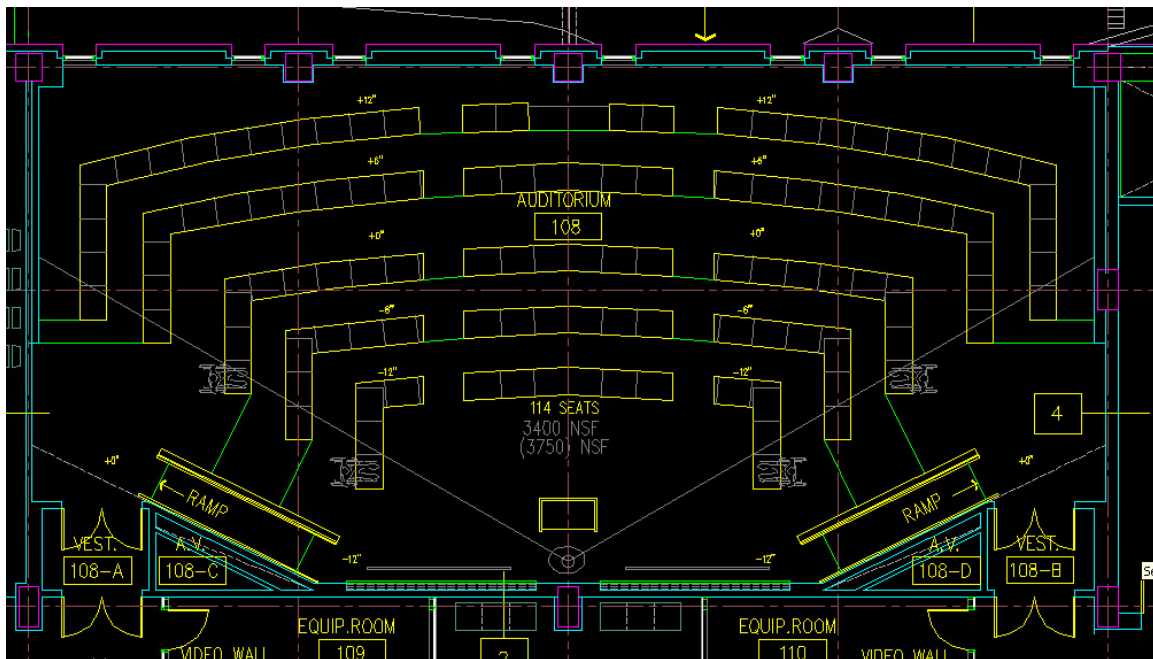
December 21st 1 pm



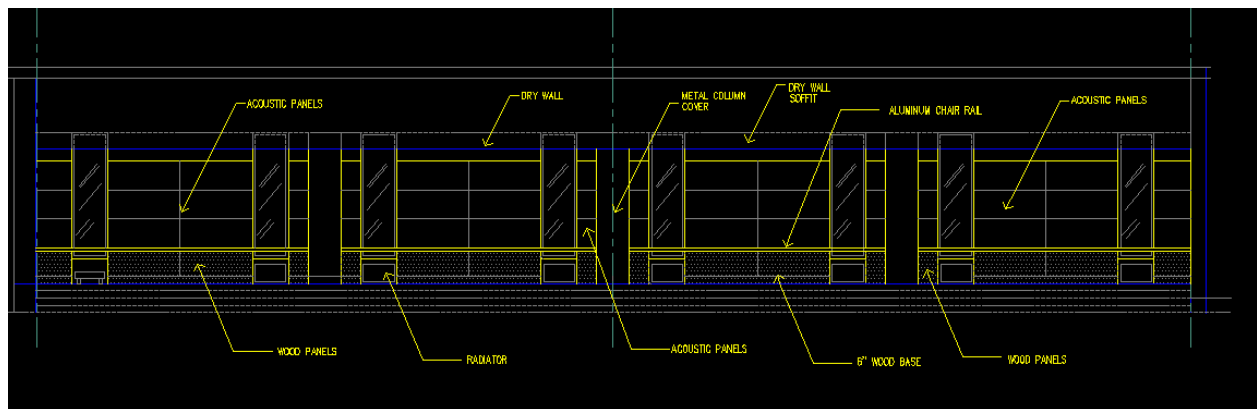
39.0	41.1	42.7	44.5	46.9	48.3	50.0	51.2	53.2	51.9	52.3	51.6	51.0	49.7	48.7	47.3	46.0	45.0
44.4	45.9	48.2	50.2	52.1	53.9	55.4	56.3	57.8	57.6	57.8	57.5	57.0	55.5	55.5	53.3	51.8	51.0
49.8	51.8	54.0	56.2	58.2	59.7	61.6	62.7	63.5	64.1	64.4	64.2	63.6	62.5	61.2	59.8	58.4	57.4
55.8	58.3	60.9	63.6	65.6	67.4	69.3	70.5	71.3	72.2	72.4	72.5	71.8	70.1	69.1	68.0	66.4	65.3
63.5	66.8	69.6	71.9	74.7	76.5	79.3	81.0	81.3	82.2	82.7	82.8	81.8	80.5	79.3	77.9	76.5	75.4
74.8	78.0	81.0	83.7	86.5	88.7	90.9	92.8	94.4	95.2	95.8	95.8	95.3	94.6	92.9	91.4	89.5	87.6
87.3	91.4	94.6	96.2	101	104	106	108	109	111	112	112	111	110	109	107	105	104
102	107	112	115	119	123	125	127	128	130	131	131	132	130	129	128	126	123
119	128	134	139	143	146	148	150	150	151	152	153	154	156	156	154	152	148
142	153	162	169	174	177	176	175	174	174	178	180	184	187	187	187	186	179
167	185	199	208	213	212	209	201	194	194	201	209	215	220	225	226	223	216
197	225	242	253	260	260	253	218	160	189	216	238	253	261	266	272	268	260

Auditorium Lighting

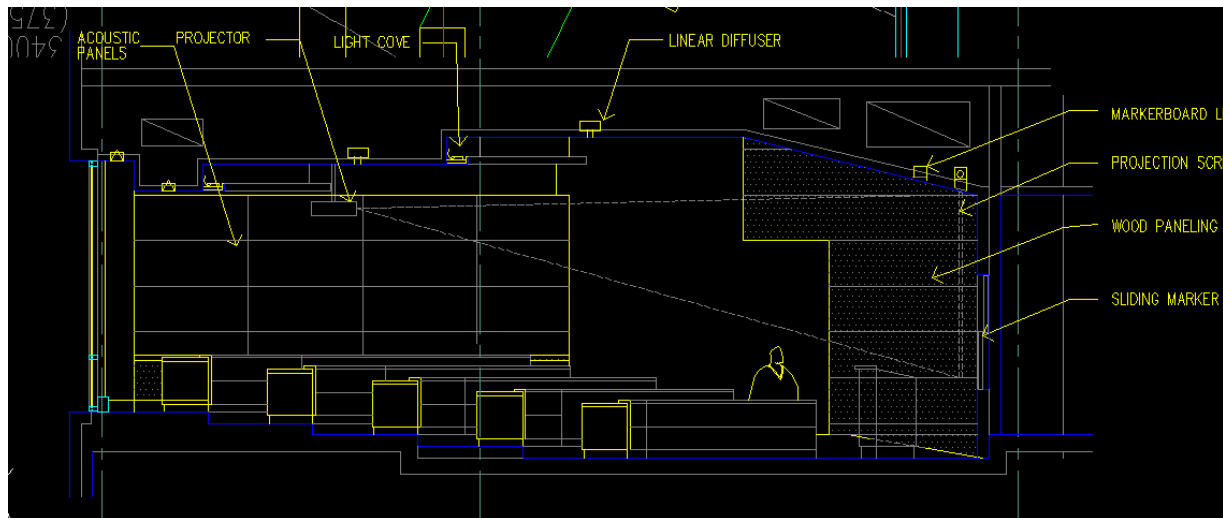
The auditorium is an important room, and needs to be designed with many different scenarios in mind. Such as space can be as simple as a normal classroom while also being a space where more important presentations can be held. Situations need to be set up to deal with presentations that focus on proper lighting in the front of the classroom, while a normal classroom setting would need to focus on lighting for the normal classroom space. If the design is set up properly, the room could be a room used for video conferencing. Because of its multipurpose functionality, the room becomes very important, and the lighting needs to become adaptive to the numerous scenarios that can take place.



West Elevation



Section View

*Spatial Overview*

The auditorium seats 114 people. The desks are set up in stadium seating with a line of seats down the center with seats set up in an “L” on either side of the room. There is a speakers podium in the center of the room.

As mentioned in the classroom space, the auditorium also has a motorized blackboard to adjust the board as needed. This room has much smaller window space, but it still has motorized blinds to allow for easy adjustment.

