Lighting Electrical Technical Report #1

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10.19.2006
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Lighting Electrical

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Executive Summary

The purpose of technical report one is to discuss the overall existing lighting conditions of the Center for Health Research and Rural Advocacy (CHRRA) and to analyze in further detail the following five spaces: the first floor open office, the double height entrance lobby, the multipurpose space, the 400-seat ellipsoidal auditorium, and the exterior site lighting.

The lighting concept carried throughout the building is that of a sharp, streamline, and clean edge design. CHRRA is architecturally a standout building on the Geisinger Health System campus; it is the only building with a glass façade and curvilinear footprint on the rectilinear campus. The aluminum and somewhat high-tech component of the existing luminaires is appropriate for the architectural aesthetic.

The open office has a south facing glass curtain wall demanding daylight controls in the space. The lighting is controlled in three separate zones by photocells that will dim the electric lighting depending on the daylight entering each of the zones. This system was to be integrated with automated shades spanning the entire south façade of the building. The automated shade system was not included in the final construction of CHRRA, and a manual system was installed in its place. This change leaves the integration between electric and natural light sources inadequate for the needs of the space. Direct glare from the daylight, veiling reflections on VDT's, and visual discomfort are all possible if the manual shades are not used properly.

The auditorium's shape makes it a more difficult space to light. A curved cove lines the perimeter of the space while linear fluorescent direct luminaires illuminate the audience seating. The front of the auditorium has evenly spaced compact fluorescent downlights which illuminate both the speaker and the projection screen. The controls for this space allow all three systems to be dimmed separately making the area multifunctional. The illuminance levels on the audience and speaker are relatively the same, making the space washed out and dimming necessary. The lighting is over designed in this space and fewer fixtures could be used. A more controlled lamp source is necessary for the speaker lighting; the current system incorporates only one stage lighting option which creates a great deal of glare on the projection screen.

The lobby is a double height space with recessed induction lamp fixtures and compact fluorescent downlights in the breakout areas. Integration of daylight is important in this area due to the glass curtain wall spanning most of the space; however, the lighting in the lobby is not controlled by photocell and is not dimmed based on daylight. This leaves much room for improvement in the realm of energy savings and heating/cooling costs.

The multipurpose space can be easily transformed from one large area to three smaller work spaces with moveable partitions. The lighting controls allow for easy operation of the lighting system depending on the size of the space. The linear fluorescent direct luminaires are also used in this area along with a dimmable cove fixture along the partitions and side walls. The accent lighting would be more effective on the front and back walls where it would not change depending on room layout. This space can also be used as a banquet area and does not provide an alternative lighting system for a more elegant setting.

The exterior lighting is dark sky compliant with minimal spill light on the site. Metal halide fixtures are used on the site but high pressure sodium are specified for roadways, making the road look yellow and hindering color rendering. This source can take away from occupants' feeling of security. Adding more accent lighting around the building on the non-glass surfaces may help to bring interest to the exterior of the building in a nighttime setting.

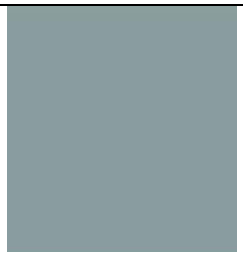
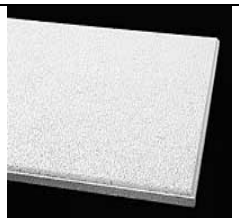
The main design criteria that should be addressed in the lighting systems for CHRRA include: energy efficiency, versatility, pleasing aesthetics, and optimal daylight integration.

Open Office

Existing Lighting System

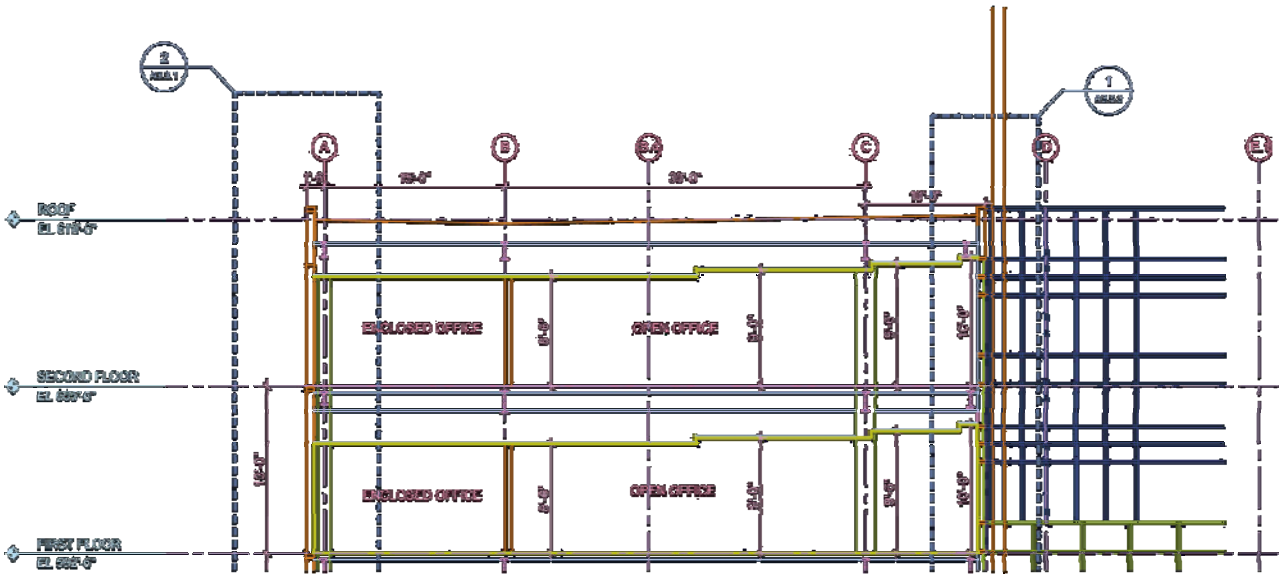
The open office is a large rectangular space surrounded by private offices, open circulation space, and a south facing glass curtain wall. The current lighting system is controlled by three photocells placed at three different distances from the glass. The control area closest to the glass is the circulation space lighting system which is made up of compact fluorescent dimming downlights. The general workstation lighting is broken up into three areas: the front two are dimming controlled and the back area is on/off. These layouts are based off of a daylight analysis for the building's location over a six month time period. The lighting system was designed to be implemented with a less expensive version of the Mecho shade system that would control the shade level depending on a program written based on the time of day and time of year. This would optimally prevent direct sunlight from entering the space and allow the daylight to take over as the major lighting system. This computer operated shade system was ultimately removed from the project.

Room Surface Materials

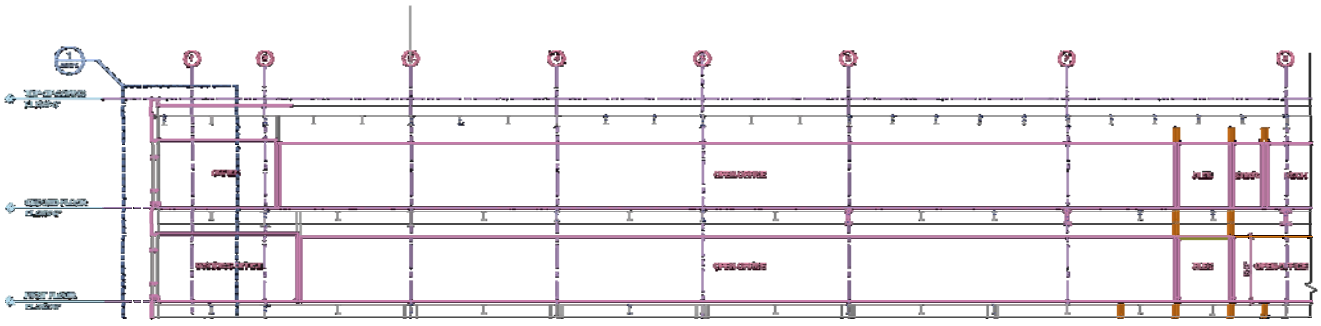
 (p=0.45)	(p=0.95)
Secondary Wall Paint	Primary Wall Paint
 (p=0.08)	 (p=0.44)
Open Office Commercial Carpeting	Accent Fabric Wall Covering near private offices
 (p=0.85)	 (p interior = 0.10) (t= 0.45)
Armstrong 2'x4'beveled acoustical ceiling tile	Low-E insulated glazing

Open Office Room Furnishings

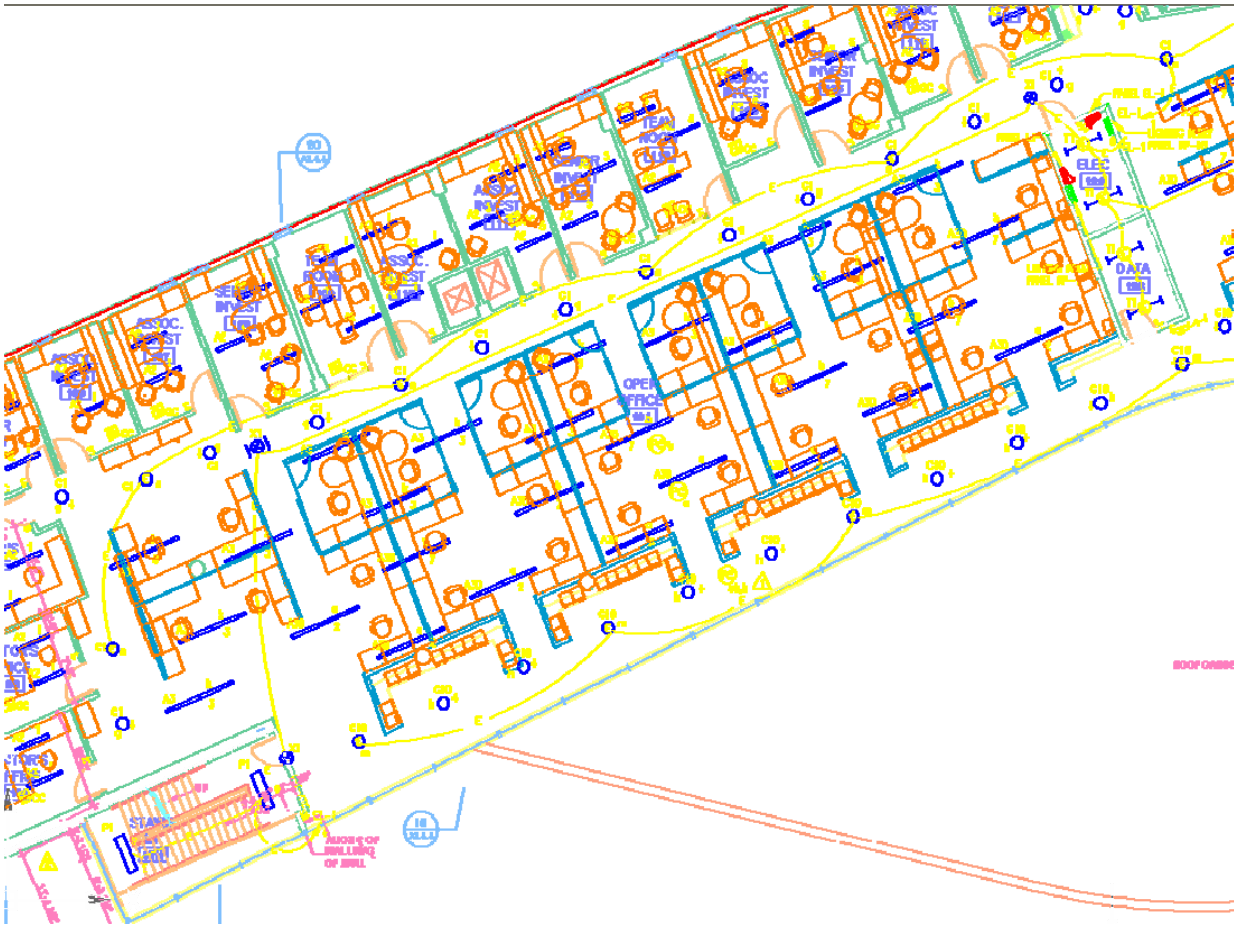
	
Open office first and second floor	Lounge seating
	
Open office first and second floor	Cubicle work stations
	
Open office first and second floor	Work Station desk chair



Open Office Section 1 – North/South



Open Office Section 2- East/West



Open Office Existing Lighting Plan

Open Office Luminaire Schedule

OPEN OFFICE LUMINAIRE SCHEDULE

TYPE	DESCRIPTION	MANUFACTURER	CATALOG NUMBER	LAMP NO.	LAMP TYPE	LAMP WATTS	BALLAST NO.	BALLAST TYPE	VOLTAGE	MOUNTING	NOTES
A3	4"X8' ONE LAMP RECESSED LINEAR FLUORESCENT WITH SATINE LENS, EXTRUDED ALUMINUM HOUSING, BAKED WHITE ENAMEL FINISH.	SE'LUX ZSLI LINEAR FOCAL POINT	M1R1-1T8-SD-SH-008-WH-120 APPROVED EQUAL APPROVED EQUAL	2	F32T8 3500K 82 MIN CRI	32	1	ELECTRONIC	120	RECESSED	
A3D	4"X8' ONE LAMP RECESSED LINEAR FLUORESCENT WITH SATINE LENS, EXTRUDED ALUMINUM HOUSING, BAKED WHITE ENAMEL FINISH.	SE'LUX ZSLI LINEAR FOCAL POINT	M1R1-1T8-SD-SH-008-WH-120-[APPROVED EQUAL APPROVED EQUAL	2	F32T8 3500K 82 MIN CRI	32	1	ELECTRONIC DIMMING	120	RECESSED	
C1	8" DIAMETER APERATURE TWO LAMP COMPACT FLUORESCENT DOWNLIGHT WITH CLEAR ALZAC REFLECTOR, PARABOLIC CROSSBAFFLES AND WHITE PAINTED FLANGE.	LITHONIA COOPER ZSLI	AFZ-2/26DTT-84A-120-GEB APPROVED EQUAL APPROVED EQUAL	2	PL-C 26 3500K 82 MIN CRI	26	1	ELECTRONIC	120	RECESSED	
C1D	8" DIAMETER APERATURE TWO LAMP COMPACT FLUORESCENT DOWNLIGHT WITH CLEAR ALZAC REFLECTOR, PARABOLIC CROSSBAFFLES AND WHITE PAINTED FLANGE WITH DIMMING BALLAST.	LITHONIA COOPER ZSLI	AFZ-2/26DTT-84A-120-DM APPROVED EQUAL APPROVED EQUAL	2	PL-C 26 3500K 82 MIN CRI	26	1	ELECTRONIC DIMMING	120	RECESSED	

FIXTURE	BALLAST	B.F.	P.F.	INPUT WATTS
A3	electronic instant start ballast 120v	0.92	0.99	32
A3D	electronic dimming programmed start 120v	0.05/1.0	0.99	9/35
C1	electronic rapid start 120v	1.0	0.99	51
C1D	electronic dimming programmed start 120v	0.05/1.05	0.98	16/58

IESNA Lighting Design Criteria

Direct Glare is a serious issue in the open office. Glare from the luminaires can be a problem for employees working at their computers. It is important to limit light output at the middle downward angles that can be an issue to employees in a seated position. Using louvers can lower the high contrast between lamp and luminaire that causes direct glare. The south facing façade is a glass curtain; direct sunlight will be entering the space and can cause glare especially in the winter months when there are lower sun angles. The sunlight should be managed with the use of glazing, blinds, or shades to control the direct sunlight.

Part of the reason the glass is such a glare issue is because of its high luminance. The exterior sky, ground, and sun seen through the glass will appear extremely bright compared to the other room surfaces, therefore; it can be a distraction to workers and will slow their productivity. The luminances of the lighting fixtures are also important in an open office space. Having a large luminous area on a darker ceiling will create a high level of contrast (greater than the 3:1 ratio suggested) and will not only be distracting but will also cause reflected glare in the VDT. Having a light colored ceiling can help with the contrast between ceiling and luminaire. It is important to have accent lighting on the side walls to balance the luminance of the daylight and the lighting fixtures. It is also vital to light the walls when VDT lighting fixtures which have parabolic louvers are being used in the space. These lighting fixtures which direct the majority of the light downward can cause a space to feel cave-like and dark.

Daylighting integration and control is an area of design which should be addressed in the early design phase for this space. The lighting design will be greatly affected by the luminance of the glass surface, the illuminance levels provided by the daylight through the open office, and the direct sunlight that may reach the cubicles. This open office has a circulation space directly adjacent to the glass which will work as a buffer for much of the direct sunlight. However, this still will not do enough to prevent glare issues. Blinds should be used that can be adjusted in height depending on the time of day and the time of year to still get the maximum use of the daylight. Photocells should be implemented to control dimming of the lighting fixtures depending on the daylight entering the space. This will help save money on energy costs for lighting and will avoid illuminance levels that are too high and unnecessary for the work environment.

Reflected glare is a major issue for VDT use in an office. This is a computer intensive space and must be treated as such. The daylight in the space can cause the computer screen to be a complete reflection of the surroundings making the material on the screen invisible. It is very important to orient the screen away from windows. Facing the window may cause direct glare in the face of the employee but it will not cause any reflected glare on the computer screen. This is one of the reasons controlling the daylight is such a concern. Reflected glare from the luminaires are also a problem. Direct lighting systems can cause veiling reflections from luminaires behind the worker on the screen. This is because of the luminance contrasts. A brighter ceiling with indirect lighting systems can be more beneficial for computer use. Reflected glare can also occur on the desktop

surface. Under cabinet lighting/task lighting can cause reflected glare on glossy desk surfaces, or on reading/writing material.

Shadowing is an issue in this space because of the large number of cubicles and partitions that are blocking light from reaching the work plane. Placement and distance between luminaires is important to assure an even distribution of lighting on all work plane surfaces. An under cabinet desk light can help with this issue and create a more uniform surface which is very important for reading and writing tasks.

Light Distribution on the task plane (uniformity) is also affected by the spacing between luminaires. Spacing fixtures too far apart will create large differences in illuminance values on the work plane. Also, avoiding narrow distribution luminaires will allow for an increase in spacing. These fixtures will also help to avoid scalloping on the walls around the office, creating a more uniform space.

Facial modeling is somewhat important here because this building is supposed to serve as a gathering space for the rest of the health campus. There will be many people moving through the office space so the proper vertical illuminance levels are important.

