Auditorium – Lighting Design

Picture Aud.1

The Auditorium in Duques Hall is located on the first floor of the building. It is a tiered room and holds a seating capacity of 114 people. Furnishings in the room are set up in "L" brackets around the center of the room. The focus of the space is a speaker's podium in the center of the room, with white boards and retractable presentation screens on either side of the podium. Very little daylight enters the space, as there are only a few windows, which are very narrow in their design. Motorized blinds are utilized to control the light entering the space, as it is very important to eliminate daylight as a glare source during presentations.

The aspect that makes the auditorium so unique in its design is that the space is essentially a multipurpose space. Design implications call for the space to be utilized as a classroom and as a presentation space both for class related functions and for larger university presentations. Because of these implications, it requires the lighting design to be adaptive to the requirements of the occupants of the space.

Picture Aud.2

Finishes became very important in the design of the auditorium, as it is more important than the design of a typical classroom. The auditorium will not be used solely by students, but by administration, and possibly groups outside of the university as well. It became important to create an atmosphere that reflects "high society," and would raise the standards in which the building and the university were viewed.

Design Considerations

With such an adaptive room, a conscious effort was made to make the room as versatile as possible so it was capable of accommodating any situation in which the room would be used. Comfort was a key factor in creating the design of the space, as the space could be used for a potentially long period of time, and it is very important that the user of the space would not feel uncomfortable in these situations. Utilizing the architecture of the auditorium also impacted the design of the space. Negating glare sources while implicating the most efficient method of lighting the space was very important not only to the effectiveness of the room. Using a lighting system to help accent some of the more dynamic and unique systems in the auditorium became an important factor in elevating the status of the room. Easy methods of controlling the space were also pivotal in the design of this space. Implementing video conferencing possibilities to the room was also an important part of the design. Having the option to transmit lectures and presentations to users across the country elevates the importance of the room, and adds an exclamation point behind the versatility factor of the room.

Design Criteria

All design criteria is based upon the standards set forth in the IESNA Lighting Handbook, and the following criteria was taken from it.

One of the larger considerations for the space was the elimination of direct glare. The primary use of the space will most likely be that of a classroom, and avoiding glare on the work plane must be minimized. Accounting for reflected glare from specular surfaces and avoiding it will help to create a more visually comfortable environment.

Contrast ratios between task planes and visual surroundings will be very important in visual comfort. Maintaining proper ratios according to IESNA standards will be important in creating a comfortable environment for the user.

An even distribution of light across the work plane is also important in proper design of the space. Providing not only proper fc values on the work plane, but also making sure there are not large disparities in the fc level is important to the use-ability of the space and also to the visual comfort of the space.

Creating an environment that does not only provide proper lighting levels, but accents the unique architectural aspects of the room will enhance the atmosphere in the space. While lighting these different spaces, it is also important to avoid over lighting which could cause glare source or even begin to wash out the finish on the surface.

Light source and type

Selection of lamps containing good CRI and CCT lamps is important to the space as well. Improper selection can cause the light to clash with the finish colors and help to create a space that is not very visually inviting.

Design Standards

Horizontal Illumination
Reading / writing tasks – 40 to 50 fc

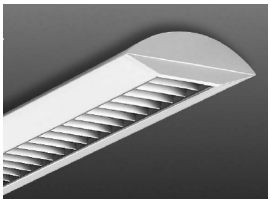
Vertical Illumination
Presentation / lecture – 50 fc

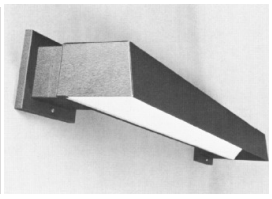
Power Density requirements
1.4 w/ft2 **(Ashrae Standard 90.1 standards)**

Fixture Schedule

Fixture cut sheets can be found in **(appendix L)**, and the lamp and ballast data that was used with each of the fixtures can be found directly after it.