Finishes

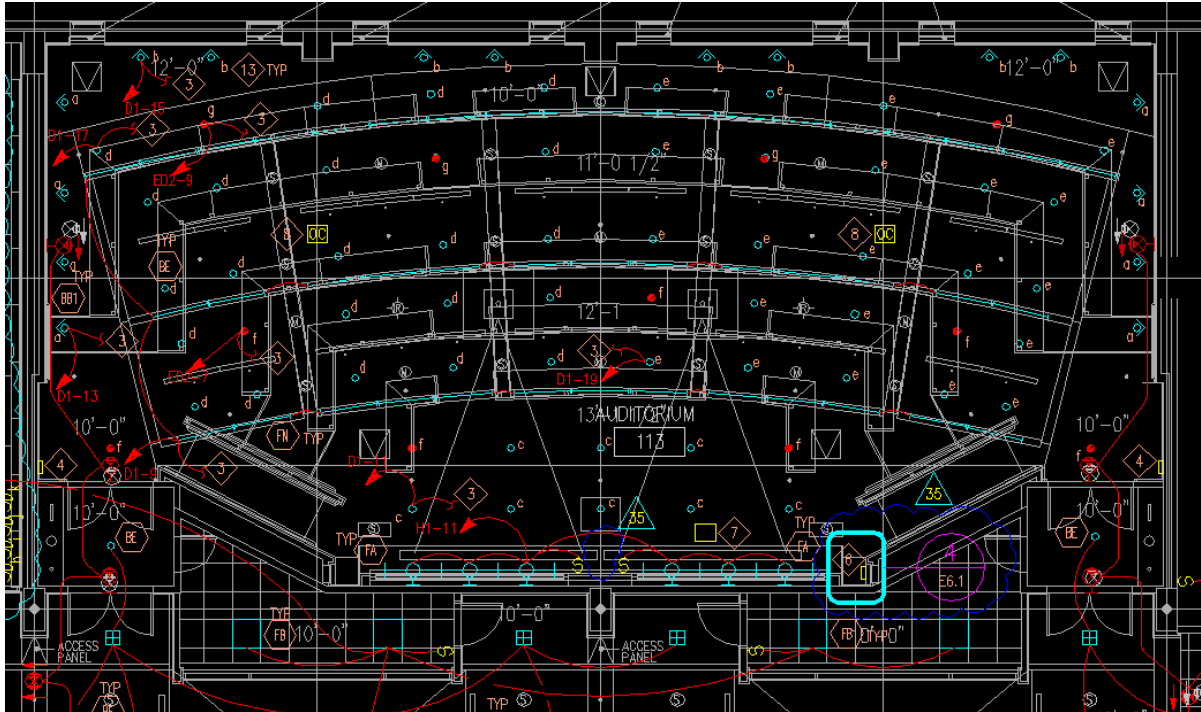
The floor of the auditorium is very similar to the floor with in the capital market. It needs a sturdy carpet for typical wear and tear, and uses the same type of carpet found in the classroom. It’s the same custom color Knightswood carpet mentioned above. It is also an assume reflectance of .25

The base of the wall is stained to match maple wood, assumed reflectance is .40.

The capital market is designed to appear much nicer because of it’s importance as a presentation room. The room has sections of wall which are painted with paint from Benjamin Moore, and are the same color of mixed white used in the capital market classroom, Balboa Mist. The assumed reflectance for the paint is .6. They also have the same acoustical wall panel used in the classroom, with an assumed reflectance of .6. The wall also has plain sliced maple stained to match the maple wood floor board. The assumed reflectance for the wood is .6.

The ceiling is designed so that it contains no acoustical panel. It is made up of all gypsum wall board with coves to allow for indirect light. The assumed reflectance for the wall board is .8.

The exact window information is not available, so it was assumed to have a transmittance of .9 for all windows.



Luminaires

Type	Description	Lamp	No. Lamps	Ballast	Mounting	Voltage
BE	Compact Fluorescent Downlight	32W	2	Elec.	Recessed	277
FA	Wall Wash for Chalkboard	54W T5HO	1	Dim	Wall	277
F1	4' Fluorescent Strip Light	32W T8	2	Dim	Surface	277

Light Loss Factors

Type	BF	Cleaning	Maintenance	LLD	LDD	RSDD	LLF
BE	.95	12 Months clean	III	.85	.9	.95	.72
FA	.95	12 Months clean	V	.85	.88	.95	.71
F1	.95	12 Months clean	III	.85	.9	.95	.72

Controls

The auditorium makes use of the same Lutron Grafik Eye system mentioned above. See the Capital Market Control Section for more details on the the Grafik Eye. In the auditorium, the controls are located at the entrances to the rooms by the doors. For this room, two 4 zone panels are placed at the entrance to either door, with a single 8 zone control panel being located at the center of the room.

To help control the lighting system in the rooms, occupancy sensors have been provided in this space. The occupancy sensors help by turning off lights if they are left

on in an unoccupied room. In the auditorium the two occupancy sensors are run to a single sensor interface above the ceiling near the front of the room.

Power Density

BE – 68 luminaires * 2 lamps * 32W = 4352 W

FE – 44 luminaires * 2 lamps * 32 W = 2816 W

F1 – 6 luminaires * 1 lamp * 54 W = 324 W

Total Wattage = 7492 W

Area = 3000 sq ft

Wattage per square foot = $7492 / 3000 = 2.5 \text{ W / sq ft}$

ASHRAE 90.1 Standard → .9 to 3.2 W/sq ft.

For an audience seating area the recommended wattage per square foot has a large range. The auditorium in the new business school falls within the designated standard. There are few times when all the lights are going to be on in this space, so it will seldom use that much wattage at once.

Design Criteria

Ratios, Glare, Reflectance, Light Source,

The above issues are the important considerations to keep in mind when designing for a space such as the auditorium. However, the above criteria have already been discussed in the Capital market section. Because they are both classrooms, the design must have the same general principles behind it, and planned to design both rooms under those criteria.

Lighting

Larger lecture halls and auditoriums create a unique difficulty in designing a lighting system. Lecture halls must be able to satisfy two different situations, a general lighting system that provides higher level illuminances for note taking, and a much lower level for film projection and lecture. Direct lighting should be applied at approximately a 45 degree angle off the horizontal and vertical. This provides good facial rendering for the speaker while minimizing glare and adding possibilities for video conferencing.

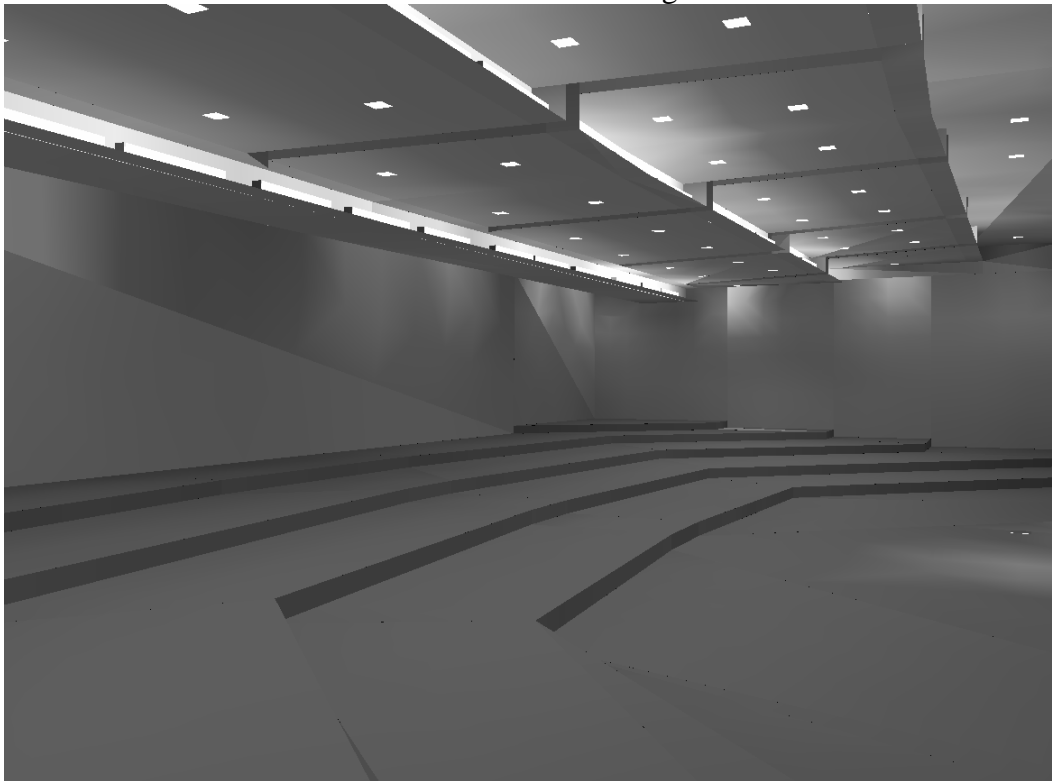
The design criteria for the auditorium share many of the same criteria as the Capital Market Lab. The Auditorium is still a classroom; it is just designed for a much larger number of occupants. Although it is a classroom, it has to account for a variety of different tasks that are not found in your typical classroom. It is very important to provide the light on the task plane while also providing lighting that will be beneficial to presentation format.

Like any classroom, the horizontal work plane is the most important surface in the room, and for all extensive purpose the auditorium must act as a large classroom, it is important to provide an illuminance level from 30 to 50 fc. The walls and vertical surfaces, particularly the front wall, will play a very important role in the use of the facility as well, and it is important that these surfaces provide numbers that are similar to

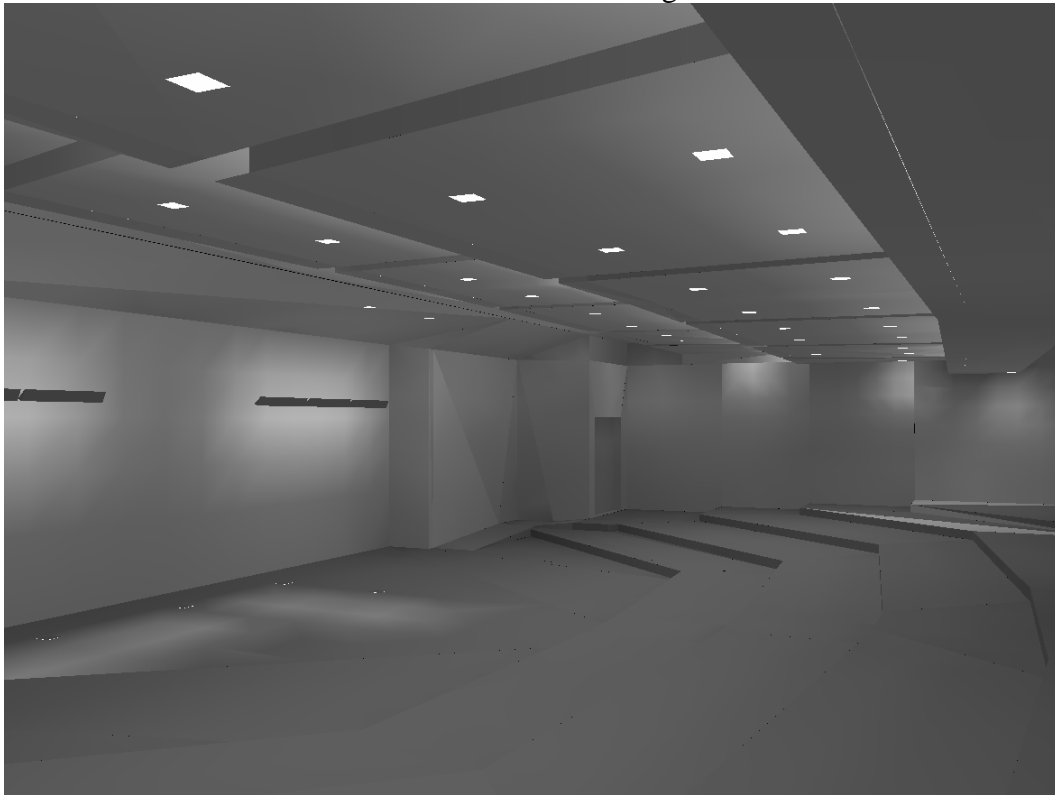
the horizontal surfaces and never reach less than a third of their values. It is also important to be able to supply varying light levels on the walls to create different atmospheres for varying situations.