The suggested vertical illuminance for the open office space is category B- 5 fc.
The suggested horizontal illuminance for the open office space (with intensive VDT use) is category D- 30 fc.
For VDT's, the luminance ratio between screen and paper task should be 3:1. For screen to far background surfaces it should be 10:1.
For task lighting the suggested horizontal illuminance is 50fc. This can be achieved using under cabinet lighting.

Power Density/ Lighting System Control Requirements

The power density requirement for an open office space, in accordance with the ASHRAE 90.1 Space-by-Space method, is 1.1 Watts per square foot. An additional 0.35 Watts per square foot is allowed for lighting that is specified to be installed to meet requirements of VTD's as the primary viewing task. An additional 1.0 Watts per square foot is also allowed for accent lighting systems such as the installation of wall sconces or highlighting artwork.

This space must also have some type of automatic shut-off control. This includes either occupancy sensors or a time sensor where the lights automatically turn off during non-business hours. Override switches for maintenance staff are also required.

Light Loss Factors

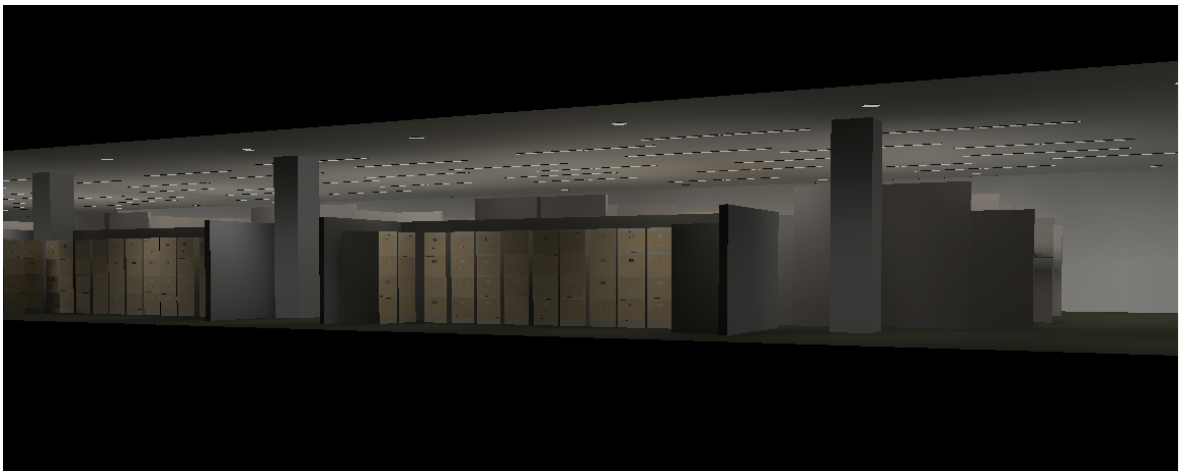
Fixture	LLD for lamp	Luminaire Category	LDD for fixture	Ballast Factor
A3	0.95	five	0.94	0.92
A3D	0.95	five	0.94	1.0
C1	0.86	four	0.95	1.0
C1D	0.86	four	0.95	1.05

Space	Room Cavity Ratio (RCR)	RSDD
OPEN OFFICE	1.46	0.98

SPACE	LUMINAIRE	TOTAL LLF
OPEN OFFICE	A3	0.81
	A3D	0.88
	C1	0.80
	C1D	0.84

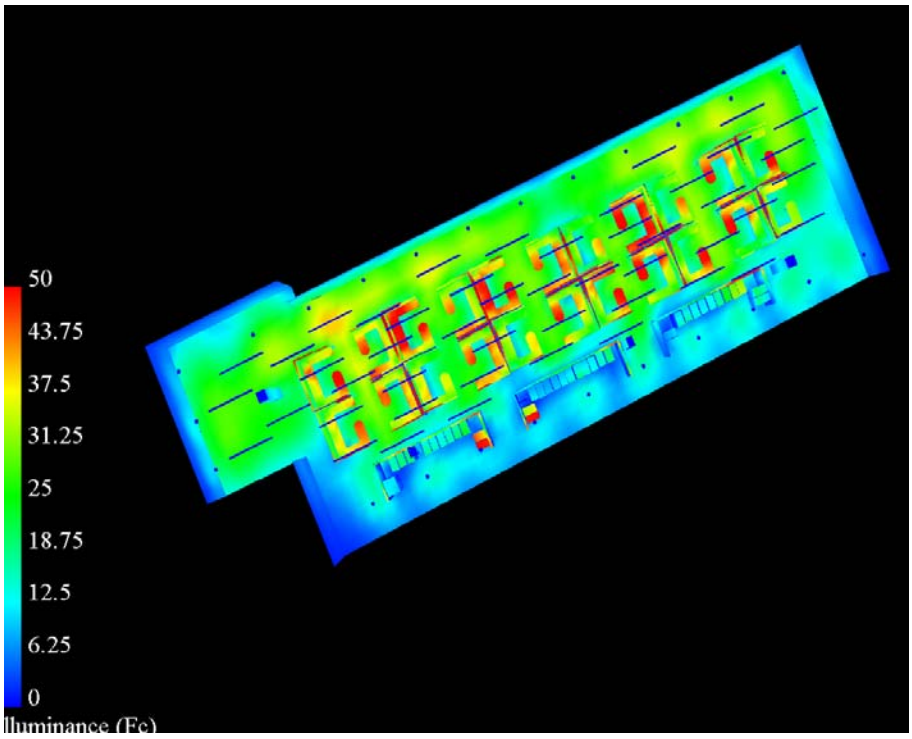
AGI Model of Existing Lighting System

AGI Open Office view from North East corner

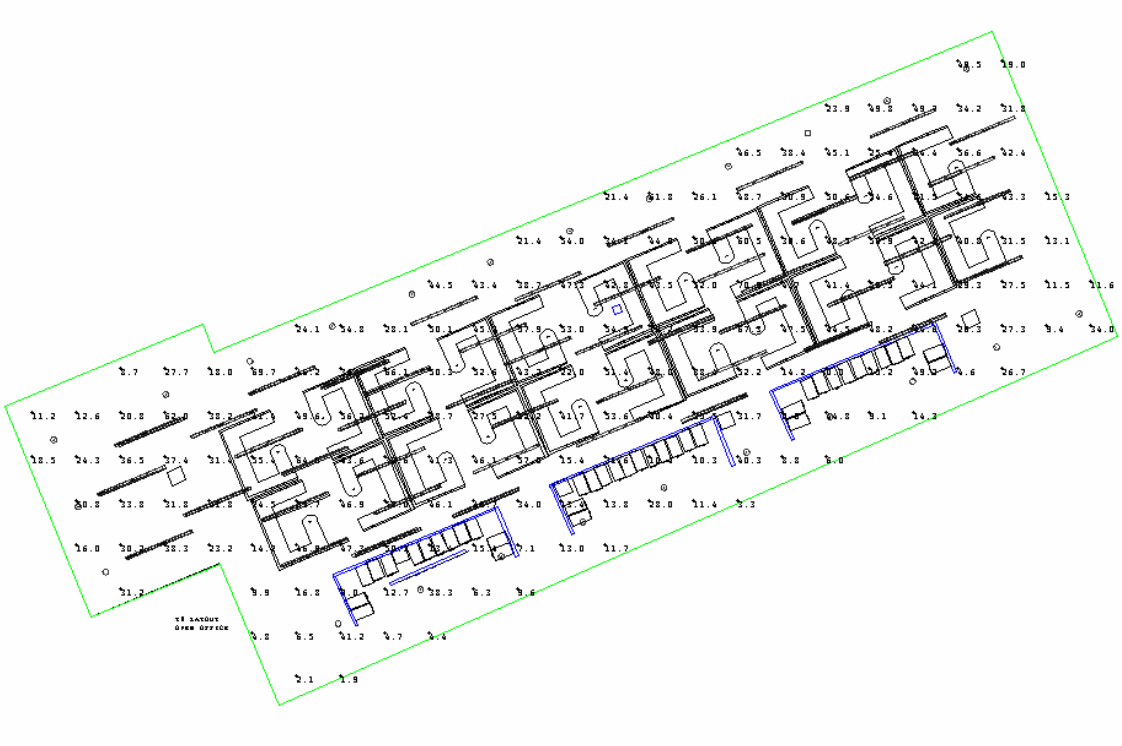


AGI Open Office view looking into South glass façade

AGI Open Office View of circulation space

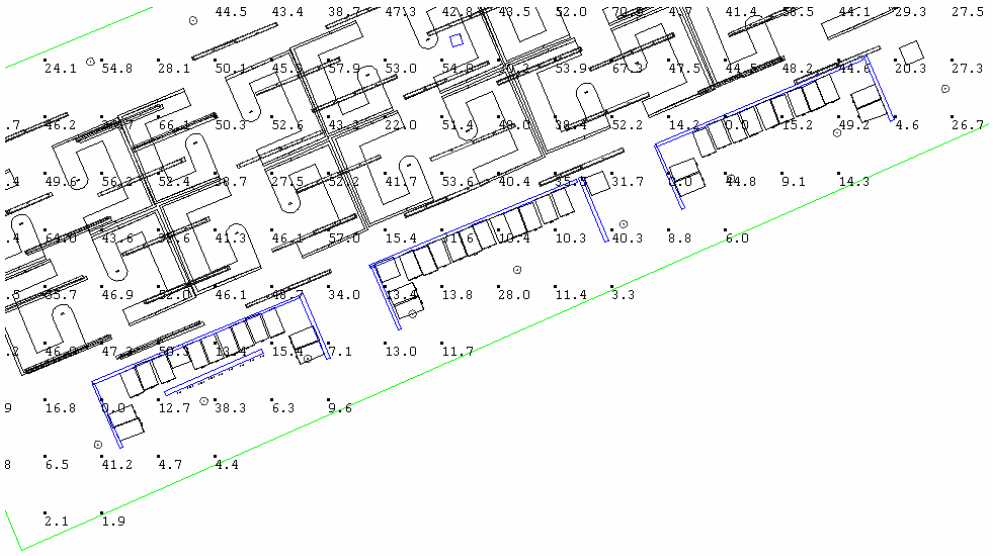


AGI Open Office Pseudo Image- illuminance (fc)

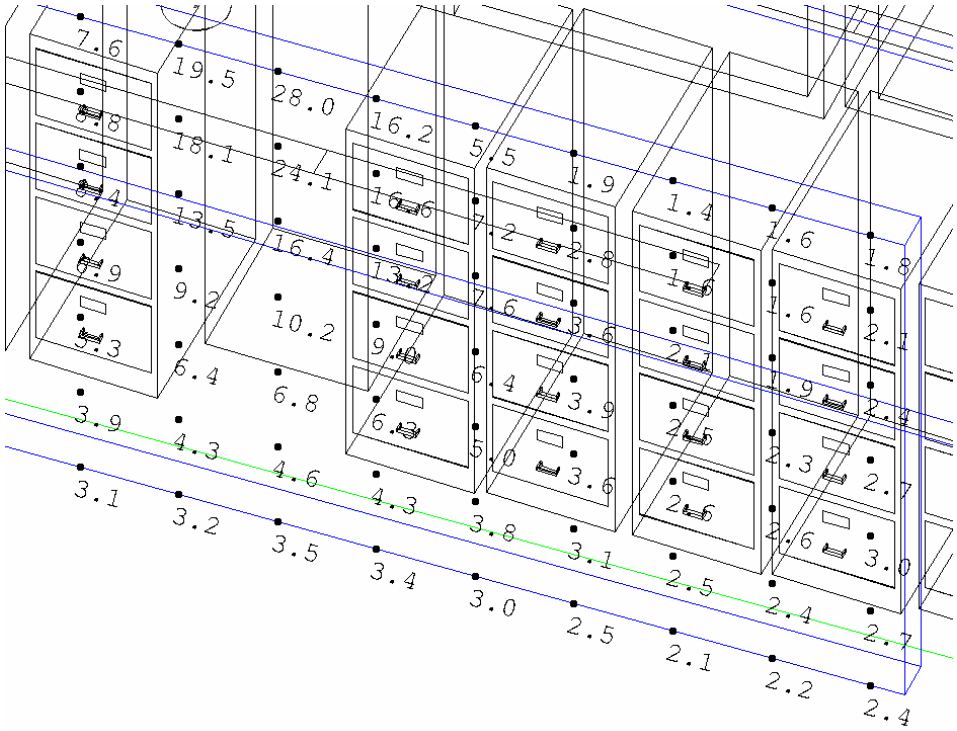


AGI Open Office Model- illuminance (fc) on workplane
Eavg= 34 fc

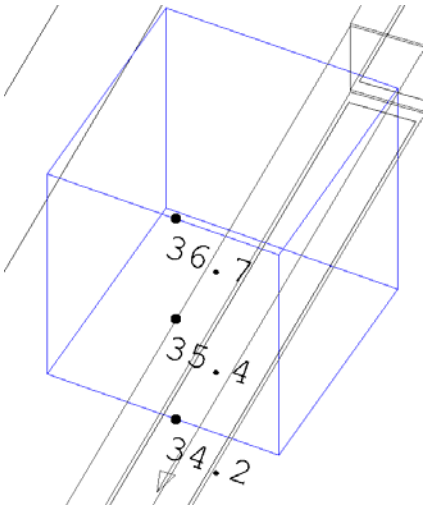
AGI Open Office Model- illuminance on workstation
Eavg= 48.4 fc
Emax/Emin= 2.40



AGI Open Office Model – illuminance in circulation space



AGI Open Office Model- vertical illuminance on filing cabinets
Eavg= 6.2 fc
Emax/Emin = 20



AGI Open Office Model- vertical illuminance on face (facial modeling)
Eavg= 35.4 fc
Emax/Emin= 1.07

Daylighting Analysis

A daylight analysis was conducted on CHRRA for the open office south facing glass façade. An automated shade system was to be implemented into the design which would control the level on the shade based on the time of day and the time of year for this specific building location. The shapes would block direct sunlight from entering the workstation portion of the office.

The following spreadsheets were compiled based on information found in several Lightscape daylighting studies of the CHRRA building. LightScape calculations were run based on the latitude and longitude position of Danville, Pa. The daylight study was then run at four different times during a typical work day, over 6 months of the year. For each of these different times, calculations were run to determine if the shades needed to be completely up, 1/4 of the way down the glass, 1/2 of the way down, 3/4 of the way down, or all the way down to the floor. This information was intended to help program the shades based on the time of year.

Month	Time	Shades Up	Shades1/4 down	Shades 1/2 down	Shades 3/4 down	Shades Down
December	10am				X	
	12am				X	
	2pm				X	
	4pm				X	
January	10am				X	
	12pm			X		
	2pm			X		
	4pm				X	
February	10am			X		
	12pm			X		
	2pm			X		
	4pm			X		
March	10am			X		
	12pm			X		
	2pm			X		
	4pm			X		
April	10am		X			
	12pm			X		
	2pm			X		
	4pm		X			
May	10am		X			
	12pm		X			
	2pm		X			
	4pm		X			
June	10am		X			
	12pm		X			
	2pm		X			
	4pm		X			

After determining the proper shade levels for the 6 months of the year, 4 different times of the day, Lighscape was used to determine how much daylight was entering the corridor and the workstation area which would allow for the dimming of the electric lighting. The lighting was broken up and controlled in four different sections: the circulation space with dimming control, the front section of office lighting was dimming control, the middle section of office with dimming control, and the back section of office with on/off control. The following charts show the average illuminance on the work plane from daylight with the appropriate shade level, and what percent of the light in the room will be from daylighting. (This helps to show the possible electric lighting savings).

Month	Time	Area	fc from daylight	% of light that is daylight in rm
December	10am- 3/4 SHADE			
		corridor	direct daylight	100%
		front office	4.9	14%
		middle office	3.7	11%
	12pm- 3/4 SHADE			
		corridor	direct daylight	100%
		front office	11	32%
		middle office	4.9	14%
	2pm-3/4 SHADE			
		corridor	direct daylight	100%
		front office	9.5	27%
		middle office	4.5	13%
	4pm- 3/4 SHADE			
		corridor	direct daylight	100%
		front office	4.7	13%
		middle office	3.8	11%
January	10am- 3/4 SHADE			
		corridor	direct daylight	100%
		front office	6.9	20%
		middle office	5.4	16%
	12pm- 1/2 SHADE			
		corridor	direct daylight	100%
		front office	14.1	40%
		middle office	1.8	5%
	2pm-1/2 SHADE			
		corridor	direct daylight	100%
		front office	18.4	53%
		middle office	2.6	8%
	4pm-3/4 SHADE			
		corridor	direct daylight	100%
		front office	8.3	24%
		middle office	4.6	13%

February	10am- 1/2 SHADE			
		corridor	direct dayligt	100%
		front office	15.83	45%
		middle office	3.22	10%
	12PM- 1/2 SHADE			
		corridor	direct daylight	100%
		front office	16.53	47%
		middle office	2.86	8%
	2pm- 1/2 SHADE			
		corridor	direct daylight	100%
		front office	20.67	59%
		middle office	3.71	11%
	4pm- 1/2 SHADE			
		corridor	direct daylight	100%
		front office	15.41	44%
		middle office	3.71	11%
March	10am- 1/2 SHADE			
		corridor	direct daylight	100%
		front office	22.46	64%
		middle office	3	9%
	12pm- 1/2 SHADE			
		corridor	direct daylight	100%
		front office	13.85	40%
		middle office	4.57	13%
	2pm- 1/2 SHADE			
		corridor	direct daylight	100%
		front office	16	46%
		middle office	3.69	11%
	4pm- 1/2 SHADE			
		corridor	direct daylight	100%
		front office	25.42	73%
		middle office	2	6%

April	10am- 1/4 SHADE			
		corridor	direct daylight	100%
		front office	30.3	87%
		middle office	14.34	41%
	12pm- 1/2 SHADE			
		corridor	direct daylight	100%
		front office	7.43	21%
		middle office	3	9%
	2pm- 1/2 SHADE			
		corridor	direct daylight	100%
		front office	6.41	18%
		middle office	2.39	7%
	4pm- 1/4 SHADE			
		corridor	direct daylight	100%
		front office	33.3	95%
		middle office	14.39	41%
May	10am- 1/4 SHADE			
		corridor	direct daylight	100%
		front office	26.76	77%
		middle office	16.43	46%
	12pm- 1/4 SHADE			
		corridor	direct daylight	100%
		front office	35	100%
		middle office	14.45	41%
	2pm- 1/4 SHADE			
		corridor	direct daylight	100%
		front office	36.91	100%
		middle office	14.45	39%
	4pm- 1/4 SHADE			
		corridor	direct daylight	100%
		front office	30.67	88%
		middle office	17.4	50%

June	10am- 1/4 SHADE			
		corridor	direct daylight	100%
		front office	26.07	75%
		middle office	15.33	44%
	12pm- 1/4 SHADE			
		corridor	direct daylight	100%
		front office	31.57	90%
		middle office	14.4	41%
	2pm- 1/4 SHADE			
		corridor	direct daylight	100%
		front office	36.07	100%
		middle office	13.19	38%
	4pm- 1/4 SHADE			
		corridor	direct daylight	100%
		front office	27.15	78%
		middle office	15.79	45%

Analysis of Existing Lighting System

The existing lighting system in the open office technically meets the illuminance design criteria for an open office with VDT use, but there may be other design issues that will affect occupants of the space. The A1D fixture installed over the workstations had a satin colored lens which causes it to be a bright luminous source on a dark ceiling. There is only direct lighting in this space so the level of contrast between the luminance of the ceiling and that of the fixture will be very high and possibly distracting. The high contrast will also cause direct glare in the eye of the employee, especially since the cubicle stations are partial height and only come up 5 feet. Luminaires within a close distance to the employee will have visible luminous areas. These lighting fixtures will also create problems with veiling reflections in the VDT's. The luminous areas will show up as streaking bright lines on the computer screen, especially when the fixtures are directly behind the workstation.