Label	Description	Lamps	Manufacturer	Voltage	Wattage	Ballast
A1	Enspire Pendant mount fixture, louvered enclosure on the bototm, diffuse enclosure on top	(1) T5HO - T5ho-A	Energie	277	49W	Dimming
A2	Perimeter recessed trough system, direct down light w/ louvered enclosure	(1) T8 - T8-A	Lightolier	277	25W	Dimming
A3	Wall mounted wall wash, countinuous mounting for even wash	(1) T8 T8-A	Alkco	277	25W	Electronic
B1	7-3/8" circular recessed downlight, lensing optional	(1) Triple tube - TT-C	Portfolio	277	45W	Dimming
C1	Low voltage parascan spot light, tight beam angle, w/ cross baffle	(1) Halogen LV - Halo-A	Erco	120	50W	-






Lamp Data

Label	Type	CRI	CCT	W	Initial Lumen	Mean Lumen	Manufactuer	Ballast
T5ho-A	T5Ho	80	3500	49	4900	4606	GE	BL-1
T8-A	T8	80	3500	25	2250	2050	Philips	BL-2,BL-4
TT-C	TT	80	3500	45	3200	-	Philips	Btt-3
Halo-A	Hal. LV	-	-	50	75	-	GE	-

Ballast Data

Label	W	Lamp	Dimming	BF	Manuf
BL-1	54	t5ho	Yes	1	Lutron
BL-2	25	t8	yes	1*	Lutron
BL-4	25	t8	no	1	Advanced
Btt-3	45	TT	yes	1*	Lutron

* Exact ballast data was not given so one was assumed.

Light Loss Factor

The assumed room cleaning period for this room was 12 months and the room was kept under the clean category. The calculated percent of expected dirt depreciation was 12%. Data for this section was assumed to be lower than actual standards would be. By assuming standards to be low, it provides the design in the space will be over sufficient as opposed to under sufficient.

RC = (2.5 * 12 * 222.5) / 2708.1 = 2.5

Label	Maintenance Category	LLD	RSDD	LDD	BF	LLF
A1	III	0.80	0.90	0.80	1.00	0.65
A2	IV	0.80	0.95	0.88	1.00	0.67
A3	V	0.80	0.95	0.88	1.00	0.67
B1	IV	0.80	0.95	0.88	1.00	0.67
C1	IV	1.00	0.95	0.88	-	0.84

** LLD was determined at standard .8 value for fluorescents.
** All ballast factors were calculated at 1.0, as all other values were under estimated

Power Density

Label	Wattage	Quantity	Total Wataqe
A1	49	40	1960
A2	25	20	500
A3	25	6	150
B1	45	21	945
C1	50	2	100
		Total =	3655

According to the ASHRAE standards, the w/ft^2 can not exceed 1.4 for a lecture hall.

3655 W / 2709 ft^2 = 1.35 W/ft^2

Lutron Control Information

Because of the necessity for a system that can be easily controlled and changed to fit the needs of the classroom, choosing the proper control simulation was very important. As you can see by viewing the lighting layout on this page, there were three dimming zones that had to be considered in the design of the space, and two zones, which would be undimmed and needed to be controlled separately.

The Lutron Grafik Eye 3000 series was chosen to provide the controls for my space. This model of the Grafik Eye can control up to four scenes while utilizing 2, 3, 4 or 6 Zones. After the Grafik Eye is installed, it can be linked with up to 8 other Grafik eye control units to create more zones. Each system comes with an infared remote wireless remote control that works with the power interfaces provided in the room.

Due to the layout of the room, there could easily be complications in setting up the location of the control systems. You want to be able to turn on the lights while entering and exiting the room, but you also do not want the operator to have to walk to one of the doors any time he wants to utilize the controls. To alleviate this situation, the scene control box was placed at the center of the room behind the podium, and a two-button entrance control was placed at each of the entrances to allow for people entering and exiting the room to turn the lights on or off.

Also, occupancy sensors were added to the space to provide automatic shut off when the lights were not turned off and the space was unoccupied. Occupancy sensors were ceiling mounted to get a view of the entire room, and they were switched to connect to the lutron sensor interface.

Spec data for the Grafik eye and the on/off controls can be found in the lighting appendix.

