The Pennsylvania State University, Architectural Engineering

Spring 2014 Senior Thesis Design Report for: Perot Museum of Nature and Science

Faculty Adviser: Shawn Good

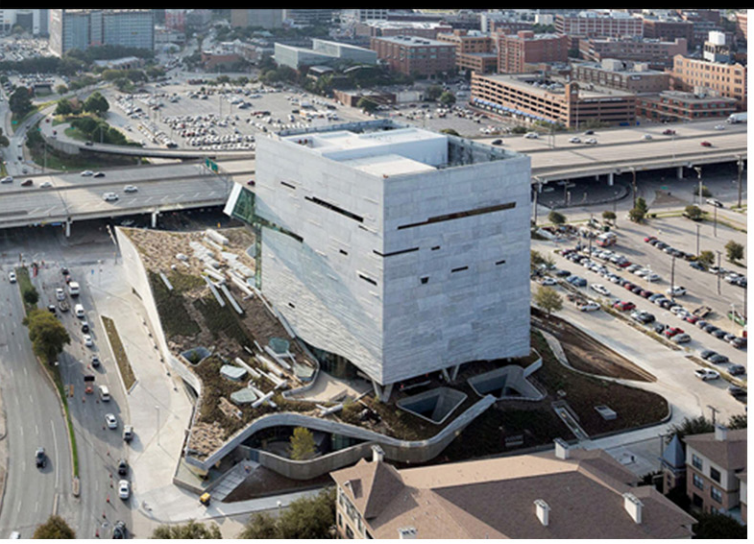
Yucheng Lu

Lighting | Electrical

4/6/2014

Perot Museum of Nature and Science

Dallas, TX



Site View

Main Lobby

Theater

Basic Information

Name: Perot Museum of Nature and Science
Location: 2201 N Field St, Dallas, TX 75201
Occupancy Type: Public Museum
Size: 180,000 ft^2
Number of stories above grade: 5
Dates of construction: 05/2010 – 12/2012

Primary Project Team

Owner: Perot Museum of Nature and Science
Architect: Morphosis Architects
Associate architect: Good Fulton & Farrell
Lighting Consultant: Office for Visual Interaction
General contractor: Balfour Beatty Construction
Structural Engineer: Datum Engineers
MEP Engineer: Buro Happold

Architecture

The site of the building incorporated rock panel and drought-resistant grasses to reflect two of the most typical Texas ecologies: forest and desert. Cubical tower with iconic 'tree bark' texture was built on such a site, demonstrating the coexistence of nature and science.

Electrical

Power is supplied through two 480Y/277V, NEMA type 1, 3 pole switch boards fed through utility. Total balanced load is 4880A. A 750 KVA generator was prepared to provide 812 Amps power supply in case of emergency situation.

Lighting

High output metal halide floodlight was the major lumianire used for facade lighting of the Museum. In the open lobby area, fluorescent luminaire was applied to create an energy efficient lighting scheme with halogen spot light used to provide visual emphasis on exhibits. In the theater space, liner LED luminaire was used to match the existing curvature of acoustic panel.

Structural

The cubical tower was supported by concrete columns. Columns were placed away from the building perimeter to save space for a curtain wall on ground level that sunk from the tower perimeter. In the gap between ground level curtain wall and building perimeter, V shaped concrete column was built to handle horizontal loads.

Yucheng Lu
Lighting / Electrical

Table of Contents

Executive Summary

The purpose of this report is to briefly summarize design works performed for Penn State Architectural Engineering Senior Thesis Project. The project is focused on exploring alternative design options for Perot Museum of Nature and Science, especially its lighting and electrical systems. Additionally, acoustic property, architectural appearance and daylight harvesting strategy are also studied as breadth options.

The following spaces: Classroom, Main Lobby, Theater, Building Façade and Escalator Cartridge were selected for lighting depth study. The target of this study is to develop various design solutions that meet the unique need of each space, yet ensure all designs share a common concept: to make the building itself being an exhibit uniting nature, science and urban elements all together. The classroom space in basement is carved into an underground cave with dark ceiling. A light well located in the center of the classroom becomes the major source of natural light, connecting the cave from the world above ground. The major purpose of lighting system is to provide enough illuminance that allows practice without distract occupant from the light well. Light trespass to the ceiling is also minimized to maintain the dark cave impression. Lighting in the lobby is designed to navigate visitors since it is the major entrance and ticket center of the museum. Plenty of ceiling space allowed a three dimensional placement of luminaires, shaping the space into an underwater world. Façade texture is one of the most iconic elements of this building. Thus the mission of façade lighting is to ensure that its texture can be recognizing in the nighttime while also guarantee the building's nighttime identity as a whole. Unique acoustic panels were used in the theater space, makes lighting design a challenge to maintain space integrity. Lighting systems in the escalator attempts to trick visitors' eye and bring them an exciting escalator riding experience.

Electrical analysis is performed to check influences of new lighting solutions on building's electrical system. Short circuit calculation is also performed to double check the electrical safety. Luminaires are rewired to match new control strategy as well.

Additional breadth studies include acoustic analysis, focus on the evaluation of theater's acoustic quality; Architectural breadth, focus on designing façade texture that resonate with landscape layout and also daylighting breadth exploring higher daylight harvest efficiencies by smart lighting control strategies.

Acknowledgements

Special thanks to following individuals who generously helps me:

Kevin Parfitt	Director of Senior Thesis Program, The Pennsylvania State University
Shawn Good	Faculty Adviser of Senior Thesis Program, The Pennsylvania State University
Kevin Houser	Professor of Architectural Lighting, The Pennsylvania State University
Richard Mistrick	Professor of Architectural Lighting, The Pennsylvania State University
Leslie Beahm	Electrical Consultant, The Pennsylvania State University
Thom Mayne	Design Director, Morphosis Architects
Arne Emerson	Project Architect, Morphosis Architects
Enrique Peiniger	Principal, Office for Visual Interaction inc
Jean Sundin	Principal, Office for Visual Interaction inc
Jennifer Scripps	Business and Partnership Director, Perot Museum of Nature and Science
YOU, dear reader	Thanks for your support!

Thanks to all parties associated with this project:

Owner:
Perot Museum of Nature and Science | http://www.perotmuseum.org/

Project Architect / Architect of record / Interior designer:
Morphosis Architects | http://www.morphosis.com/

Lighting Consultant:
Office for Visual Interaction | http://www.oviinc.com/

Associate architect / Sustainability Consultant:
Good Fulton & Farrell | http://www.gff.com/

Engineer:
Structural: Datum Engineers | http://www.datumengineers.com/
Consulting structural engineer: John A. Martin Associates, Inc. | http://www.johnmartin.com/
MEP: Buro Happold | http://www.burohappold.com/
Civil: URS Corporation | http://www.urscorp.com/
General contractor / Construction manager:
Balfour Beatty Construction | http://www.balfourbeattyus.com/

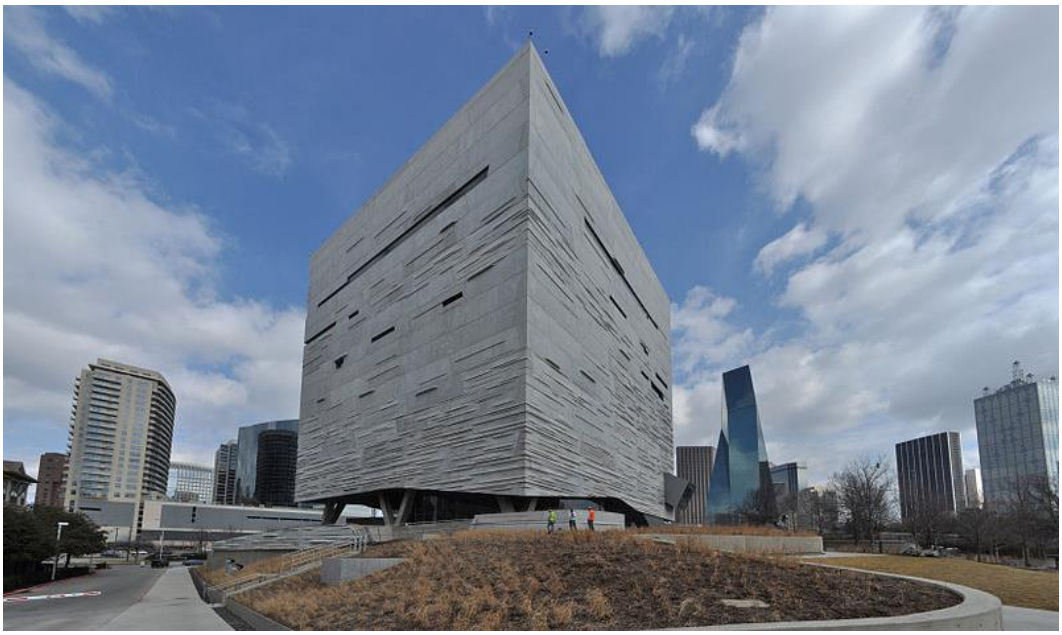
Consultant:
Landscape Architecture & Sustainability: Talley Associates | http://www.talleyassociates.com/
Acoustical: Jaffe Holden | http://jaffeholden.com/

Project Background

Perot Museum of Nature and Science is a comprehensive museum located in Dallas, TX. Just as its name indicated, the museum's exhibition covers large range of subjects in Nature and Science field. Targeting at school and family market, the museum made special effort to ensure its young visitors will have a delightful experience. The basement level, for example, is designed specifically for children with classrooms and a children's museum. Unlike regular museums with static exhibitions, most items here are designed to interact with visitors. From a robot assembling station to a running track where visitor can race against real scale dinosaur projections, visitors can enjoy their one of a time experience of learning while laughing. Moreover, the museum also has its own IMAX Theater, offering ultimate visual impact.

The history of Perot Museum of Nature and Science can be trace back to 1936 when it was first established as the Dallas Museum of Natural History. As a critical part of Texas' centennial exposition, it was used to present various ecology and geology systems unique to this state.

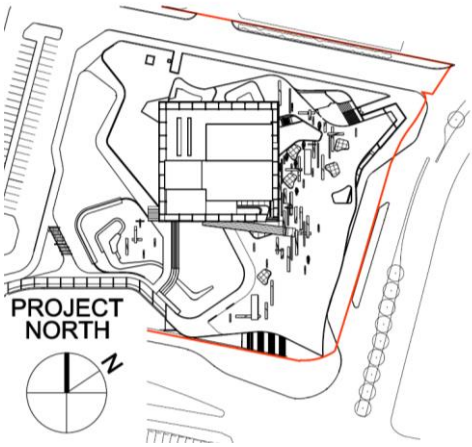
In 2006, the Museum oversees the importance to incorporate new elements, especially modern technology and entertainments. Therefore, it merged with Science Place and Dallas Children's Museum and became the new Dallas Museum of Nature and Science.



The merge turns out to be a brilliant decision. In response to the increasing interest of Dallas citizens, the museum relocated into victory park campus next to downtown Dallas. In order to recognize the museum's generous donation Mr. Ross Perot, the museum was renamed to be the Perot Museum of Nature and Science.

General Information

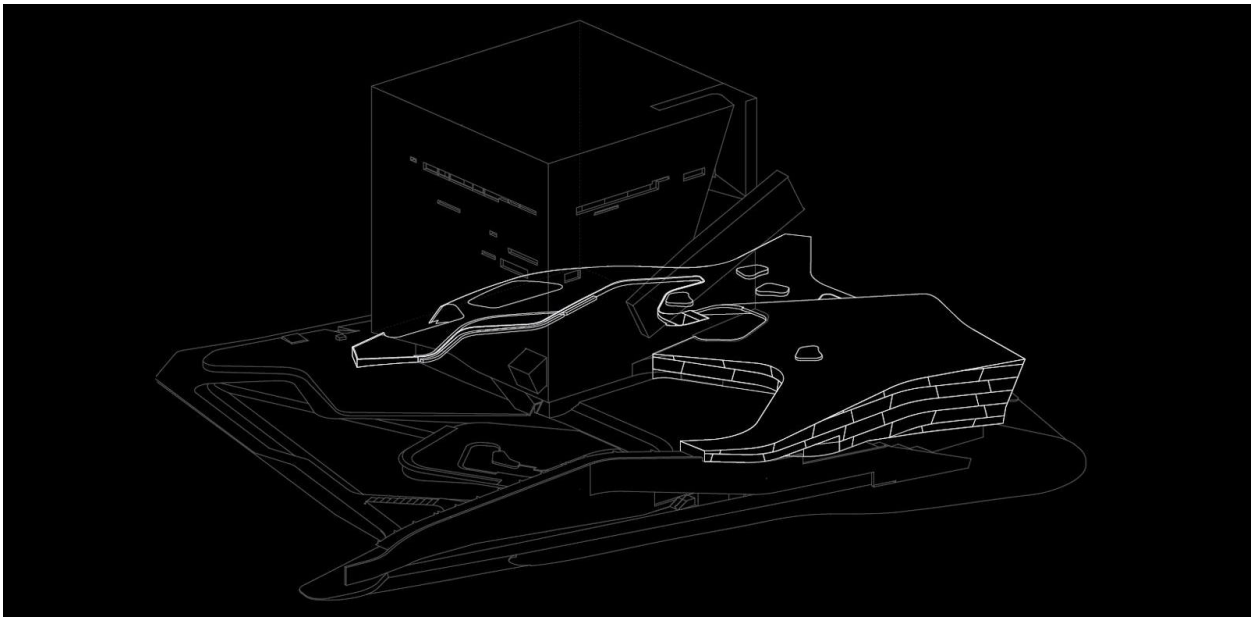
Project Site



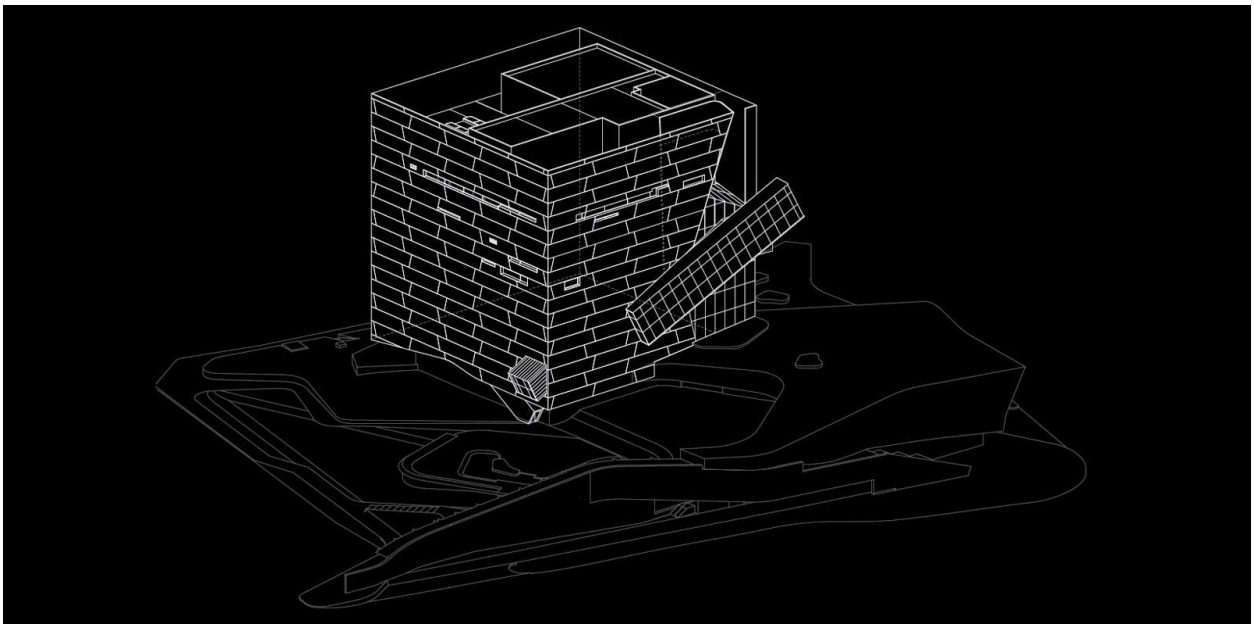
The Perot Museum of Nature and Science is located in Victory Park, Dallas, a district just north from downtown Dallas with their borderline clearly marked by highway 366. From the photo below, an obvious contrast of building types can be seen: while on the downtown side every block seems to be occupied by skyscrapers, parking lots and residential buildings is all we can find around the museum.

Such contrast is formed because the developer, Mr. Ross Peort envisions Victory Park as an urban lifestyle destination, a retreat from fast paced urban life. This explains his tenant choice such as American airline center, home of NBA team dallas mavericks, high end residential unit, luxury restaurants and most importantly, Peort Museum of Nature and Science.

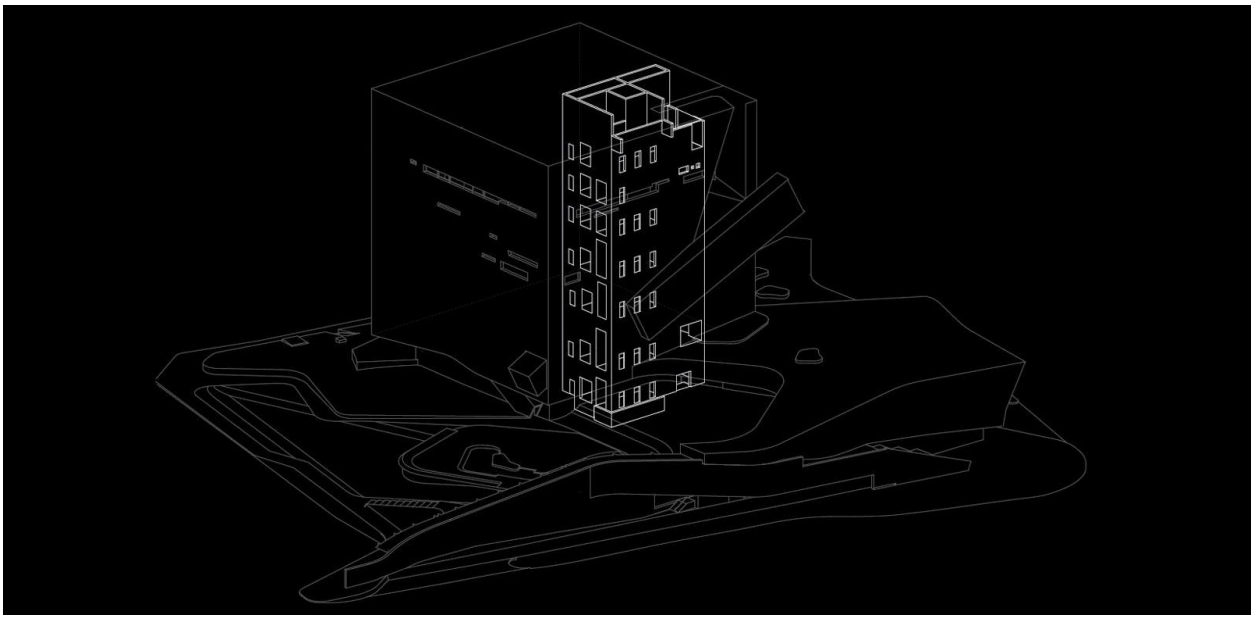
Architecture



The museum is built on an artificial landscape plinth elevated from street level to create unique geologies around the building. The landscape plinth wraps up around the cubical building mass in the center, originally at ground level behind north facade, functioning as the roof of basement levels, then gradually rising up, gaining additional 20’ and become the roof of theater located on the first floor, south side of the building.

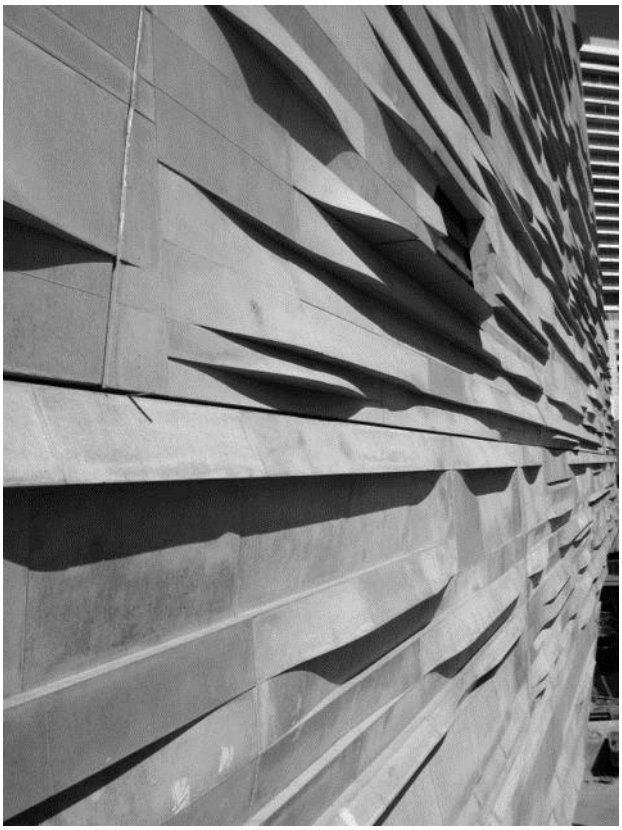


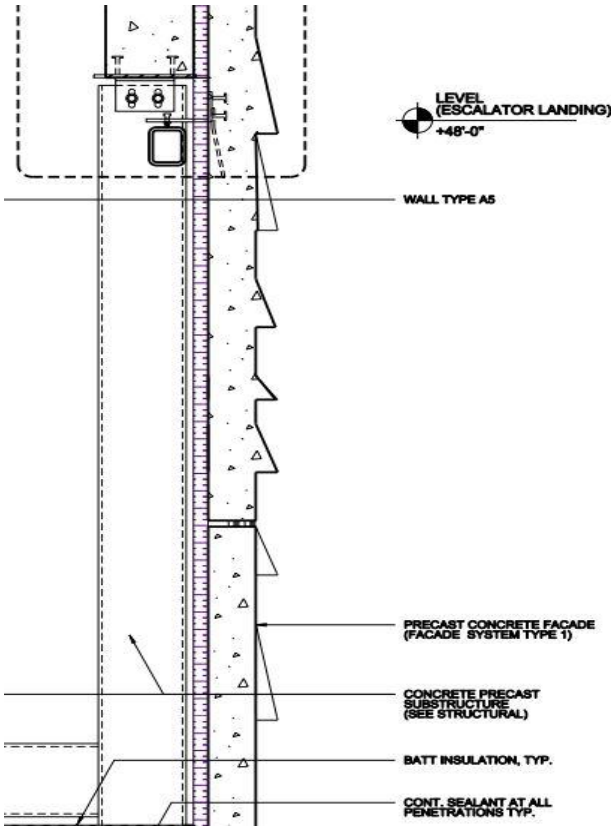
The building mass can be described as a cube covered by textured precast concrete panels, with first floor being the exception covered by curtain walls. Atrium of the building opened up south east corner of the cube, replacing concrete panels by curtain walls as well as a skylight, bringing daylight into the space.



Right next to the atrium is the core, designed as a transportation terminal providing staircase and elevator. Center of the core is also used to place mechanical and electrical equipment. The atrium and core together occupies 25% of the floor area, leaving the rest 75% on each floor exhibition spaces.