For the auditorium, most of the important design issues are the same as the design issues mentioned for the Capital Market Lab. It is important to create an adapting space that will meet the criteria mentioned above.

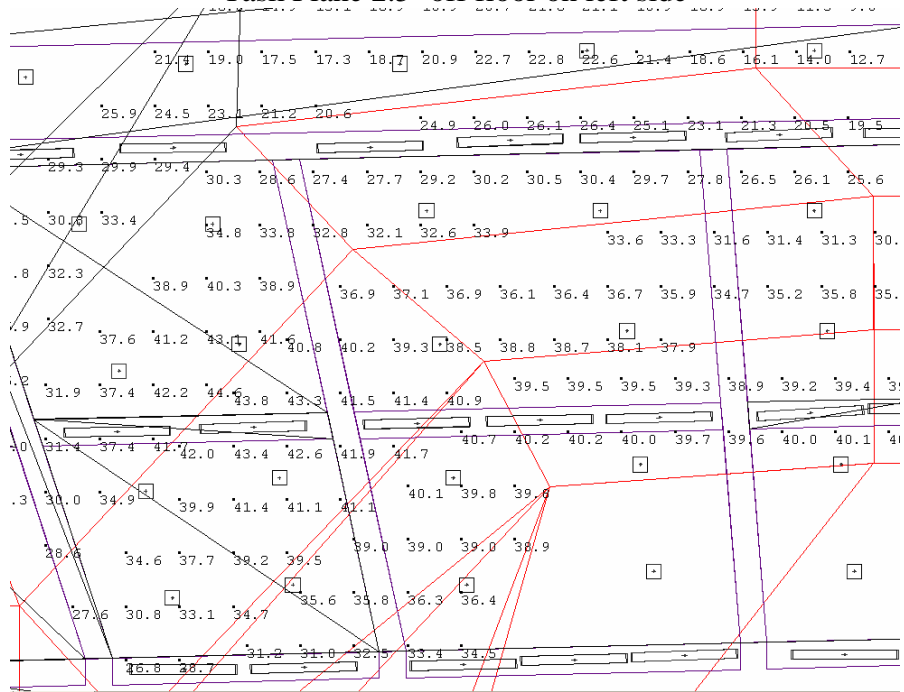
Auditorium Rendering



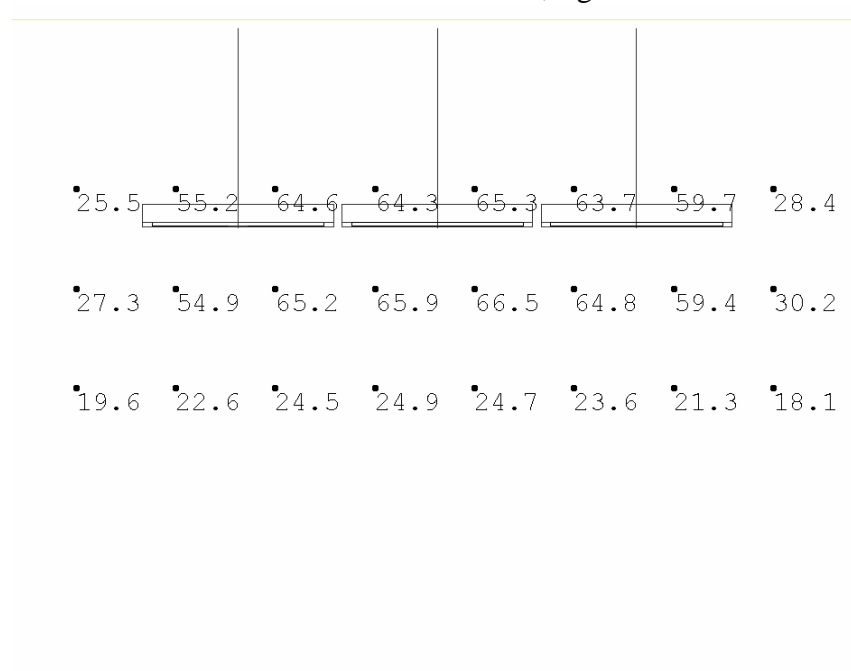
Auditorium Rendering



Task Plane 2.5' off floor on left side



Calc Plane on Front Board, right side

***Design Standards******New Lighting Design***

The existing lighting design for the Auditorium is acceptable by both IESNA and ASHRAE 90.1 standards. As I mentioned previously, some levels may not seem to be up to standard and there may be few other minor issues, but the models, reflectances, and IES files that were used were not necessarily the same ones that were used by the designer and this information is subjective to my interpretation. I assumed that the design would be more than adequate for this space, and the suggestions I make below are my opinions on how improvements could be made to this space.

There is a nice mixture of indirect and direct light with added wall wash to highlight the room. With these three types of lighting, it is easy to mix and match the systems using the Lutron system to create different atmospheres with in the room. To enhance this space I would like to see a direct fixture in the ceiling that would greatly decrease the number of luminaries needed. This is not an issue due to power density, but a visual aspect. Also, the spacing of the wall washers is inherent to the creation of scallops. Finding more of a strip source, or possibly finding a way to create cove lighting on the walls could add a more interesting degree to this space.

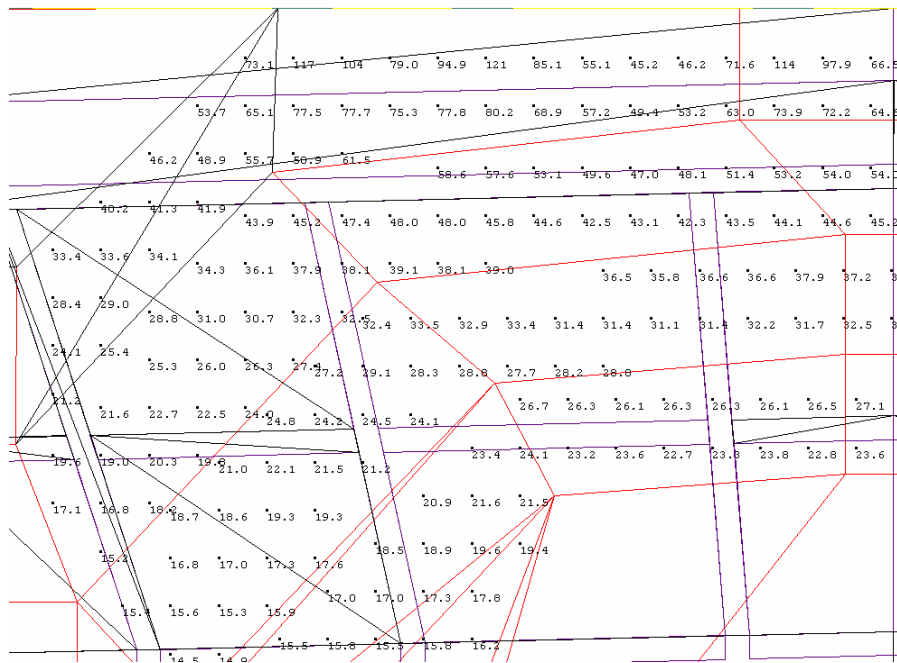
This Auditorium is not very adaptive to day lighting because of its lack of window space. An Auditorium is a space that commonly uses presentation type material, and direct glare coming from the back of the room will not necessarily benefit the space. However daylight can be manipulated and redirected at the window, and even though there are only a few windows, the light can be used to decrease the amount of direct lighting needed as mentioned in the capital market section.

A great addition to this space, as in the Capital Market Lab, would be the addition of facial rendering lights to allow for video conferencing. The advantages of video conferencing have already been discussed in the previous section.