Floor Plan -

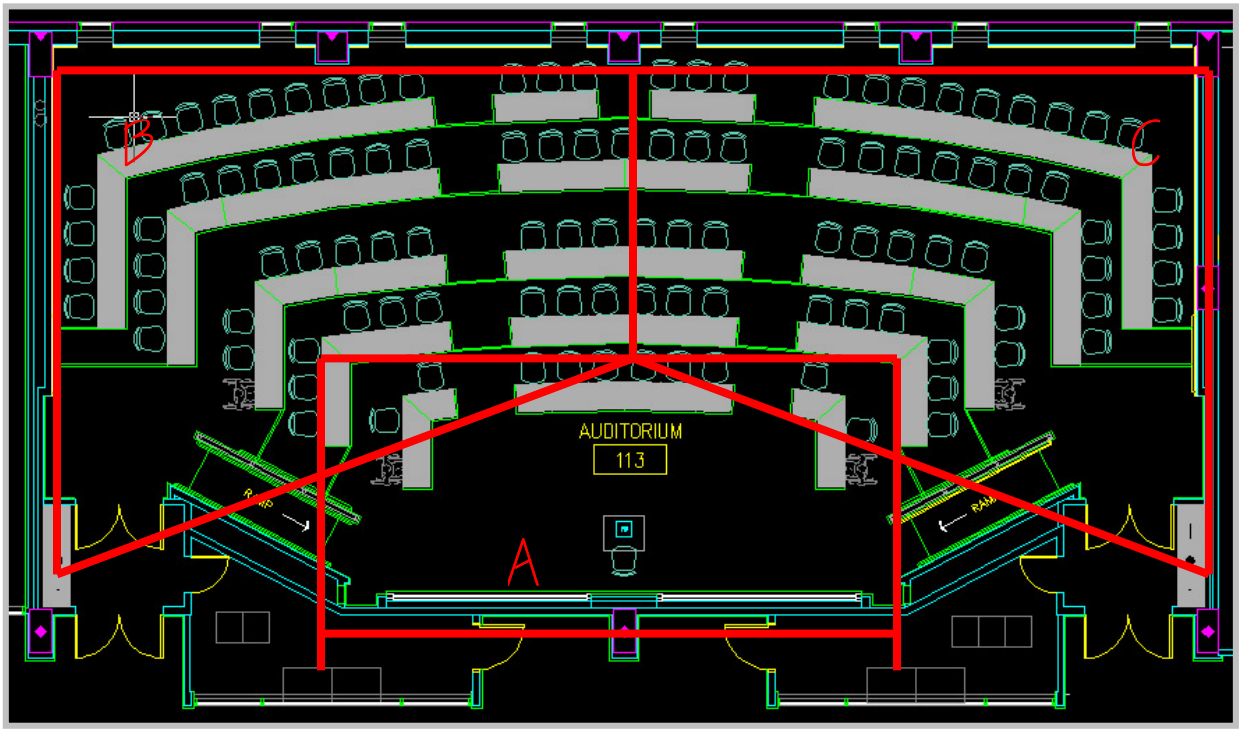


Figure AUD.1

Luminaire Plans

The following figures contain the luminaire layout for the auditorium. Each luminaire is labeled in the similar manner:

X1 – PXX – X – X

The first number represents the fixture's representation in the luminaire plan. The second number is the panel on which the circuit can be found, the third number is the branch circuit on the panel, and finally, the final number is in correspondence to the dimming zone of the room when dimming is applicable.