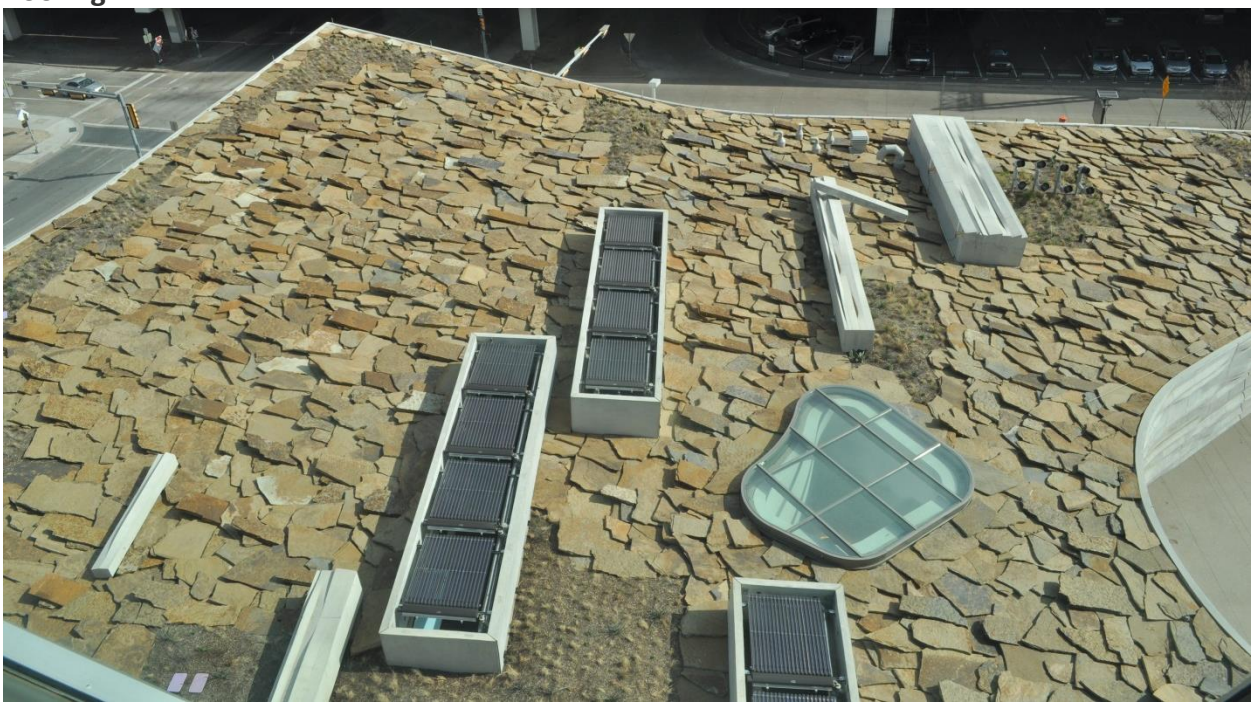
Facades





The façade was assembled with textured precast concrete panels. Supporting system such as rain screen, moisture barrier, exterior insulation finishing system and aluminum composite material contributes greatly to protect the façade system from environmental damage. Typical concrete panel have a thinness of 6 inch, which can be increased into 10 inch with texture.

Roofing



Roofing system of the building consists of three major parts, the landscape roof using Hydrotech Garden Roof technology, tower roof made by modified bitumen and a roof plaza with Carlisle FleeceBack TPO membrane applied on it.

Electronic Leak Detection System is installed on landscape roof and roof plaza which is accessible by visitors.

Construction

The original contract project delivery method for Perot Museum of Nature and Science was set to be Design-Bid-Building. During the schematic design phase, the client reconsidered the possibility to minimize the construction duration and decided to switch the project delivery method into Design Assist. This decision allowed a construction manager/general contractor to be selected to assist the design team with pricing and other decisions, thus made the design process more efficient.

In addition, Guaranteed Maximum Pricing and Early Foundation/Superstructure Package were published after the Design Develop phase, allowing the project to break ground 4 months earlier than the publication of full Construction Document package. All the strategies allowed a 6 moth reduction in overall construction duration.

The museum was designed as a 5 story building with its 'ground level' set to be 20 feet above the street level, which requires the contractor to build a 4.7 acre landscape around the building mass. The contractor's approach is to precede the construction of the building first, building it as a 6 story building from the street level. When the general building envelop is completed, the construction of landscape started to take place along with interior finishes.

Electrical

Electrical power of the museum was supplied through two major switch boards MSB1 and MSB2, both were 480Y/277V, 3 pole switch boards fed through utility with NEMA type 1 enclosure. MSB1's balanced load is 3230A, protected by a 4000A breaker. MSB2's balanced load is 1650A, protected by a 2000A breaker. Other than two switch boards, a 750 KVA generator was also prepared to provide 812 Amps power supply in case of emergency situation. The emergency boar is also 480Y/277V, 3 pole switch board with NEMA type 1 enclosure.

Lighting

Exterior spaces like façade and parking lot of the museum were lid by high output Metal Halide floodlights mounted on the landscape plinth. T5 Fluorescent/Compact fluorescent down lights was widely applied in general interior work spaces including classroom and offices due to their excellent energy efficiency and availability. Linier fluorescent luminaire was installed in the lobby/gallery area behind the featured metal mesh. In order to provide concentrated light on exhibition, suspended halogen luminaire was also used in the lobby/gallery area. For special purpose space, especially the theater, LED linier luminaire was applied to create an elegant curvature of accent light. LED luminaires were also used as under bridge, under bench light where small luminaire size was preferred.

Crestron dimming allows light to be controlled through multiple interfaces including local control switch, control touchscreen installed in each space, switch override at the panel board wireless touchscreen devices that connected to the space through internal wi-fi network. Photo sensor and occupancy sensor devices were also installed in the museum to adjust the energy consumption automatically.

Mechanical

Storm water drainage system is the highlight of the museum's mechanical system. When it rains, water reached the roof will be taken through drain piping to the landscape plinth. The plinth was designed to have a specific slope that will direct the water to two major cisterns located at parking lot and North-East corner. Condensing water from the mechanical system will be collected in the same way. Another major waster source being recycled is the irrigation water, which is stored in a separate cistern near North-East cistern. All three cisterns were equipped with basic plumbing and filtration system. Pipe were built between cisterns, allows them to share single advanced filtration system including UV treatment and DYE system as the final treatment before water enter the building. Recycled water will be pumped back to the building for toilet flushing and cooling tower evaporation.

Structural
The primary floor system of the building is concrete slab on metal deck supported by steel frames. The slab is supported by a combination of concrete and steel columns. At the perimeter of the building, series of large V-shaped concrete columns are also designed to distribute load away from building core, especially horizontal loads. The foundation is supported by piles 24" in diameter using mechanical splice.

Fire Protection
Based on 2006 International Building Code (IBC) with City of Dallas Amendments, the museum was classified as type 1-A high rise building. For structural support and interior bearing walls, a 3-hour fire rating is required. 2-hour fire rating is required for roof support, exterior bearing wall, floor construction and emergency power room. Roof construction needs a 1.5-hour fire rating while the building atrium and storage space need a 1-hour fire rating. Any other interior partitions have 0 fire rating.

In order to prevent fire disaster, the building is equipped with a class 1 standpipe system connected to a 2-1/2 inch hose. Automatic sprinkler system covered the entire building with the exception of roof penthouse. Automatic fire alarm system and an emergency voice/alarm communication system are designed as required in DBC (Dallas Building Code) 907.2.1. Smock control system is installed as required in DBC 909, fire command center and fire department connections are designed according to DBC 911, 912.

Transportation
The major transportation is a series of escalators that connects from the ground floor to the uppermost level. The escalators span total of 57 feet in horizontal and lift visitors 110ft higher. The escalator only move upward, in order to get back down, visitors can either take the elevators or stairs. There are four elevators equipped in the atrium. Three regular elevators are 9fee by 9 feet in dimension while the grand elevator is 10 feet by 17 feet. The elevators were equipped with sprinkler and emergency power supply to ensure that they can function as efficient egress means for the 4^{th} floor or above. Two set of stairs are also available in the museum, on is located inside the center atrium while the other one is located on the North-West corner of the building.

Telecommunication
The major telecommunication device in the building is emergency voice/alarm communications systems. The system is supported by secondary power system to guarantee its operation under emergency circumstance. A two-way communication system such as telephone and intercom is also available for a security personal on site to report emergency.

Depth Study

Lighting Depth

Lighting depth of this project is dedicated to develop customized lighting solutions for each individual space that fits its unique need and geometry. While design for each space has its own consideration and highlights, they do share a common design concept that binds them together and make them more than just carefully calculated functional lighting layouts.

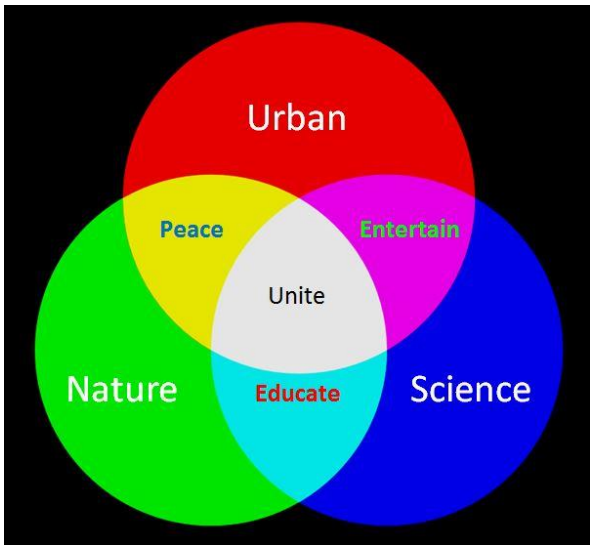
In order to develop lighting concepts that resonant with the architecture, one must understand the story behind the building and the expectation of its occupant.

*"I envision Victory Park as an **urban lifestyle** destination"*
Mr. Ross Perot, the donor of the museum and the developer of the victory park district shows a great interest to make this museum another retreat for Dallas citizens, helping them to get away from the stressful civil life and enjoy modern entertainment.

*"Once museums were combined, the ambition was to replace them with a new building that would seamlessly **unite** these variegated strands"*
On the museum site, the CEO Mrs. Nicole Small concerned more about the how this new facility can help reinforce the merging process of three museums, not only facility vise but also the philosophy behind each field.

*"The building is compelling and will expand user's imagination. Everywhere in the building will be left **transparent** and you will understand architecture. The subject of the building: how we **understand nature** and ecological terms and how it is an absolutely vital issue, is exactly where we are at this moment of time"*
As for chief architect, Mr. Thom Mayne focuses more on the architecture itself. He envisions the museum itself being an exhibit that educating visitor about building system, energy consumption and raising the awareness about how important it is to live with nature.

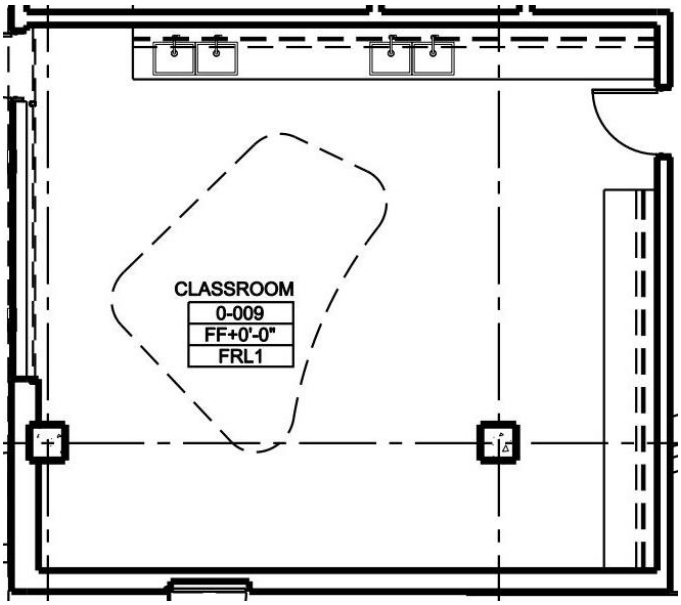
Incorporating visions from urban planner, executive officer and architect, the key word of the lighting design will be **UNITE**. Uniting urban lifestyle with modern technology to provide a brand new **entertainment** experience. Uniting the subject of science and nature to **educate** next generation and inspire new ideas. Uniting natural geology into the crowded urban area as a spiritual oasis that helps people finds **peace**.

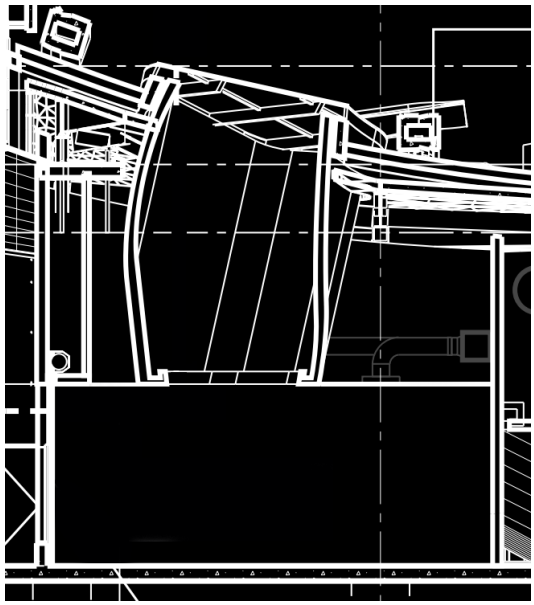


Classroom

Description

One of the classrooms located on basement level is selected to study lighting solutions for typical **working space**. The class room is located underneath the landscape plinth, with a unique light well structure stretched down from the roof, draining daylight directly from the ground level and feed them into the space after several bounces on its inner surface.





Dimensions

Length = 31 ft
Width = 25 ft
Area = 735 ft^2
Ceiling Height = 12 ft
Roof Height = 28 ft in average
Light Well Area = 80 ft^2
Light Well Height = 16 ft

Finish Material

	Description	Location	Color	Reflectance
Floor	Carpet, Grey	Floor	Grey	0.2
Wall	White Paint	Walls, 0 - 12 ft	White	0.4
	Dark Grey Paint	Walls, 12 – 28 ft	Dark Grey	0.1
	Light Green Paint	Light Well Interior	Green	0.6
Ceiling	Dark Grey Paint	Ceiling	Dark Grey	0.1

Design Consideration

For visiting students and teacher, visiting a classroom seems to be a boring decision since that's where they original come from. Therefore, the design consideration is to create a space that remarkably distinct from typical education facilities and being able to provide **enjoyable** learning experiences. Light well feature should also be highlighted for **demonstration**.

Design Criteria

Considering the fact that basement floor is mainly designed for young visitors, and this space is intended to create a dark cave atmosphere, illuminance target is design assuming occupants are 20 years old or younger, which is slightly lower that typical target of 300 lux.

Space Type	**E_h**	**E_v**	**Avg : Min**
Classroom	200 lux	75 lux	2 : 1
White Board		150 lux	3 : 1

For lighting power density, space by space method from ASHRAE standard 90.1 is applied, concluding a recommended lighting power density of 1.28 W/ft^2.

Design Approach

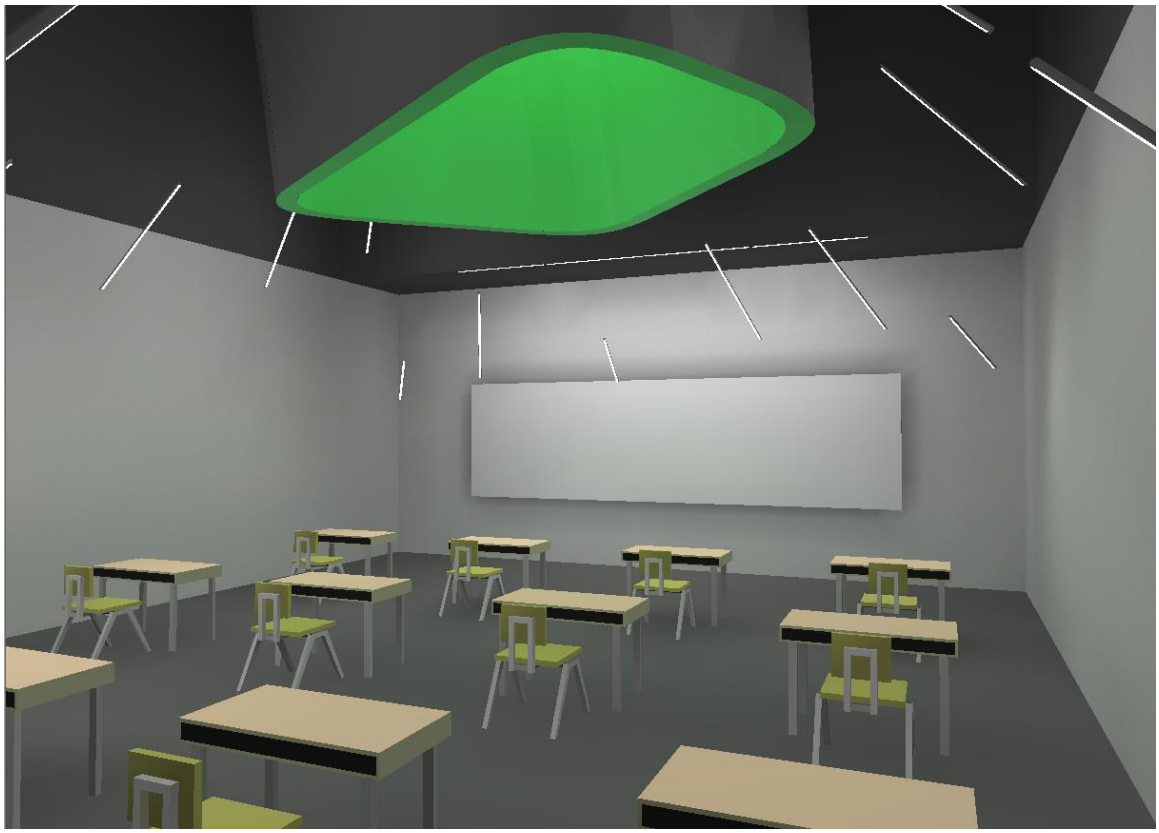
The space itself has a great potential to become an impressive exhibition itself, revealing the fascinating structure of the light well. To achieve this one possible solution is to open up the original 12 feet high ceiling and expose the landscape plinth roof instead. Such a tall space often have a poorly lid ceiling, which will be used as an advantage to create a underground cave theme to attract children with adventurous spirits.

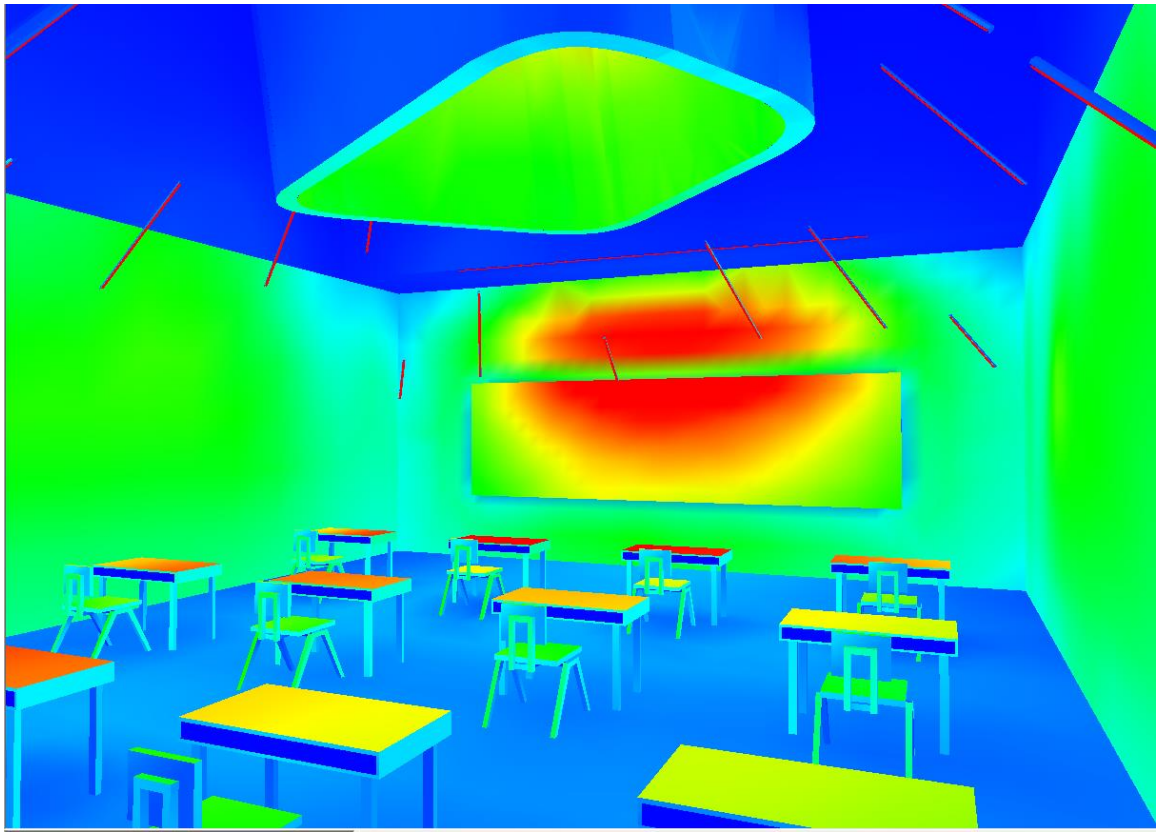
In order to mimic typical cave elements such as stalactite and cave plants, T8 LED tube and fiber optics are used. Unlike T8 fluorescent tube, LED T8 tube is directional luminaires with 40% of its surface area glowing. These tubes are suspended 45 degrees vertically, maximizing glowing surfaces that are visible from any direction while reducing light trespass to the ceiling. In case of cloudy weather and nighttime application, flood lights on the top of the light well will be turned on to simulate daylight. To guarantee this room's functionality as a classroom, recessed wall washer will be used to enhance lighting on the white board.

Design Result

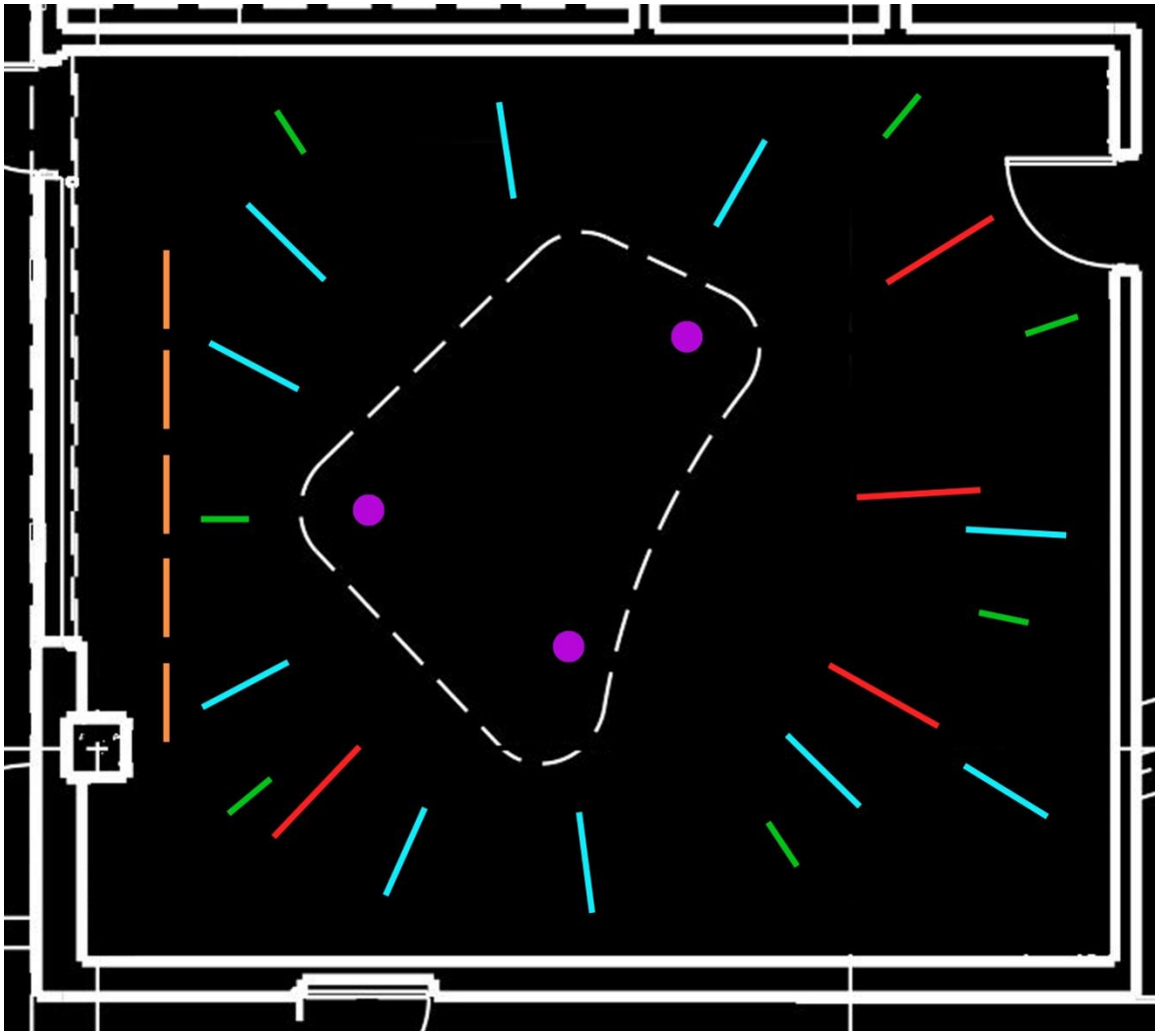
Lighting analysis in AGI32 indicates that all the light level has reached the illuminance criteria and the uniformity level is also controlled within 10% of the target. Total power consumption is 773W in this room, result in a lighting power density of 1.05 W/ft^2.