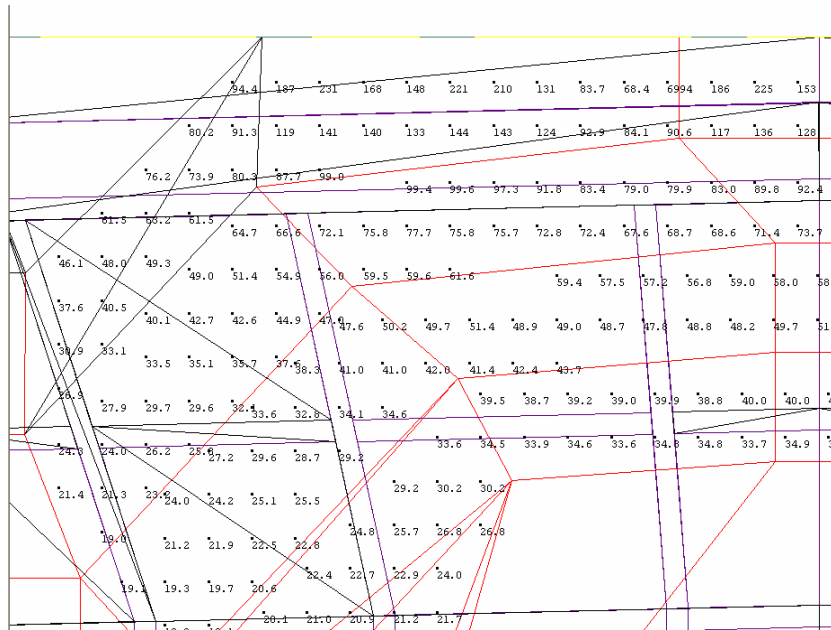
Daylighting

Washington DC → 38.9 Latitude, 77 Longitude

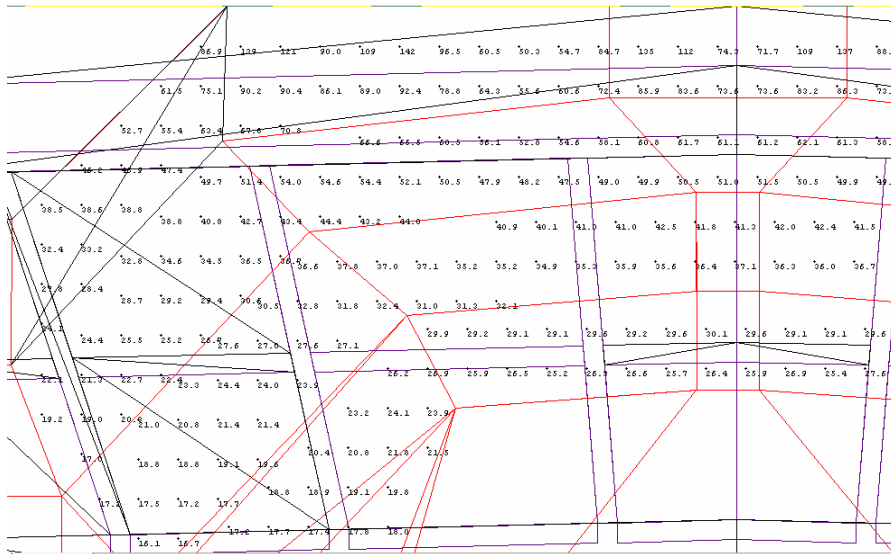
March 21st 10 am



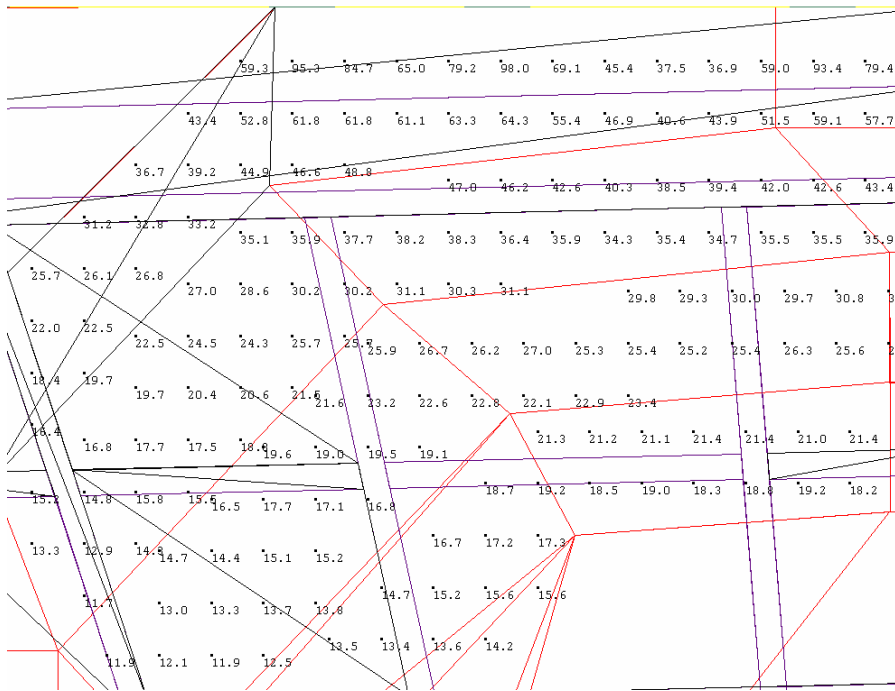
March 21st 1 pm



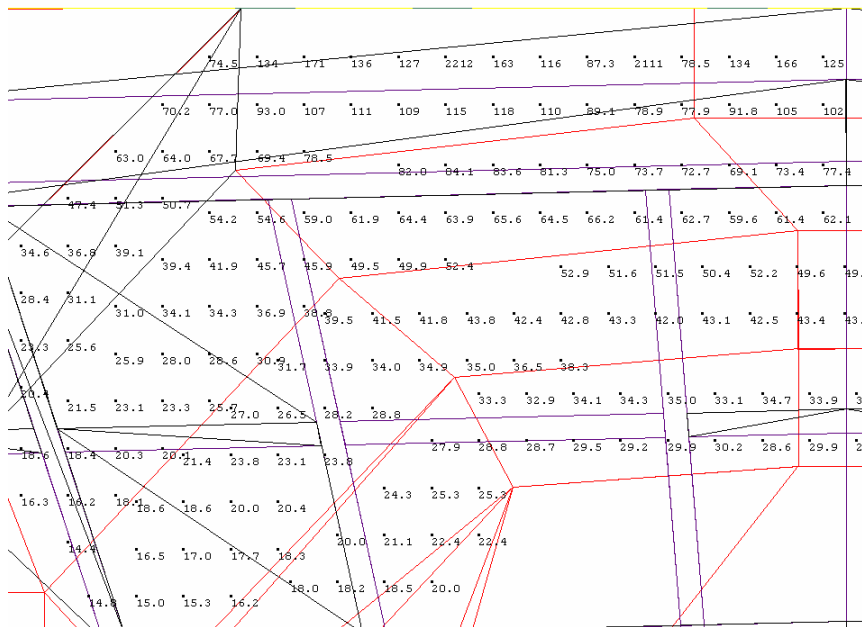
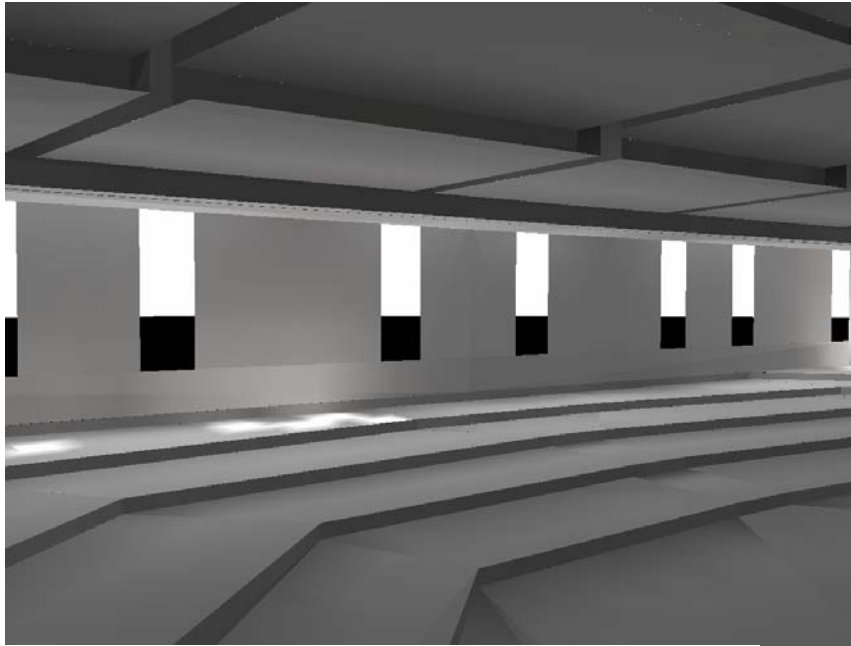
June 21st 10 am