Luminaire Plan for Section A

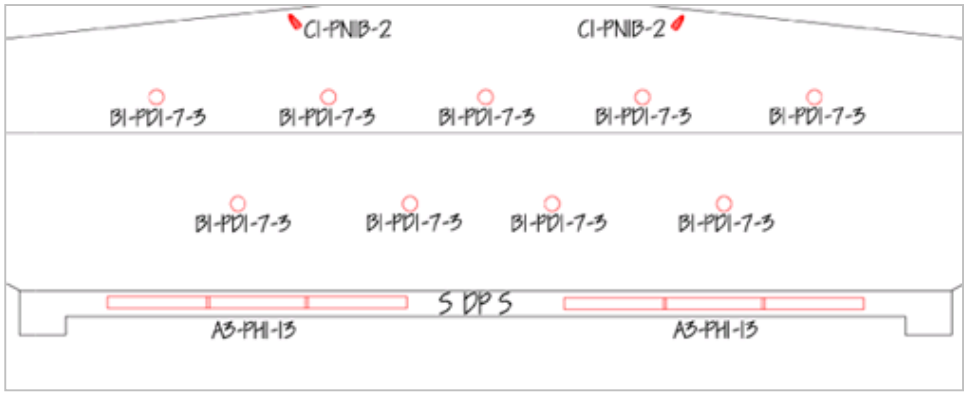
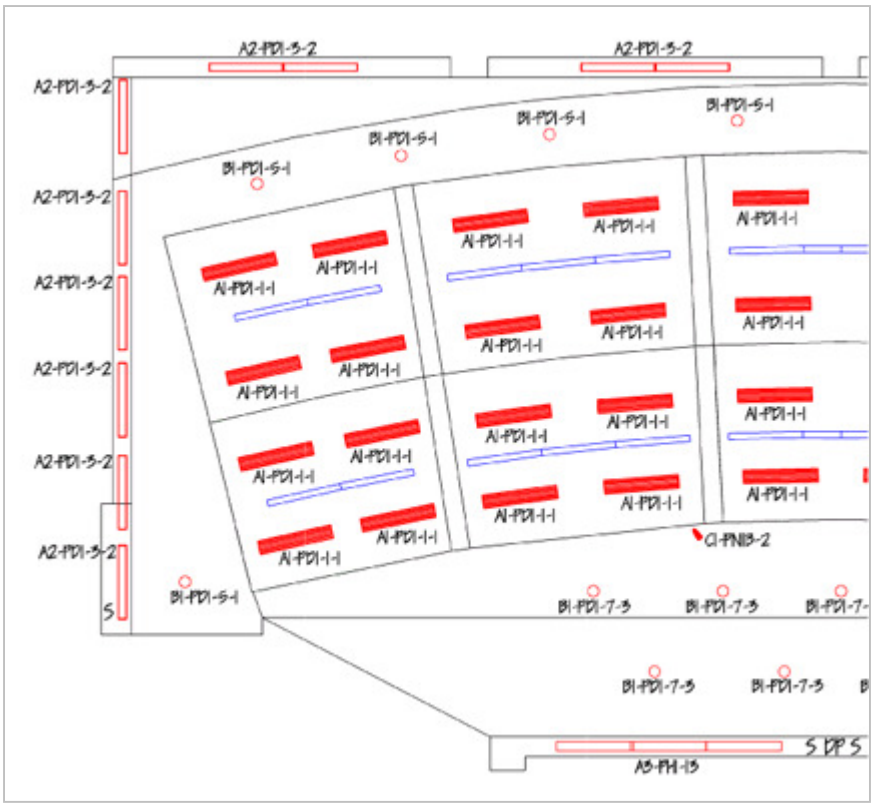
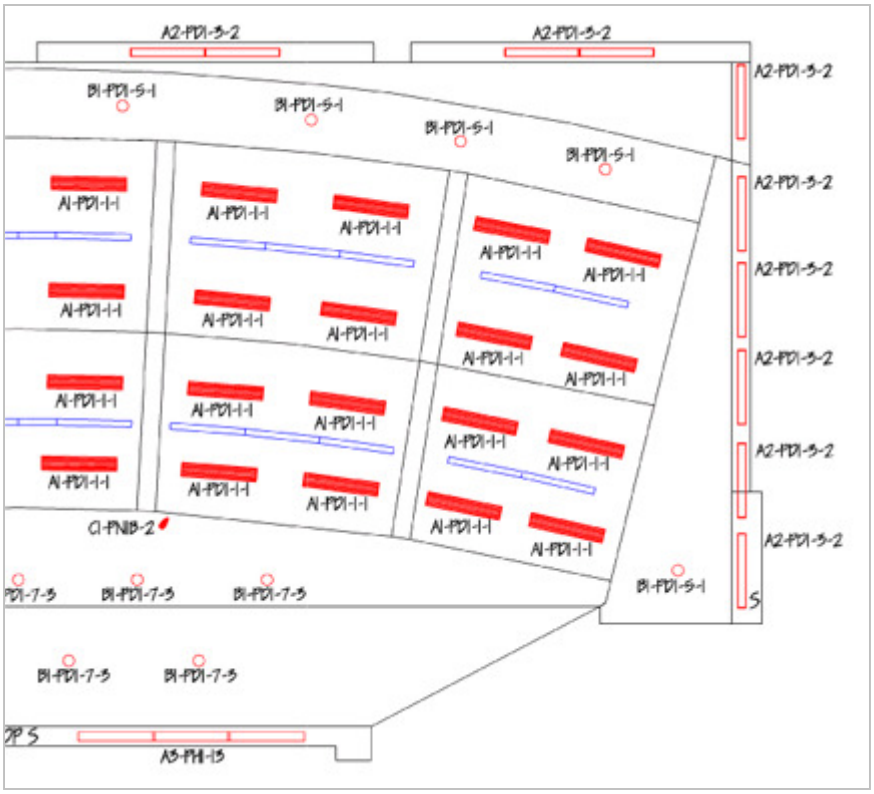