Space Type	**E_h**	**E_v**	**Avg : Min**
Classroom	268 lux	128 lux	2.19 : 1
White Board		215 lux	2.17 : 1

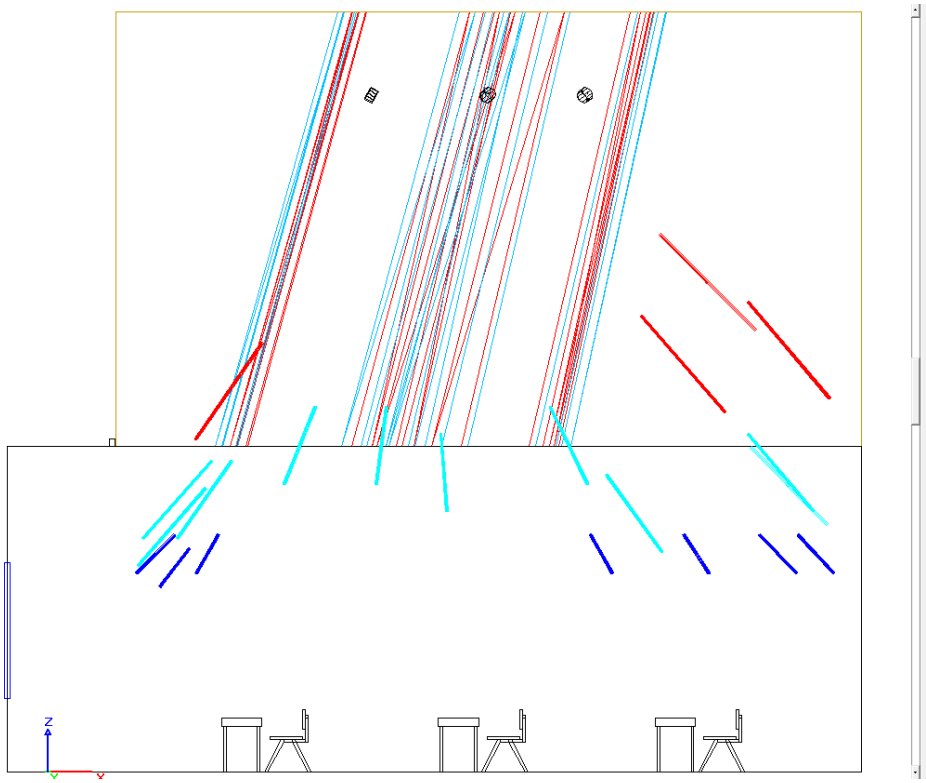




Lighting Plan



Type	Unit	Lamp/Wattage	Manufacturer	Description
C1	Per 2'-0" lengths	LED 13 W	GE	LED T8 tube suspended 45 degrees from horizontal facing towards the center of the room. Suspention cable varies from 6' to 20' in length.
C2	Per 4'-0" lengths	LED 22 W	GE	LED T8 tube suspended 45 degrees from horizontal facing towards the center of the room. Suspention cable varies from 6' to 20' in length.
C3	Per 5'-0" lengths	LED 27 W	GE	LED T8 tube suspended 45 degrees from horizontal facing towards the center of the room. Suspention cable varies from 6' to 20' in length.
C4	Per 4'-0" lengths	T5HO Fluorescent 57 W	COOPER	Neo-Ray recessed wallwasher
C5	Each	LED 42 W	WE-EF	FLC 142 Surface mounted floodlight instaled inside the skylight structure to simulate daylight.



Summary

The design successfully created attractive visual context that helps raise visitors' interest. All illuminance targets are achieved with reasonable power consumption. LED tubes are arranged in a way to surround the light well and gather attention on it, gives visitor a better understanding about how daylight is harvested in modern architecture. Wide distribution floodlight inside the light well made the entire structure itself a luminaire, distributing light throughout the space uniformly.

The design also has its disadvantages. Opening up the ceiling mean increase space volume that requires heating and ventilation, result in increased mechanical load.

Main Lobby

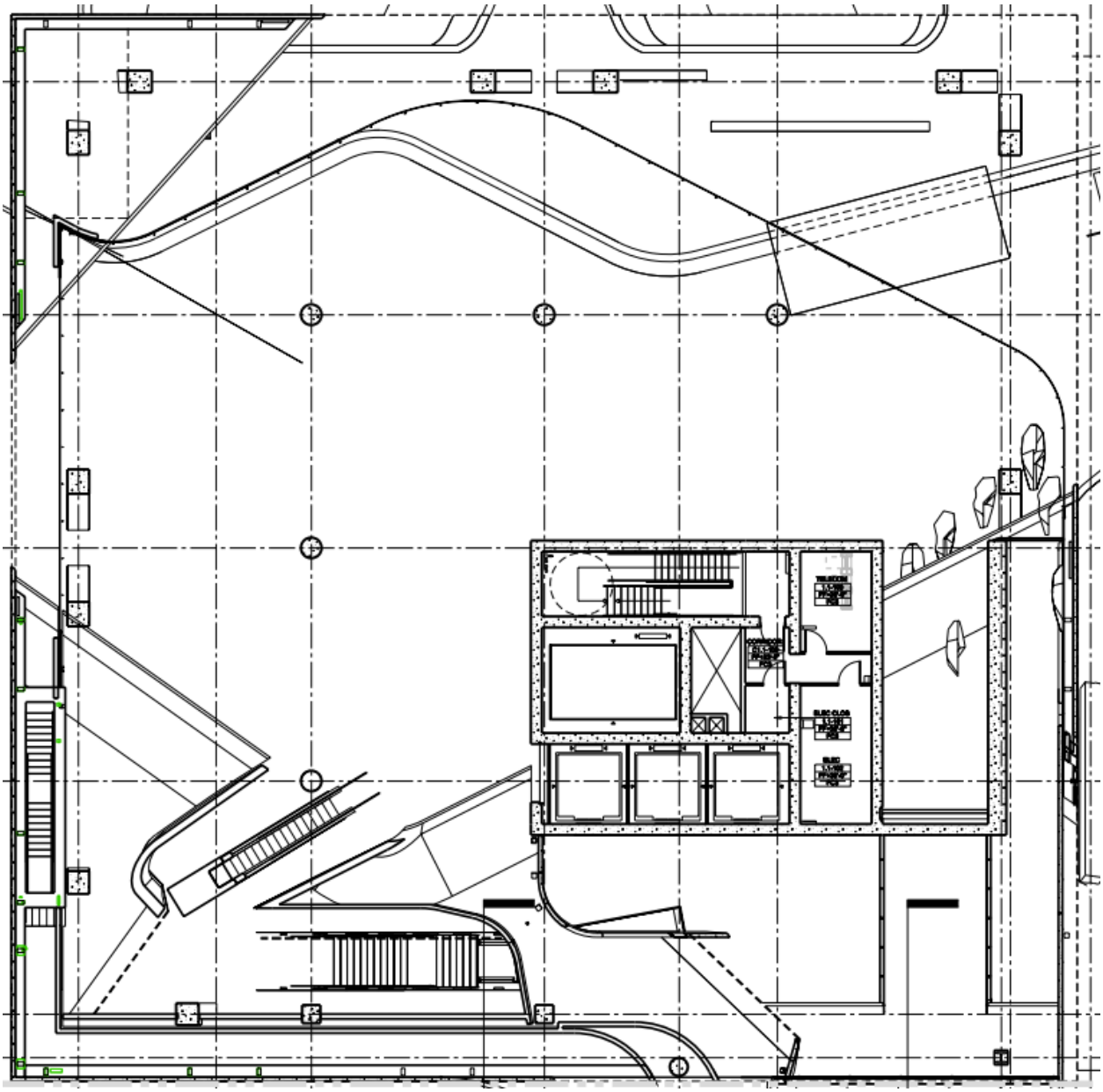
Description

Functioning as the exhibition entrance, exit and ticket center, Main Lobby is probably the busiest **circulation space** in the museum. Perforated metal was used on the ceiling, allowing visitors to catch a rough outline of the mechanical system above head while maintain the property of a surface from a far distance. On the north end of the lobby, part of the landscape plinth is brought into the space, providing an elevated platform as seating area and also function as the base of a dinosaur skeleton exhibition.

Unlike other floors above with rectangle perimeter and slid concrete walls, ground level sets back into a curved outline as indicated below. It also have curtain walls built around to maximize daylight gain while using floor slab of level above as overhang to prevent excessive solar penetration.

Dimensions

Approximate Area = 7750 ft^2
North to South Length = 100 ft in average
East to West Length = 112 ft in average
Ceiling Height = 20 ft
Roof Height = 30 ft



Finish Material

	Description	Location	Color	Reflectance
Floor	Masonry Tile	Main Lobby	Grey	0.25
	Rock	Landscape Plinth	Brown	0.15
Wall	Paint	Center Atrium	White	0.5
	Reinforced concrete	Lobby Column/Stair	Grey	0.4
Ceiling	Metal wire mesh panels	Main Lobby	Black	0.7 (50% Open)

Design Consideration

Being a space with heavy traffic flow, it is very important to guide visitor the correct direction. Lighting solution can definitely be used as a navigation tool, marking the suggested route leading to exhibition area. While waiting in line it is easy for visitor, especially children to get upset. Therefore lighting should also be used to create a **relaxing environment** for tension release. The dinosaur skeleton together with its rock base is technically the first exhibition visitors see on their tour, thus it should be highlighted as an **attention getter**.

Design Criteria

The major purpose of lobby lighting is to guarantee transportation safety. An illuminance level of 100 lux on ground level is suggested.

Space Type	E_h	E_v	Avg : Min
Lobby	100 lux @ floor	30 lux	4 : 1

For lighting power density, space by space method from ASHRAE standard 90.1 is applied, concluding a recommended lighting power density of 0.9 W/ft^2.

Design Approach

The landscape base in the lobby is a symbol of architectural integration, combining exterior and interior element together. Lighting design, as well, took the approach to seek inspiration from the landscape layout.

The landscape plinth was designed into six small blocks each reflecting a typical Texas geology. Simply by walking around the museum visitor can experience a dramatic landscape shift. This landscape puzzling, however, is missing its last piece: the ocean.

The ocean is constantly flowing, just like visitors flowing through the museum every day. Linear LED lighting is arranged into an elegant curve, representing flowing water that guides visitor towards their destination.

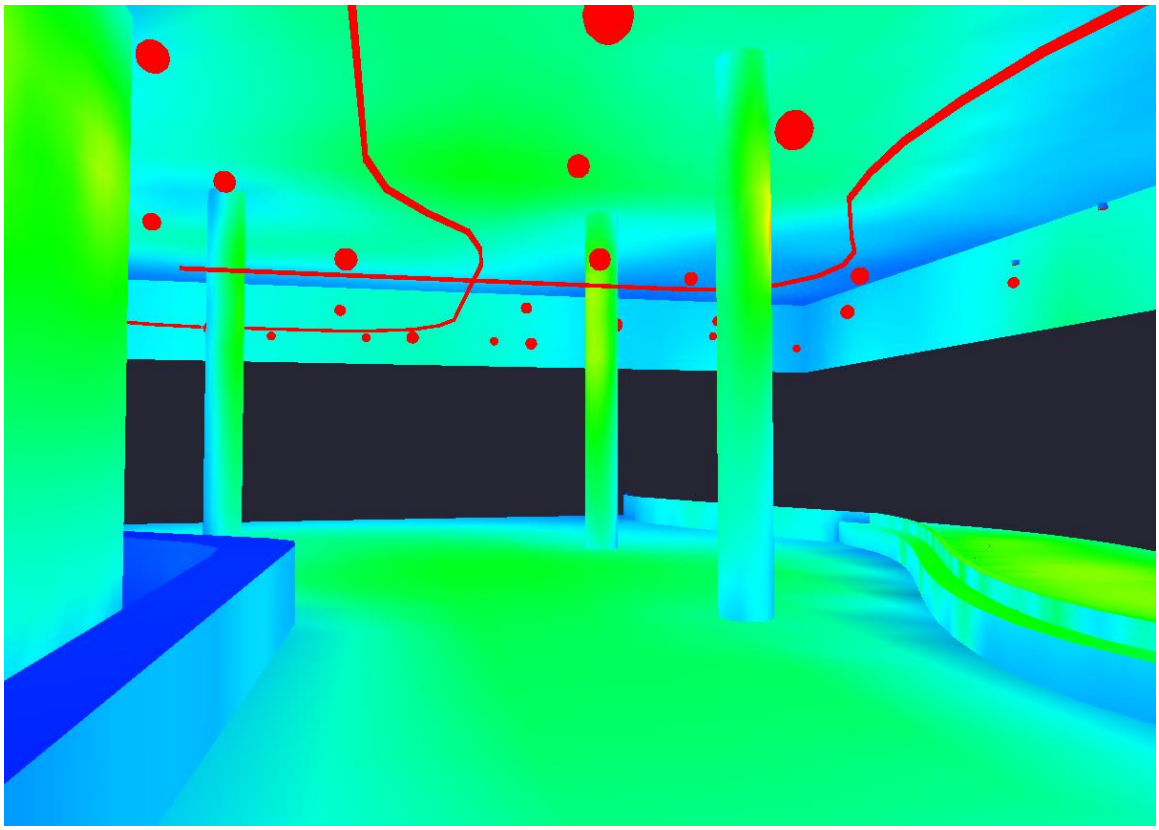
The ocean is also very steady, thus an ocean themed design often helps people to feel relaxed. Suspended sphere luminaire is used to imitate bubbles floating toward the sky, create an illusion that the lobby is located under water. This impression is enhanced by blue architectural glazing films, add a light blue on the curtain wall, and make the space fees like an aquarium surrounded by water.

The landscape base is illuminated with warm colored flood light to create contrast against the major theme, thus attract visitor's attention.

Design Result

Lighting analysis in AGI32 indicates that light level in the lobby within 10% of the target. Total power consumption is 4430 W, result in a lighting power density of 0.57 W/ft^2.

Space Type	**E_h**	**E_v**	**Avg : Min**
Lobby	96 lux @ floor	48 lux	3.5 : 1



Lighting Plan

L1	Per 4'-0" lengths	T5HO Fluorescent 32 W	REGENT	FLOW pendant luminaire with direct light emission and translucent housing
L2	Each	Compact Fluorescent 46 W	BEGA	L5211 pendant sphere luminaires with three-ply opal glass with satin matte finish. Integral electronic ballasts included. 1ft in diameter.
L3	Each	Compact Fluorescent 62 W	BEGA	L5212 pendant sphere luminaires with three-ply opal glass with satin matte finish. Integral electronic ballasts included. 1.5ft in diameter.
L4	Each	LED 42 W	WE-EF	FLC 142 Surface mounted floodlight instaled inside the skylight structure to simulate daylight.

Summary

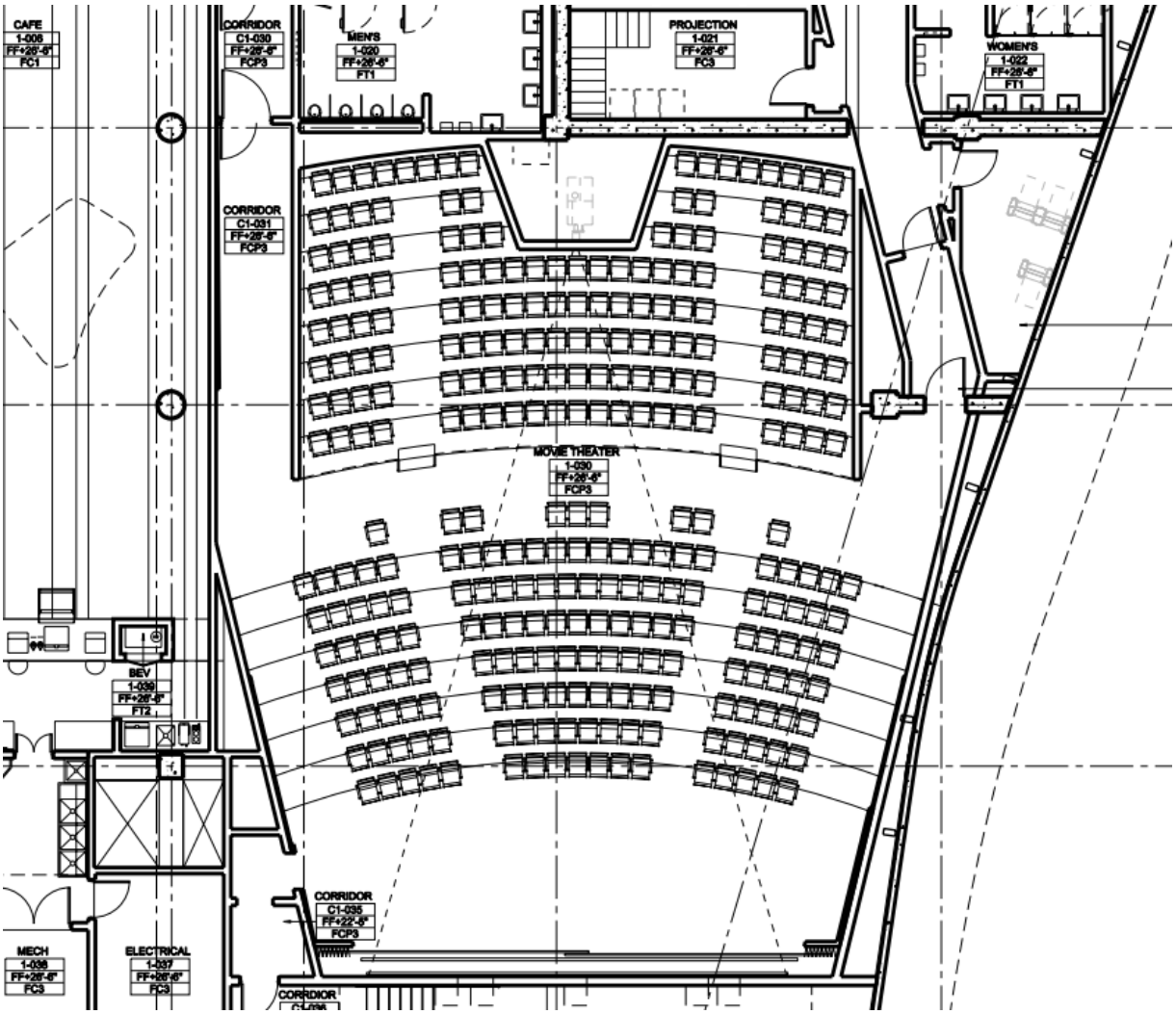
The design solution provided adequate illuminance level. Linear luminaire clearly marked up the recommended route, help visitor navigating through the area. Sphere luminaire not only worked as an adorable glowing ornament above ceiling but also lighted up space above ceiling with its spilled side light, help visitor understand the plumbing and mechanical system. Warm colored light made the area around landscape base stand out from the space, enhancing the red color tone of rock and skeleton texture.

Due to the limitation of AGI32, the analysis is done treating the perforated metal as a glass with same transmittance. Therefore the render might not reflect the realistic visual effect. The scale of this space also made some design ideas less efficient. From the render we can see that although mounted on different height, the sphere luminaire still looks as if they were all at the same mounting height. Nevertheless there is no doubt that design solution proposed can provide a satisfying light level.

Theater

Description

The theater is a **special purpose space** designed for 3D movie shows. Customized ceiling panel not only reinforced acoustic performance of this space but also serves as the host for luminaires. This space does not have any type of glazing, audiences are isolated from external world once the entrance is sealed.



Dimensions

Approximate Area = 3726 ft^2
Length = 69 ft
Width at Front Row = 43 ft
Width at Back Row = 64 ft
Ceiling Height at Front Row = 22 ft
Ceiling Height at Back Row = 18 ft

Finish Material

	Description	Location	Color	Reflectance
Floor	J+J Invision carpet tiles	Theater	Grey	0.2
Wall	Fabritrak system with Knoll and Maharem fabric acoustic wall	Theater	Grey	0.4
Ceiling	Fabritrak system with Knoll and Maharem fabric acoustic ceiling	Theater	Grey	0.4

Design Consideration

Ceiling surface of the theater is customized into a unique form that its very existence can be viewed as an exhibition. Lighting design should be designed around this feature and reinforces its **visual impact**.

The isolation of the space allows lighting design to dominate the space and convince audience that they have entered a different world. Lighting design should be able to allow audience to see the space from a different perspective and get **inspired** by views cannot be seen in daily life.

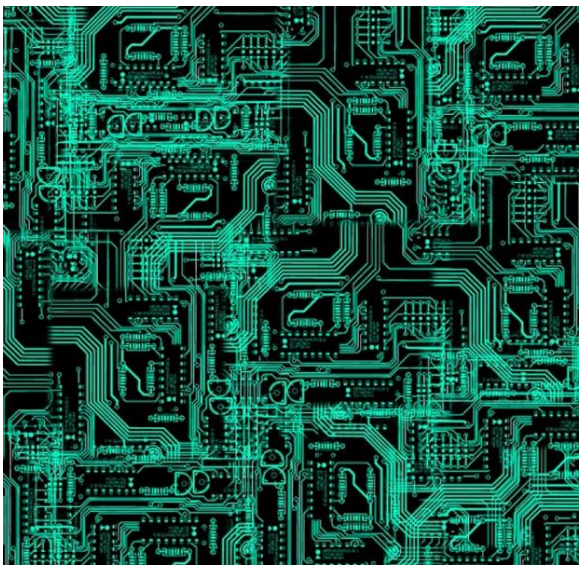
Design Criteria

Major purpose of the theater lighting is to navigate audience to their seats and to the exit, therefore high illuminance target is not required.

Space Type	E_h	E_v	Avg : Min
Theater	50 lux	30 lux	2 : 1

For lighting power density, space by space method from ASHRAE standard 90.1 is applied, concluding a recommended lighting power density of 0.52 W/ft^2.