The AGI model also showed a lack of electric light on the filing cabinets which separate the circulation space from the workspace. These calculations were completed without the daylight component, which will usually make up for the lack of electric light in the space, however at night these levels may be a problem. A closer downlight spacing or choosing a fixture with better lateral light distribution over the filing cabinets may be beneficial.

The lighting in the space provides a good level of vertical illuminance on the faces of the employees making it easier for identification and for work conversations.

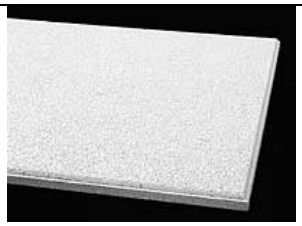
The daylighting analysis shows a great deal of thought went into the consideration for automated shades in the open office. Daylight has the capability to overpower the space and the use of proper daylight controls is vital for the success of the open office lighting system. Unfortunately, automated shades were not installed in the CHRRA building due to the large initial expense. There are manual shades over the glass curtain wall, but relying on employees to constantly change the shade levels is neither efficient nor realistic. Daylight integration is not successfully achieved in this space and additional heat gains and possible employee discomfort will result from the lack of daylighting control.

Auditorium

Existing Lighting System

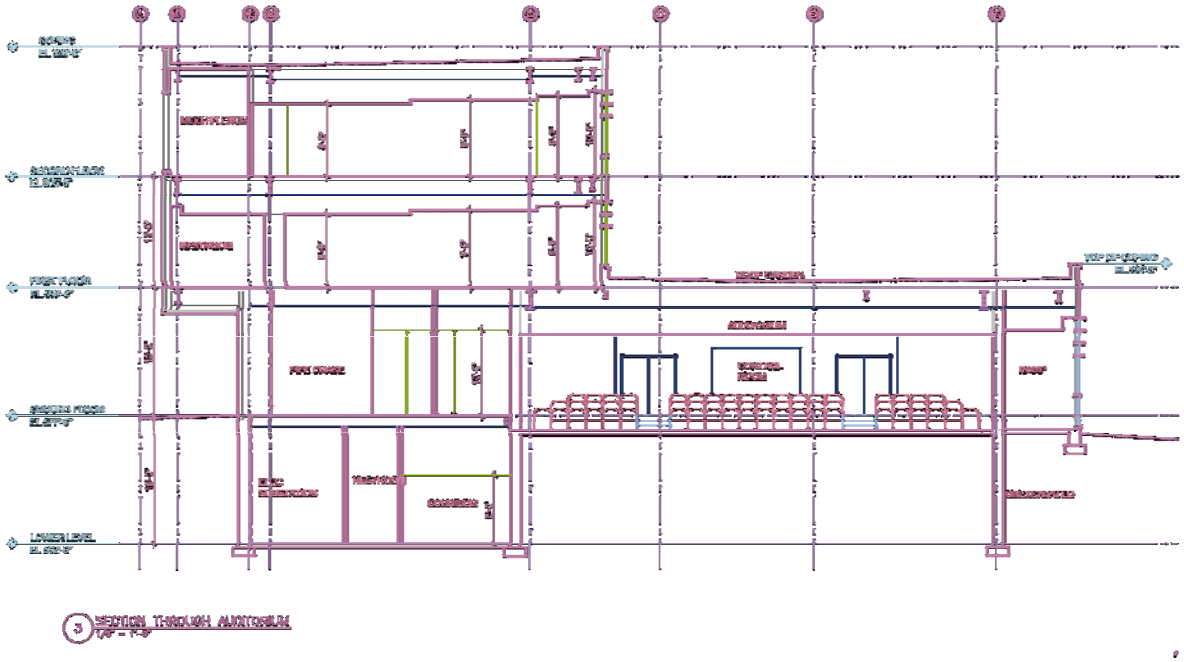
The auditorium is a 400-seat ellipsoidal space that has stadium seating from the lower level up into the ground floor. The current lighting system is 100% dimming with separate controls for audience, speaker, and accent lighting. There is a dimmable, compact fluorescent biax lamp curved cove that goes around the entire perimeter of the space. The seating area has linear fluorescent T8 direct fixtures that are parallel with the rows of seating. The stage/ speaker area has compact fluorescent dimming downlights that are on equal spacing. The entire system is controlled by a preset control panel behind the speaker podium in the front of the auditorium. There is also a projector room in the back of the auditorium. This space is in the center of the building and therefore has no daylight integration.

Room Surface Materials

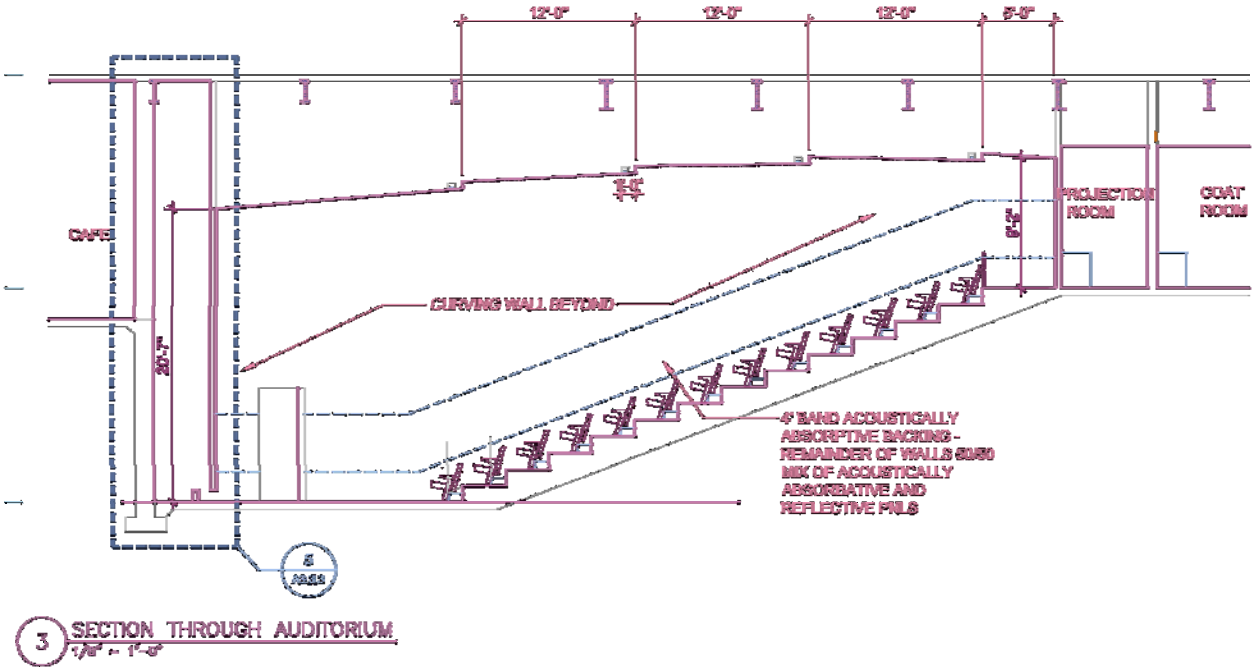
 (p=0.08)	 (p=0.03)
Auditorium Commercial Carpeting	Auditorium Rubber Flooring- stairs
 (p=0.46)	(p=0.95)
Accent Fabric Wall Covering	Primary Wall Paint
 (p=0.85)	
Armstrong 2'x4' beveled acoustic tile ceiling	

Auditorium Room Furnishings

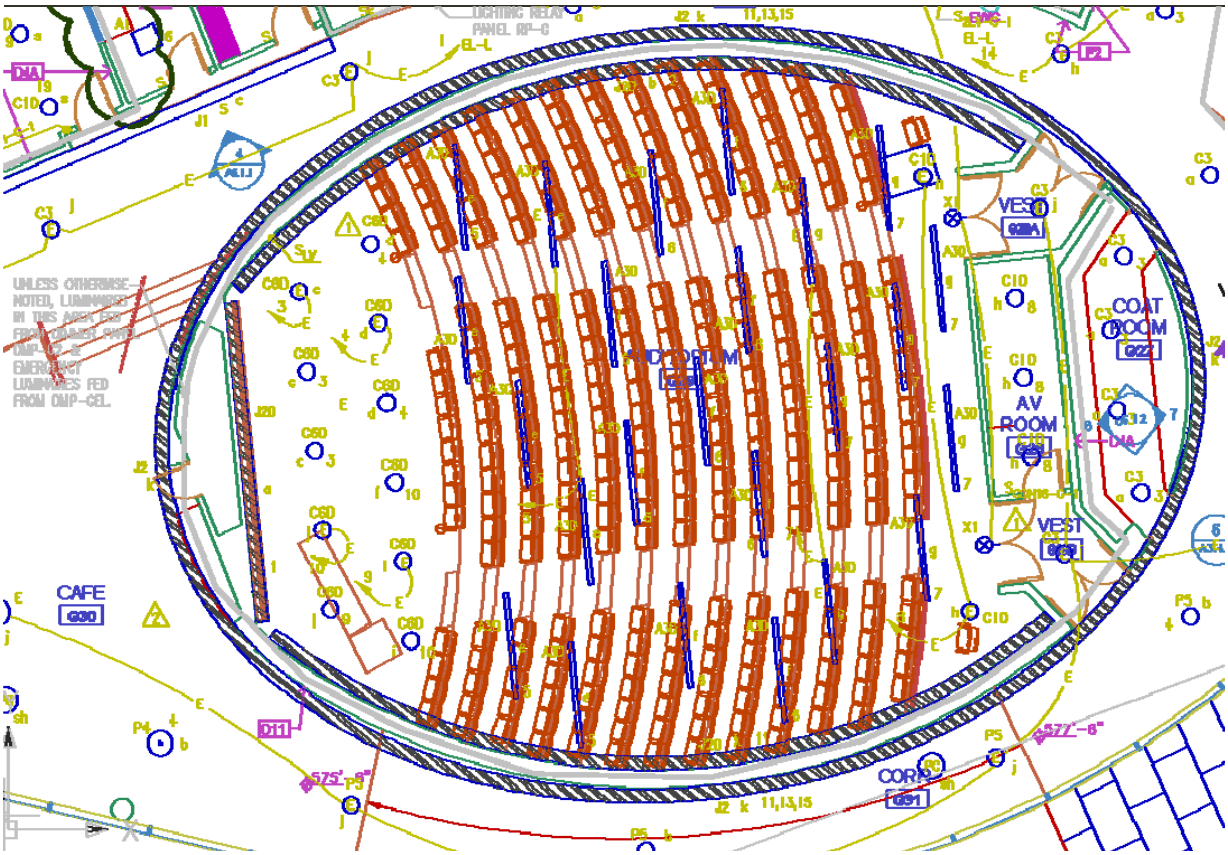
	
Auditorium	Audience Stadium Seating
	Matte white background with black trim
Auditorium	Projection Screen



Auditorium Section One- North/South



Auditorium Section 2- East/West



Auditorium Existing Lighting Plan

Auditorium Luminaire Schedule

AUDITORIUM LUMINAIRE SCHEDULE

TYPE	DESCRIPTION	MANUFACTURER	CATALOG NUMBER	LAMP NO.	LAMP TYPE	LAMP WATTS	BALLAST NO.	BALLAST TYPE	VOLTAGE	MOUNTING	NOTES
A3D	4"X8' ONE LAMP RECESSED LINEAR FLUORESCENT WITH SATINE LENS, EXTRUDED ALUMINUM HOUSING, BAKED WHITE ENAMEL FINISH.	SE'LUX ZSLI LINEAR FOCAL POINT	M1R1-1T8-SD-SH-008-WH-120 APPROVED EQUAL APPROVED EQUAL	2	F32T8 3500K 82 MIN CRI	32	1	ELECTRONIC DIMMING	120	RECESSED	
C1D	8" DIAMETER APERATURE TWO LAMP COMPACT FLUORESCENT DOWNLIGHT WITH CLEAR ALZAC REFLECTOR, PARABOLIC CROSSBAFFLES AND WHITE PAINTED FLANGE WITH DIMMING BALLAST.	LITHONIA COOPER ZSLI	AFZ-2/26DTT-84A-120-DM APPROVED EQUAL APPROVED EQUAL	2	PL-C 26 3500K 82 MIN CRI	26	1	ELECTRONIC DIMMING	120	RECESSED	
C6D	DECORATIVE COMPACT FLUORESCENT DOWNLIGHT.	GOTHAM COOPER ZSLI	PDGF-2/32TRT-BAR-WHT-277-D APPROVED EQUAL APPROVED EQUAL	2	PL-T 32 3500K 82 MIN CRI	32	1	ELECTRONIC DIMMING	120	RECESSED	
J2D	ONE LAMP RAMPED FIELD CURVABLE FLUORESCENT STRIP COVE LUMINAIRE WITH DIMMING BALLAST.	BELFER CELESTIAL	2855FX2S391E-* APPROVED EQUAL	1/ SEC	BX39 3500K 83 MIN CRI	39	1	ELECTRONIC DIMMING	120	COVE	*SEE NOTE 1

1. Field measure for actual lengths

FIXTURE	BALLAST	B.F.	P.F.	INPUT WATTS
A3D	electronic dimming programmed start 120v	0.05/1.0	0.99	9/35
C1D	electronic dimming programmed start 120v	0.05/1.05	0.98	16/58
C6D	electronic dimming programmed start 120v	0.05/1.0	0.98	20/76
J2D	**Unable to find dimming ballast**	**Assumed 0.9**		

IESNA Lighting Design Criteria

System control and flexibility is very important in this space because it will be used for many different types of assemblies. This building houses the heath research department for Geisinger so presentations can range anywhere from completely professional on a scientific level, to educational for children. Different audiences cause a need for different lighting moods in the space. The speaker lighting, audience lighting, and any accent lighting should all be controlled separately and should be dimmable. There should be proper light levels in the audience for reading, and note taking. This room will also hold a front lit projection system for visual demonstration.

Facial modeling and vertical illuminance levels are important for group discussion and presentations. When open discussion takes place, which is possible in this auditorium, both the speaker and the audience should be well lit vertically but also free from direct glare in order to stimulate conversation. It is also important to create a balanced lighting system in the front of the auditorium where both the presenter and the projector screen are located. It is important to front light the speaker but also to avoid lighting the screen to avoid contrast issues, reflected glare, etc. This is why luminaire selection is critical.

Lamps must have a tight beam spread in the front of the space to avoid issues with the projector screen. Also, it is important to choose fixtures that match with the surrounding architecture and feel appropriate in the space. This is an area where visitors to the campus will come and it is important the auditorium reflect the hospital in a positive manner. The ceiling is also many different levels as it steps back from the stage up to the top of the auditorium. This coupled with the ellipsoidal shape makes it crucial to coordinate the fixture locations with the architects. Lamps should not be visible to avoid any direct glare issues.

Glare in the eyes of the speaker is as much a problem as it is for the audience. It is important to front light the speaker, and the optimal angle to do so would be 45 degrees from the normal; however, this would put the speaker in direct view of the lamp and the luminous area of the fixture. It is important for the speaker to appear comfortable and confident to the audience, but this could be somewhat difficult to achieve with an abundance of light in the presenter's face. Choosing luminaires specifically created for this purpose may be necessary. Veiling reflections can be an issue for the audience off of the screen, and off of any highly reflective, specular surfaces. It is important in the auditorium, not only for acoustical reasons but also for lighting design, that the room surfaces are matte and absorptive (fabrics and paneling).

The suggested vertical illuminance on walls for an auditorium is category A- 3 fc.
The suggested horizontal illuminance for an auditorium is category B or C- 5 to 10 fc.

Power Density/ Lighting System Control Requirements

The power density requirement for an auditorium, in accordance with the ASHRAE 90.1 Space-by-Space method, is 1.5 Watts per square foot. Auditoriums are not actually listed in the chart, but I decided this auditorium acted like a multipurpose space and I used the appropriate power density. An additional 1.0 Watts per square foot is also allowed for accent lighting systems such as highlighting artwork, chandeliers or wall sconces.

Because this space is a large presentation space and in some ways acts like a theater, it is not appropriate to have automatic shut off control unless it is heat sensitive. This is a space where there may not be a lot of movement, just and audience sitting still. An automatic shut off based on the time of day and on business hours with a manual override is more appropriate for the space.