Figure AUD.2



Luminaire Plan for Section B

Figure AUD.3



Luminaire Plan for Section C

Figure AUD.4

Calculation Data

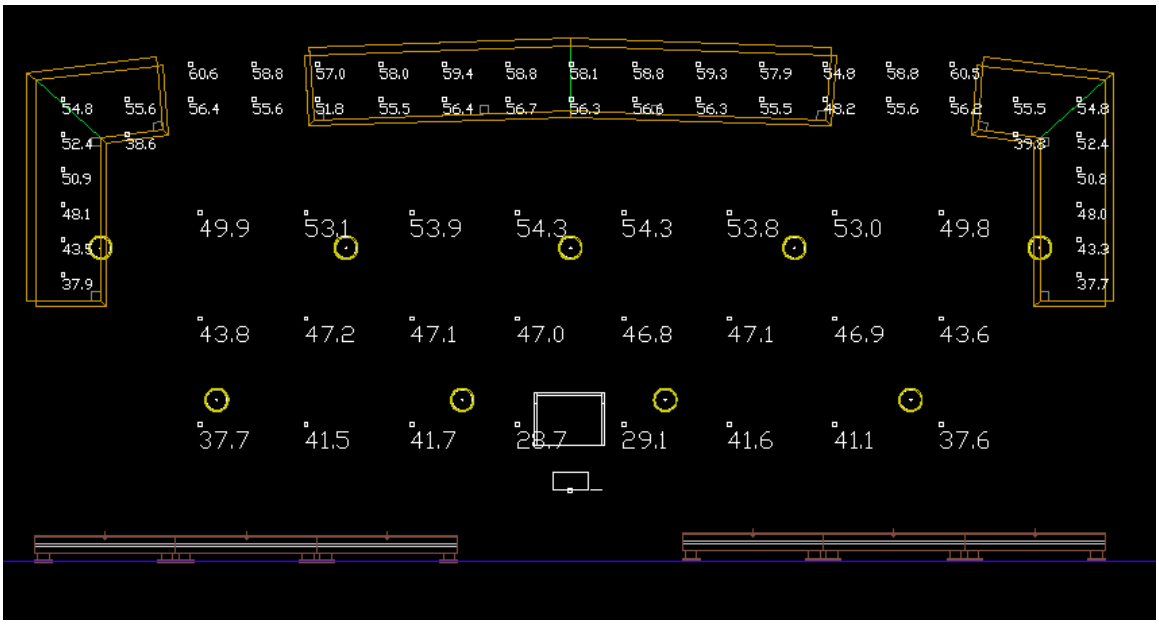


Figure AUD.5

Calculations for the front of the room, displayed in Figure CM.5, are taken at the task plane, 2.5' above the ground. Average illuminance values on the work plane are between 50fc and 60 fc.