Design Approach



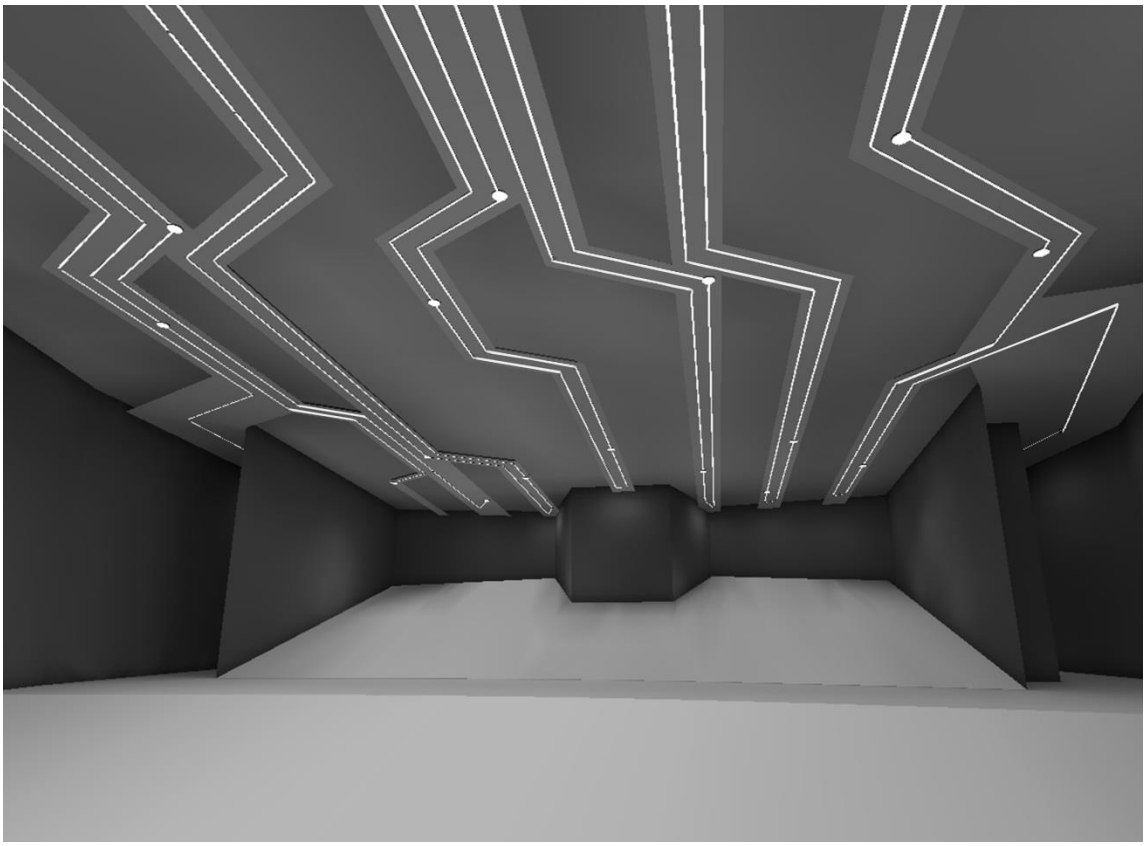
Most people have electronic devices with them but few of us know how they operate. Lighting solution in this space attempts to convert the entire space into a computer chip, showing its visitor how circuit wires and nodes work together to keep information transported.

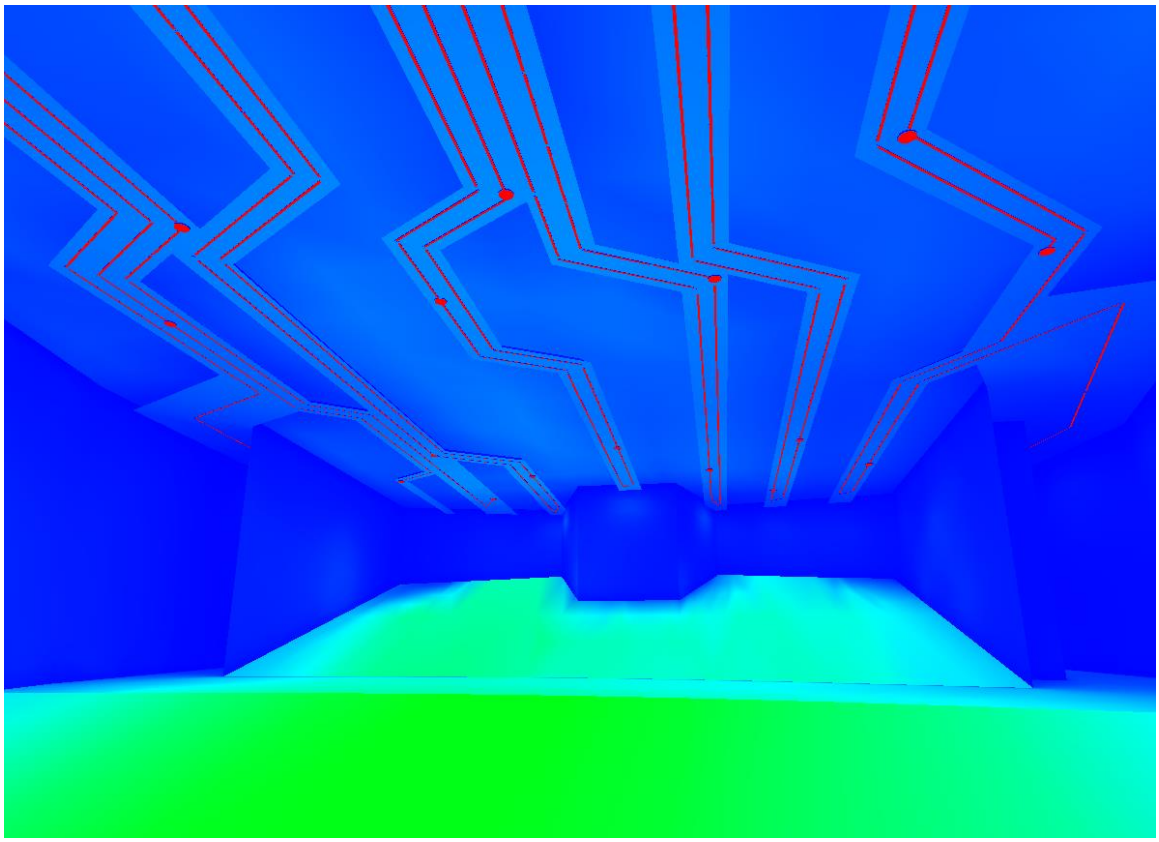
Since the acoustic ceiling does not hold structural load and is relatively easy to customize, it will be customized into a more linear geometry to assist with the electronic design theme. Luminaire also serves a navigation purpose to help audience find seating area when entering as well as the exit when leaving.

Design Result

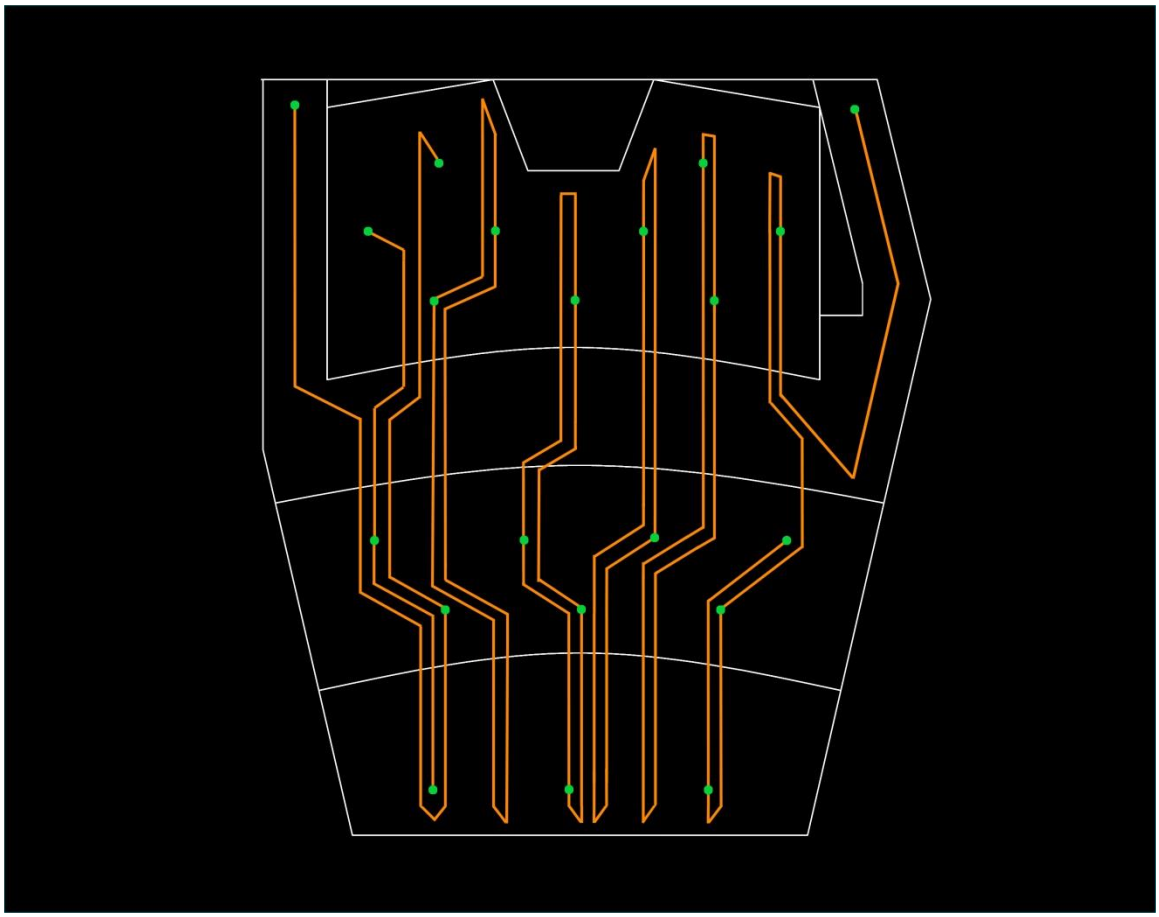
Light level in the theater achieved the target illuminance and uniformity. Total power consumption is 1953 W, result in a lighting power density of 0.52 W/ft^2 just on target.

Space Type	**E_h**	**E_v**	**Avg : Min**
Theater	124 lux	44 lux	1.5 : 1





Lighting Plan



T1	Per 1'-0" lengths	LED 2.2 W	ELECTRIX	L101 recessed linear LED, standard output
T2	Each	Compact Fluorescent 18 W	Edison Price	DTT 13/6 recessed combination downlight.

Summary

The rending image presents a very dramatic visual effect in this space. Linear LED distributed across the space in a seemingly random pattern to provide visual impact. Uniformly distributed downlights regulates the flow of 'circuit' from being too random and create hot spot. Entrance and Exist lighting are connected with the major lighting scheme. When the audience is entering the space, they will initially follow one line of light. Once they turned the Corner they will be astonished that this line they have been following is part of a complicate lighting system.

Facade

Description

The iconic façade texture of this building is definitely one of the most popular features known by public. During the day textures on the façade cast shadow under sun lighting and from unique scenery. To make those texture properly lighted at night is no doubt a challenge for **exterior lighting** practice.

Dimensions

Approximate Area = 19856 ft^2

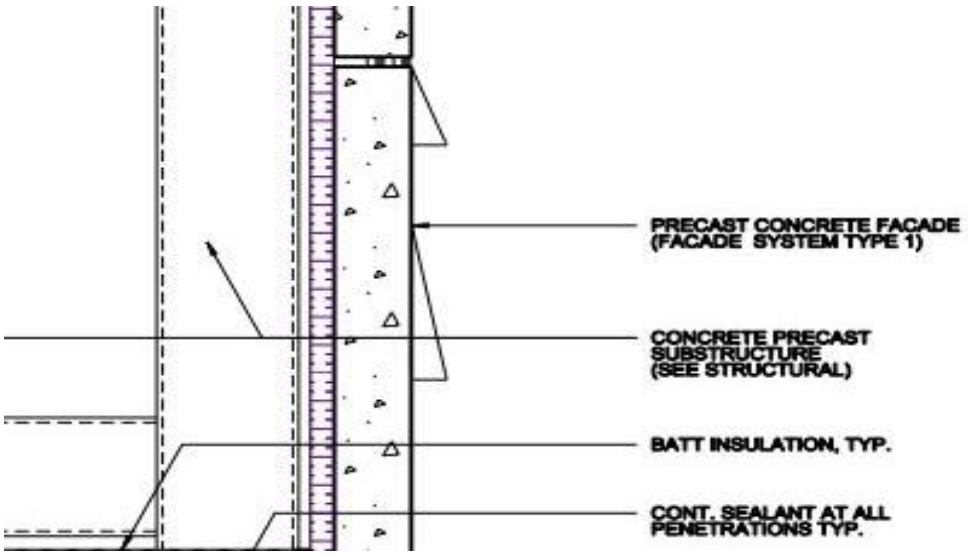
Length = 146 ft

Height = 136 ft

Finish Material

	Description	Location	Color	Reflectance
Floor	Reinforced concrete	South Entrance	Grey	0.2
Wall	Precast concrete	South Façade	Grey	0.4

Design Consideration



The façade is made of precast concrete panels 6 inch thick. Texture on the panel varies from 2 to 4 inch wide. Textures can be easily observed under daylight because the shadow they can formed a contrast with the bright façade itself. Beam with large incident angle can easily eliminate the shadow and make texture hard to be detected. Design for this space should somehow simulate the daytime situation in a different way.

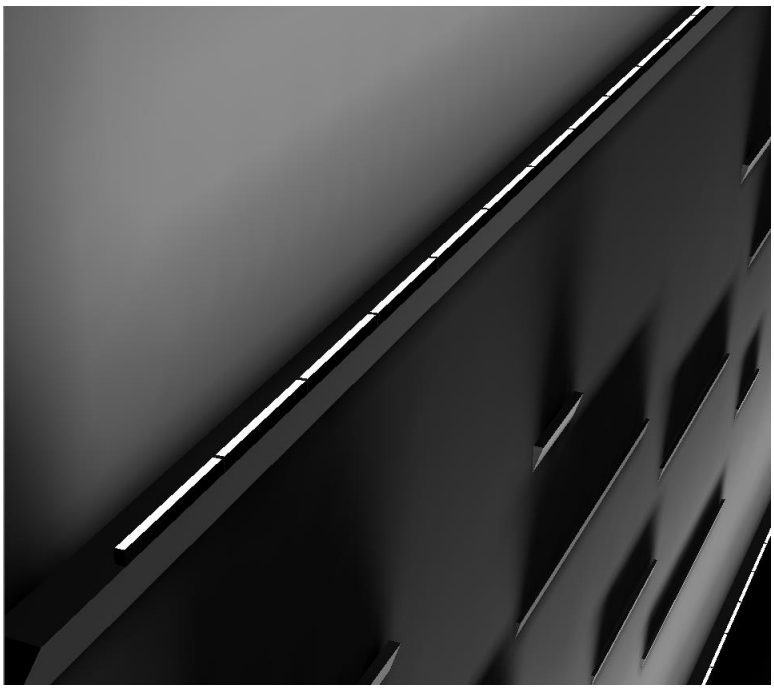
To maintain the nighttime identity of the museum, lighting solution should also provide sufficient amount of light level on the façade surface.

Design Criteria

Space Type	**E_h**	**E_v**	**Avg : Min**
Facade		20 lux	5 : 1

For lighting power density, space by space method from ASHRAE standard 90.1 is applied, concluding a recommended lighting power density of 0.75 W/ft^2.

Design Approach

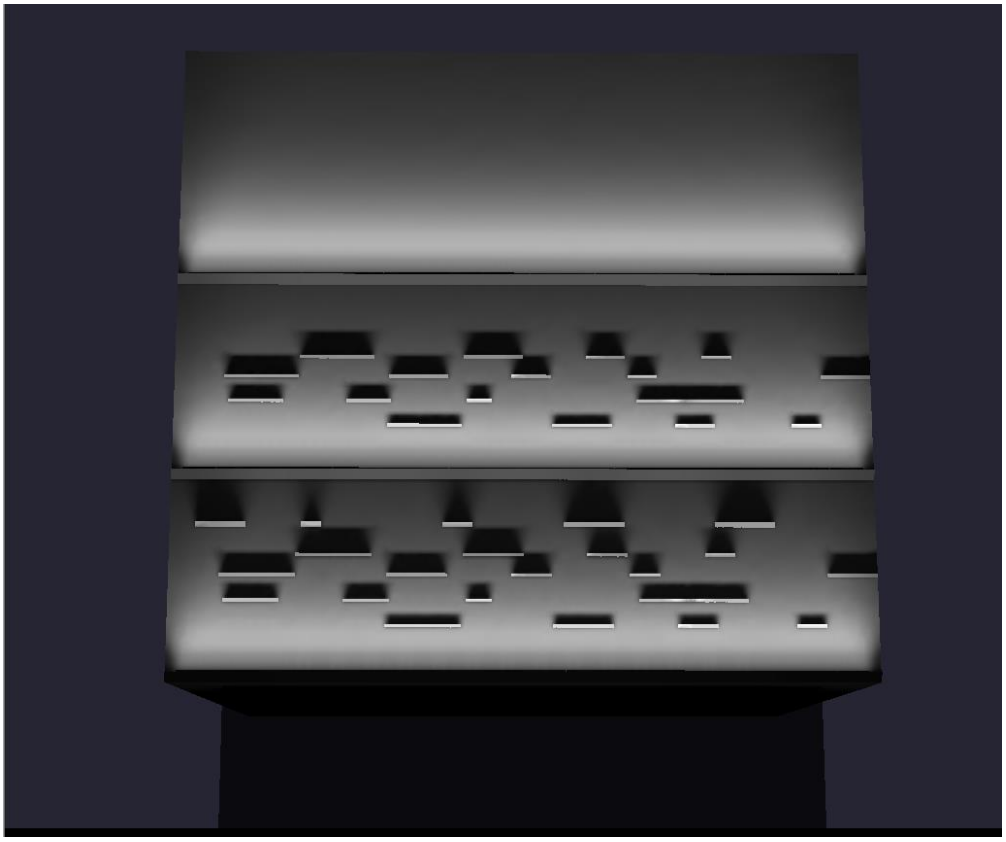


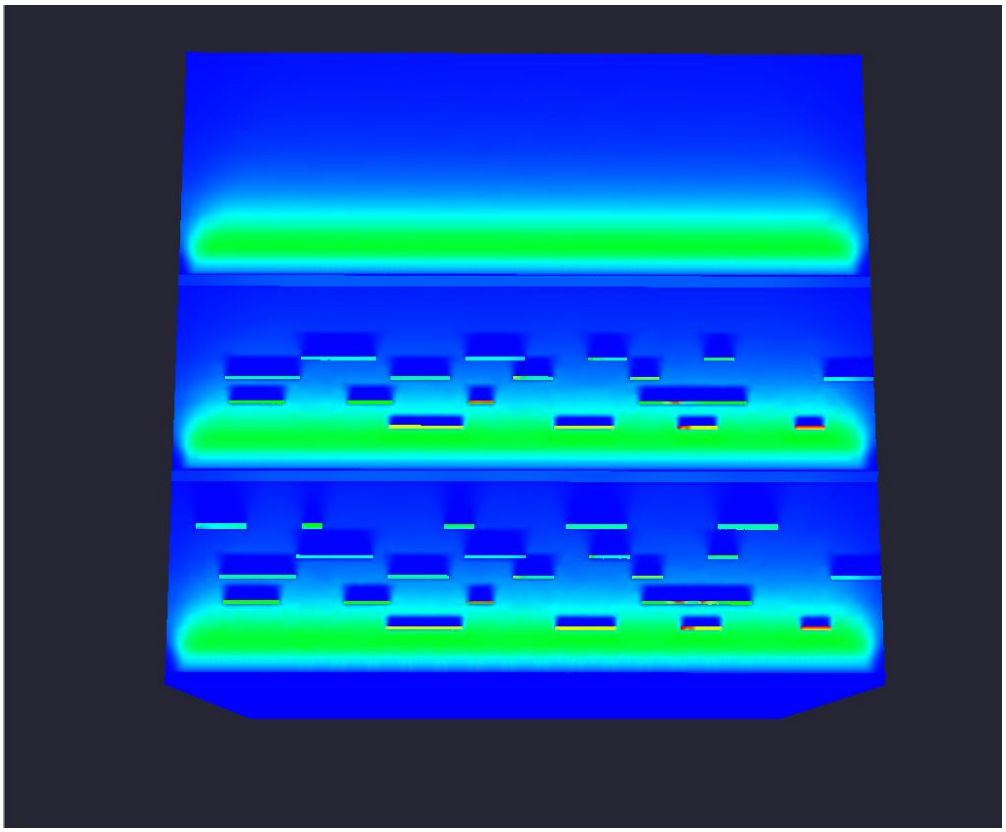
IP rated linear LED luminaire is mounted on a customized platform, which is simply a larger version of façade texture with a width of 1 foot. Narrow beam distribution is selected to project light further up while also avoid hot spot near the luminaire. The concrete portion of the façade is 140 feet tall. Using one row of luminaire cannot reach the desired target. Therefore total of three rows of luminaire is applied on each facad.

Design Result

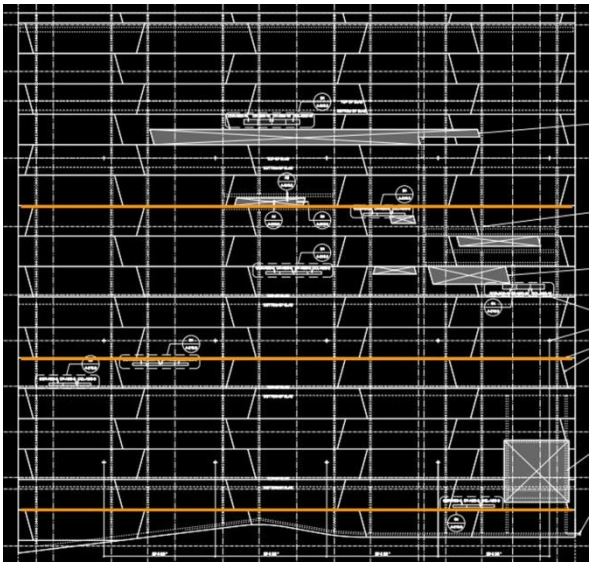
Light level calculated is twice as much as the target. Total power consumption is 25 KW, with lighting power density of 1.28 W/ft^2 over the design target. Reason for this is because luminaire with narrow distribution is used while there is not alternative luminaires available with lower output. Considering that most times we can dim all luminaire by half, the LPD them become 0.64 W/ft^2 which meets the target. Since up lighting is the major strategy used in this space, lighting trespass to the sky is also measured to evaluation light pollution. 22% of the light output is released to the sky.