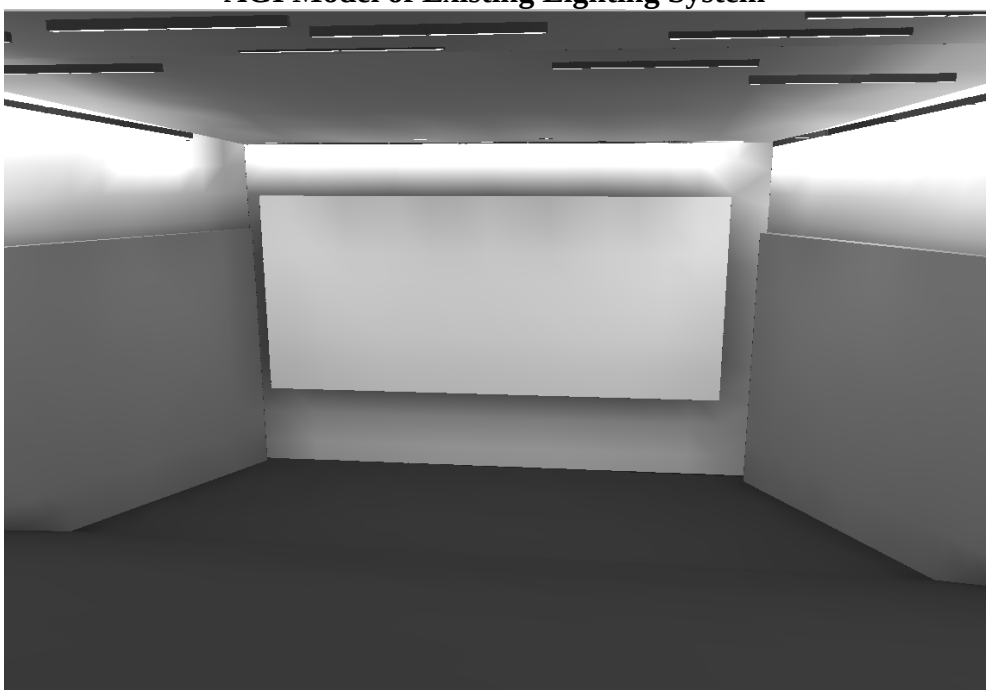
Light Loss Factors

Fixture	LLD for lamp	Luminaire Category	LDD for fixture	Ballast Factor
A3D	0.95	five	0.94	1.0
C1D	0.86	four	0.95	1.05
C6D	0.84	four	0.95	1.0
J2D	0.9	one	0.95	0.9

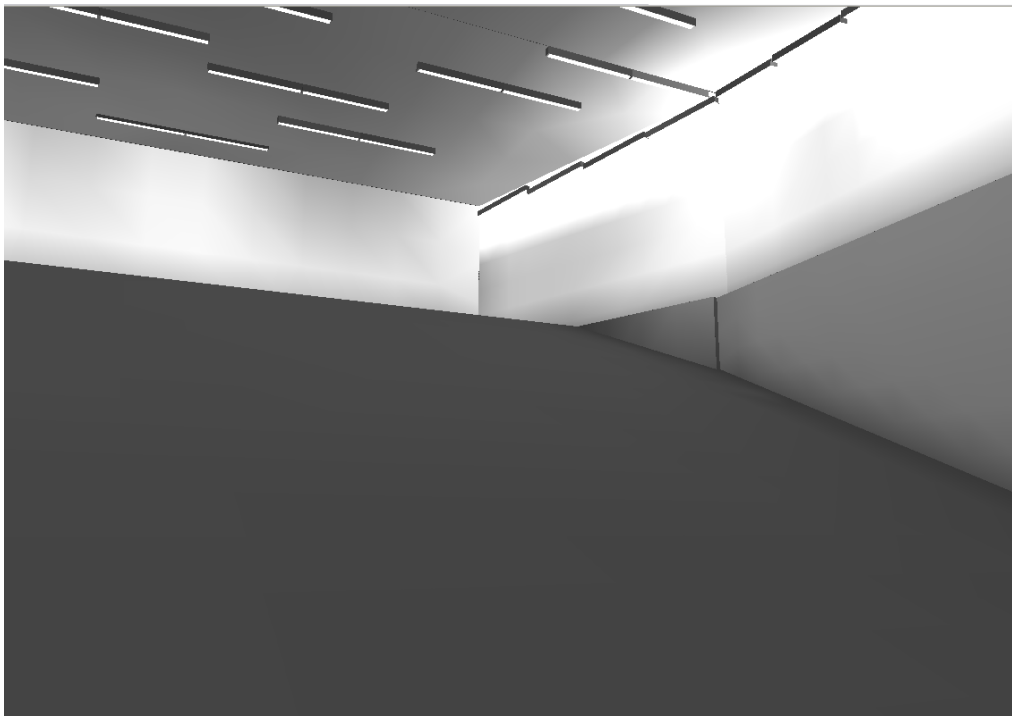
Space	Room Cavity Ratio (RCR)	RSDD
AUDTIORIUM	2.43	0.98

SPACE	LUMINAIRE	TOTAL LLF
AUDITORIUM	A3D	0.81
	C1D	0.84
	C6D	0.78
	J2D	0.75

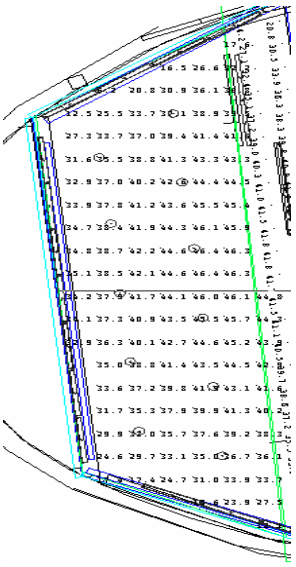
AGI Model of Existing Lighting System



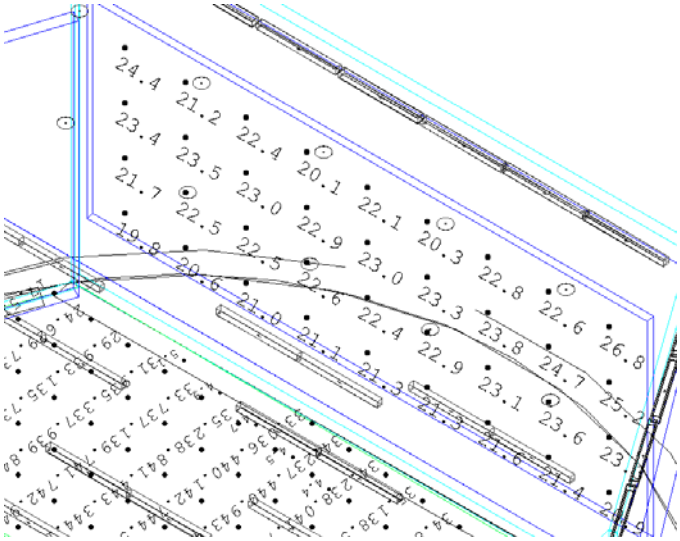
Auditorium- AGI grayscale image (illuminance-fc)



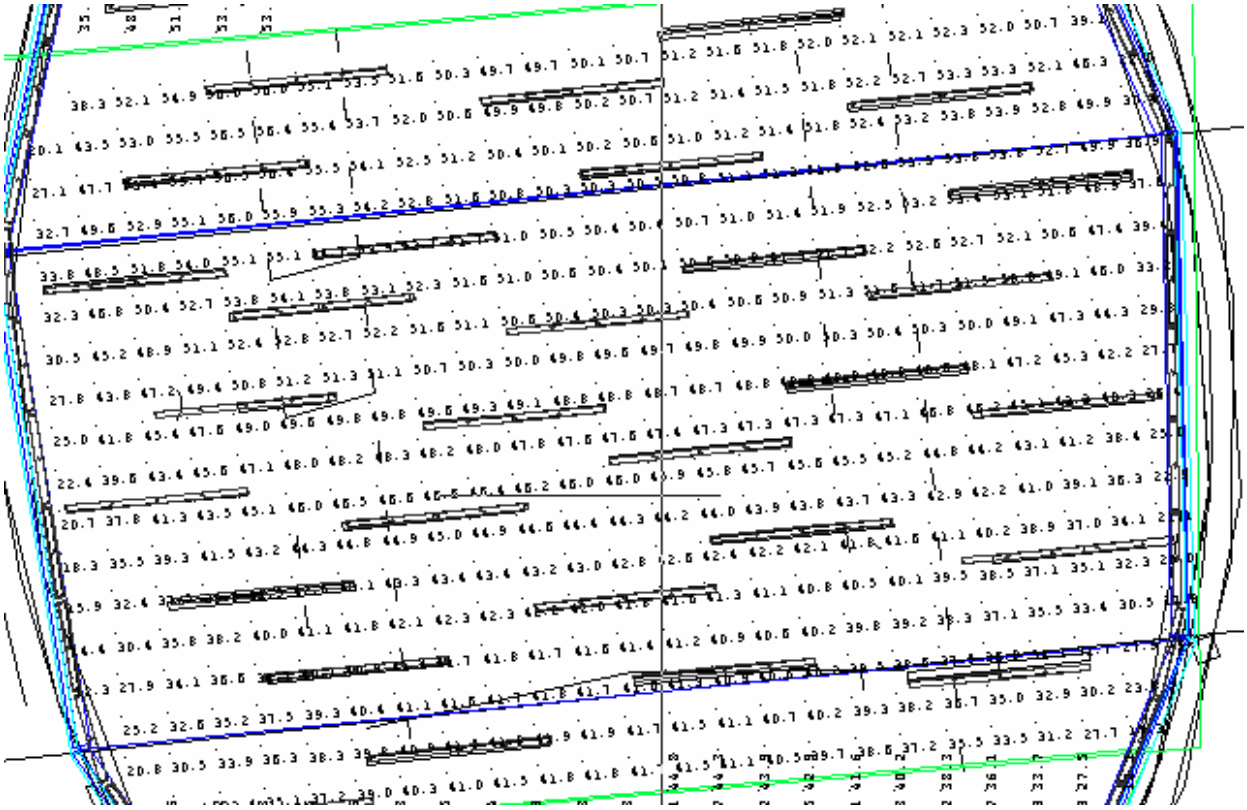
Auditorium view from speaker area- AGI grayscale image



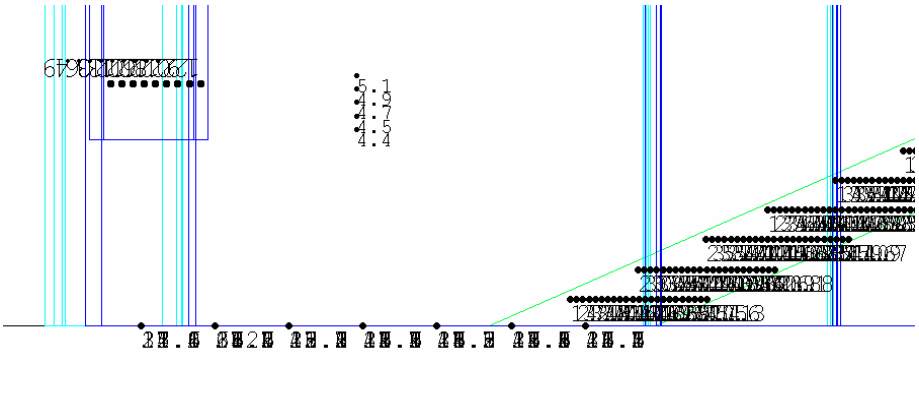
The illuminance (fc) calc points on the floor of the speaker area
Eavg= 36.7 fc
Emax/Emin= 7.48



The vertical illuminance (fc) calc points on the white projector screen in the front of the auditorium.
Eavg= 22.48 fc
Emax/Emin= 1.35



The illuminance (fc) on the floor of the sloped audience seating area of the auditorium
Eavg= 44.32 fc
Emax/Emin= 4.59



The small calc points in the middle of the speaker space were to calculate facial modeling.
Eavg between 5' and 7' off floor = 4.72 fc

Analysis of Existing Lighting System

The auditorium is a very interestingly shaped space, making it more of a challenge to light effectively. The current layout and control system does a good job of providing multiple lighting zones to create versatile lighting which can be made appropriate for several different functions. There is also a great deal of layering of lighting, making the walls glow, illuminating the audience, and separately lighting the speaker and the stage. Layering light makes the space more interesting and helps direct an occupants' attention to the proper areas in the space.

The AGI model shows that the illuminance levels are somewhat high for the possibly functions of the auditorium. The audience lighting has an average illuminance level high enough for an open office without computer screens. There is dimming which will allow the lighting to be brought down to a more appropriate level, but it seems there is a bit of over design and not all of the fixtures may actually be needed in the space. The illuminance level on the front stage of the auditorium is very close to that of the audience. This makes it difficult to really highlight the speaker without dimming the audience lighting significantly. There is also only one lighting system provided (the downlights) for the front area of the space. The projection screen and the speaker are both being illuminated by one source of lighting which makes it difficult to control issues such as glare and low contrast on the projector screen. This is a front projection setup which does not work well with direct front lighting. Seeing the images on the screen from the audience seating may be difficult unless all the front lighting is turned off. In this case, a speaker could not be seen while explaining the visual aid.

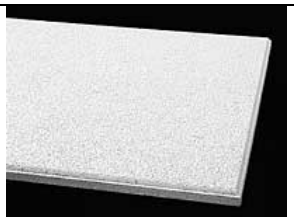
The downlighting system is also not the most ideal type of light distribution for facial modeling. The majority of the light output is directly downward which can make a person appear ghostly. Lighting the speaker from a 45 degree angle would be more appropriate.

Lobby

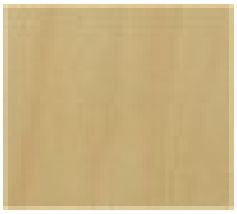
Existing Lighting System

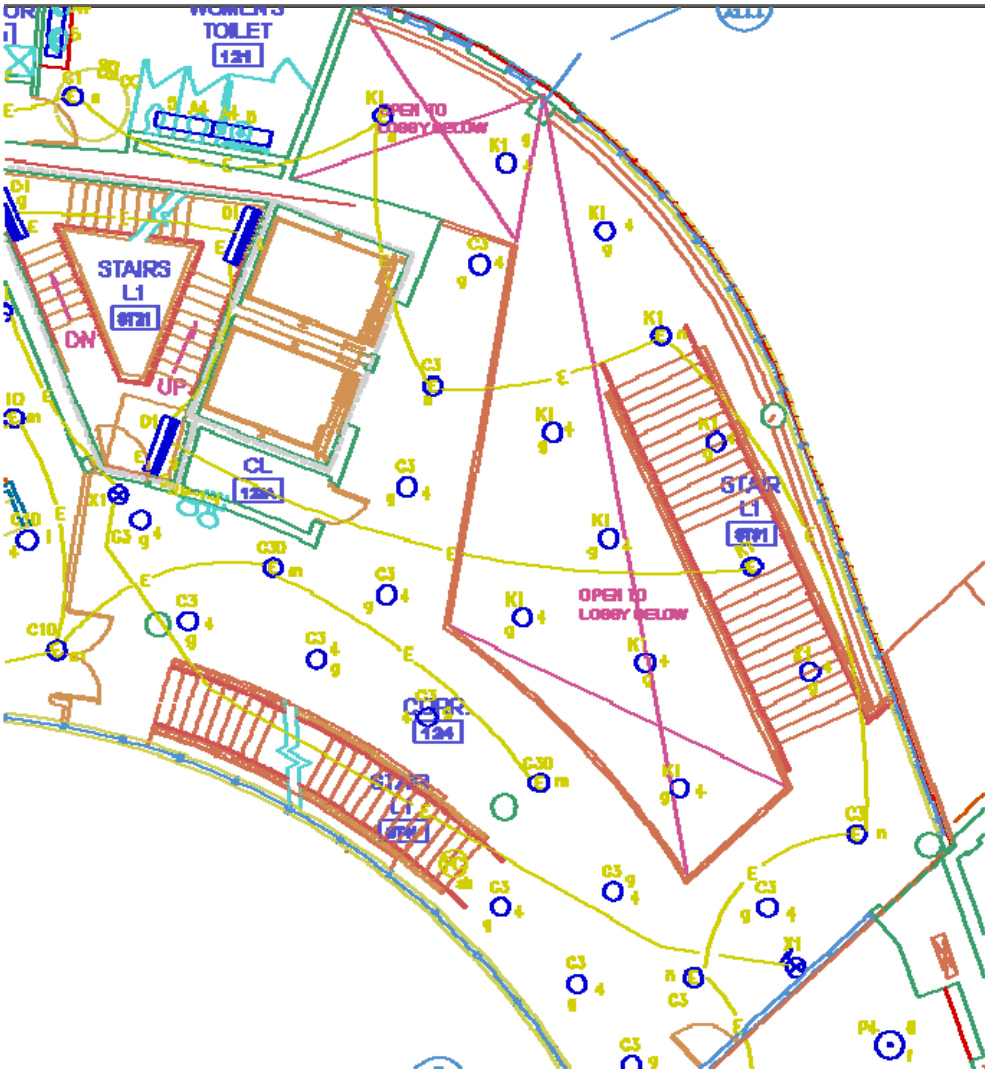
The Lobby is the double height main circulation space as you enter the building. The exterior walls are glass, bringing a great deal of transition daylight into the space. The current lighting system consists of recessed induction lamp downlights in the double height space. Directly next to this is circulation space both on the first and second floors. Here the design utilizes compact fluorescent downlights. The system is not dimmed and is not controlled in order to integrate daylight.