December 21st 10 am



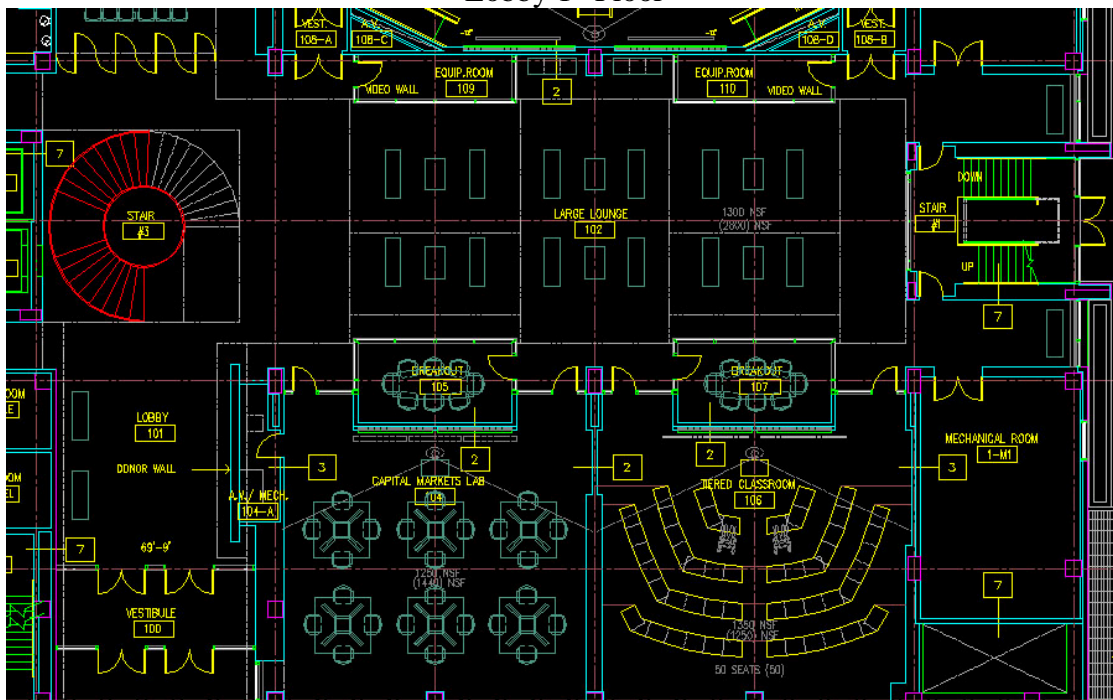
December 21st 1 pm



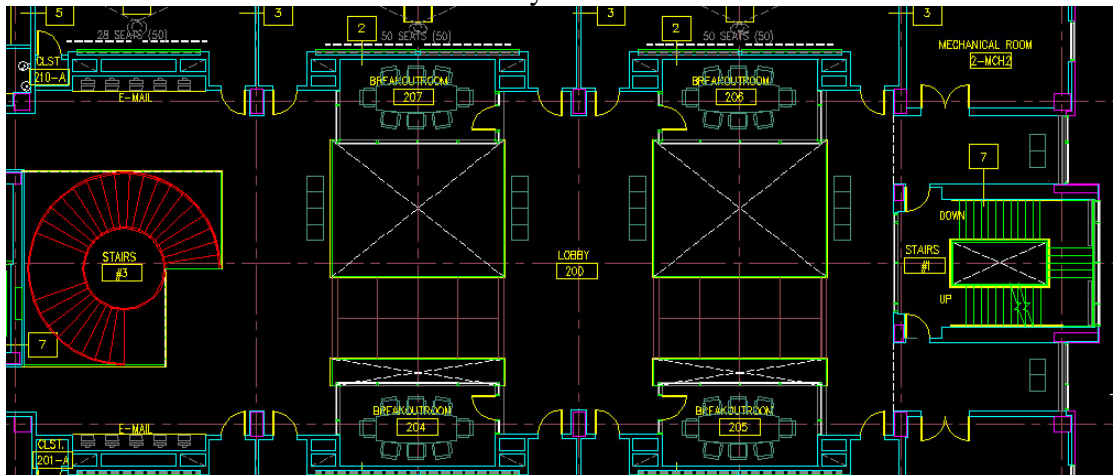
Lobby

The lobby and student lounge is a transition space for students entering and leaving the building. It's an important part of the building because of its purpose as a transition space. One of the main stairwells is accessible from this space, and the main entrance leads directly to a stairwell that goes to the second floor. This portion of the building is valuable as a meeting place for groups and students entering the building, and connects to the more important parts of the building. The second floor of the lobby acts as a transition space and connects to the classrooms and breakout rooms on the second floor. The space adds dynamic to the space and a diversity that is not found throughout the rest of the building.

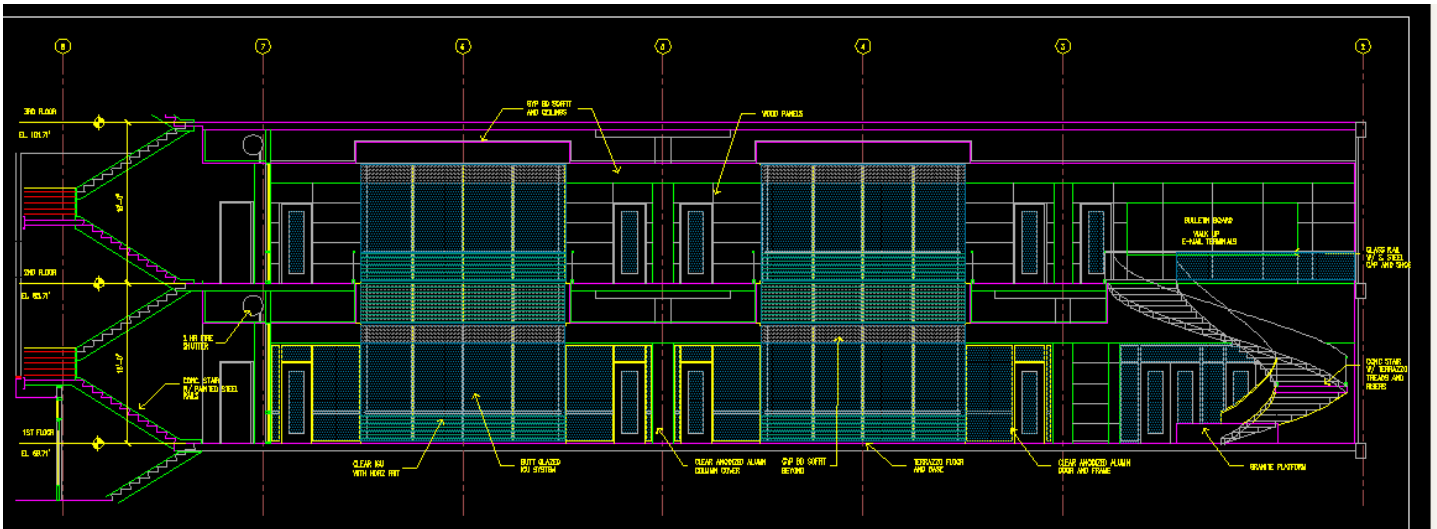
Lobby 1st Floor



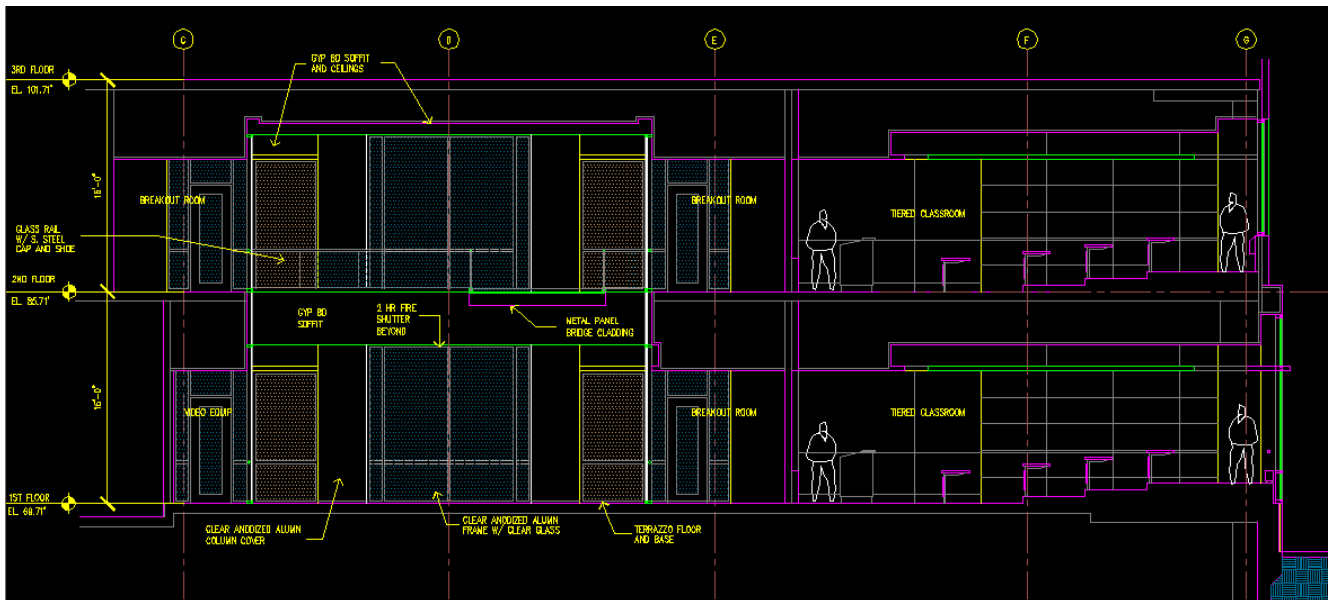
Lobby 2nd Floor



East Elevation



North Elevation



Spatial Overview

Because it is designed as a transition space, there are a few furnishings in this area for students entering or exiting the building, students waiting for class to start, and students who want a study space. Couches and end tables (B-1 and T-1) are spread through the center of the lounge area to give students a comfortable place to wait. Also, the breakout rooms which are a direct off shoot of the lounge contain a large table and chairs that can act as a quiet meeting place for small groups. The continuation of the lounge on the second floor opens to the space below so there is not room for the couches

and end tables, but rows of chairs are set along the openings to below. The break out rooms on the second floor contains the same furniture.