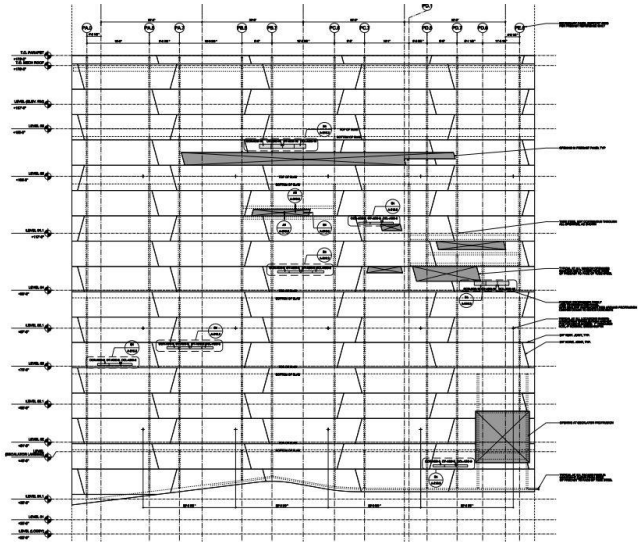
Space Type	**E_h**	**E_v**	**Avg : Min**
Facade		39 lux	11 : 1





Lighting Plan





F1	Per 3'-0" lengths	LED 45 W	PHILIPS	Vaya Linear LED with 10 deg narrow distribution

Summary

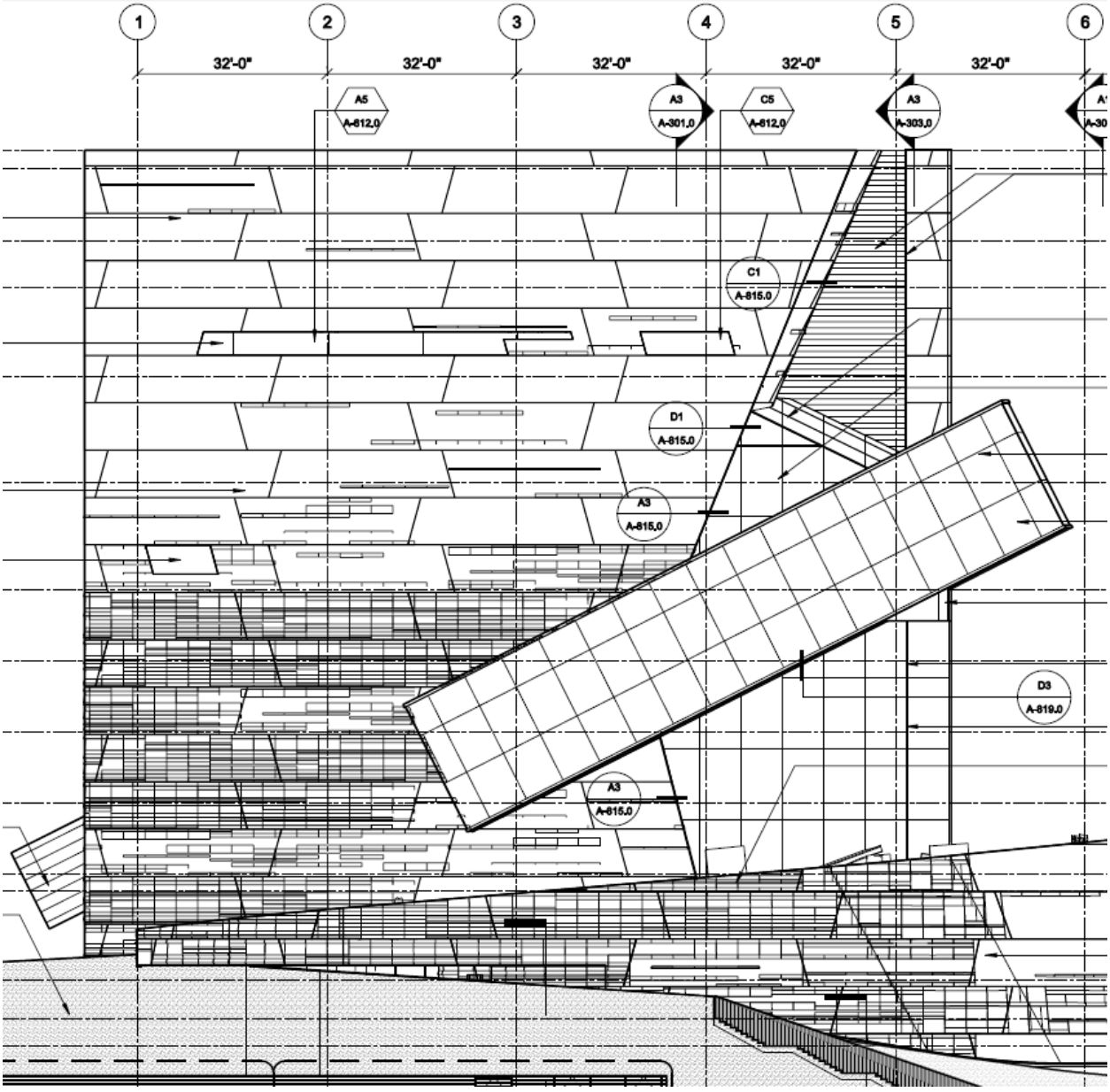
The design solution did achieve the target of highlight façade texture at nighttime. However there are also many issues exist with this solution. First, with most luminaire aiming towards the sky, about 20% of the lighting output is released into the night sky, causing energy waste and might even face code issue for certain district. Also, narrow distribution require in this design is only available in a high wattage, making the solution provide twice as much light as needed.

As for nighttime identity, plenty of light on the façade surface can definitely attract citizens attention even from several streets away.

Escalator Cartridge

Description

The escalator cartridge is a rectangle space extended out from the facade. Below its floor is 100 feet's void space above ground. The only activity in this space is riding escalator to the level above. Curtain wall is applied in this space, provide occupant a fascinating view of the city.



Dimensions

Approximate Area = 1272 ft^2

Length = 113.6 ft

Width = 11.2 ft

Height = 24 ft

Tilt Angle = 26 deg

Finish Material

	Description	**Location**	**Color**	**Reflectance**
Wall	Reinforced concrete	Concrete Wall	Grey	0.4
Ceiling	Metal Panel	Escalator Ceiling	Black	0.8

Design Consideration

While allowing visitor to enjoy the view from the curtain wall, interior lighting should also be used to create some entertaining element to make the 100 feet long escalator drive more **exciting**.

Design Criteria

Enough lighting should be provided to guarantee the safety in this space.

Space Type	**E_h**	**E_v**	**Avg : Min**
Escalator	50 lux	30 lux	2 : 1

For lighting power density, space by space method from ASHRAE standard 90.1 is applied, concluding a recommended lighting power density of 0.69 W/ft^2.

Design Approach

Two major strategies are applied in this space to make the rise feels much faster:

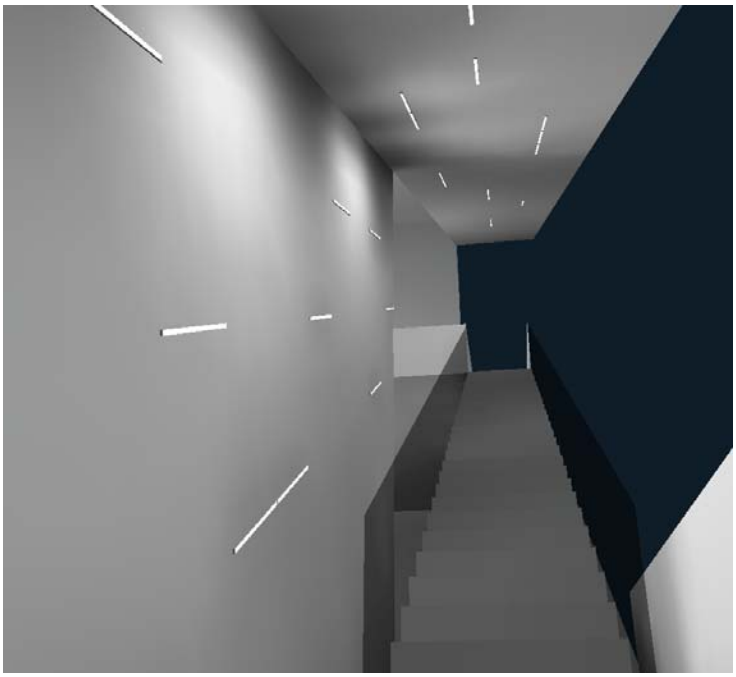
When kept in motion, people tend to find reference objects to measure speed and distance. Luminaires in this space is divided into 3 control groups. All three groups of luminaire switch their diming level alternatively to make the visitor lose track with his current location, providing an overwhelming riding experience.

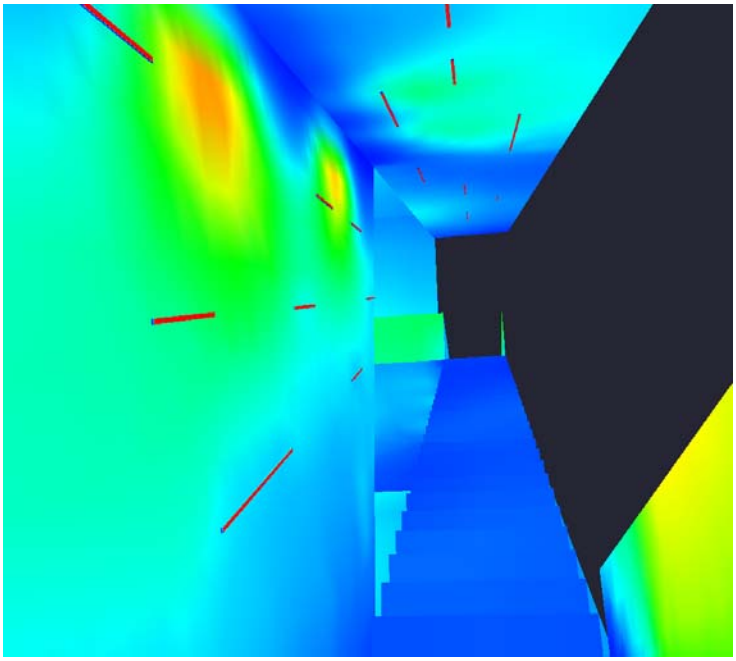
Linear luminaires in the space, when viewed as a whole, can from into multiple lines seemingly parallel. In fact, the luminaire is arranged into an exaggerated perspective line to make the space looks longer that it actually is.

Design Result

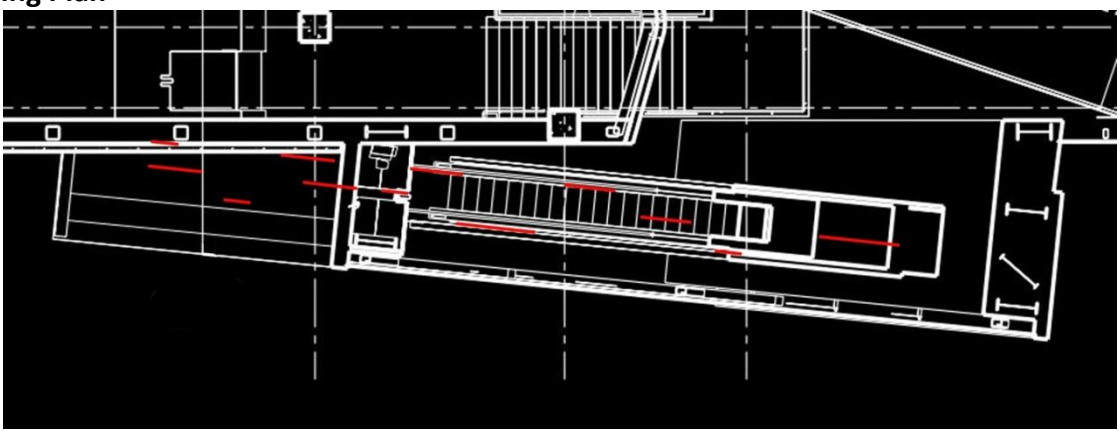
Horizontal light level and uniformity have achieved the target. Vertical illuminance and uniformity are lower than the target with electrical lighting alone, however half of the wall area is consist of curtain wall so datlight should be sufficient to make up for it. Total power consumption is 640 W, result in a lighting power density of 0.5 W/ft^2.

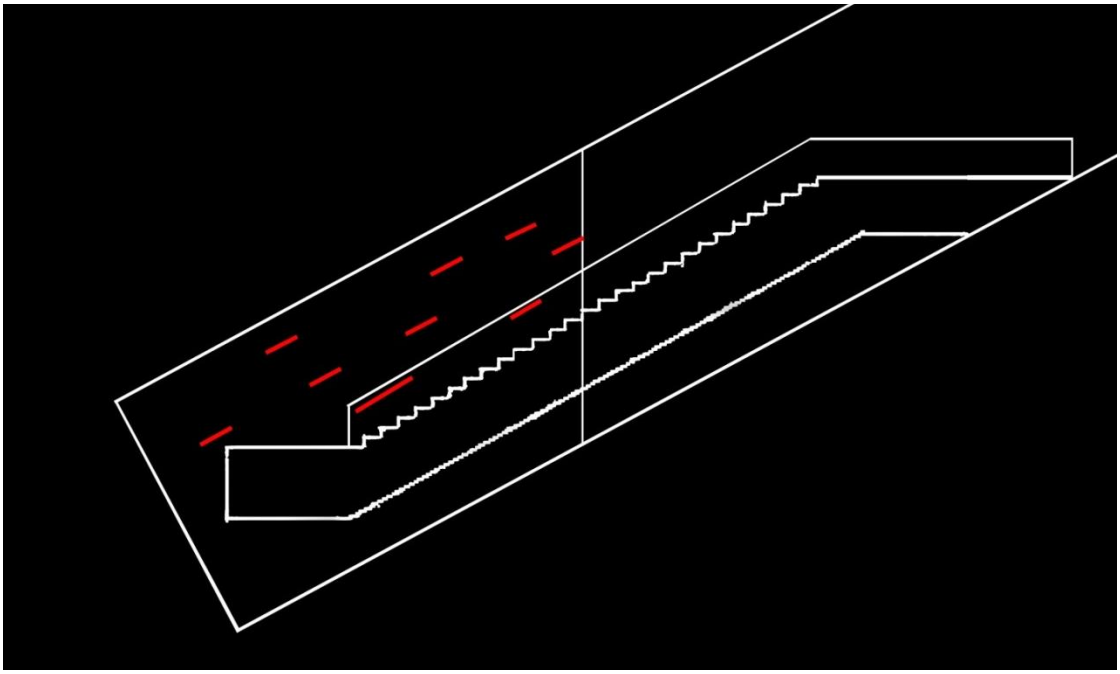
Space Type	**E_h**	**E_v**	**Avg : Min**
Escalator	47 lux	13 lux	1.4 : 1(h), 7:1(v)





Lighting Plan





E1	Per 4'-0" lengths	LED 20 W	ELECTRIX	L101 recessed linear LED, high output

Summary

The lighting solution have successfully achieve target on vertical surface. Vertical light level is lower than the design criteria. Daylight gain from the window should be able to solve this issue.

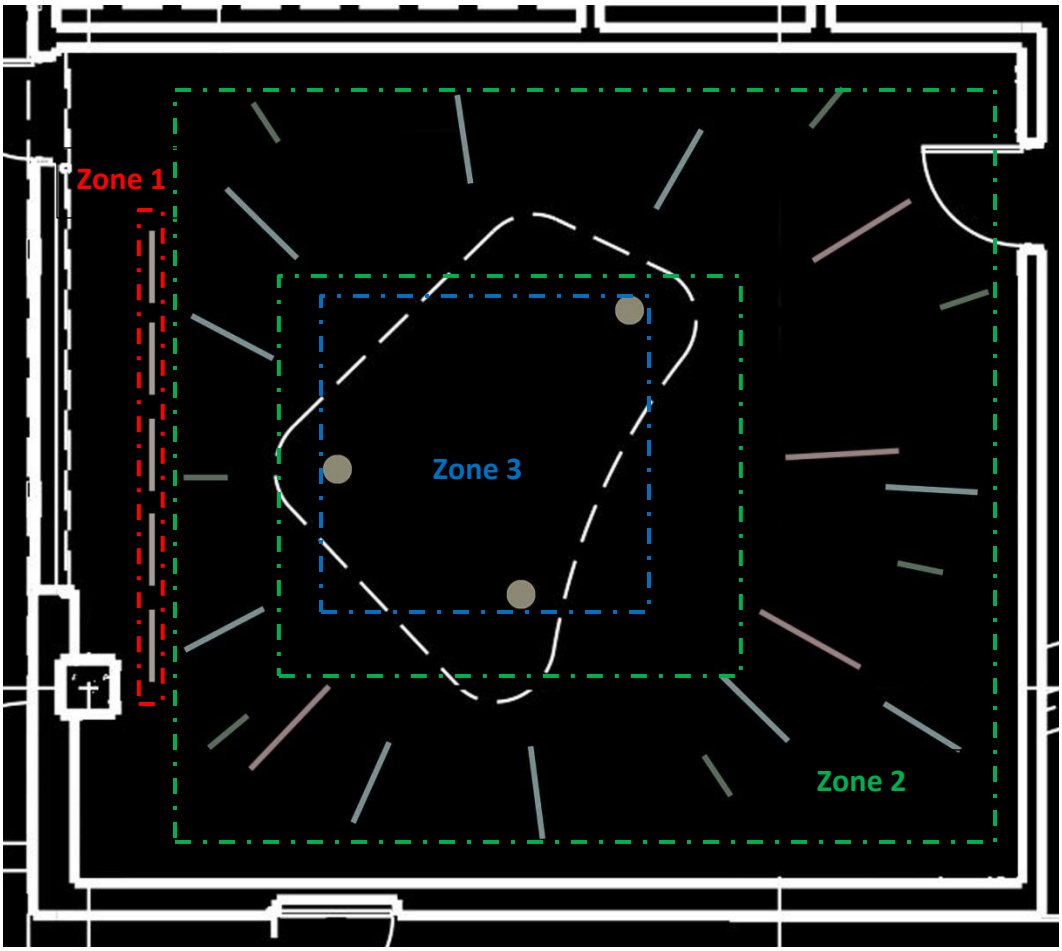
Lighting solution in such a narrow space made hotspot become a critical issue. From the rendering we can see some hotspots on the wall. However, as mentioned earlier the concrete wall will be lid by daylight from the curtain wall eventually, which will help maintain the uniformity.

Electrical Depth

Control Strategy Development

Lighting control strategy not only has critical influence to user experience but also affects the way luminaire is wired and arranged on panel boards. Therefore, establishing accurate yet simple become an essential part of electrical design.

Classroom

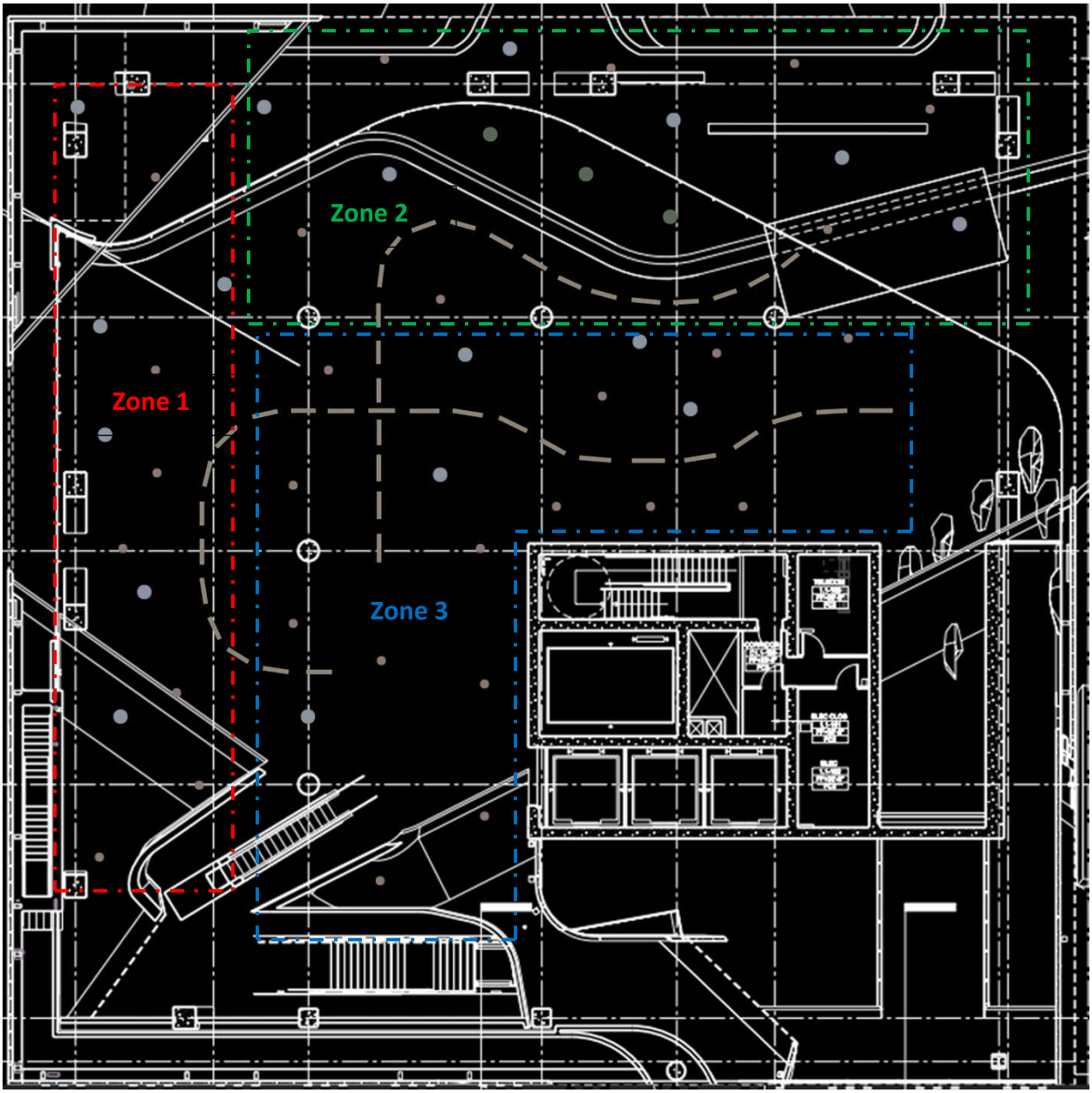


Zone 1 controls recessed luminaires washing the white board. Unlike the floor areas white board benefit less from the light well and therefore requires constant illumination.

Zone 2 controls all the suspended LED luminaire, provide general illumination to the work surface. Photosensor pointing to the floor measures light gain from the light well and adjust dimming level to maintain the target light level.

Zone 3 controls flood lights within the light well. Photosensor pointing to the sky measures solar gain and raise dimming level up when solar gain is below expectation.