Room Surface Materials

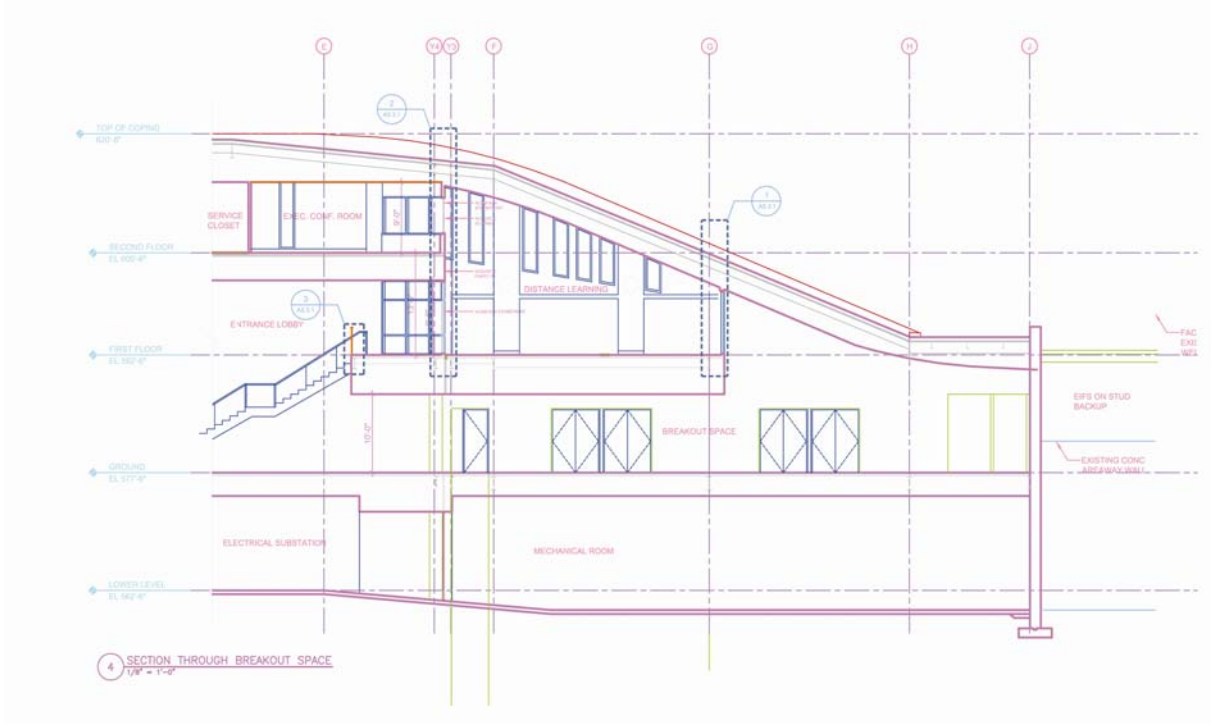
 (p=0.13)  (p=0.01)	 (p=0.05)  (p=0.28)
Floor Tile (1 and 2)	Floor Tile (3 and 4)
 (p=0.39)  (p=0.22)	 (p=0.62)
Floor Tile (5 and 6)	Wood Wall Veneer
(p=0.95)	 (p=0.85)
Primary Wall Paint	Armstrong 2’x4’ beveled acoustical ceiling tile
 (p interior=0.10) (t= 0.45)	
Insulated Low-E Glazing	

Lobby Room Furnishings

	
Lobby Circulation	Coffee Table
	
Lobby Circulation	Circulation Space Metal Chair with Black Fabric
	
Lobby Circulation	Circulation Space Metal Chair with Burgundy Fabric



Lobby Existing Lighting Plan



Lobby Section 1- East/West

Lobby Luminaire Schedule

LOBBY LUMINAIRE SCHEDULE												
TYPE	DESCRIPTION	ANUFACTURE	CATALOG NUMBER	LAMP NO.	LAMP TYPE	LAMP WATTS	BALLAST NO.	BALLAST TYPE	OLTAG	MOUNTING	NOTES
C3	6" DIAMETER APERATURE ONE LAMP COMPACT FLOURESCENT, SEMI RECESSED DOWNLIGHT WITH GLASS DIFFUSER.	DELRAY WILA	1-32-4740.0.1 APPROVED EQUAL	1	PL-T 32 3500K 82 MIN CRI	32	1	ELECTRONIC	120	RECESSED	
K1	9" APERATURE INDUCTION LAMP LUMINAIRE WITH DUAL REFLECTOR.	KIRLIN INDY	RR80980 APPROVED EQUAL	1	QL 85	85	1	ELECTRONIC	120	RECESSED	

FIXTURE	BALLAST	B.F.	P.F.	INPUT WATTS
C3	electronic rapid start 120v	0.98	0.98	36
K1	**Could only find as a induction system, could not find ballast information**	**Assumed 0.85**		

IESNA Lighting Design Criteria

The lobby is the first space a person sees when entering a building. It also serves as the transition between daylight and electric lighting. It is therefore important to consider the luminance values of the room surfaces. In this lobby, the exterior wall is a large, curved glass curtain wall. A great deal of daylight will enter the space, creating a large surface with an extremely high luminance. Keeping the other room surfaces a light color may help to balance the overwhelming amount of daylight. Using a glazing with a lower transmittance may also help to lower the luminance level. It is important to transition from a bright space to a darker space gradually to avoid discomfort and a drastic change in vision. It is also important to highlight areas which should be seen first to lead people who may not be familiar with the building in the correct direction. Highlighting the stairs is important for this reason.

The appearance of the surfaces and the color rendering are also important. This space is one of the few that has wood paneling and an elaborate tile floor design. These surfaces should be lit in such a way to enhance their color and appearance. The contrast between colors should be addressed since this space is more decorative than many of the other office areas in the building. Choosing a lamp type with good color rendering at a wide range of wavelengths is crucial to the appearance of the space. The luminaires should also fit with the appearance of the space. Although this is a double height space and the majority of the lighting fixtures are out of normal view, wall sconces and accent lighting may be used at a lower level. These luminaires should be in sync with the mood the architect has created.

Daylight integration and control will be crucial in the lobby to avoid extreme direct glare and discomfort. Although this is considered a circulation space, there are furnishings such as chairs and coffee tables where patrons may sit and read a paper, or wait for a meeting. This would not be a comfortable space to relax with direct sunlight. The daylight may also allow for the dimming or on/off control of the light fixtures in the space. Photocell control may be optimal for the lobby.

Direct Glare may also be a result of the excessive daylight. There may be a glare in the eye of the readers/ receptionist, etc. Veiling Reflections will also be a serious concern especially when considering the floor material chosen for the lobby. The stone tiling is highly reflective and will create definite reflected glare. Any luminaires used on a lower level may also cause glare if not shielded correctly. The lobby should have a calm feeling so the use of ambient lighting is important.

Facial modeling can be important especially since the lobby serves as a meeting ground. It is important to recognize faces from a reasonable distance in order to find guests, clients, speakers, etc. who may not be familiar with the building.

Illuminance uniformity is important in the break out areas where people may be sitting and reading. It is important to have enough light where occupants are not straining their eyes. A higher illuminance level may be necessary in these areas than the general circulation space of the lobby. This area also has a lower ceiling and is farther away from the daylight, so the use of electric light to provide the proper light levels will be more crucial.

The use of color may also be considered as a design tool in the lobby space. Color can create interesting effects that add visual drama to the space and make it more stimulating.

The suggested horizontal illuminance value for a lobby is category C- 10 fc for circulation, but I think this space is an exception, and a higher level (closer to 25-30 fc) is necessary where reading and writing may take place.
The suggested vertical illuminance value for a lobby is category A- 3 fc.
Horizontal illuminance for a receptionist workstation should be 30fc.
Art Work should be highlighted with a 10:1 luminance ratio with the surrounding wall.

Power Density/ Lighting System Control Requirements

The power density requirement for a lobby, in accordance with the ASHRAE 90.1 Space-by-Space method, is 1.3 Watts per square foot. An additional 1.0 Watts per square foot is also allowed for accent lighting systems such as highlighting artwork, chandeliers or wall sconces.

Timed automatic shut off based on operation hours along with a maintenance override may be the best method for the control system. Having switching in the space is not really appropriate since it is a public area.

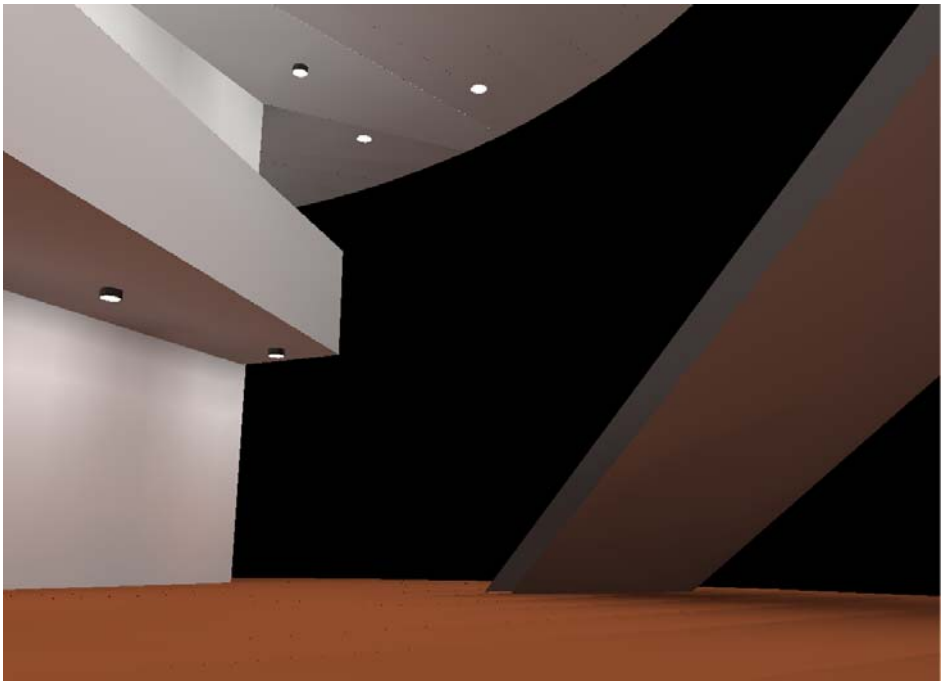
Light Loss Factors

Fixture	LLD for lamp	Luminaire Category	LDD for fixture	Ballast Factor
C3	0.84	five	0.94	0.98
K1	0.76	four	0.95	0.85

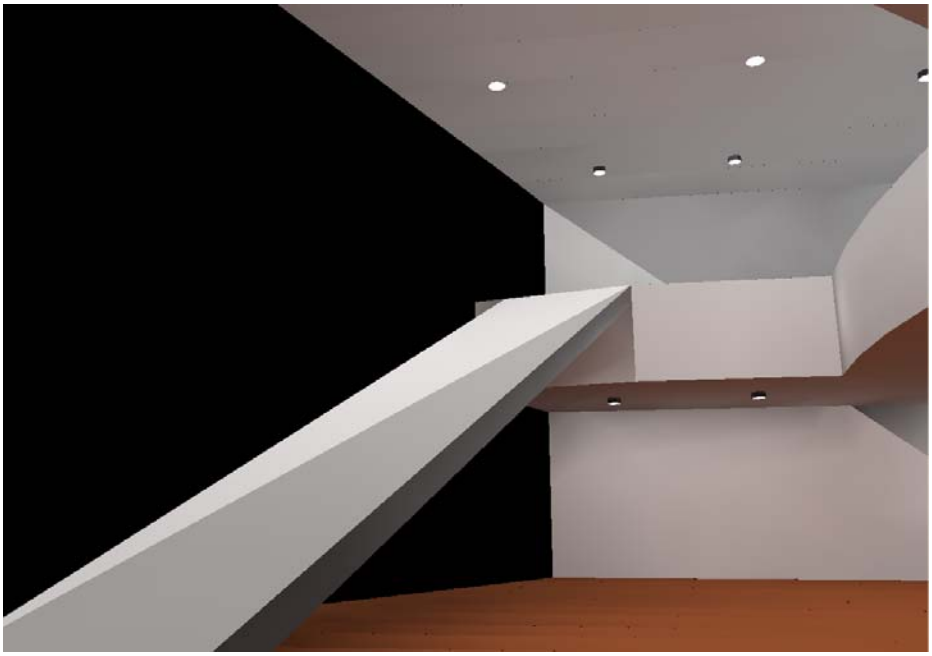
Space	Room Cavity Ratio (RCR)	RSDD
LOBBY	10.65	0.96

SPACE	LUMINAIRE	TOTAL LLF
LOBBY	C3	0.74
	K1	0.59

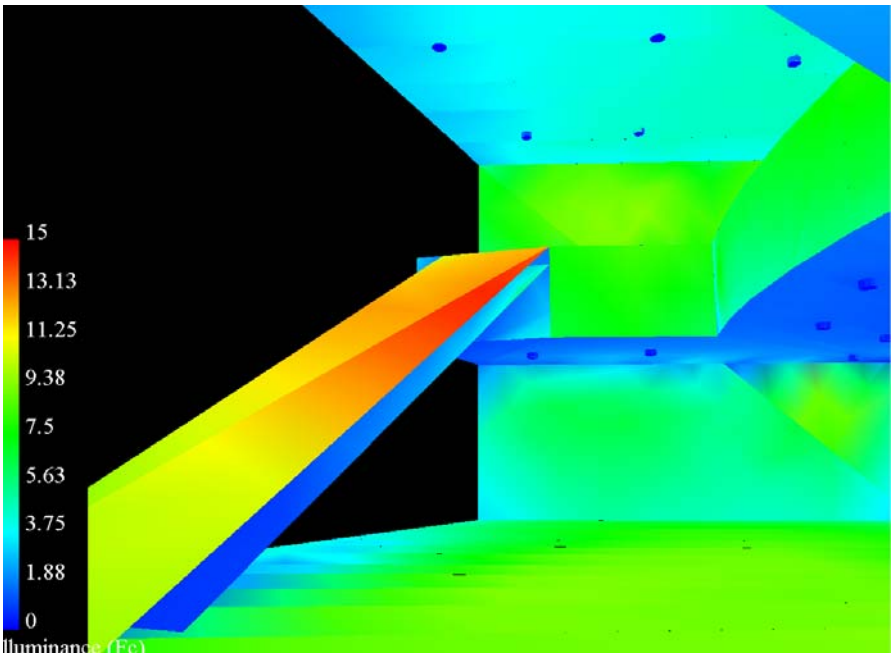
AGI Model of Existing Lighting



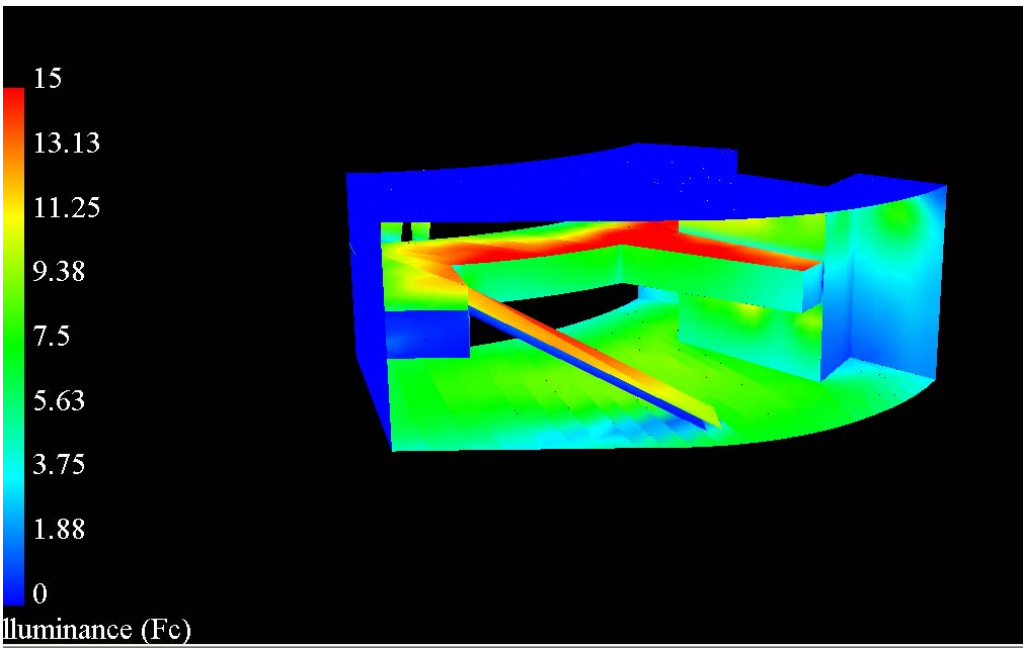
AGI Lobby Model- view from behind stairs looking out north glass façade



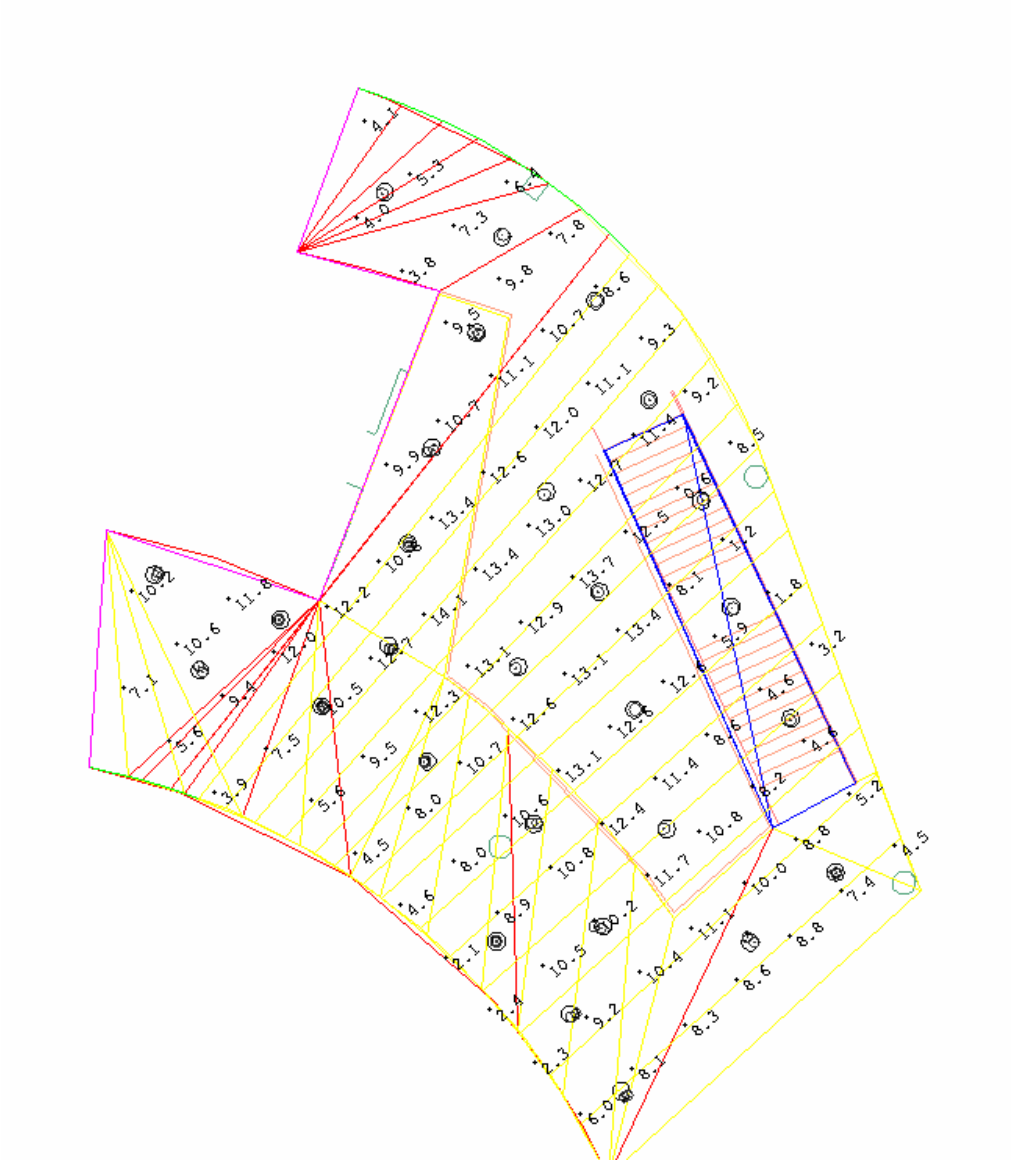
AGI Lobby Model- view from entrance, looking up stairs