Finishes

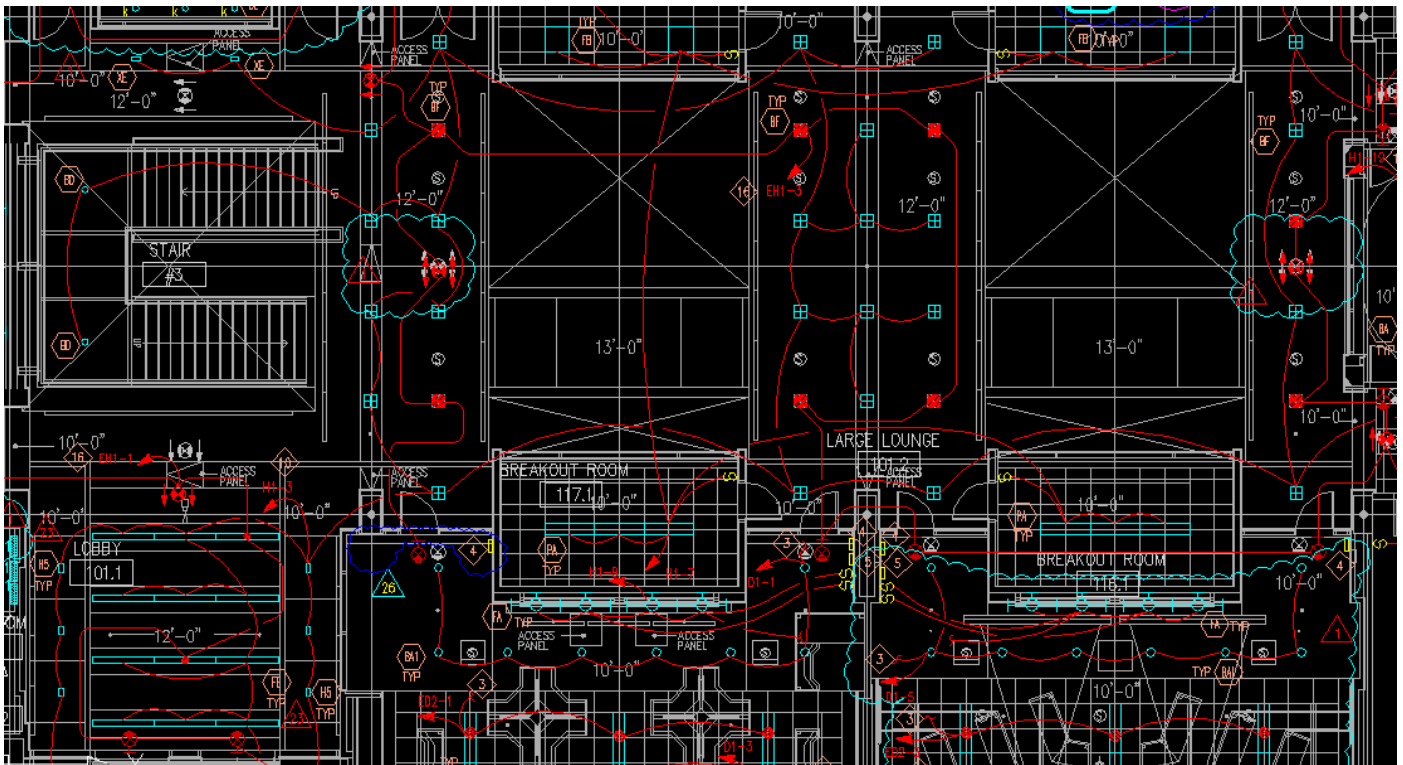
The lobby and lounge area have a variety of finishes throughout their entirety. The floors of the majority of the area are covered with terracotta tile. They are roman mosaic tiles of colors varying from black/white, to grey/white, to black. The assumed reflectance was .3 for these floors.

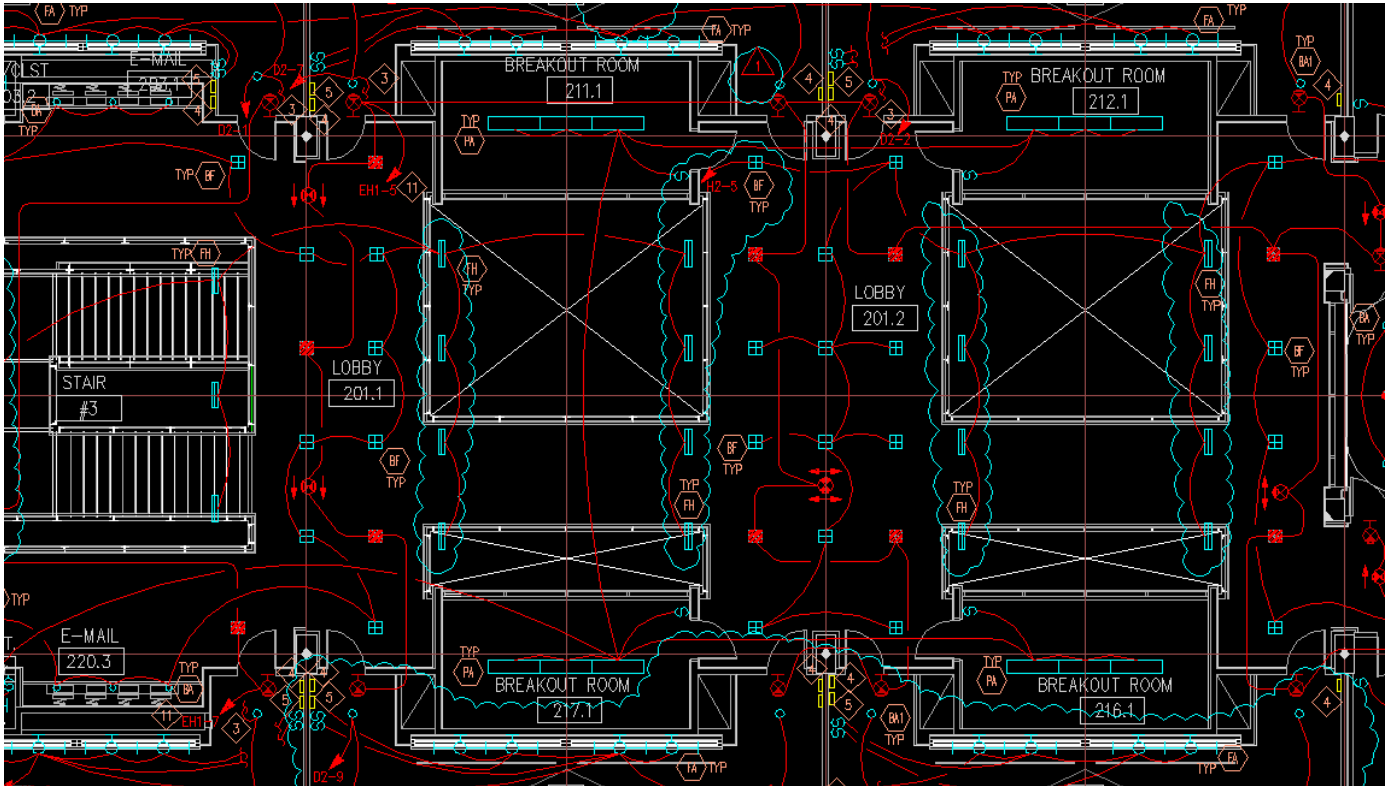
The base board was made to match the flooring, and is of the same type of finish as the floors. They are made of the terracotta tile, and they are the same assumed reflectance of .3.

Walls for the lobby and lounge area are made of a mixture of the same Benjamin Moore paint. It's the same type of mixed white used before, only the color this time is Simply White and has an assumed reflectance of .6 just in the lounge area. The lobby and lounge both use the maple wood finish, which was already using an assumed reflectance of .4.

The ceiling in both spaces is made from gypsum wall board to house the recessed lights. The assumed reflectance for this space is .8.

The exact window information is not available, so it was assumed to have a transmittance of .9 for all windows.





Luminaires

Type	Description	Lamp	No. Lamps	Ballast	Mounting	Voltage
BF	Square Downlight	38W DD	2	Elec.	Recessed	277
XC	Compact Fluorescent	26W Quad	1	Elec.	Surface	277
FE	Indirect / Pendant	F28W T5	2	Dim	Pendant	277
FH	2' Fluorescent Ceiling Wash	T5 HO	1	Elec	Pendant	277

Light Loss Factors

Type	BF	Cleaning	Maintenance	LLD	RSDD	LDD	LLF
BF	.95	12 Months clean	III	.85	.9	.97	.74
XC	.95	12 Months clean	III	.85	.9	.97	.74
FE	.95	12 Months clean	II	.85	.94	.93	.74
FH	.95	12 Months clean	IV	.85	.89	.97	.73

Controls

Unlike the other spaces already mentioned, the lobby is not set up with the graphic eye. The Lobby and Lounge will only need two lighting settings, on and off. Because of this, the Lobby and Lounge space are run to a astronomical time clock. The time clock will keep track of the time during the day, and turn lights on and off according to the pre-programmed hours.

*Power Density**1st floor*

BF – 32 Luminaires * 2 Lamps * 32 Watts = 2048W

XC – 8 Luminaires * 1 Lamp * 26 Watts = 208W

FE – 18 Luminaires * 2 Lamp * 28 Watts = 1008W

Total Wattage = 3264W

Area = 4800 sq ft

Wattage per square footage = $3264 / 4800 = .68 \text{ W / sq ft}$

ASHRAE 90.1 Standard → .8 to 1.8 W/sq ft

2nd floor

BF – 31 Luminaires * 2 Lamps * 32 Watts = 2016W

FH – 12 Luminaires * 1 Lamp * 54 Watts = 648 W

Total Wattage = 2664W

Area = 2632 sq ft

Wattage per square footage = $2664 / 2632 \sim 1.0 \text{ W / sq ft}$

ASHRAE 90.1 Standard → .8 to 1.8 W/sq ft

The lobby spaces meet the criteria for ASHRAE 90.1 standards. What makes this space unique is the open atrium space going through the center of the lobby. The space still meets the criteria.

Design Criteria*Ratios*

The lobby has different ratio criteria then the other spaces. The lobby and lounge are not designed primarily for reading and writing tasks, so the lighting levels are not required to be as high as the classrooms. However, it is important to keep the floor and the walls at similar illuminance levels so eyes do not need to make adjustments when scanning the spaces.

A lobby is an excellent place to display artwork and other school paraphernalia that will enhance the atmosphere of the space. It is important that when accent lighting is

being used, that the lighting levels do not create levels that stay with in the proper ratio for the surrounding space.

Glare and Reflectance

As stated in the previous paragraph, lobbies are excellent places to include accent lighting to highlight a particular part of the lobby or any artwork contained in the space. It is important to consider the placement of lighting to eliminate glare on the source. Proper placement of accent luminaries will play an important part in preventing glare on these surfaces and will make the object more viewable.

Along with glare, improper accent lighting will place veiling reflections on artwork. These reflections, created in part by object specularities and light angles, can prevent easy viewing of portions of the room or objects. Reflections can greatly depreciate the appearance of a room.