Main Lobby



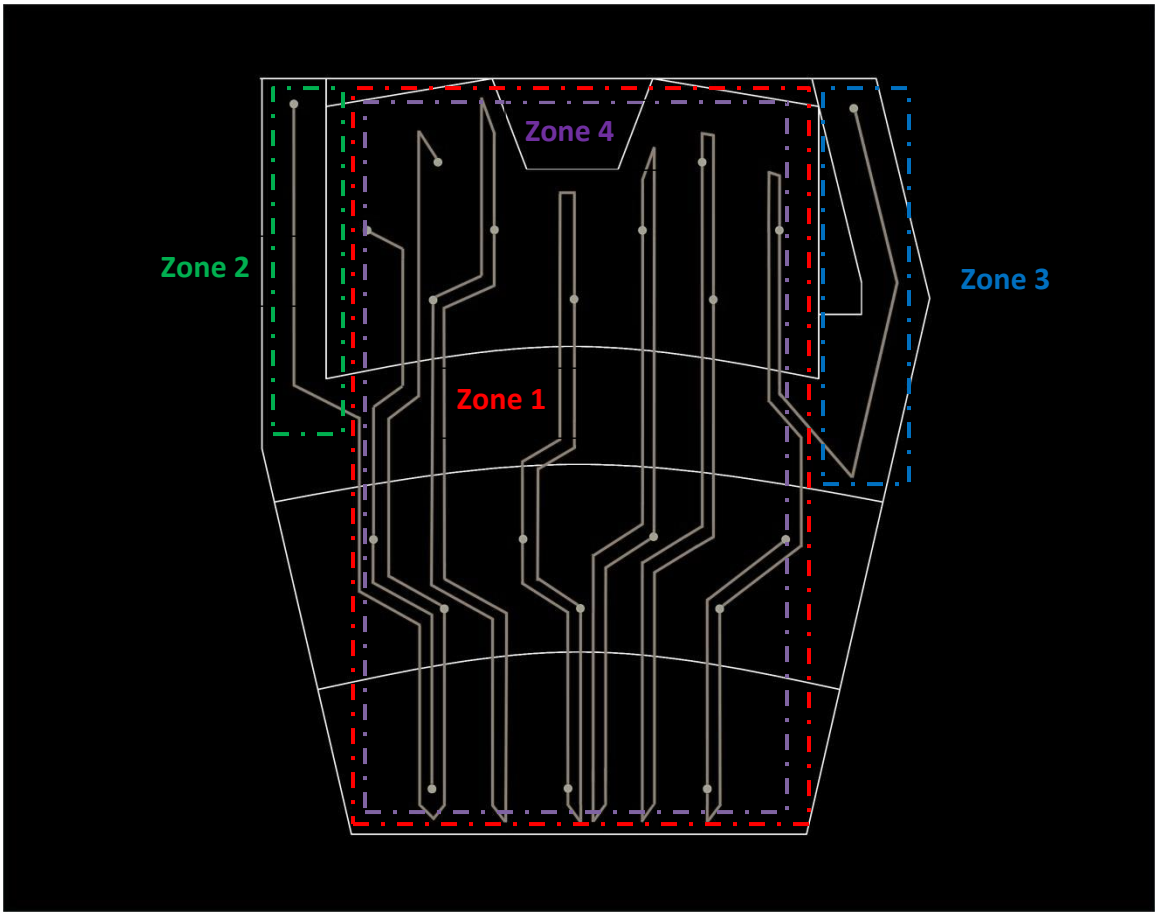
Zone 1 faces project west (South West) direction and receive direct sunlight during noon time, therefore all LED spheres is controlled to adjust output according to aerial daylight gain.

Similarly, **Zone 2** controls LED spheres on the north side of the lobby as well as metal halide floodlight for landscape base, controlling lighting output according to sunlight penetration during late afternoon.

Zone 3 groups the rest of LED spheres in the center of the lobby, where direct sunlight can rarely reach and constant lighting output is preferred.

Linier LED luminaires are zoned separately as **Zone 4**, since they were arrange as a continuous line and should have a consistent brightness regardless of its location.

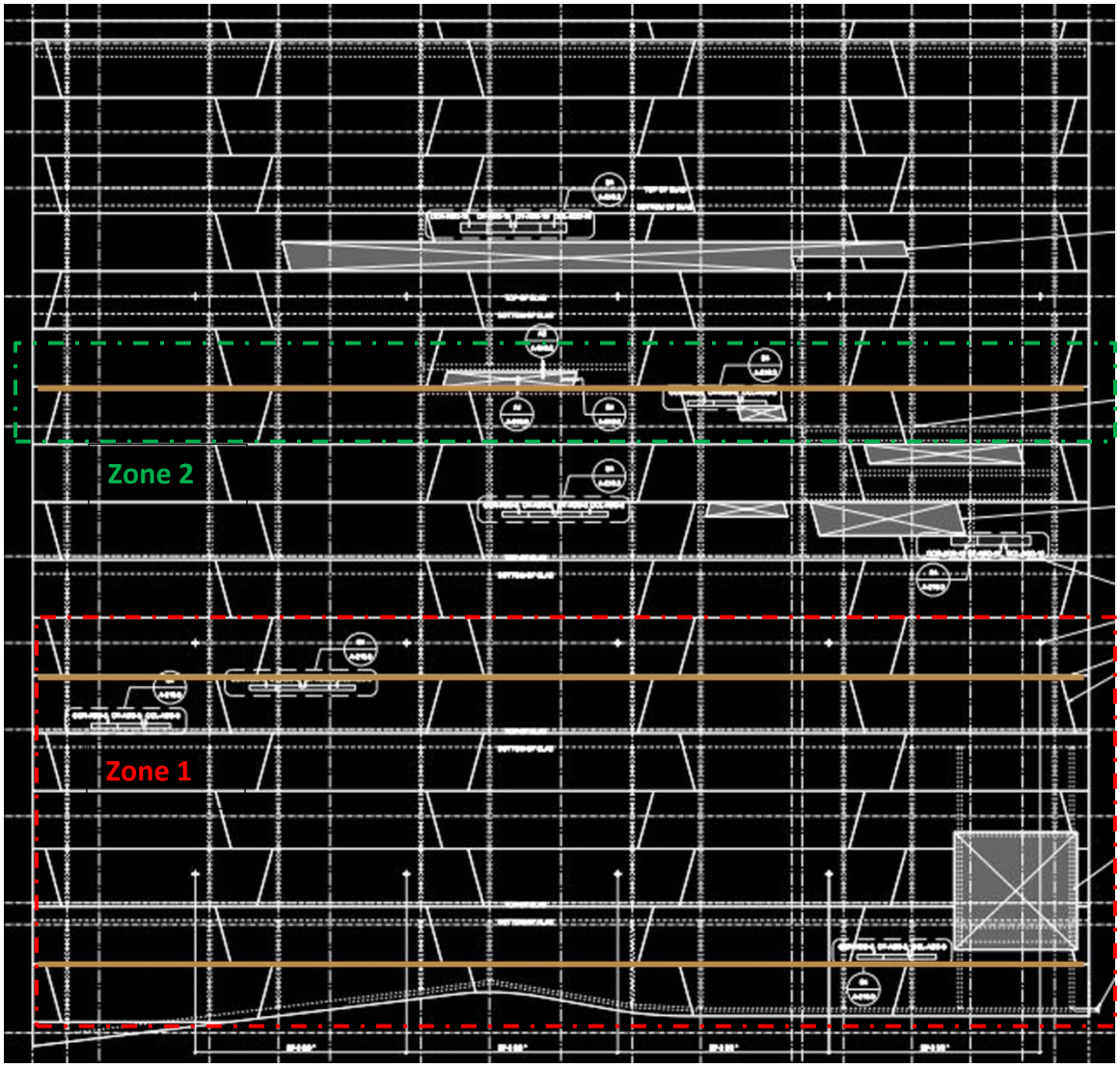
Theater



Being an enclosed space with no external solar gain, control strategy in the theater focus on improves user experience. Linear LEDs in the center of the space are grouped as **Zone 1** while compact fluorescent downlight in the same area are grouped as **Zone 4**. Together they create a circuit board diagram highlighting the design theme of this space. Entrance and Exit lighting in **Zone 2** and **Zone 3** are controlled separately for navigation purpose.

When a movie ended, **Zone 4** will be turned on first, allowing audience to adjust to the brightness change. Then **Zone 1** and **Zone 3** will be turned on to provide additional illumination while also marking the exit path.

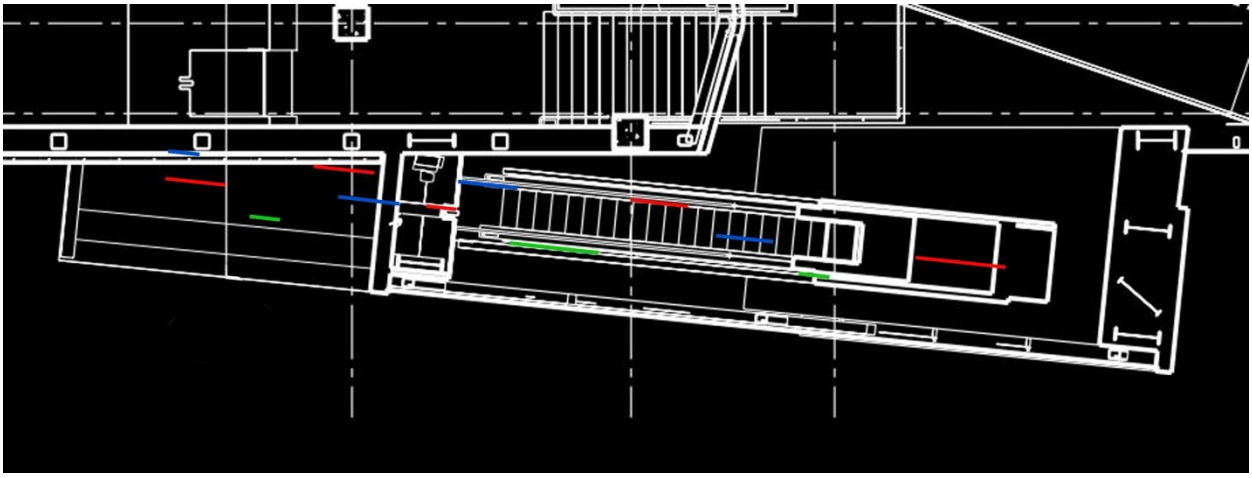
Façade

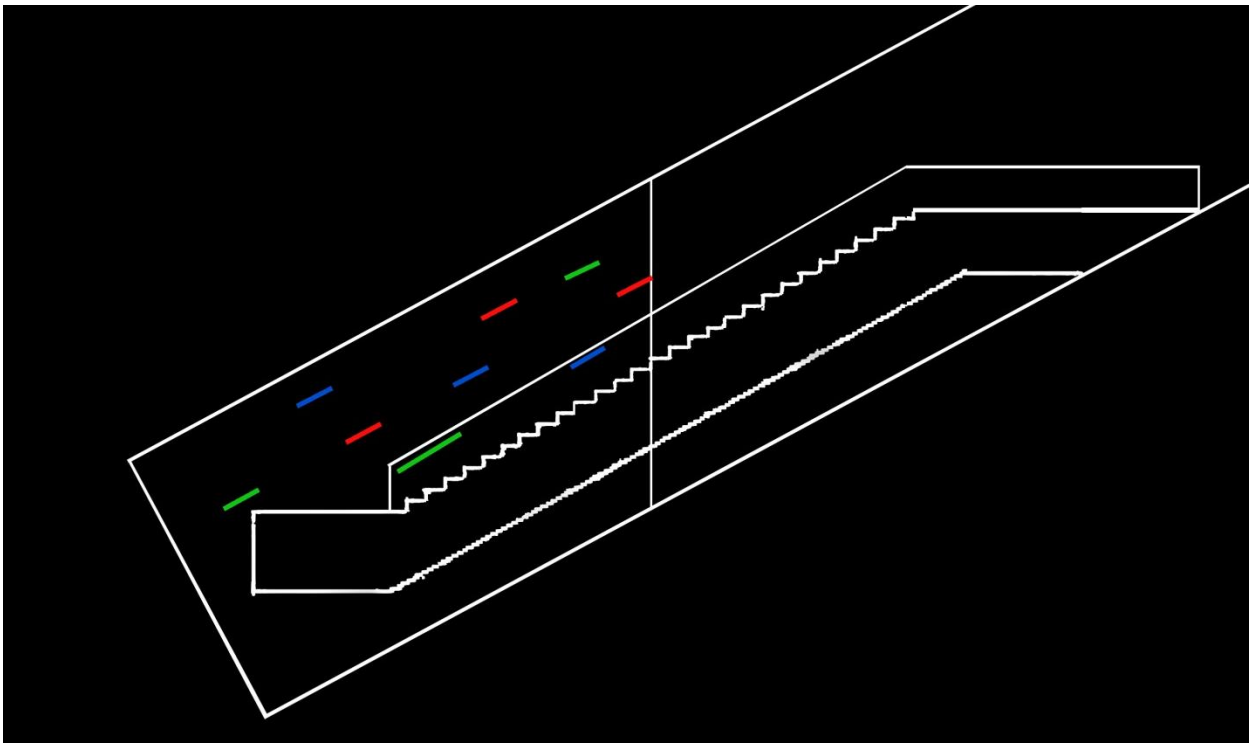


For the façade lighting, first two rows of luminaire on the bottom are grouped as **Zone 1**, washing the façade surface to highlight its texture.

Luminaires on the top row will be **Zone 2**, which can be dimmed more frequently to reduce energy consumption.

Escalator Cartridge





Although escalator cartridge space have a great potential for daylight harvesting, lighting strategy applied will focus on enhancing the visual theme of speed. Luminaires are grouped into three control groups and dimmed alternatively to produce a lighting scheme constantly in motion.

Panel Board Resizing

Lighting solutions proposed in this project will change to total lighting load. Lighting control strategy change also affect number of circuits used in each space. Therefore it is critical to check the load, available space and phase balance on panel board making sure that those design can fit in the current building system. Power factor is assumed to be 0.8.

Classroom

L0A

ROOM BASEMENT TELECOM RM-0-111 | VOLTS 480Y/277V 3P 4W | AIC 65,000
MOUNTING SURFACE | BUS AMPS 100 | MAIN BKR MLO
FED FROM M0C | NEUTRAL 100% | LUGS STANDARD
NOTE

NOTE	CKT #	CKT BKR	CIRCUIT DESCRIPTION	KVA LOAD A	KVA LOAD B	KVA LOAD C	NOTE	CKT #	CKT BKR	CIRCUIT DESCRIPTION	KVA LOAD A	KVA LOAD B	KVA LOAD C
	1	20/1	AL4	1.32				2	20/1	AL18, AL12	0.74		
	3	20/1	AL55		0.275			4	20/1	C5		0.16	
	5	20/1	E5			0.11		6	20/1	AL44			0.6
	7	20/1	AL30	1.38				8	20/1	AL18	0.04		
	9	20/1	AL16, AL49, AL9		1.33			10	20/1	E5		1.54	
	11	20/1	AL30			1.08		12	20/1	AL43			1.2
	13	20/1	AL21	0.5				14	20/1	AL9	0.06		
	15	20/1	E1, LN. FL.		0.585			16	20/1	AL9		0.48	
	17	20/1	AL9			0.48		18	20/1	E1			0.195
	19	20/1	AL43	0.15				20	20/1	C1, C2, C3	0.52		
	21	20/1	C4		0.29			22	20/1	SPACE		0	
	23	20/1	SPACE			0		24	20/1	SPACE			0
	25	20/1	SPACE	0				26	20/1	SPACE	0		
	27	20/1	SPACE		0			28	20/1	SPACE		0	
	29	20/1	SPACE			0		30	20/1	SPACE			0
	31	20/1	SPACE	0				32	20/1	SPACE	0		
	33	20/1	SPACE		0			34	20/1	SPACE		0	
	35	20/1	SPACE			0		36	20/1	SPACE			0
	37	20/1	SPACE	0				38	20/1	SPACE	0		
	39	20/1	SPACE		0			40	20/1	SPACE		0	
	41	20/1	SPACE			0		42	20/1	SPACE			0
										TOTAL CONNECTED KVA BY PHASE	4.71	4.66	3.67
										TOTAL CONNECTED AMPS BY PHASE	17	16.8	13.2

	CONN. KVA	CALC. KVA	
LIGHTING	13	16.3	(125%)
LARGEST MOTOR	0	0	(125%)
OTHER MOTORS	0	0	(100%)
RECEPTACLES	0	0	(50%>10)

	CONN. KVA	CALC. KVA	
CONTINUOUS	0	0	(125%)
HEATING	0	0	(100%)
NONCONTINUOUS	0	0	(100%)
KITCHEN EQUIP	0	0	(N/A)
NONCOIN/DIVERSE	0	0	(N/A)
TOTAL KVA	13	16.3	

BALANCED THREE PHASE AMPS 19.6

Main Lobby

ELS1A

ROOM 1ST FLR ELEC CLOSET–1.1–102 | VOLTS 480Y/277V 3P 4W | AIC 14,000
MOUNTING SURFACE | BUS AMPS 60 | MAIN BKR 60
FED FROM ELS2 | NEUTRAL 100% | LUGS STANDARD
NOTE

NOTE	CKT #	CKT BKR	CIRCUIT DESCRIPTION	KVA LOAD A	KVA LOAD B	KVA LOAD C	NOTE	CKT #	CKT BKR	CIRCUIT DESCRIPTION	KVA LOAD A	KVA LOAD B	KVA LOAD C
	1	20/1	(EGRESS LTG) AL47A	0.405				2	20/1	AL55	0.225		
	3	20/1	AL49		0.144			4	20/1	(EMERGENCY) E5, E4, EXIT LTGS (LIFE SAFETY), E2		0.345	
	5	20/1	AL56			0.225		6	20/1	EXIT LTGS (LIFE SAFETY)			0.035
	7	20/1	AL66B	1.2				8	30/3	XFMR TEP1A	1.85		
	9	20/1	AL16B		0.75			10	|			2.32	
	11	20/1	AL12			0.5		12	|				2.32
	13	20/1	L2, L3	1.06				14	20/1	AL49	0.36		
	15	20/1	L1		2.36			16	20/1	E6		0.366	
	17	20/1	L2, L3			0.93		18	20/1	AL21			2.5
	19	20/1	L2, L3	1.19				20	20/1	SPACE	0		
	21	20/1	(EGRESS LTG) AL18		0.32			22	20/1	SPACE		0	
	23	20/1	(EGRESS LTG) AL27A			0.3		24	20/1	SPACE			0
	25	20/1	SPACE	0				26	20/1	SPACE	0		
	27	20/1	SPACE		0			28	20/1	SPACE		0	
	29	20/1	SPACE			0		30	20/1	SPACE			0
	31	20/1	SPACE	0				32	20/1	SPACE	0		
	33	20/1	SPACE		0			34	20/1	SPACE		0	
	35	20/1	SPACE			0		36	20/1	SPACE			0
	37	20/1	SPACE	0				38	20/1	SPACE	0		
	39	20/1	SPACE		0			40	20/1	SPACE		0	
	41	20/1	SPACE			0		42	20/1	SPACE			0
										TOTAL CONNECTED KVA BY PHASE	6.29	6.61	6.82
										TOTAL CONNECTED AMPS BY PHASE	22.7	23.9	24.6

	CONN. KVA	CALC. KVA	
LIGHTING	19.7	24.7	(125%)
LARGEST MOTOR	0.1	0.125	(125%)
OTHER MOTORS	0	0	(100%)
RECEPTACLES	4.42	4.42	(50%>10)

	CONN. KVA	CALC. KVA	
CONTINUOUS	0	0	(125%)
HEATING	0	0	(100%)
NONCONTINUOUS	1.98	1.98	(100%)
KITCHEN EQUIP	0	0	(N/A)
NONCOIN/DIVERSE	0	0	(N/A)
TOTAL KVA	26.2	31.2	

BALANCED THREE PHASE AMPS 37.5

Theater

ELS1B

ROOM RESTAURANT–1ST FLOOR | VOLTS 480Y/277V 3P 4W | AIC 22,000
MOUNTING SURFACE | BUS AMPS 100 | MAIN BKR MLO
FED FROM ELS2 | NEUTRAL 100% | LUGS STANDARD
NOTE

NOTE	CKT #	CKT BKR	CIRCUIT DESCRIPTION	KVA LOAD A	KVA LOAD B	KVA LOAD C	NOTE	CKT #	CKT BKR	CIRCUIT DESCRIPTION	KVA LOAD A	KVA LOAD B	KVA LOAD C
	1	20/1	(EGRESS LTG) AL27B	1.41				2	20/1	(EGRESS LTG) AL27A	0.57		
	3	20/1	(EGRESS LTG) AL44, AL27A		1.83			4	20/1	AL18		0.28	
	5	20/1	(EGRESS LTG) AL27A			1.02		6	20/1	EXIT LTGS (LIFE SAFETY)			0.085
	7	30/3	XFMR TEP1B	1.54				8	20/1	(EGRESS LTG) AL27A	0.18		
	9	|			2.07			10	20/1	(EMERGENCY) E4, E2, E5		0.7	
	11	|				1.83		12	20/1	AL62, AL18			0.144
	13	20/1	T1, EXIT	0.12				14	20/1	E4	0.165		
	15	20/1	T1, ENTRANCE		0.1			16	20/1	(EGRESS LTG) AL18, E4		0.355	
	17	20/1	T1			2.34		18	20/1	(EGRESS LTG) AL62			0.32
	19	20/1	T2	0.45				20	20/1	AL62	0.224		
	21	20/1	SPACE		0			22	20/1	E4, E2		0.37	
	23	20/1	SPACE			0		24	20/1	AL62			0.256
	25	20/1	SPACE	0				26	20/1	E2	0.455		
	27	20/1	SPACE		0			28	20/1	(EGRESS LTG) AL27A		0.21	
	29	20/1	SPACE			0		30	20/1	SPACE			0
	31	20/1	SPACE	0				32	20/1	SPACE	0		
	33	20/1	SPACE		0			34	20/1	SPACE		0	
	35	20/1	SPACE			0		36	20/1	SPACE			0
	37	20/1	SPACE	0				38	20/1	SPACE	0		
	39	20/1	SPACE		0			40	20/1	SPACE		0	
	41	20/1	SPACE			0		42	20/1	SPACE			0
										TOTAL CONNECTED KVA BY PHASE	5.11	5.92	6
										TOTAL CONNECTED AMPS BY PHASE	18.4	21.49	21.7

	CONN. KVA	CALC. KVA	
LIGHTING	17	21.3	(125%)
LARGEST MOTOR	0	0	(125%)
OTHER MOTORS	0	0	(100%)
RECEPTACLES	1.72	1.72	(50%>10)

	CONN. KVA	CALC. KVA	
CONTINUOUS	0	0	(125%)
HEATING	0	0	(100%)
NONCONTINUOUS	0.8	0.8	(100%)
KITCHEN EQUIP	0	0	(N/A)
NONCOIN/DIVERSE	0	0	(N/A)
TOTAL KVA	19.5	23.8	

BALANCED THREE PHASE AMPS 28.6

Façade

ELSOA

ROOM | VOLTS 480Y/277V 3P 4W | AIC 14,000
MOUNTING SURFACE | BUS AMPS 100 | MAIN BKR 100
FED FROM ELS2 | NEUTRAL 100% | LUGS STANDARD
NOTE

NOTE	CKT #	CKT BKR	CIRCUIT DESCRIPTION	KVA LOAD A	B	C	NOTE	CKT #	CKT BKR	CIRCUIT DESCRIPTION	KVA LOAD A	B	C
	1	20/1	AL61A, AL46B	1.4				2	20/1	AL59	0.88		
	3	20/1	AL61A, AL46B		1.58			4	20/1	AL59		0.64	
	5	20/1	AL61A, AL61B			1.75		6	20/1	AL54			1.4
	7	20/1	AL15	0.75				8	20/1	(EGRESS LTG) E3	0.32		
	9	20/1	AL50		0.825			10	20/1	AL59		0.16	
	11	20/1	(EGRESS LTG) AL47A			0.945		12	20/1	AL45			0.15
	13	20/1	AL47A	0.945				14	20/1	AL56	1.95		
	15	20/1	(EGRESS LTG) AL47A		0.945			16	20/1	AL56		0.6	
	17	20/1	F1			2.2		18	20/1	AL21			0.5
	19	20/1	F1	4.5				20	20/1	AL55	0.175		
	21	20/1	F1		2.2			22	20/1	F1		4.5	
	23	20/1	F1			2.2		24	20/1	SPACE			0
	25	20/1	SPACE	0				26	50/3	XFMR TEP0A	4.59		
	27	20/1	F1		2.2			28	|			4.37	
	29	20/1	AL45			0.15		30	|				5.09
	31	20/1	E5	1.21				32	20/1	EXIT LTGS (LIFE SAFETY)	0.125		
	33	20/1	AL49		0.144			34	20/1	E5, E2		0.435	
	35	20/1	AL21			0.5		36	20/1	(EGRESS LTG) AL62, AL7			0.808
	37	20/1	AL55	0.5				38	20/1	AL62, AL18	0.808		
	39	20/1	(EMERGENCY) E8, E3		0.632			40	20/1	AL57		0.19	
	41	20/1	(EGRESS LTG) AL4			0.99		42	20/1	AL47A			1.13
	43	20/1	(EGRESS LTG) AL9	1.26				44	20/1	(EMERGENCY) E2	0.325		
	45	20/1	SPACE		0			46	20/1	SPACE		0	
	47	20/1	SPACE			0		48	20/1	SPACE			0
										TOTAL CONNECTED KVA BY PHASE	19.7	21.7	20.1
										TOTAL CONNECTED AMPS BY PHASE	71	78.4	72.5