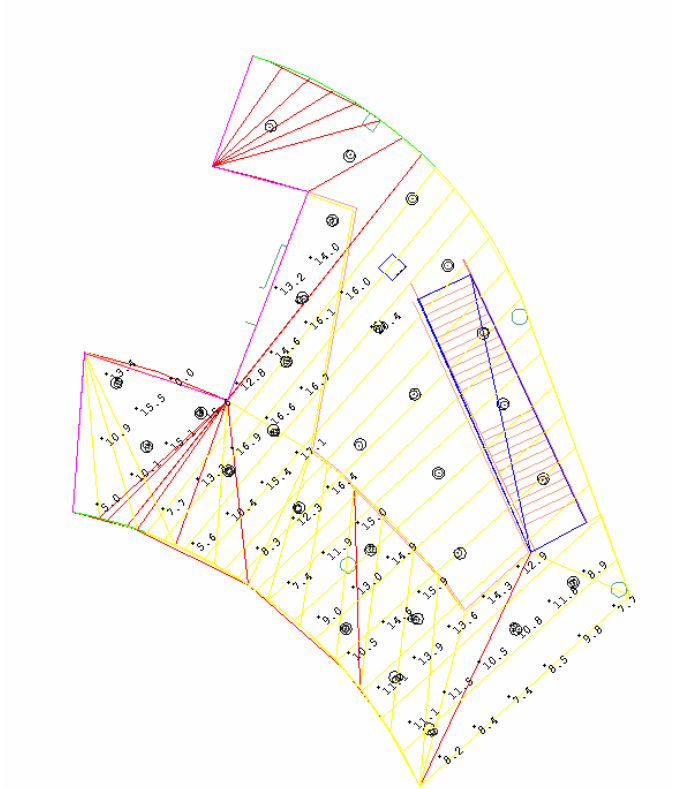
AGI Lobby Model- Pseudo of illuminance (fc) on stairs, floor, walls



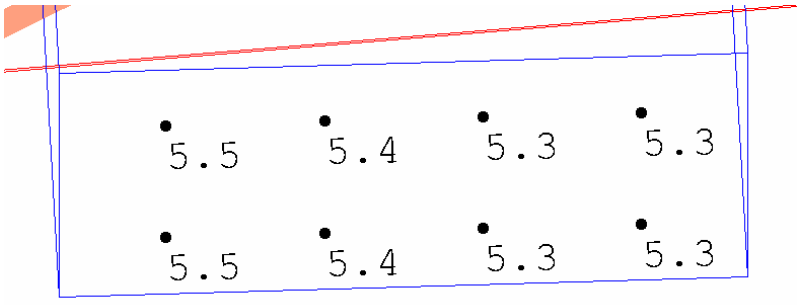
AGI Lobby Model- Pseudo of illuminance (fc) on second floor breakout space



AGI Lobby Model- illuminance (fc) on floor of ground level
Eavg= 9 fc
Emax/Emin= 23.50
Emax= 14.1 fc
Emin = 0.6 fc



AGI Lobby Model- illuminance (fc) on floor of second level
Eavg=12.11 fc
Emax/Emin= (NA min of 0)



AGI Lobby Model- vertical illuminance (fc) on face (Facial modeling)
Eavg= 5.4 fc
Emax/Emin= 1.04

Analysis of Existing Lighting

The existing lighting layout for the lobby deals well with maintenance issues due to the double height ceiling. The use of induction lamps provides a dimmable option for the luminaires while also holding a longer lamp life and incandescent.

The illuminance levels on the ground of the lobby are satisfactory for a circulation space, but may be low for tasks such as reading. The calculations completed in the AGI model did not include the daylight component of the lobby which would provide a significant amount of daylight into the space. However, at dusk or night the electric lighting system may be a bit inadequate.

The current lighting design does a good job of keeping a uniform illuminance level between single height and double height spaces. The illuminance on the floor of the compact fluorescent areas are very similar that that on the floor of the induction lamp areas. The daylight entering through the glass curtain wall will add an element of drama to the space which is usually a plus for a circulation area.

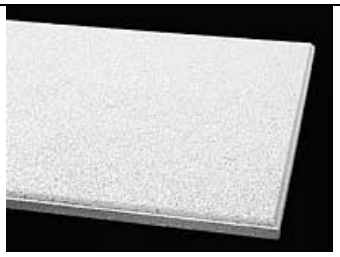
The luminaires near the glass curtain wall are not controlled by photocell. The compact fluorescent downlights are on/off control. Daylight integration is not completed in this case where electric lighting dimming could account for added energy savings in the daytime hours.

Multipurpose Room

Existing Lighting System

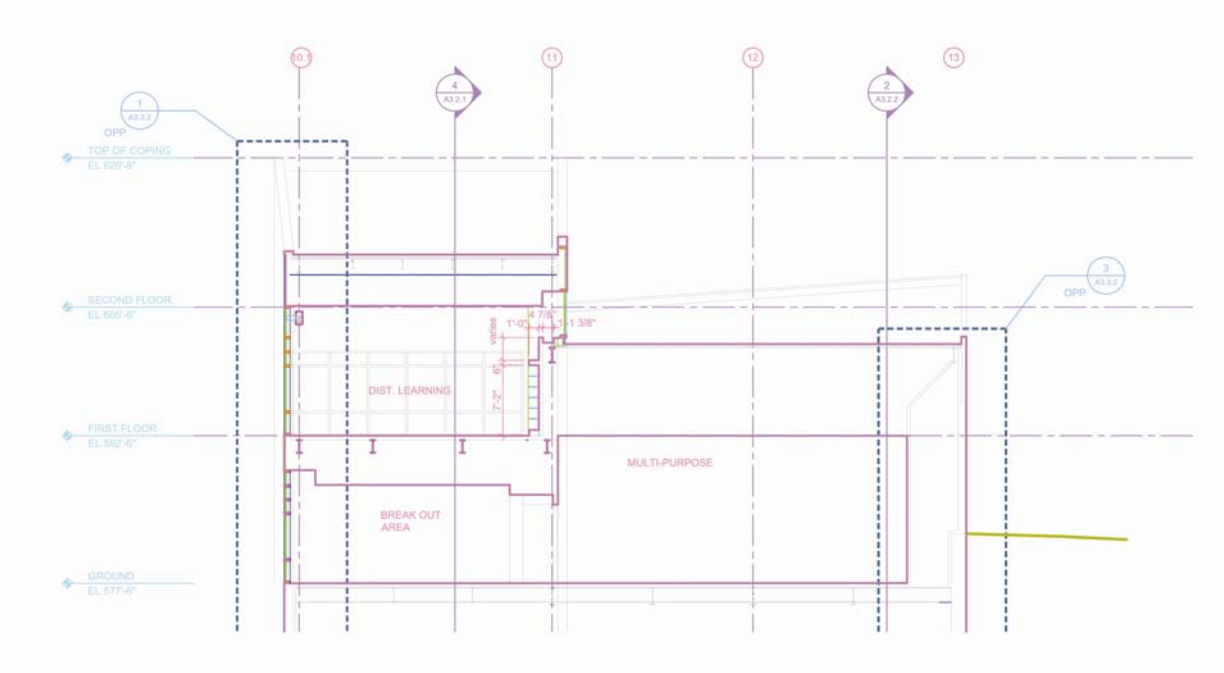
The multipurpose room is one large space which can be broke down into three separate spaces with moveable partition walls. The general lighting consists of linear fluorescent T8 dimming fixtures controlled separately in the three different smaller spaces. Along the North and South sides of the smaller areas are architectural coves with linear fluorescent T8 concealed cove luminaires. These are also controlled separately according to smaller spaces. The entire area is controlled via a dimmer panel which controls the lighting based on signaling which can tell if the partitions are opened or closed. This allows the occupants the control the space as a whole or as three separate areas from one control panel.

Room Surface Materials

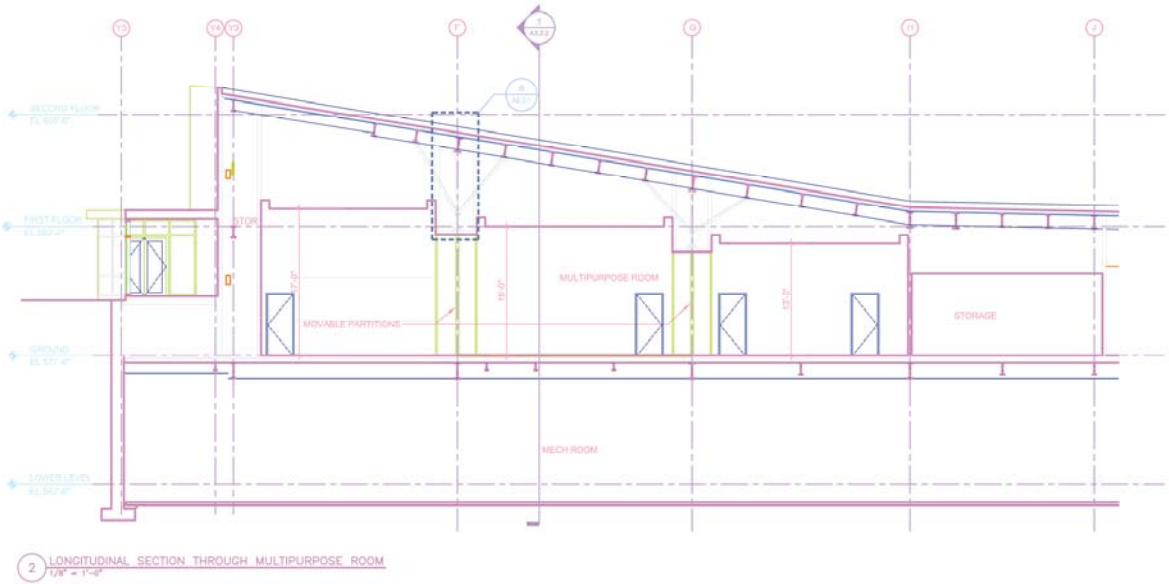
 (p=0.07)	 (p=0.85)
Multipurpose Commercial Carpeting	Armstrong 2'x4' beveled acoustical ceiling tile
(p=0.95)	
Primary Wall Paint	

Multipurpose Room Furnishings

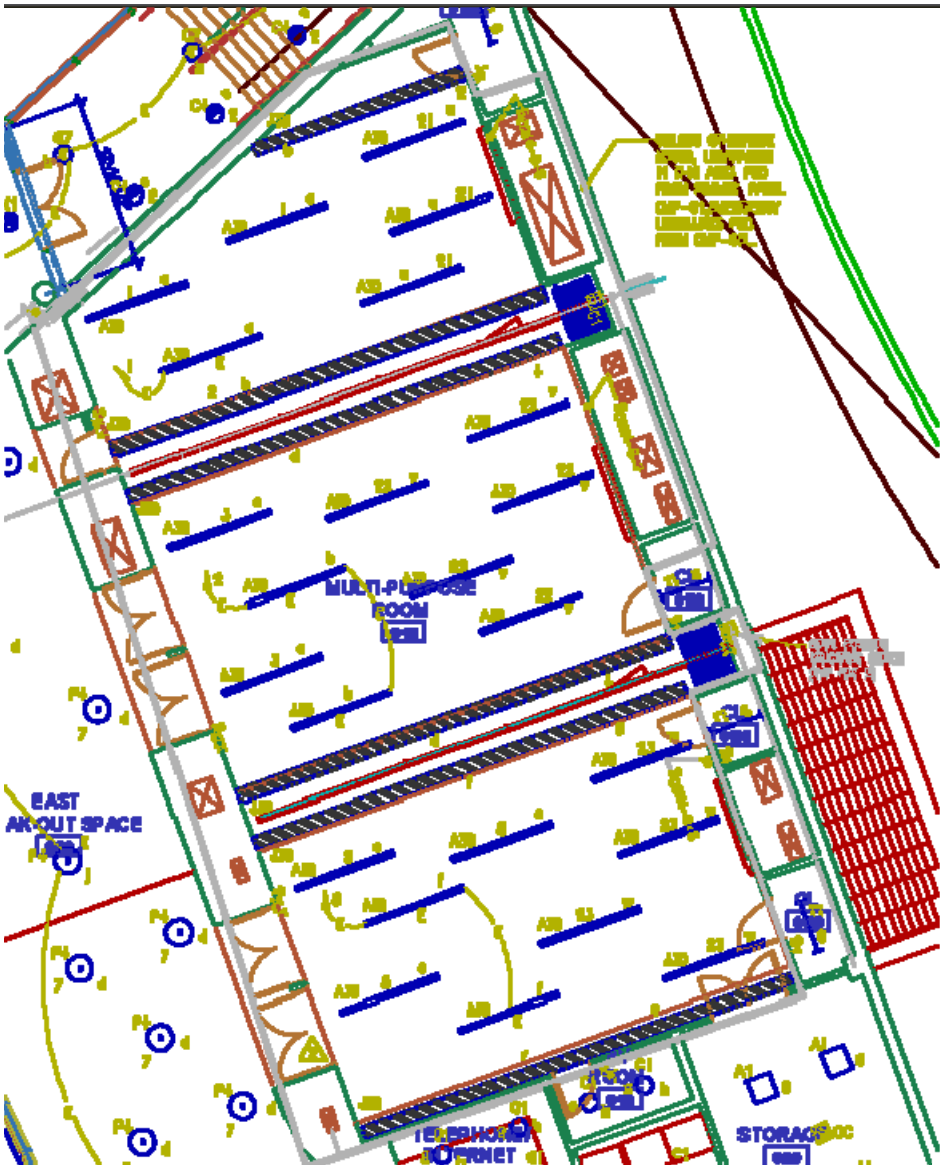
	
Multipurpose Room Typical Chair	Black Plastic with metal frame
	
Multipurpose Room Work Stations	Plastic laminate top with aluminum finishes
	
Multipurpose Room Banquet Tables	Round Light weight folding table



Multipurpose Room Section 1- East/West



Multipurpose Room Section 2- North/South



Multipurpose Room Existing Lighting Plan

Luminaire Schedule

MULTIPURPOSE LUMINAIRE SCHEDULE

TYPE	DESCRIPTION	MANUFACTURER	CATALOG NUMBER	LAMP NO.	LAMP TYPE	LAMP WATTS	BALLAST NO.	BALLAST TYPE	VOLTAGE	MOUNTING	NOTES
A3D	4"X8' ONE LAMP RECESSED LINEAR FLUORESCENT WITH SATINE LENS, EXTRUDED ALUMINUM HOUSING, BAKED WHITE ENAMEL FINISH.	SE'LUX ZSLI LINEAR FOCAL POINT	M1R1-1T8-SD-SH-008-WH-120-DI APPROVED EQUAL APPROVED EQUAL	2	F32T8 3500K 82 MIN CRI	32	1	ELECTRONIC DIMMING	120	RECESSED	
J3D	ONE LAMP CONCEALED COVE LUMINAINE WITH WHITE REFLECTOR, DIMMING BALLAST.	LITECONTROL LEDALITE PMC	CC-A130-*-*-T8-CWM-DIM APPROVED EQUAL APPROVED EQUAL	1/ SE C	F25T8/F32T8 3500K 82 MIN CRI	5/3	1	ELECTRONIC DIMMING	120	COVE	*SEE NOTE 1

FIXTURE	BALLAST	B.F.	P.F.	INPUT WATTS
A3D	electronic dimming programmed start 120v	0.05/1.0	0.99	9/35
J3D	electronic dimming ballast 120v	0.05/0.88	0.9/0.99	8/35

IESNA Lighting Design Criteria

A flexible lighting design is important for the multipurpose room because of the moveable partitions and the area's large range of uses. Geisinger will be using this space for small banquets and receptions, so a more elegant and decorative lighting system should be incorporated with the standard task lighting system. On a normal basis, the room will have rows of tables with desk like stations facing the front of the room. Flexible lighting layouts should be available for different types of presentation and seminar lighting. Zoning between the front and back of the space should be considered. It is also important to have controls that can adapt to the larger area being broken down into three smaller work spaces. These three work areas should have control over their own lighting with out any effects on the adjacent areas.

Uniformity of the light distribution on the task plane is critical for reading and writing tasks. The multipurpose room will most likely hold tutorials and information session on a regular basis where attendees will receive handouts and worksheets. When the space acts as a more formal banquet setting, illuminance levels can be much lower. Dimming the task fixtures may be necessary to achieve the proper ambient lighting in the space.

The luminances of room surfaces should be considered during the design process to avoid any bright spots or direct glare in the room. The walls should have accent lighting in order to balance the potentially high ceiling luminance values (with an indirect system). The materials of this room are also important. Although it is not overly decorative, the materials should be rendered properly especially in the banquet setting.

Facial modeling for a speaker and the audience is important to stimulate discussion. This may be more difficult when the furniture layout consists of round tables with occupants facing multiple directions. Using lighting fixtures that provide higher light output at vertical angles will be necessary to achieve this goal.

Direct glare from lighting fixtures is always a concern when room occupants are performing tasks such as reading or writing. People may be in this space for a good period of time, so considering the effects of the fixtures' lamps and luminous surfaces is important. If implementing the use of wall sconces in the multipurpose room it is important to consider their luminances at eye level. This may be distracting and unpleasant for the room occupants if the luminous surfaces of the fixture are too bright. However, in a banquet room setting, non uniformity on the walls may enhance the spatial appearance.

Reflected glare may be an issue off of glossy surfaces such as magazines, leaflets, etc. Glare off of framed pictures on the wall may also be an issue for the room occupants.