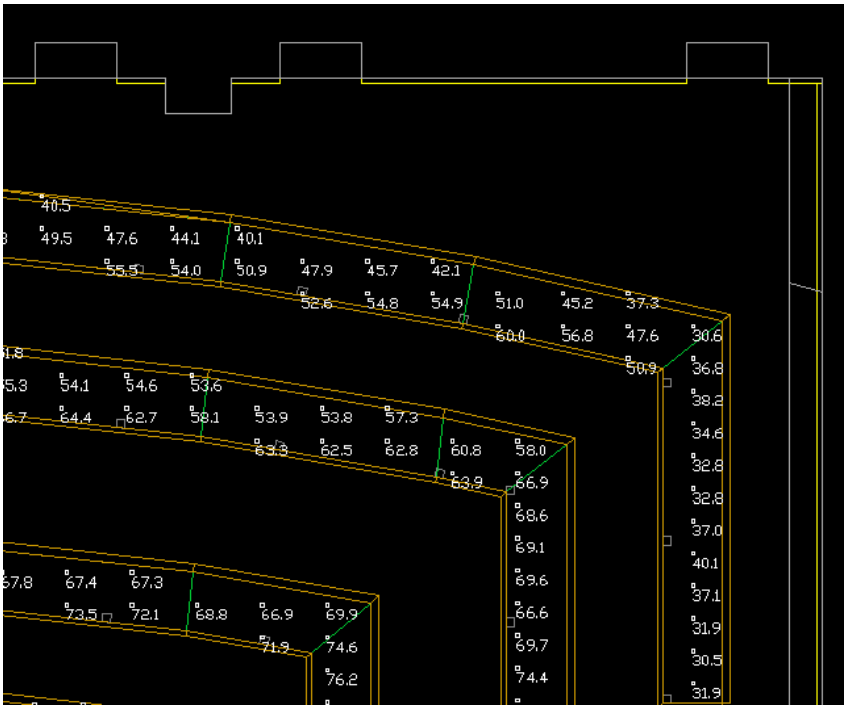


Figure AUD.6 is an example of the calculation data across the task plane in a corner of the room. All values are in the average of 50fc to 60 fc.

Figure AUD.6

The following figures are pseudo color representations of the space. The red is the highest fc value, while the blue colors are the lowest values. The max, or the brightest red, was seta at a value of 70 fc. These renderings show that there is a very uniform value across the task plane, and that the average across the desks is between 50-60 fc.