	CONN. KVA	CALC. KVA	
LIGHTING	51.9	64.9	(125%)
LARGEST MOTOR	0.1	0.125	(125%)
OTHER MOTORS	0	0	(100%)
RECEPTACLES	7.32	7.32	(50%>10)

	CONN. KVA	CALC. KVA	
CONTINUOUS	0	0	(125%)
HEATING	0	0	(100%)
NONCONTINUOUS	6.63	6.63	(100%)
KITCHEN EQUIP	0	0	(N/A)
NONCOIN/DIVERSE	0	0	(N/A)
TOTAL KVA	66	80.1	

BALANCED THREE PHASE AMPS 96.3

ELSOB

ROOM | VOLTS 480Y/277V 3P 4W | AIC 14,000
MOUNTING SURFACE | BUS AMPS 100 | MAIN BKR 100
FED FROM ELS2 | NEUTRAL 100% | LUGS STANDARD
NOTE

NOTE	CKT #	CKT BKR	CIRCUIT DESCRIPTION	KVA LOAD A	B	C	NOTE	CKT #	CKT BKR	CIRCUIT DESCRIPTION	KVA LOAD A	B	C
	1	20/1	AL52	0.315				2	20/1	AL53	0.765		
	3	20/1	AL21		2			4	20/1	AL53		0.72	
	5	20/1	AL45, AL59			0.57		6	20/1	AL53			0.765
	7	20/1	AL59	0.16				8	20/1	AL54	2.5		
	9	20/1	(EMERGENCY) E1, AL62		0.971			10	20/1	EGRESS LTG E2		0.975	
	11	20/1	E1			0.78		12	20/1	E2			0.845
	13	20/1	AL4	1.85				14	20/1	E2	0.78		
	15	20/1	E8		0.046			16	20/1	EXIT LTGS (LIFE SAFETY)		0.105	
	17	20/1	(EMERGENCY) E3			0.192		18	20/1	(EMERGENCY) E5, E4			1.43
	19	20/1	E1	0.26				20	20/1	E9	0.6		
	21	20/1	F1		4.5			22	20/1	E9		0.6	
	23	20/1	F1			4.5		24	20/1	(EMERGENCY) E9			0.6
	25	20/1	F1	4.5				26	20/1	SPACE	0		
	27	20/1	SPACE		0			28	20/1	SPACE		0	
	29	20/1	SPACE			0		30	20/1	SPACE			0
	31	20/1	SPACE	0				32	20/1	SPACE	0		
	33	20/1	SPACE		0			34	20/1	SPACE		0	
	35	20/1	SPACE			0		36	20/1	SPACE			0
	37	70/3	XFMR TEP0B	18.7				38	20/1	SPACE	0		
	39	|			17.4			40	20/1	SPACE		0	
	41	|				16.1		42	20/1	SPACE			0
										TOTAL CONNECTED KVA BY PHASE	26	27.3	25.8
										TOTAL CONNECTED AMPS BY PHASE	93.9	98.6	93.1

	CONN. KVA	CALC. KVA	
LIGHTING	17.8	22.3	(125%)
LARGEST MOTOR	0	0	(125%)
OTHER MOTORS	0	0	(100%)
RECEPTACLES	20.1	15.1	(50%>10)

	CONN. KVA	CALC. KVA	
CONTINUOUS	0	0	(125%)
HEATING	0	0	(100%)
NONCONTINUOUS	1.1	1.1	(100%)
KITCHEN EQUIP	0	0	(N/A)
NONCOIN/DIVERSE	31	23.9	(77%)
TOTAL KVA	79	73.7	

BALANCED THREE PHASE AMPS 88.6

Escalator Cartridge

ELS3

ROOM 3RD FLR ELEC RM–3.1–101 | VOLTS 480Y/277V 3P 4W | AIC 65,000
MOUNTING SURFACE | BUS AMPS 60 | MAIN BKR 60
FED FROM ELS5 | NEUTRAL 100% | LUGS STANDARD
NOTE

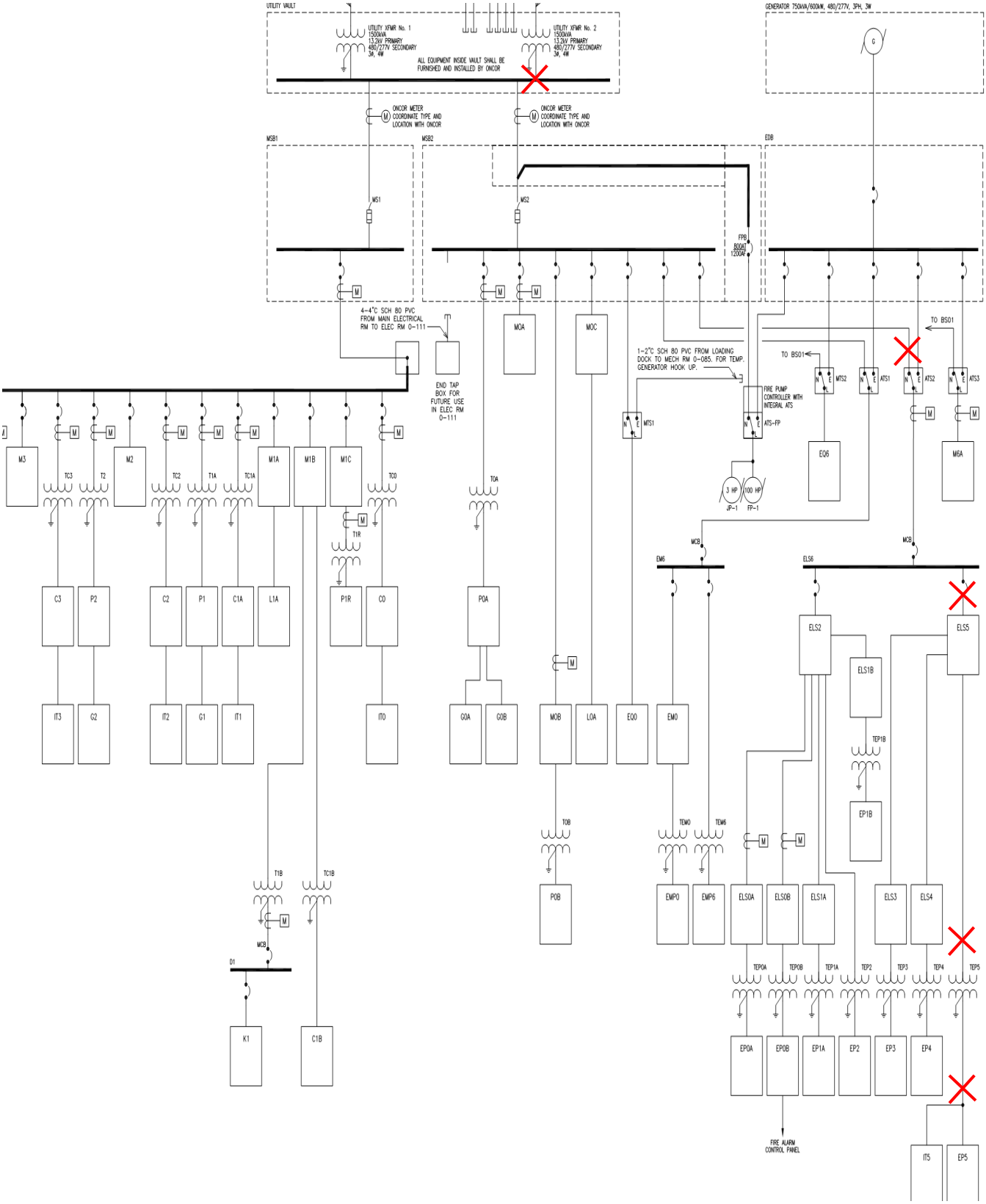
NOTE	CKT #	CKT BKR	CIRCUIT DESCRIPTION	KVA LOAD A	KVA LOAD B	KVA LOAD C	NOTE	CKT #	CKT BKR	CIRCUIT DESCRIPTION	KVA LOAD A	KVA LOAD B	KVA LOAD C
	1	20/1	(EGRESS LTG) AL47A	0.585				2	20/1	AL47A	0.54		
	3	20/1	AL47A		0.585			4	20/1	(EGRESS LTG) AL47A		0.63	
	5	20/1	(EGRESS LTG) AL47A			0.63		6	20/1	AL47A			0.63
	7	20/1	(EMERGENCY) E4	0.495				8	20/1	AL47A	0.405		
	9	20/1	E4		0.275			10	20/1	AL58		0.66	
	11	20/1	AL47A			0.045		12	20/1	AL66A			2.05
	13	20/1	E1	0.25				14	20/1	AL47A	0.135		
	15	20/1			0.5			16	20/1	AL16		0.65	
	17	20/1	(EGRESS LTG) AL18			0.48		18	20/1	EXIT LTGS (LIFE SAFETY)			0.065
	19	20/1	(EGRESS LTG) AL47A	0.855				20	30/3	XFMR TEP3	1.26		
	21	20/1	AL47A		0.495			22	|			1.58	
	23	20/1	(EGRESS LTG) AL47A			0.27		24	|				0.72
	25	20/1	AL62	0.448				26	20/1	AL49	0.144		
	27	20/1	(EGRESS LTG) AL62, AL7		0.392			28	20/1	AL21		1.5	
	29	20/1	AL58			1.32		30	20/1	E1			0.28
	31	20/1	E1	0.28				32	20/1	AL21	1		
	33	20/1	SPACE		0			34	20/1	SPACE		0	
	35	20/1	SPACE			0		36	20/1	SPACE			0
	37	20/1	SPACE	0				38	20/1	SPACE	0		
	39	20/1	SPACE		0			40	20/1	SPACE		0	
	41	20/1	SPACE			0		42	20/1	SPACE			0
										TOTAL CONNECTED KVA BY PHASE	6.4	7.27	6.49
										TOTAL CONNECTED AMPS BY PHASE	23.1	26.2	23.4

	CONN. KVA	CALC. KVA	
LIGHTING	20.2	25.2	(125%)
LARGEST MOTOR	0	0	(125%)
OTHER MOTORS	0	0	(100%)
RECEPTACLES	2.76	2.76	(50%>10)

	CONN. KVA	CALC. KVA	
CONTINUOUS	0	0	(125%)
HEATING	0	0	(100%)
NONCONTINUOUS	0.8	0.8	(100%)
KITCHEN EQUIP	0	0	(N/A)
NONCOIN/DIVERSE	0	0	(N/A)
TOTAL KVA	23.7	28.7	

BALANCED THREE PHASE AMPS 34.5

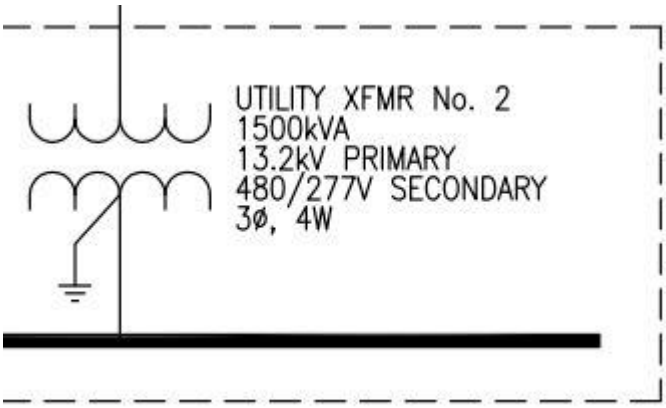
Short Circuit Calculation



Short circuit calculation is a critical evaluation for a building's electrical system to make sure that all equipmetns can handle short current from the utility under worst case scenario. The calculation covers 5 levels:

1. Switchboard MSB2, AIC = 100000A, (5) 600kcmil, L = 200ft
2. Switch ATS2, AIC = 65000A, 500kcmil, L = 280ft
3. Panelboard ELS5, AIC = 14000A, #2, L = 85ft
4. Transformer TEP 5, AIC = 14000A, #6, L = 2ft
5. Panelboard EP5, AIC = 14000A, #6, L = 2ft

Transformer Full Load:



I_{FLA} = KVA*1000/E*1.732 = 1500*1000/480*1.732 = 1804 A

M = 100/$Z_{transformer}$ = 100/3.5 = 28.57

I_{SC} = I_{FLA} * M = 1804*28.57 = 51540 A

$I_{SC.motor}$ = 4* I_{FLA} =4*1804 = 7216 A

$I_{SC.total}$ = I_{SC}+ $I_{SC.motor}$ = 51540+7216 = **58720 A**

Level 1, Switchboard MSB2

MSB2

ROOM MAIN ELECTRICAL ROOM– BASEMENT	VOLTS 480Y/277V 3P 4W	AIC 100,000
MOUNTING SURFACE	BUS AMPS 2000	MAIN BKR 2000
FED FROM UTILITY	NEUTRAL 200%	LUGS STANDARD

f = 1.732*L*I/C*n*E = 1.732*51540*200/480*17962*5 = 0.41

M = 1/(1+f) = 1/(1+0.32) = 0.71

$I_{SC.symRMS} = I_{SC} * M = 51540*0.71 = 36593$ A

$I_{SC.motor} = 4* I_{FLA} = 4*1804 = 7216$ A

$I_{SC.total.symRMS} = I_{SC.symRMS} + I_{SC.motor} = 36593+7216 =$ **43809 A** < 100000 A

Level 2, Switch ATS2

ATS2

ROOM	VOLTS 480Y/277V 3P 4W	AIC 65,000
MOUNTING SURFACE	BUS AMPS 400	MAIN BKR MLO
FED FROM MSB2	NEUTRAL 100%	LUGS STANDARD

f = 1.732*L*I/C*n*E = 1.732*39102*280/480*17492 = 2.26

M = 1/(1+f) = 1/(1+1.78) = 0.31

$I_{SC.symRMS} = I_{SC} * M = 36593*0.31 = 11344$ A

$I_{SC.motor} = 4* I_{FLA} = 4*1804 = 7216$ A

$I_{SC.total.symRMS} = I_{SC.symRMS} + I_{SC.motor} = 11344+7216 =$ **18560 A** < 65000 A

Level 3, Panelboard ELS5

ELS5

ROOM 5TH FLR ELEC ROOM 5–101	VOLTS 480Y/277V 3P 4W	AIC 14,000
MOUNTING SURFACE	BUS AMPS 100	MAIN BKR 100
FED FROM ELS6	NEUTRAL 100%	LUGS STANDARD

f = 1.732*L*I/C*n*E = 1.732*11344*85/480*5574 = 0.62

M = 1/(1+f) = 1/(1+0.62) = 0.62

$I_{SC.symRMS} = I_{SC} * M = 11344*0.62 = 7033$ A

$I_{SC.motor} = 4* I_{FLA} = 4*1804 = 7216$ A

$I_{SC.total.symRMS} = I_{SC.symRMS} + I_{SC.motor} = 7033+7216 =$ **14249 A** ≈ 14000 A

Level 4, Transformer TEP5

TEP5

ROOM	VOLTS 208Y/120V 3P 4W	AIC 14,000
MOUNTING FLUSH	BUS AMPS	MAIN BKR MLO
FED FROM ELS5	NEUTRAL 100%	LUGS STANDARD

f = 1.732*L*I/C*n*E = 1.732*7033*2/480*2389 = 0.02

M = 1/(1+f) = 1/(1+0.02) = 0.98

$I_{SC.symRMS} = I_{SC} * M = 7033*0.98 = 6892$ A

$I_{SC.motor} = 4* I_{FLA} = 4*1804 = 7216$ A

$I_{SC.total.symRMS} = I_{SC.symRMS} + I_{SC.motor} = 6892+7216 =$ **14108 A** ≈ 14000 A

Level 5, Panelboard EP5

EP5

ROOM	VOLTS 208Y/120V 3P 4W	AIC 14,000
MOUNTING SURFACE	BUS AMPS 60	MAIN BKR 60
FED FROM TEP5	NEUTRAL 100%	LUGS STANDARD

f = 1.732*L*I/C*n*E = 1.732*6892*2/480*2389 = 0.02

M = 1/(1+f) = 1/(1+0.02) = 0.98

$I_{SC.symRMS} = I_{SC} * M = 6892*0.98 = 6754$ A

$I_{SC.motor} = 4* I_{FLA} = 4*1804 = 7216$ A

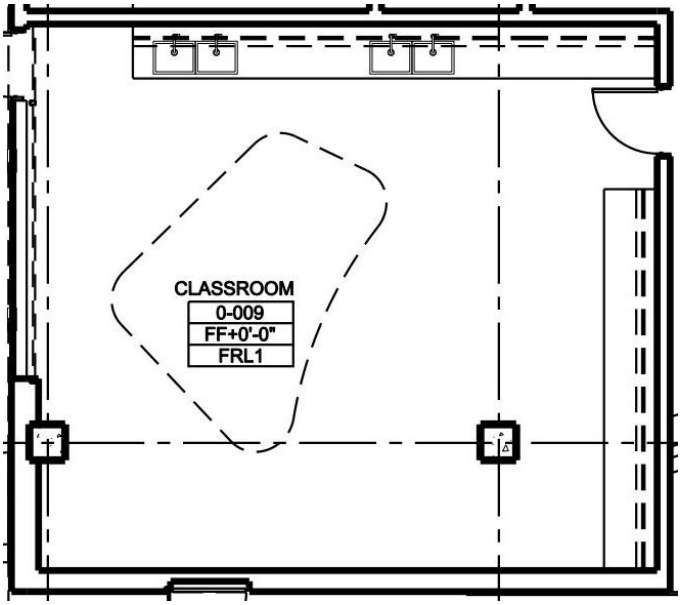
$I_{SC.total.symRMS} = I_{SC.symRMS} + I_{SC.motor} = 6754+7216 =$ **13970 A** < 14000 A

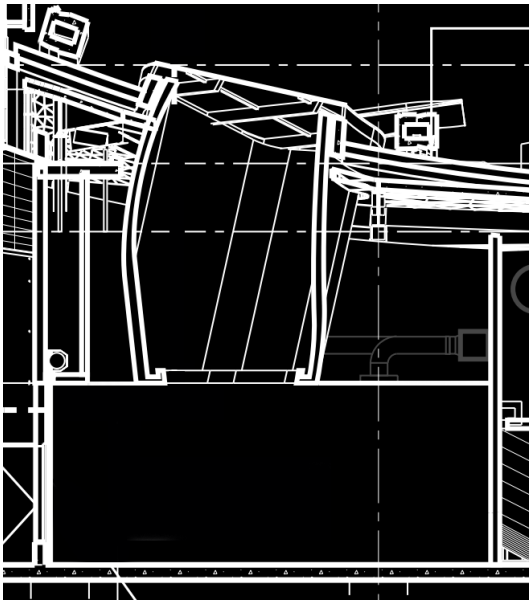
Breadth Study

Daylighting Breadth

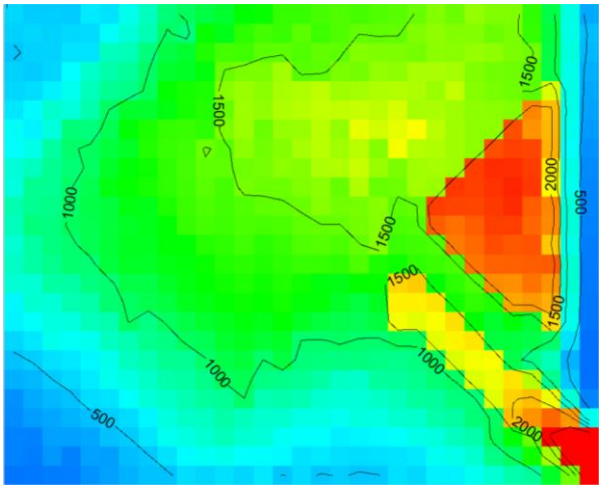
Daylighting breadth focus on program based daylighting analysis for spaces with great daylighting harvesting potential: classroom and main lobby. Result of the analysis will be used to determine whether additional daylighting strategy is required in the space and how electrical lighting should be controlled to take the most advantage from it.

Initial daylighting study will be performed to evaluate daylighting quality of the existing structure for on 4 typical days in a year: Spring Equinox, Summer Solstice, Fall Equinox, Winter Solstice at 3 typical type: 10AM (Opening Hour), 12PM, 3PM

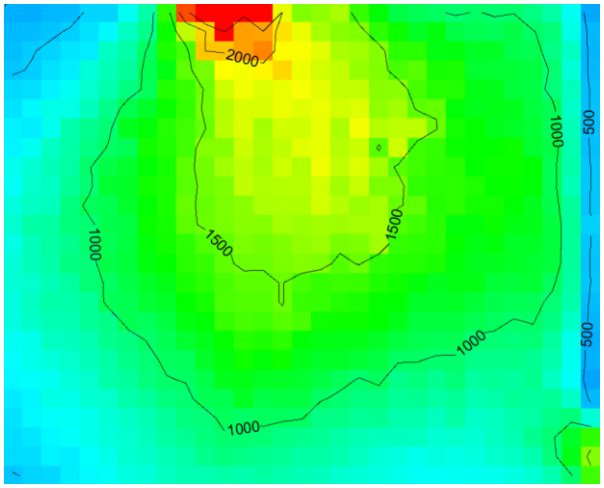




Classroom

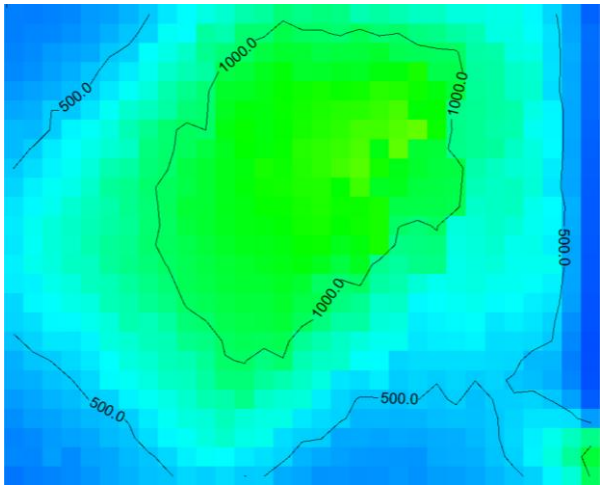


Spring Equinox, 10 AM

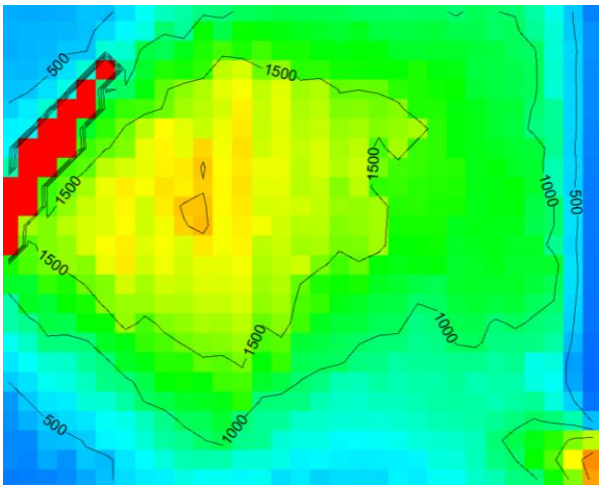


Spring Equinox, 12 PM

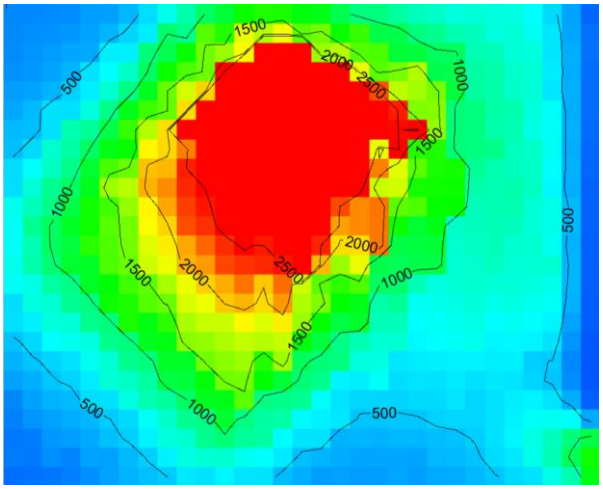
The classroom has a very efficient daylight harvesting system. Instead of bring daylight directly into the space, the classroom used a 16 feet tall sloped light well as a buffer zone, catching direct sunlight with the inner surface of the light well and reflect them into the space.