Power Density/ Lighting System Control Requirements

The power density requirement for the multipurpose space, in accordance with the ASHRAE 90.1 Space-by-Space method, is 1.3 Watts per square foot. An additional 1.0 Watts per square foot is also allowed for accent lighting systems such as highlighting artwork, chandeliers or wall sconces.

Occupancy sensors can be used in this space for automatic shut off requirements. Alternatively, a timer system may also be used that shuts down lighting after building operation hours. There should also be a maintenance override switch. The multipurpose room also requires a control system that can determine when the space is used as one large area and when it's used as three smaller areas.

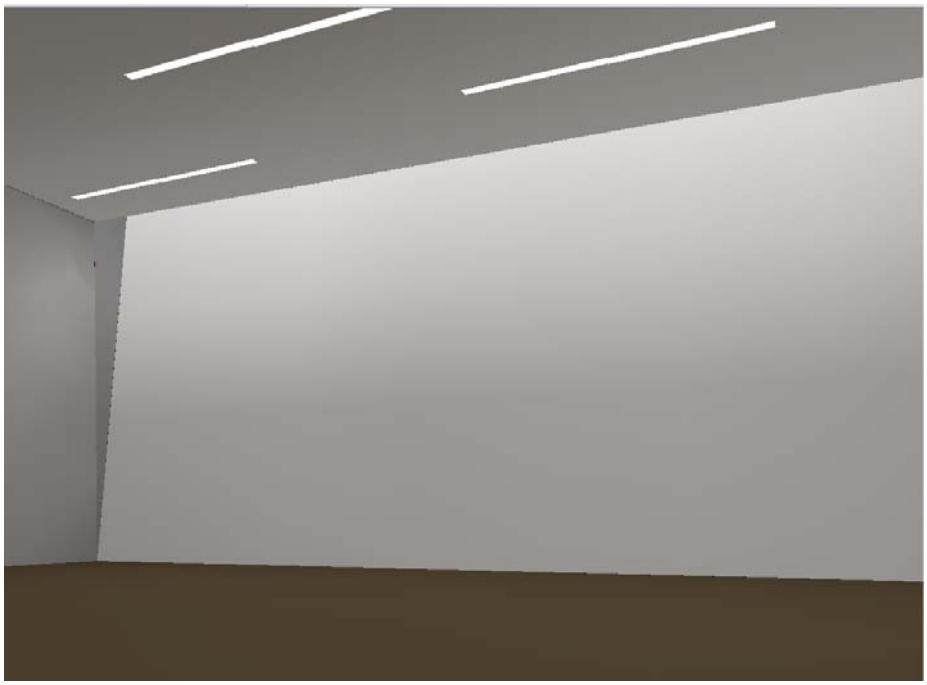
Light Loss Factors

Fixture	LLD for lamp	Luminaire Category	LDD for fixture	Ballast Factor
A3D	0.95	five	0.94	1.0
J3D	0.95	three	0.92	0.88

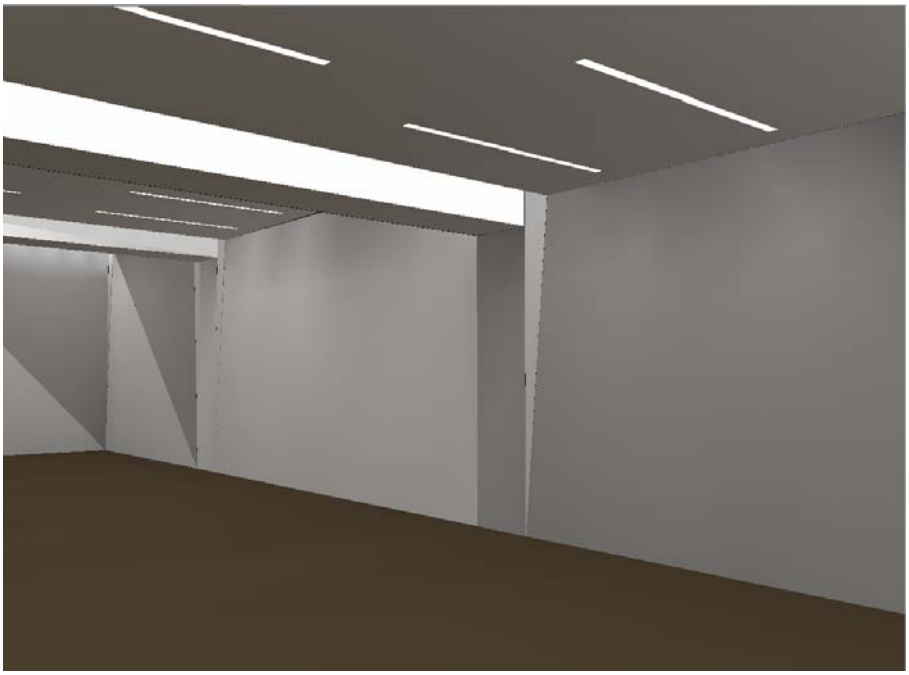
Space	Room Cavity Ratio (RCR)	RSDD
MULTIPURPOSE	2.54	0.98

SPACE	LUMINAIRE	TOTAL LLF
MULTIPURPOSE	A3D	0.88
	J3D	0.75

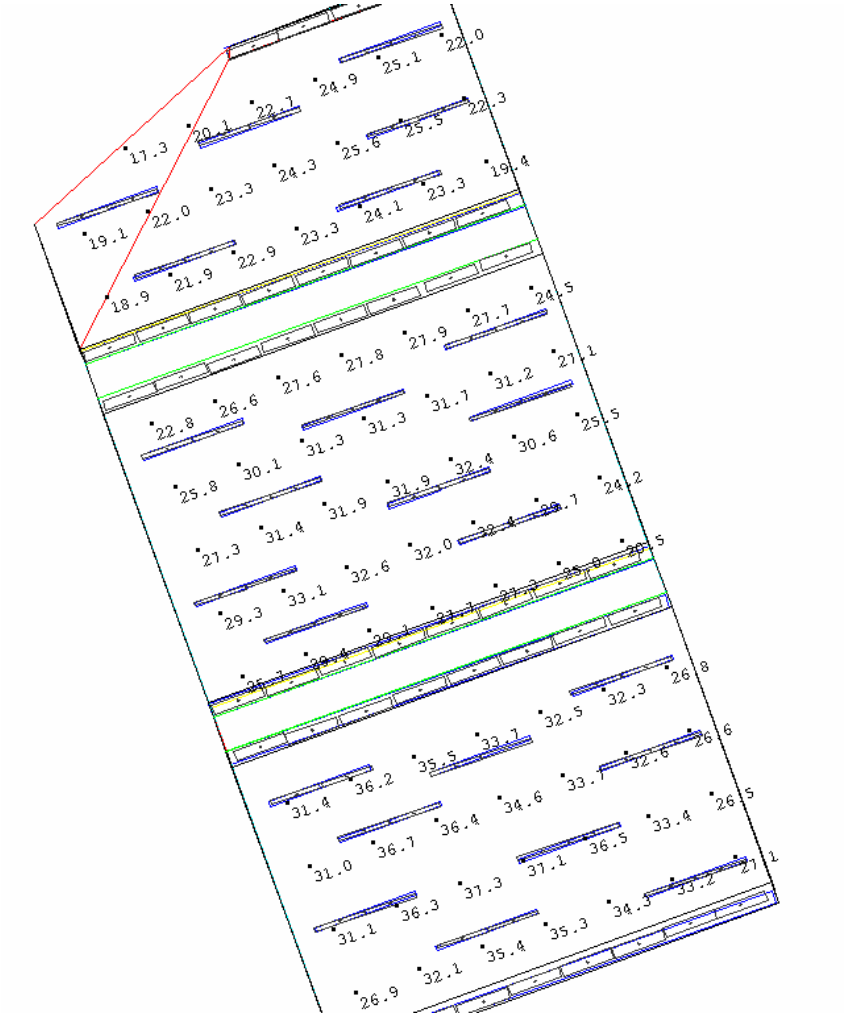
AGI Model of Existing Lighting



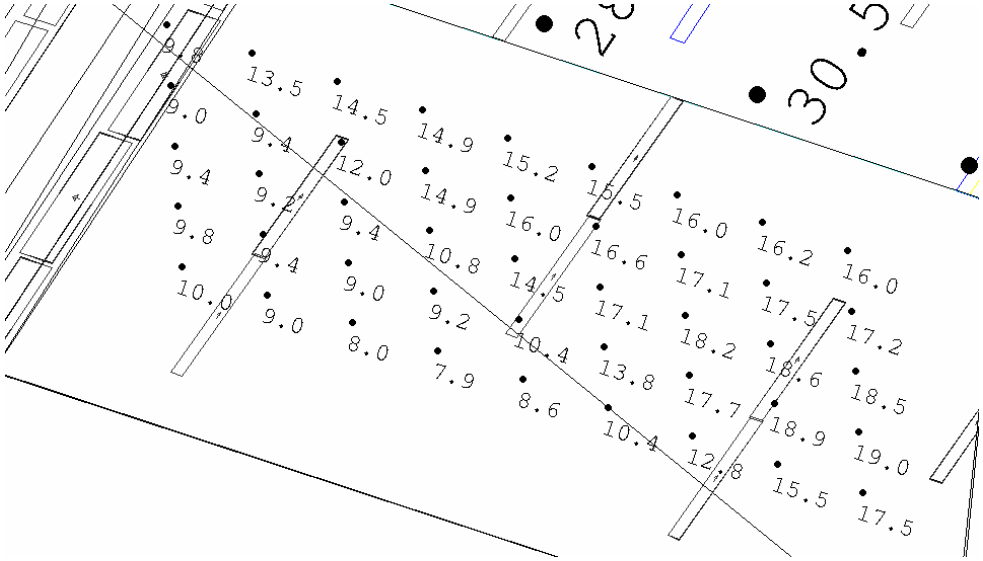
AGI Multipurpose Model – View in small room with partition closed



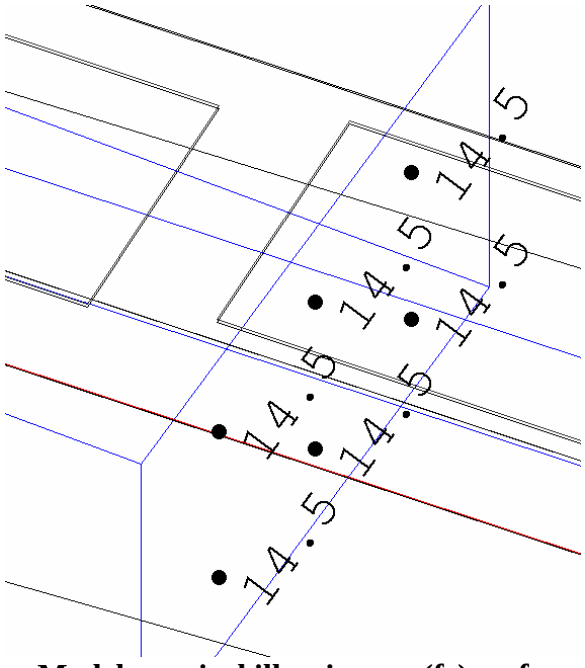
AGI Multipurpose Model- View in room without partitions



AGI Multipurpose Model- illuminance (fc) on the workplane
Eavg= 28.6 fc
Emax/Emin= 2.16



AGI Multipurpose Model- Vertical illuminance (fc) on West wall
Eavg= 13.4 fc
Emax/Emin= 2.41



AGI Multipurpose Model- vertical illuminance (fc) on face (facial modeling)
Eavg= 14.5 fc

Analysis of Existing Lighting

The lighting layout for the multipurpose room(s) provides adequate illuminance on the work plane in accordance with the IESNA lighting design criteria. There is also a uniform distribution of lighting on the vertical surfaces in the space, making the room feel larger and more open. The linear A1D fixture keeps with the lighting concept that is used throughout the entire building; however, this fixture is not as versatile as necessary for a multipurpose space. Geisinger has purchased furniture for the space that includes banquet tables and chairs. This would demand softer, darker mood of lighting. The linear fluorescent fixtures serve a purpose for everyday work related tasks, but do not have an elegant feel for a nicer event. Adding a secondary lighting system that might include wall sconces may help to make the lighting layout more versatile.

The cove helps highlight the partition walls when they are closed and the multipurpose area is separated into three smaller rooms. When the partitions are open, the cove lighting system does add some accent light to the space; however, the partial wall highlighted is only 1-2' in most areas.

The control system used in this space allows the space to be controlled with three separate switches. The control system includes partition sensors that can tell the control panel when the room is split up and when its not. All the fixtures in the space are dimmable, allowing different light levels to be set depending on the operation performed in the room.

The vertical illuminance in the center area of the multipurpose room at the level of a person's face is more than adequate for good facial modeling. This is important in this space where people may not know one another, speakers will be giving lectures, or group discussions may be taking place.

The same issues may arise as in the open office if laptops or visual aids are brought into the space. The long linear fixtures chosen will cause veiling reflections in a VDT and can be distracting to the eye.

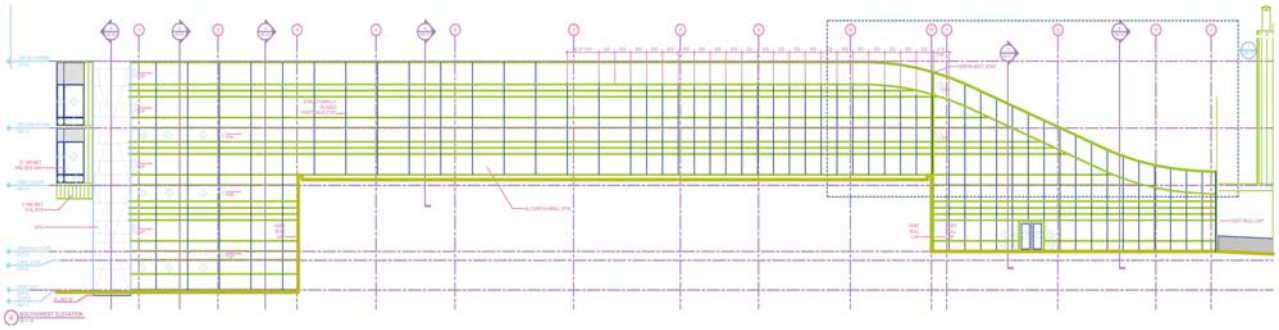
Exterior

Existing Lighting System

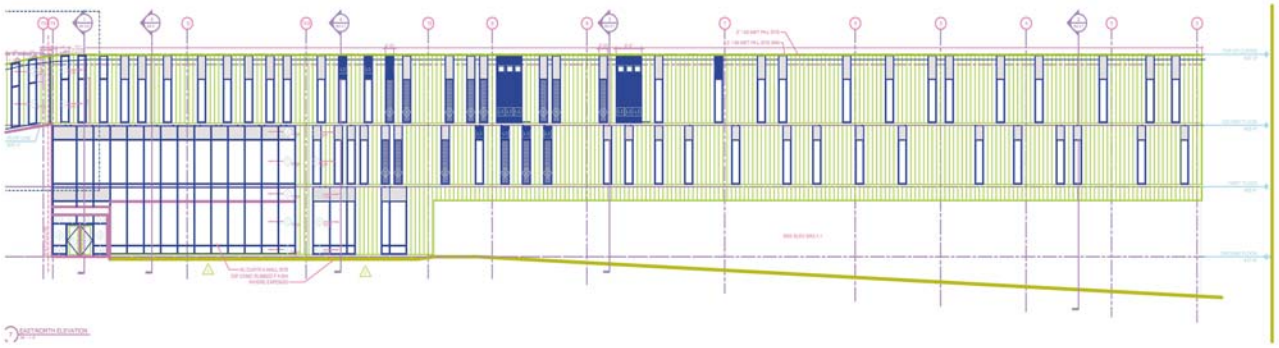
The exterior of the building is made up of mostly a curved glass curtain wall. The glass portion of the façade is not lit from the exterior but rather from inside to make the building glow at night. At the exits, there is wall mounted pathway lighting. In front of the building, on the west side, and on the concrete patio are metal halide dark-sky cut off pole top fixtures on a 10' pole. High pressure sodium shoe box fixtures on 16' poles were also added along the roadways according to Geisinger's standard specifications. The exterior lighting design is very simple, providing the minimum light levels necessary in order to achieve the LEED point of spill light and dark sky. There is also a canopy tunnel from Foss Clinic to CHRRA that starts above ground and continues under the street level to the lower level of CHRRA. This passageway is lit with metal halide downlights.