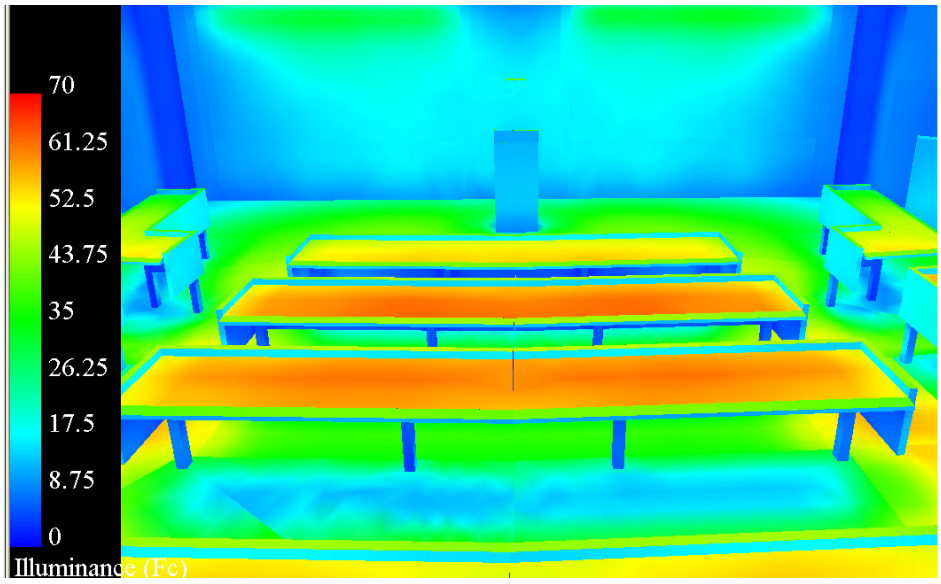


Figure AUD.7

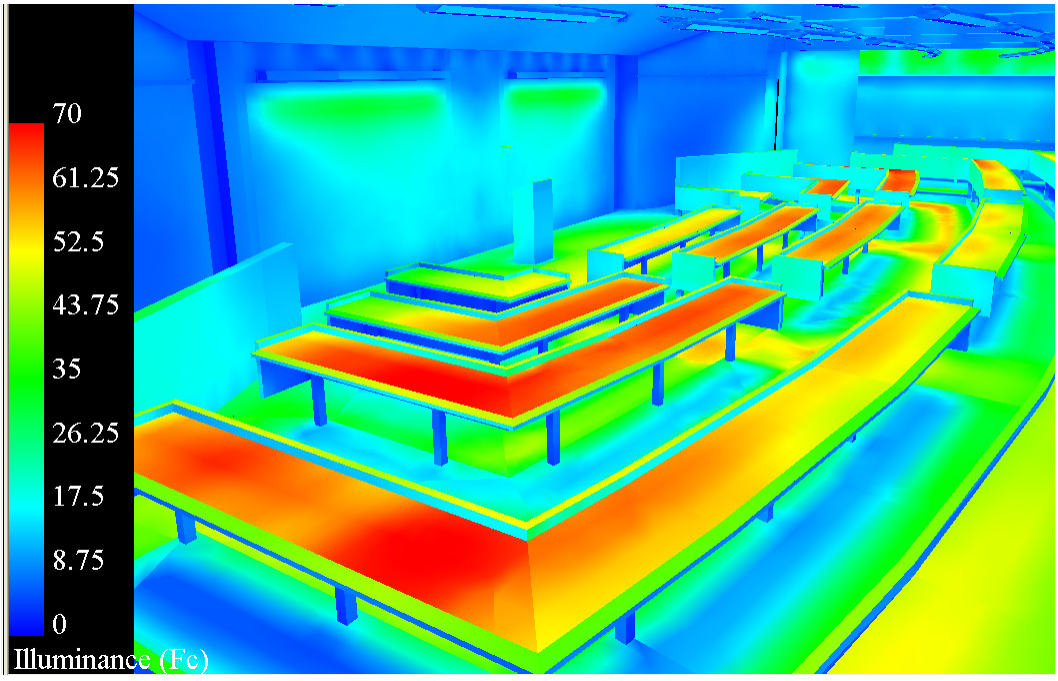


Figure AUD.8

Facial Rendering / Video Conference

Video Conferencing would not be a permanent fixture for the room, and would most likely be used very rarely. Yet, setting a room up for video conference is as simple as providing a few extra fixtures for the space, and placing light around the head at the correct values.

A simple calculation was set up to determine the values around the face of a person that would be centered at about 5' 6." The results of this calculation are included below, along with the values that were found to be acceptable in a study done in the Spring of 2005 by Dr. Moeck's AE 464 class. To determine the best way to light a face so it would appear under optimal conditions, a mock up was set up, and the values were interpreted through an average of opinions on what constituted a "good" facial rendering. The results of this study can be seen (on the following page).

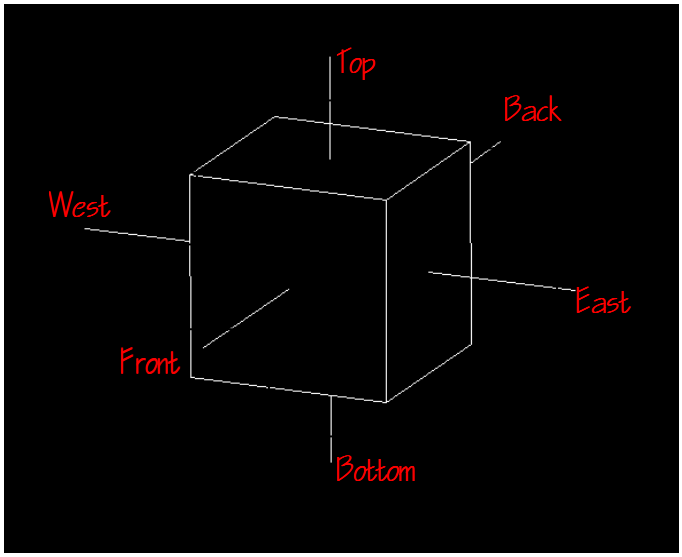


Figure AUD.9

Bottom to Back	1 : 1 to 2
Bottom to Front	1 : 4 to 7
Bottom to East	1 : 3 to 5
Bottom to West	1 : 3 to 5
Bottom to Top	1 : 2 to 7

Video Conference Table 1

In the study performed last spring, the values were not determined as a singular level for each plane of the face, but instead as a comparison ratio. Using the values that were measured during class, a table was drawn in which the fc data was converted into ratio form to simplify the relationship between each of the planes. These relationships that represent a "good" facial rendering for a video conference set up are found in Video Conference Table 1.