Light Source

The use of light sources in the lobby will have a similar affect to the spaces that I described in the Capital Market Section. It is very important to keep the same thoughts in mind when designing this space.

Lighting

Corridors, Lobby, and the Lounge areas do not need an excessive amount of light, simply enough to promote safety when traveling through the areas. Light levels can reach higher values in areas where furniture has been placed to allow for short term activities such as reading and writing. The other opportunity found in these spaces is the opportunity to add visual interest to the surrounding walls. Also, quality facial renderings should be a goal for lighting designers in these spaces, as it promotes a friendlier and peaceful environment.

When considering design criteria for this space, I considered it to be a corridor first, as it's primary purpose is the passage from space to space. Considerations for the spaces that could be used for reading and writing tasks were then made. According to IESNA standards, lighting levels for corridors is approximately 10 fc on the task plane, the floor. This allows the user to navigate the space easily while not overusing light. For the spaces that were to be furnished as well, I considered a lighting level that would be a mixture of the classroom and the corridor. Because the space is not necessarily intended for long term use, the levels would not have to be as high as a classroom, therefore I assumed that these areas should have approximately 20 – 30 fc on the floor, which would provide a slightly higher lighting level on the task plane where the reading and writing would take place.

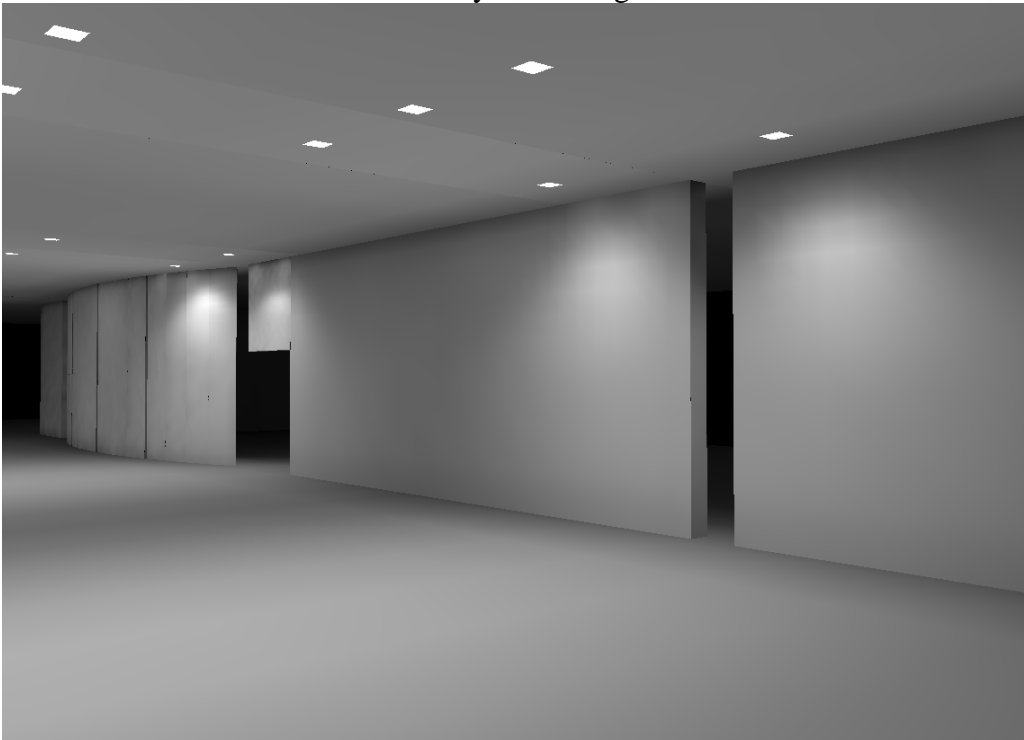
One of the great disappointments for me in this space was the lack of day lighting. Because the space does not share a wall with the exterior, it is not possible to take advantage of direct daylight in this space. Other important considerations for this space were already mentioned in the previous section. It is very important to keep direct glare and reflections away from the viewer, and an even light distribution throughout the space and it's surfaces is important as well. Probably one of the most important considerations for the space is the lighting of faces and different points of interest. In a space that will be well traveled by numerous people, it is important that people appear happy and

friendly due to the lighting, and that the space is made as interesting as possible to add to a positive environmental atmosphere.

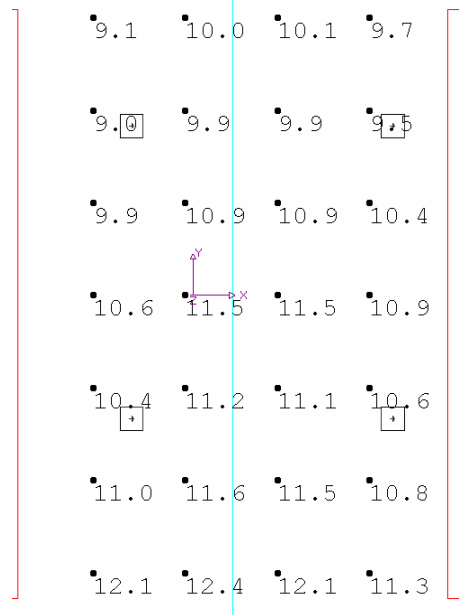
Lobby Rendering



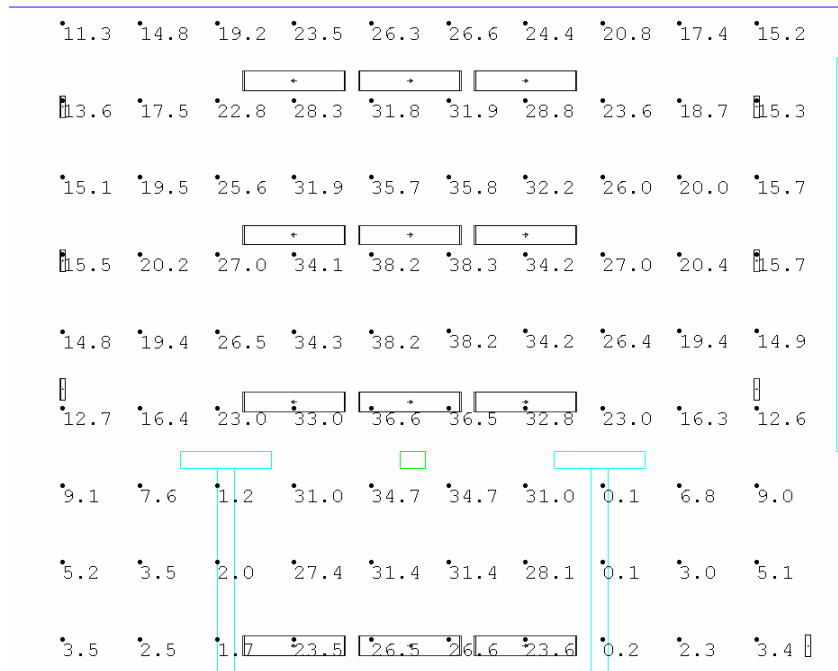
Lobby Rendering



Calculation Plane on Main Lobby Floor



Calculation Plane on Entrance Floor



Design Standards

New Lighting Design

The existing lighting design for the Lobby is acceptable by both IESNA and ASHRAE 90.1 standards. Some of the levels may not seem to be entirely appropriate, but the model was not made to meet the exact replication of the space, nor was it designed with the proper lighting on the second floor. The models, reflectances, and IES files that were used were not necessarily the same ones that were used by the designer

and this information is subjective to my interpretation. I assumed that the design would be more than adequate for this space, and the suggestions I make below are my opinions on how improvements could be made to this space.

The lighting system meets all the standards set by ASHRAE, and lights the space very well. To add to the lighting systems, more light could be added coming down from the above atrium openings to create a more even wash across the floor. Direct light is provided in abundance, but a layer of indirect light to soften the space would be a fine addition to the area. The space also lacks forms of highlight lighting for the more interesting portions of the area. Because of the breakout rooms, there is not a lot of wall space for hanging art work or any other sort of visual stimulus. Any form of lighting that could be added to enhance the space would be a fine addition.

This space also uses numerous compact fluorescent fixtures. The use of so many fixtures can easily create a glare source on the ceiling, and can become an unwelcome facet to the space. Finding another fixture that would spread the light out on the floor while also meeting the ASHRAE standards would definitely be beneficial to the space.

Exterior Lighting

Being one of the newer buildings on the George Washington University campus, the new Business School is meant to stand out. Its façade is very visible from either direction down the street, and it's meant to stand out from the surrounding area. The façade is meant to be dynamic. The entrance is set back in the building, but the overhang above it draws your attention towards it. There is a set back above the entrance to help add character to the exterior façade and a steel pole and overhang running around the top to also add to it. What truly sets the new business school apart from other buildings on campus is the light tower on the south east side of the building. No extra lighting was added to the exterior, but the lighting inside will be left on and reflected through the glass windows to create a glowing affect on the side of the building. This truly adds character to the building and creates a unique feature that is not seen on many other buildings.



Spatial Overview

The exterior of the building does not have any removable furniture, but it has a few areas that can be perceived as spaces with furniture. There are numerous planters around the exterior of the building, and benches for people waiting outside between classes. With these types of spaces, accent lighting must be added to highlight such areas and provide ambient lighting for people that would be in exterior spaces at night.

Finishes

The general façade of the building is clad in precast concrete panels. Around the general exterior of the building is stone wall with integrated bench seating, and the area around the school is coated in stone. The entrance area is offset into the building with glass and a structural aluminum canopy. There are also the windows and aluminum composite panels.