Exterior Materials

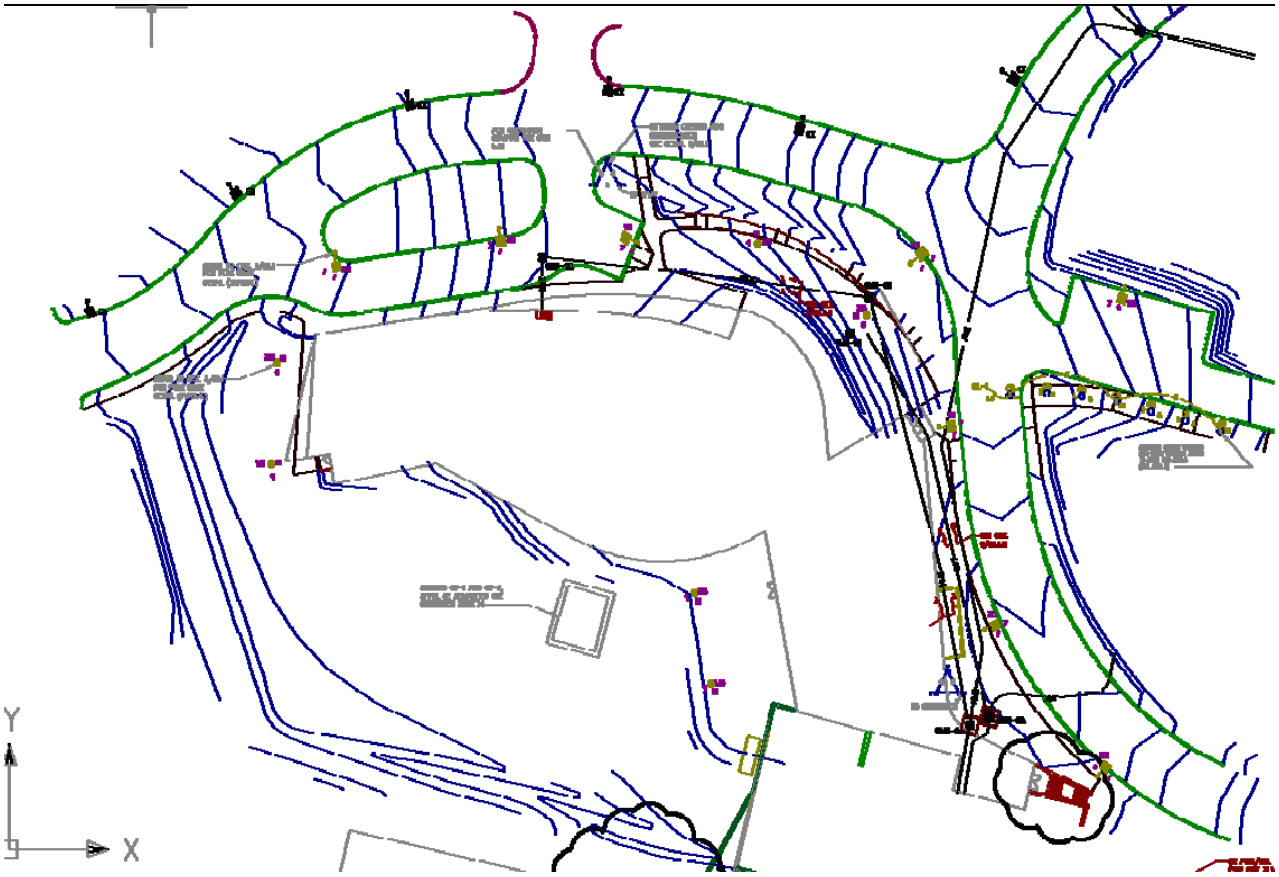
The exterior of the building is constructed of tempered glass, spandrel tempered glass, architectural precast concrete, and aluminum paneling. The tempered glass has a transmittance of 0.45 and an interior reflectance of 0.10. The glass is made of low-E insulation. The spandrel glass is to match the exterior appearance of the tempered insulated glass.



Exterior Elevation 1- South/West



Exterior Elevation 2- East/North



Site Lighting Plan

Luminaire Schedule

EXTERIOR LUMINAIRE SCHEDULE

TYPE	DESCRIPTION	MANUFACTURER	CATALOG NUMBER	LAMP NO.	LAMP TYPE	LAMP WATTS	BALLAST NO.	BALLAST TYPE	VOLTAGE	MOUNTING	NOTES
C8	8" DIAMETER APERATURE METAL HALIDE DOWNLIGHT WITH CLEAR GLASS LENS AND WHITE PAINTED FLANGE. UL LISTED WET LOCATION.	GOTHAM COOPER COLUMBIA	LGH-50M-7RW-T73-120 APPROVED EQUAL APPROVED EQUAL	1	METAL HALIDE ED-17	50	1	ELECTRONIC	120	RECESSED	
M1	METAL HALIDE DECORATIVE POST TOP LUMINAIRE, TEMPERED GLASS LENS, TYPE 3 HORIZONTAL CUTOFF REFLECTOR, 14' POLE	AAL INVUE	SL-VTH3-250MH-*-DB6-4R14 APPROVED EQUAL	1	METAL HALIDE ED-17	250	1	PULSE START	208	POLE - 14'	*SEE NOTES 2&3
M2	HPS SHOEBOX POST LUMINAIRE, TYPE 3 ASYMMETRIC HYDROFORMED REFLECTOR, ROUND 18' POLE.	LITHONIA GARDCO	KAD250S-R3-208-RPD04-*-4R18 APPROVED EQUAL	1	HPS	250	1	CONSTANT WATTAGE AUTOXFMR	208	POLE - 18'	*SEE NOTES 2&3
M3	METAL HALIDE DECORATIVE POST TOP LUMINAIRE, TEMPERED GLASS LENS, TYPE 3 HORIZONTAL CUTOFF REFLECTOR, 10' POLE.	AAL INVUE	SL-VTH3-100MH-*-DB6-4R14 APPROVED EQUAL	1	METAL HALIDE ED-17	100	1	PULSE START	208	POLE - 10'	*SEE NOTES 2&3

2. TRIM AND FINISH AS SPECIFIED BY ARCHITECT.
3. PROVIDE LOW TEMPERATURE, ELECTRONIC BALLAST.

FIXTURE	BALLAST	B.F.	P.F.	INPUT WATTS
C8	electronic metal halide ballast 120v	1	0.9	56
M1	pulse start magnetic ballast 208v	0.85	0.9	294
M2	magnetic ballast 208v	0.85	0.9	295
M3	pulse start magnetic ballast 208v	0.78	0.9	129

IESNA Lighting Design Criteria

Building Entrance:

It is very important to make the entrance of the building visibly clear. This building is unique and interesting on the exterior with different types of glass and the curving lines. This design may distract a person from finding the entrance if not clearly illuminated. Highlighting entrances for not only aesthetics but also for safety purposes is always critical.

Light pollution/trespass is crucial for Geisinger because they are going for LEED silver certification and need the light pollution points. It will be important to choose fixtures with cut off at higher angles and to avoid using wall mounted "glowing" fixtures with high light output.

Modeling of faces and objects is always important in an exterior area for safety and comfort. Although this is a safe campus, people may be walking around at night especially from the hospital. It is important to be able to identify another person or object from far enough away to avoid injury.

There are many points of interest involved in the façade design. Lighting these different features of the building draws interest and attracts patrons to the space. Highlighting the sloping ceiling, the glass lobby, or the roof garden may all help to enhance the interest of the exterior façade. This building is the only glass/ curved design on campus. The rest of the Geisinger buildings are typical rectilinear design; CHRRA should have adequate lighting to stand out.

Shadows are also important to consider because they can make entrances and overhangs seem daunting and unwelcoming. Lighting an entrance well with light in all directions will make the area seem more inviting and will attract people to it when walking toward the building. This may be more difficult to accomplish because of the light pollution concerns on this particular project. Using accent lighting such as wall washers on the architectural precast concrete portions of the building may help to light entrances without pouring light into unwanted areas.

Reflected Glare is definitely going to be a restriction for lighting the glass façade. Attempting to do so will only reflect the majority of that light off the glass and into people's eyes. Lighting from the interior to provide a glow rather than from the exterior may help to limit the effects of the glass.

Direct Glare can also be a major issue. High luminances of the lighting fixtures and large differences in luminances between the fixture and other surfaces can cause glare. These "bright spots" can be visually distracting, and sometimes cause a loss of visibility.

The suggested vertical illuminance for building entrances is category A- 3 fc but very important
The suggested horizontal illuminance for building entrances is category B- 5 fc also very important

Parking Areas:

Source/task/eye geometry is very important in a large, open parking area. If attempting to light a large area with few fixtures, the angle of the fixture head will have to be very high, allowing

parking lot occupants to see either the lamp its self or the luminance lens. This high angle will also put the majority of the light distributed in the face of the occupant, making it difficult to see or concentrate. Floodlighting should be avoided, especially for this parking lot because of the light pollution.

As state before, this building needs the light pollution point for LEED certification. Using cut off luminaires is necessary in the parking lot lighting.

Modeling of faces and objects is important for two reasons, safety and convenience. Vertical illuminance on the face will make patrons of the parking area feel safer. It will allow people to see and recognize one another from a distance giving them a better sense of their surroundings. The vertical light output will give occupants better peripheral detection to movement. This will increase safety and allow people to be more aware of moving cars, approaching people, etc. The modeling of objects is important so occupants can find their vehicles in a timely fashion. Using lamp types that emit the majority of light in one wavelength range will make it hard to distinguish between the different colors of the vehicles. Also, without any vertical luminance on the cars, there will be a lot of shadowing which will make it difficult to not only find the car, but also to get into the car, find your keys, etc.

Glare, as mentioned previously, is an issue with the luminous surface of the fixture. Glare will also occur off the top of vehicles in the parking area and off of the roadway when wet.

The suggested horizontal illuminance for a parking area is 0.4 fc and the illuminance uniformity ratio is 6:1 (I assumed the most specular of the asphalt surfaces for the parking area material). The suggested average luminance is 0.3 cd/ft^2 with a luminance uniformity from 6:1 to 10:1.

Roadways:

Roadway lighting is important to have traffic circulate properly and to lead drivers to the correct destination. Having higher illuminance levels on the roadway are necessary for safety, convenience, and for the campus appearance. The luminaires chosen reflect on the campus. The style should be continued through the campus to make it uniform and organized. The appearance of the roadway is important to make it appear inviting and safe.

Direct glare from the light fixtures should be given special attention in roadway lighting design. Here, if the luminaire is distracting it can actually blind the driver and cause an accident. It is absolutely vital to avoid glare in the eyes of the drivers. Using internal louvers or systems that have a downward distribution may be necessary.

Light distribution on the road surface is important for a uniform design. The fixtures should be spaced such that a uniform layout is achieved to provide the recommended light levels at all points of the asphalt. Distribution on sidewalks is also important so pedestrians can see where they are going, but more importantly so drivers can see pedestrians and avoid an accident. All signage on the roadway should be properly lit as well to ensure all drivers/pedestrians see stop signs. Being sure the surfaces are uniformly lit will help to avoid any possible shadowing on the street. This may

occur from surrounding landscaping, or other buildings. Taking this into consideration and possibly installing a roadway lighting system and a smaller scale pedestrian lighting system may be necessary.

The suggested horizontal illuminance for roadways of the local, intermediate type is 0.6 fc. The uniformity ratio for illuminance is 6:1.
The suggested average luminance for roadways is 0.5 cd/ft^2. The suggested luminance uniformity ratio should be between 6:1 and 10:1.

Power Density/ Lighting System Control Requirements

For exterior spaces ASHRAE 90.1 give the following restrictions:
- All exterior luminaires with greater than 100watts shall contain lamps having a minimum efficacy of 60 lumens/watt unless controlled by a motion sensor.
- The building entrances with canopies or free standing canopies can use 3 Watts per square foot of the canopy space.
- The building entrances without canopies can use 33 Watts per foot of door width.
- Building exits can use 20 Watts per foot of door width
- The building façade can use 0.25 Watts per square foot of illuminated façade area.

The exterior lighting system should be controlled by astronomical time clock which will turn the fixtures on based on the sunset and sunrise or should be motion sensor controlled.

Light Loss Factors

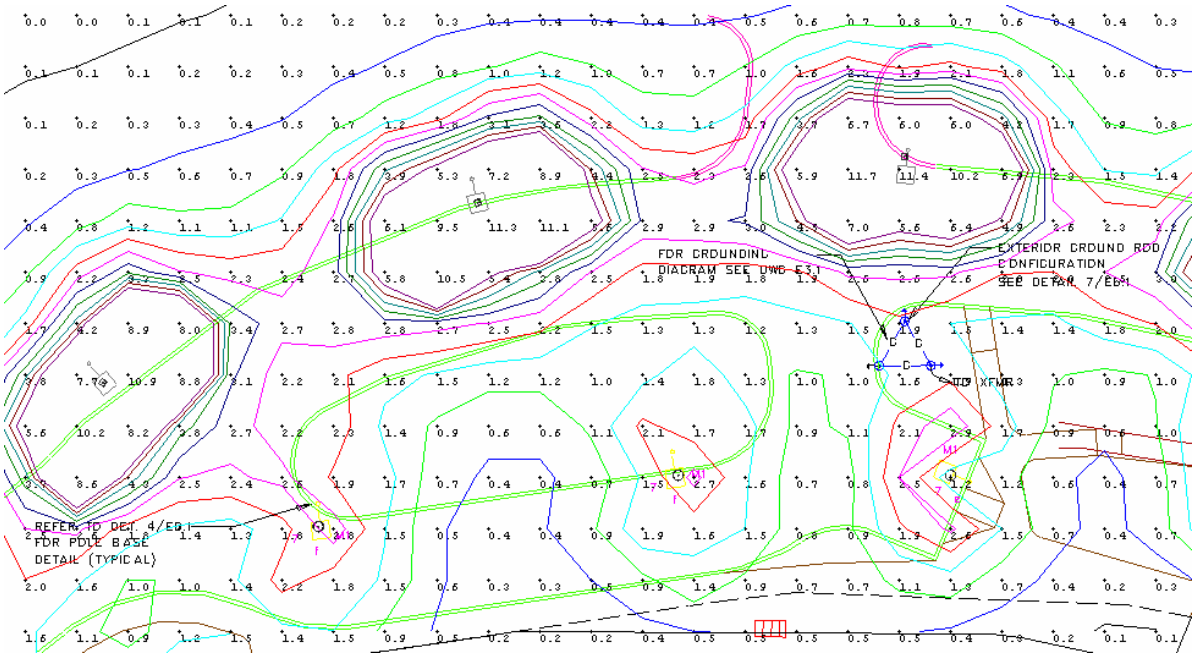
Fixture	LLD for lamp	Luminaire Category	LDD for fixture	Ballast Factor
C8	0.47	five	0.94	1.0
M1	0.72	five	0.94	0.85
M2	0.9	five	0.94	0.85
M3	0.69	five	0.94	0.78

SPACE	LUMINAIRE	TOTAL LLF
EXTERIOR	C8	0.44
	M1	0.58
	M2	0.72
	M3	0.51

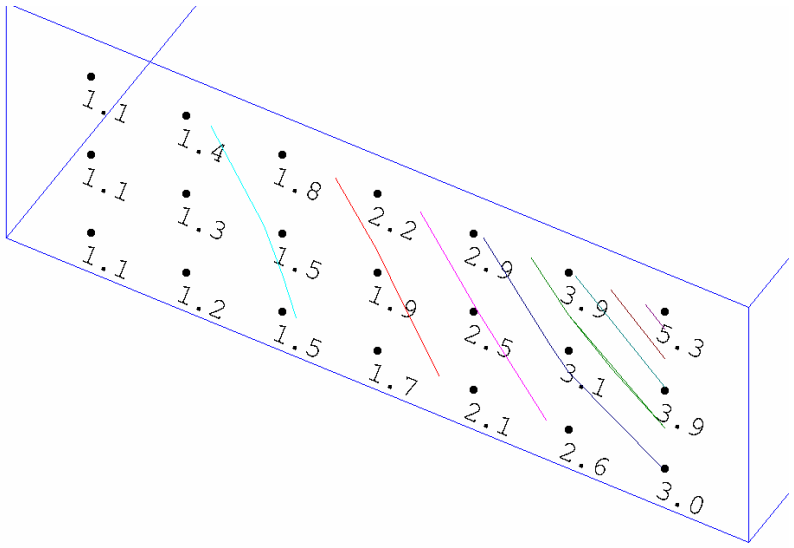
AGI Model of Existing Lighting

Note: The only luminaires included on the façade are over the door fixtures for safety purposes. There is no other façade lighting in the existing lighting conditions because of the excessive glass façade and the attempt for dark sky LEED credit. Therefore, I only analyzed the existing site lighting conditions including the surrounding roadways.

AGI Site lighting model- illuminance (fc) on ground of site



AGI site lighting model- illuminance (fc) level on the main roadway around CHRRA



AGI Site lighting model- vertical illuminance (fc) on a car on the main roadway around CHRRA.

Analysis of Existing Lighting

The exterior lighting system does a good job of lighting only the areas of the site that need to be illuminated. It is important for sustainability issues to avoid any light spill from the building and façade luminaires. Because of the glass façade, the building is illuminated from within and will look as if it is glowing at night from the emergency lighting circuits.

The fixtures chosen for the immediate site lighting are metal halide, dark sky compliant luminaires which have a much better color rending index than high pressure sodium.

The illuminance levels on the roadway have a uniformity distribution of 5.5:1 which is within the suggested ratio of 6:1. The average illuminance is 6.5fc which is adequate for a moderately traveled roadway. The luminaires used where chosen to match the existing roadway lighting fixtures used through the rest of the Geisinger campus. It is important to have a uniform design throughout a campus to have an organized layout. These fixtures, however, are high pressure sodium which give the roadway a more "yellow" look and can make it hard to identify different colors. This makes it difficult to recognize your own car in a parking lot which can take away from the security of the campus. It would be better to use a source such as metal halide that will render colors better and make occupants feel safer.

The roadway fixtures are mounted on poles 18' off of the road. This is somewhat low for a parking/roadway area and may cause some direct glare in the eye of a driver if the source is visible. The roadway fixtures are a typical shoebox type with a visible source, which could be an issue.

Conclusions

The overall lighting design for CHRRA is represented very well through all of the different spaces. A streamline, bare ceiling look is used through the building which goes very will with the look of the aluminum and glass panel façade. This building is much more industrial looking than anything else on the Geisinger Health System campus and using these new types of luminaires is appropriate. As a whole, daylight integration and control was taken into account with the design of the lighting systems. This building is slated to become LEED silver, so energy consumption along with heating and cooling costs played a big part in the lighting design process. Choosing fluorescent and induction lamp sources over incandescent was essential to energy efficiency and lamp life. In the end, some of the design elements that were removed from the building before construction hurt the daylight and electric light integration. The lack of automated shades in the open office makes it difficult to realize the space's full energy optimizing potential.

The lighting controls used for the majority of complex spaces provided the end user with the ability to create multiple lighting scenes with just a push of a button. This versatility can be critical in a building where one space is required to serve for multiple different purposes. This is common in construction when there isn't the room or money to build a separate space for all the different needs of a company.

Some visual issues such as glare and veiling reflections could be a cause for concern upon completion of construction. These are problems that may not be realized on paper and may be a lesson that comes with design experience. Although the Se'lux A1 fixture matched the aesthetics of the building well, its "glow" is not optimal for computer use. This instance shows that conflict of interest between different areas of design and in the end a solution must be chosen that may not be the best for every situation.

After analyzing the existing lighting system in the Center for Health Research and Rural Advocacy, I am more aware of the major design issues of this particular building. Daylight control and integration with the electric lighting system is crucial for a sustainable building. Finding the balance in design between using highly efficient sources and fixtures and creating an aesthetically pleasing atmosphere is very important. Finally, creating the most versatile system possible while minimizing energy used in a space is necessary for this building. The end user should have the capabilities to create any mood necessary in a certain space without having an excessive number of fixtures. Overall the main goal is to create an energy efficient, versatile, aesthetically pleasing, balanced lighting design.