Bottom	4.6	1 to 1
Back	7	1 to 1.5
Front	17.9	1 to 3.9
East	19.5	1 to 4.3
West	19.9	1 to 4.3
Top	40.8	1 to 10

Video Conference Table 2

To begin the study, measurements were taken from my room design with all lights turned on. This will help to determine how affective the facial renderings are for the existing lighting system, with out the aids of any additional "rendering" lights. As you can see, the values in Video Conference Table 2 do not fall perfectly within the standards that were determined, but they all fall very close to the proper values. The only values that show any type of disparity are the bottom to front ratio, which just misses falling into the range, and the bottom to top, which exceeds the determined ratio.

Podium and presenter's "head." Lighting set up with all lights on.

Video Rendering VC.1

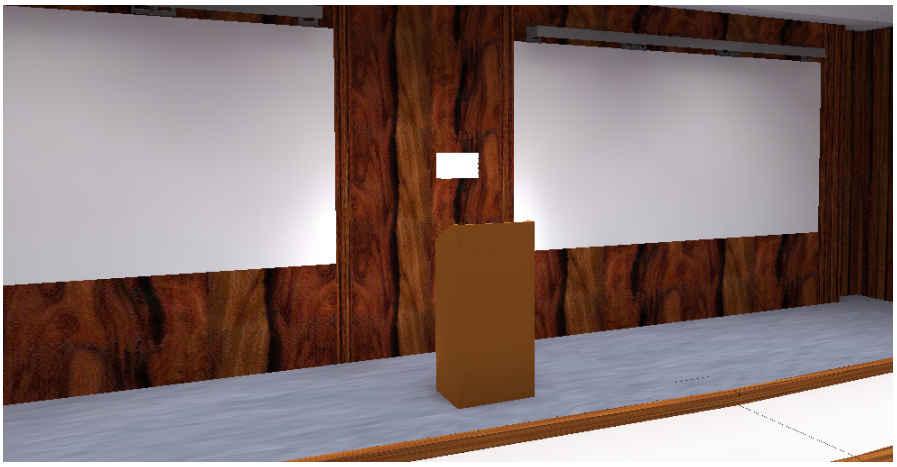
To set up a system for more ideal standards, the lights around the room were dimmed, so that there were no inference with the video conference set up from the other lights. To do this, all lighting levels were dimmed down from the full output value. Pendant fixture A1 was dimmed down to 25%, while the perimeter fixture A2 was dimmed to a level of 10%. The circular downlights, B1, in the front of the room were also dimmed to a value of 10%.

These results can be seen Below in Video Conference Table 3, and a visual comparison can be made by viewing Video Rendering VC.2 and comparing it to the previous rendering.

Bottom	5	1 to 1
Back	5.6	1 to 1.1
Front	55.7	1 to 11
East	24.8	1 to 5
West	24.1	1 to 5
Top	51.3	1 to 10

Video Conference Table 3

The lighting values for the second lighting set up were high for the front and top of the face. This could cause discomfort to the person presenting hence the wattage and lumen level of the lamp should be brought down slightly. However, these values are not placed in the highest category, but are still found to be acceptable for a good quality rendering.



Video Rendering VC.2

Just by viewing the two renderings it becomes apparent how much of an impact dimming the lights and turning on spot lights C1 can make. The concern in utilizing the lights in this manner is the foreseeable discomfort that may be caused to the presenter. Higher light levels can become blinding or heat the presenter to a level of discomfort. These considerations need to be kept in mind when selecting the luminaire for the video conference set up.

Renderings

Rendering AUD.1

Rendering AUD.2

Rendering AUD.3

Conclusion

The design for the auditorium resulted in a more than acceptable design for this space. Proper luminance levels were reached throughout the room, and supplemental lighting was also placed around the room to enhance the design. Video conference capabilities were added to the room to make it more versatile, although different lamping should be used in the design. With the adaptive settings for the room, the result should be a more than acceptable room for the user.