Luminaires

Type	Description	Lamp	No. Lamps	Ballast	Mounting	Voltage
H5	Exterior Rectangular Wall Washer	35W MH	1	Elec	Semi - Recessed	277
H8	Exterior CF Step Light	9W PL	1	Elec	Recessed	277
XB	Exterior Fluorescent Down Light	18W TRT	1	Elec	Recessed	277
XE	Exterior small surface MTD Wash	T6 39W	1	Elec	Surface	277
XF	Exterior Surface MTD Wash	T6 150W	1	Elec	Wall	277

Light Loss Factors

Type	BF	Cleaning	Maintenance	LLD	LDD	LLF
H5	.95	5 Years** Medium	V	.73*	.75	.55
H8	.95	5 Years** Medium	V	.73*	.75	.55
XB	.95	12 Months clean	V	.95	.88	.84
XE	.95	12 Months clean	V	.95	.88	.84
XF	.95	12 Months clean	V	.95	.88	.84

* Assumed LLD for a MH because I did not have access to the exact luminaire data

** 5 years, based on cleaning when re-lamping, lamp on 10 hours a day and then rounded down.

Controls

The lighting at the main entrance to the building is controlled by a photocell. Placed on the room in a weatherproof enclosure, the photocell monitors the daylight being received and based on pre-recorded values allows the lights at the main entrance to turn on and off as necessary. The photocell also controls the other exterior lighting, the ones in the set back and the other main exterior lights.

The light tower is a unique feature for this building, and although it is not part of the exterior of the building, its lights impact the exterior of the building. Inside the study lounge, the lights are set on an astrological timer which enables the owner of the building to automatically set what time the lights should turn off and on. This allows for the lights to turn on when it begins getting dark out so that the tower can begin to light up the night.

Power Density

H5 – 4 Luminaires * 1 Lamp * 35W = 140W

H8 – 1 Luminaires * 1 Lamp * 9W = 9W

XB – 2 Luminaires * 1 Lamp * 18W = 36W

XE – 2 Luminaires * 1 Lamp * 39W = 78W

XF – 12 Luminaires * 1 Lamp * 150W = 1800W

Total Wattage = 2063W

Area = 6200 sq ft

Watts per Sq ft = .33 W/sq ft

ASHRAE 90.1 → for building Façade .25 W/sq ft

For the ASHRAE calculation, the entrance lighting was included with the façade lighting. This will skew the calculation and causes it to rise above the ASHRAE standard. I am not confident that the IES files used on the exterior of the building are the correct files, and the values are not necessarily correct. The luminaries used, however, do meet code requirements.

Design Criteria*Exterior Lighting*

Exterior lighting provides a completely different type of complications that are not as vital in interior lighting. Contrast becomes a major issue as the surrounding environment becomes significantly darker during the nighttime. Eyes react differently at night, perceiving things differently in darkness than during the night time. People experience different emotions in the darkness, giving lighting a significant chance to affect emotions by creating dramatic scenery or a feeling of personal safety. Too much light can become a hindrance and take away from the atmosphere at drastically affect the people living in the surrounding environment. Many of these factors can create an environment that is easily memorable or quickly forgettable.

Glare

Because of the contrast from the night sky and the darkness it creates to the light that is being placed on a façade, glare becomes a prominent problem in the way that it can become disabling, discomforting and annoying. Stray light can scatter within the eye, reducing contrast and affecting the view of the surrounding areas. Decreasing the luminance of a light source will decrease this discomfort glare, and also help to stop from it disabling your ability to see properly.

Ratio

Ratio plays just as big of a deal on exterior spaces as it does on interior ones. The difference in illuminance values can create safety hazards, be annoying, or simply disrupt themes within the community. In general rules, the lighting on a site should not exceed twenty times that of the surrounding areas. This is a general value however, and values

can be different from community to community. The brightness of the space is very dependant on its surroundings, so it is very important to think about the environment the building is in before placing exterior lighting on the building.

Safety Lighting

When considering the lighting of a space, it is very important to consider the more important parts of the building. You don't want to leave a sidewalk in darkness, or a stairwell as it can lead to potential harm to people using the area. Using ambient light to surround the building creates a feeling of security for patrons of the space. Good exterior lighting provides ambient light over the surroundings, will accents on any hazards, important destinations, and interesting building features.

Light Pollution and Trespass

Light pollution, although unharful, has become a feature less and less desirable on buildings. Spill light reaching into the atmosphere takes away from the nighttime sky and hides stars. It creates an unwelcome glow that can be seen from afar, and must be minimized whenever possible. Aiming of lights and use of lights that are excessively bright must be carefully considered.

Light trespass is another important consideration, especially in areas such as Washington DC where façade lighting can have profound impact on surrounding buildings. Light placed coming from the building at an adjacent angle should be carefully monitored, as it can trespass into others windows and create nuisance glare and excessive brightness that can easily be avoided. This light can often times be avoided by using lights that have proper cutoff angles.

Lighting Source

Choosing a good light source for exterior lighting can often times be difficult. Color rendering and color temperature of course play a very important roll when it comes to lighting the façade and accenting it's features, but not all light sources are well suited for exterior use. Lamps should be long lasting as exterior luminaries are often hard to relamp. Certain fixtures are also not designed for use in a varying climate, and many lamps that are require ballasts that will not work in these environments. Air tight luminaries are necessary to successfully ward off the elements, and sometimes even acts of vandalism.

Lighting

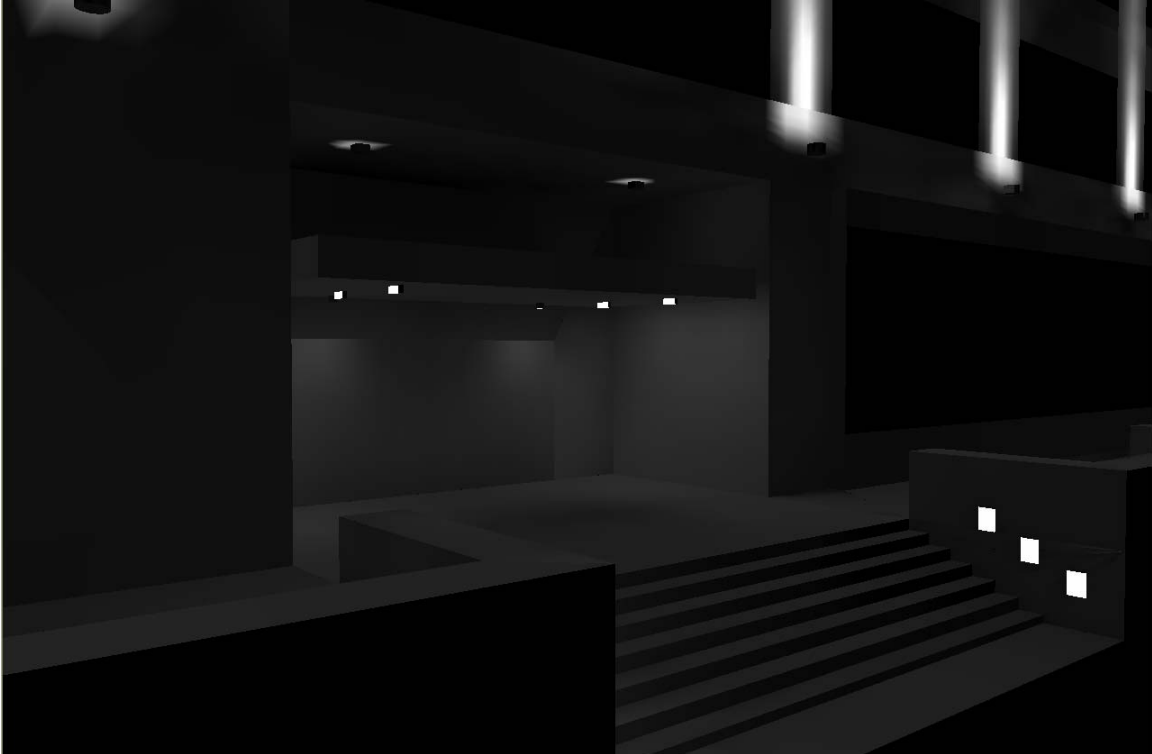
The design for the exterior building also has many factors that must be considered. The new business school may not necessarily be the most important building on campus, but as it is one of the newer ones, the lighting should be profound and dramatic enough to portray the correct traits not only about the school of business and the university itself. Exterior lighting needs to be warm and welcoming, the building should effectively draw you towards it while safely lighting your way. Entranceways and other important parts of the building should be highlighted and stand out from the rest of the building so they can offer safe admittance to its depth.

The lighting levels should not be as extreme as the interior portions of the building. Due to the contrast of the night time, a little bit of light when placed properly

can adequately light its target. Lighting levels for the pedestrian area that will be used often should be around 10 fc, while the façade lighting of the structure should be around 5 – 10 fc with the accented areas being slightly more.

One of the unique features of the business school is the south east corner where the student study areas are. This area when lit up at night provides an eloquent light tower that adds a dramatic feel to this building. It becomes a diverse feature that sets the building apart from the rest of campus and makes a strong statement about the importance of the building.





Design Standards***New Lighting Design***

The existing lighting design for the Exterior Façade is acceptable by both IESNA and ASHRAE 90.1 standards. The model does not appear to look very promising, but as stated with the other models, the models, reflectances, and IES files that were used were not necessarily the same ones that were used by the designer and this information is subjective to my interpretation. I assumed that the design would be more than adequate for this space, and the suggestions I make below are my opinions on how improvements could be made to this space.

There is a small amount of light on the area around the base of the building. Where there seems to be enough light according to the IESNA standards, it seems that there should be a bit more light on the grounds around the building. There also seems to be lots of area on the columns that is not lit by the up lights right below the second floor. I feel there should be a bit more lighting on the more interesting parts of the building, such as the corners of the building and the few features that stand out on the building.

There is quite a bit of light coming out of the light tower on the south east corner. This is an interesting feature on the building, and any other portion of the building would be beneficial to the building. Because the interior lighting that would affect the outside is not actually on the outside of the building, it does not add to the ASHRAE standards and hinder the amount of light that can be placed on the building.