Spring Equinox, 3 PM

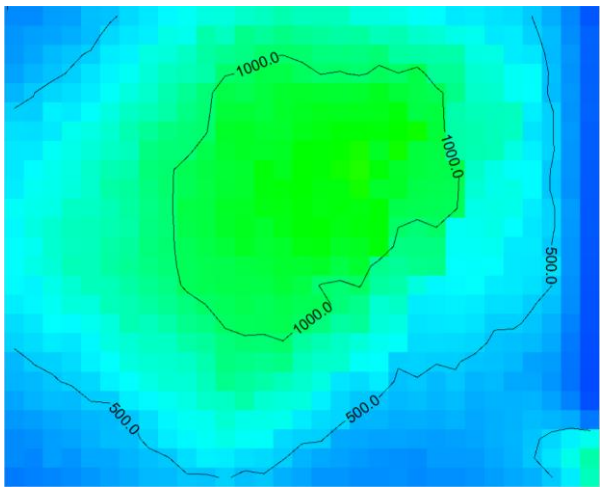


Summer Solstice, 10 AM

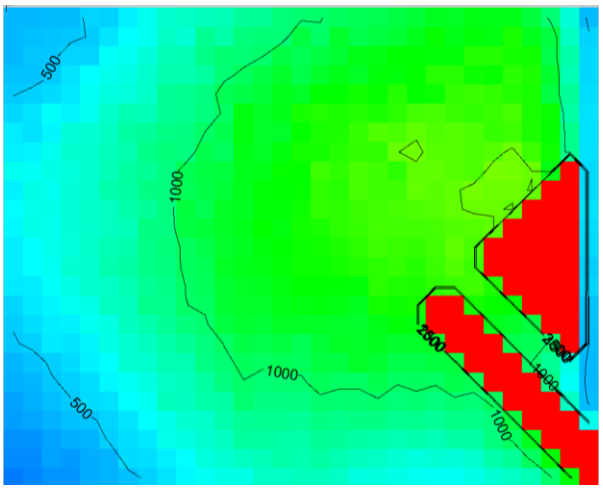


Summer Solstice, 12 PM

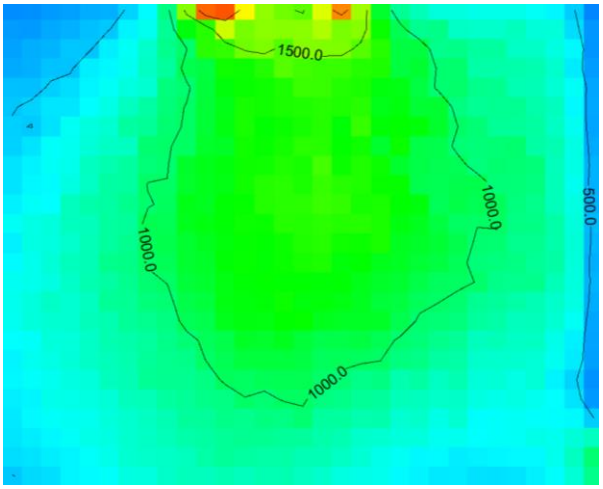
In summer time solar altitude angle grow larger, making the light well system less efficient. At noon we can see an obvious hot spot in the center of the classroom.



Summer Solstice, 3PM

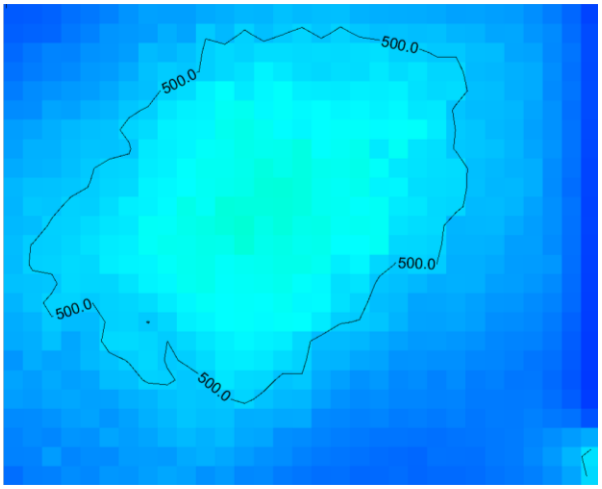


Fall Equinox, 10 AM

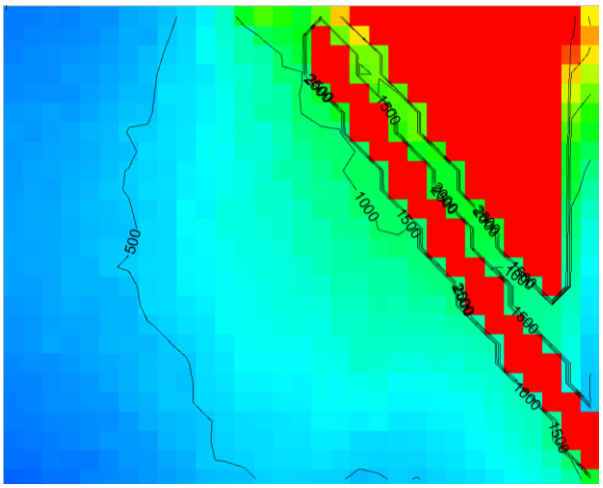


Fall Equinox, 12 PM

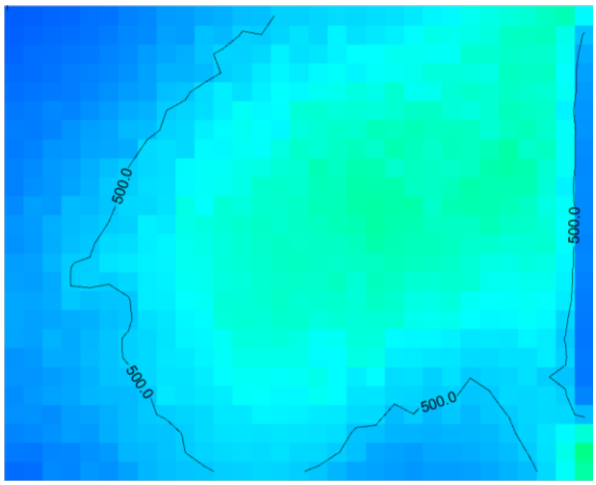
Solar angle in fall is very similar to the spring condition. Note that regardless of the season the daylight distribution maintains a stable pattern: high illuminance level in the center and lower illuminance level on the border. This distribution inspired the electrical lighting design, which distributed luminaires around room border.



Fall Equinox, 3PM

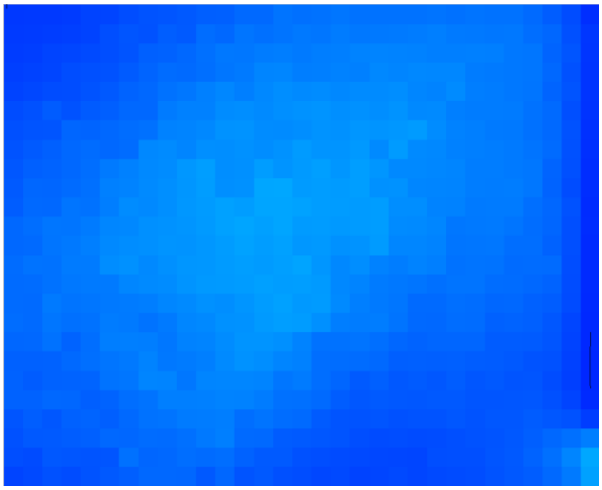


Winter Solstice, 10 AM



Winter Solstice, 12 PM

Another hot spot situation can be found in the morning on winter solstice. This is because the shifted solar azimuth angle exceeded the capacity of light well system. At noon the azimuth angel switches back to a regular value and the space become efficient again.



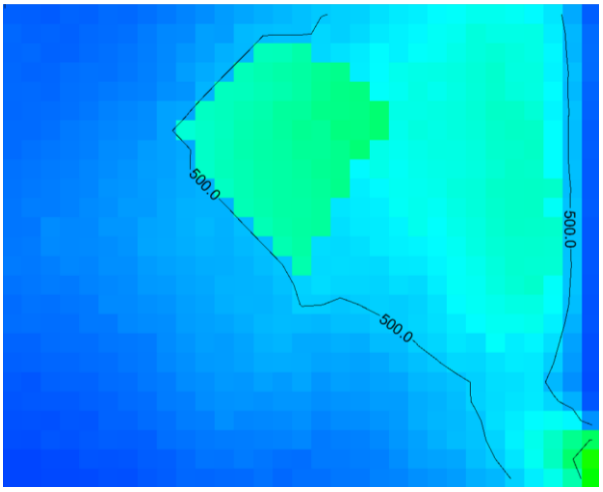
Winter Solstice, 3PM

From the initial analysis we noticed that this space has a very efficient daylighting feature. Hot spot are also found during summer and winter times which could be prevented through the application of shading system. Therefore, the second phase of the breadth study will be focused on shading system design and evaluation.

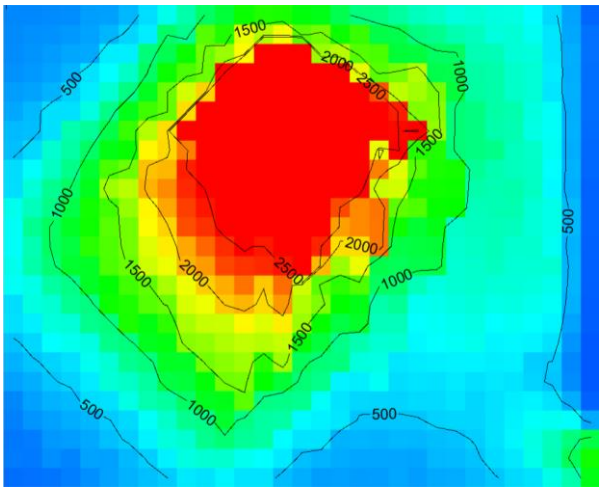
Shading geometry was extracted from the building geometry file. A photosensor is connected with the shade to activate it when high illuminance level is detected on the floor surface.

Blind/Shade Control

	X	Y	Z	X DIR	Y DIR	Z DIR	ROT	Photo Sensor File	Sig 1	Ang 1	Sig 2
Shade 1											
Signal	13.0	13.0	10.0	0	0	-1.0	0	cos.sen	2000.0	0	0
Shade 2											
Off	0.0	0.0	0.0	0	0	0	0	Click To Select	0	0	0



Summer Solstice, 12 PM, With Shade

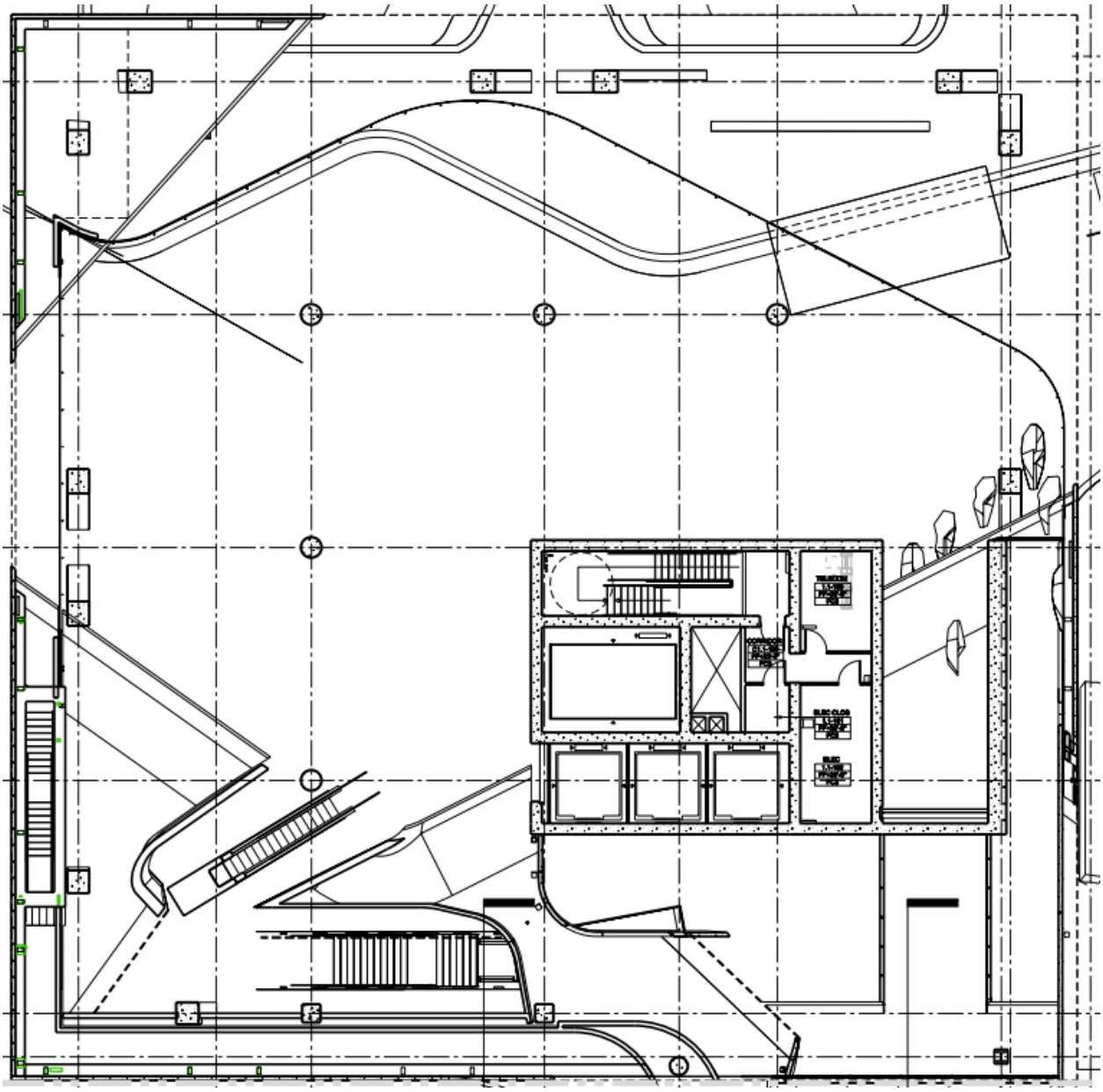


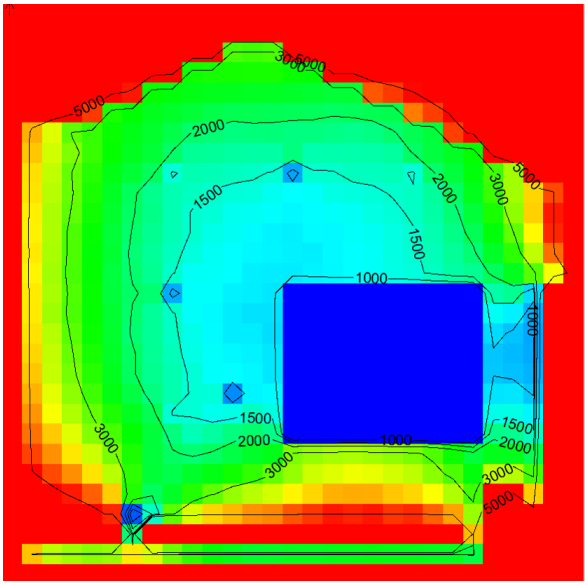
Summer Solstice, 12 PM, Without Shade

From the comparison it is clear that shading system is very efficient on eliminating uncomfortable glares. However, it also reduces the solar gain of the entire space even where a desirable light level is achieved, thus increasing energy consumption.

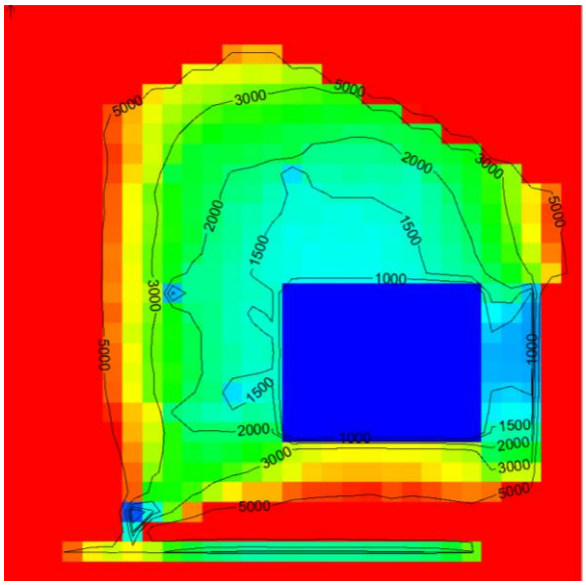
Main Lobby

Unlike the classroom whose solar gain is mainly from its light well, main lobby receive daylight from the curtain wall around its perimeter. Also, the space is more flat compared to the classroom, limited daylight penetration into the space.





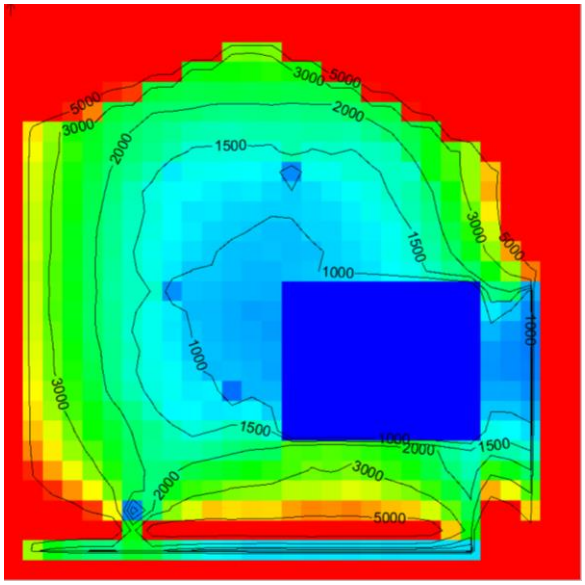
Spring Equinox, 10 AM



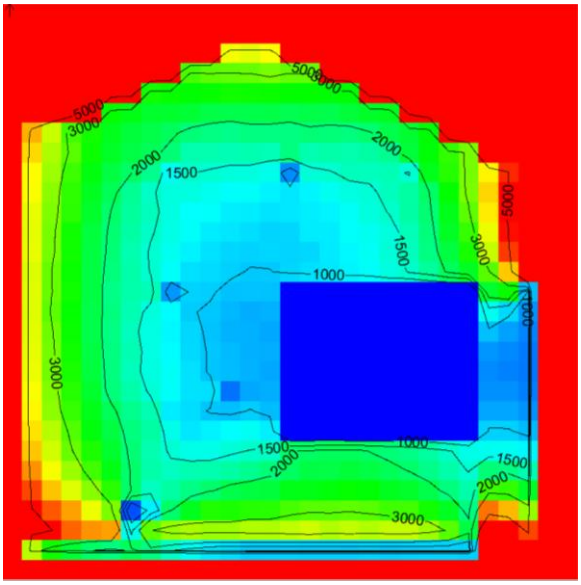
Spring Equinox, 12 PM

Exterior space outside the curtain wall has a large illuminance level over 5000 lux. This result shows how much light and heat energy is contained in direct sunlight.

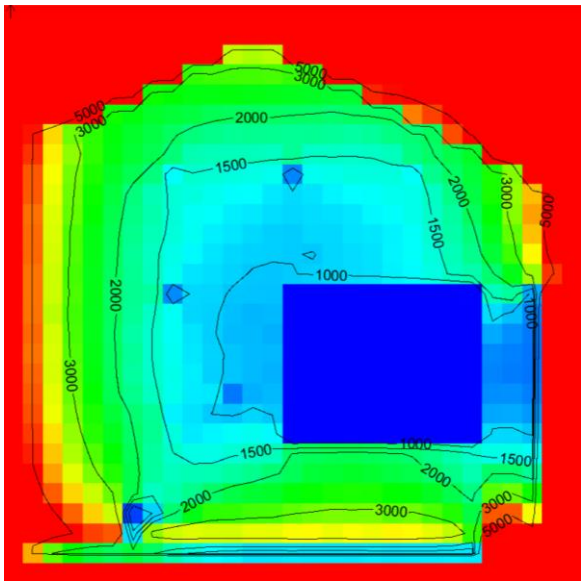
Curtain wall with architectural glazing film did an excellent work filtering excessive solar energy and control the light level below 3000 lux. Hot spot can still be seen at noon on the west side of the lobby.



Spring Equinox, 3 PM

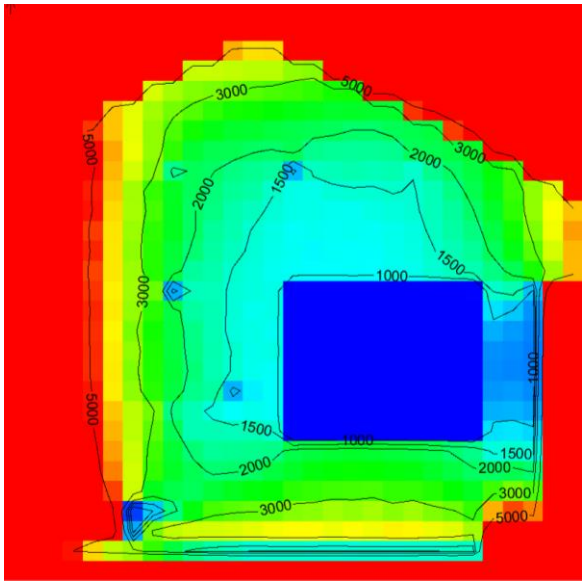


Summer Solstice, 10 AM

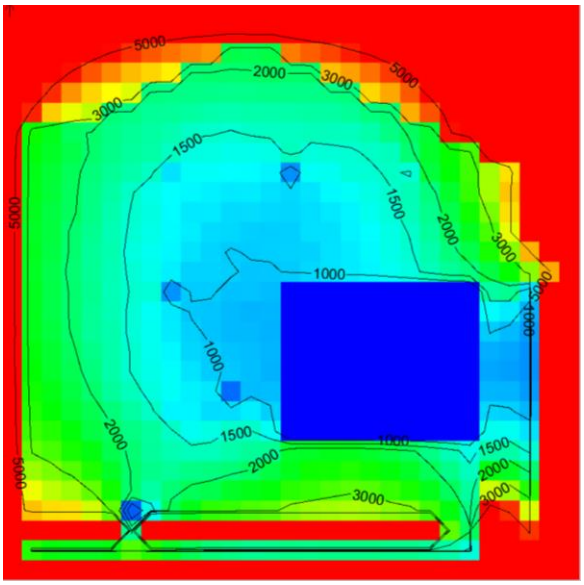


Summer Solstice, 12 PM

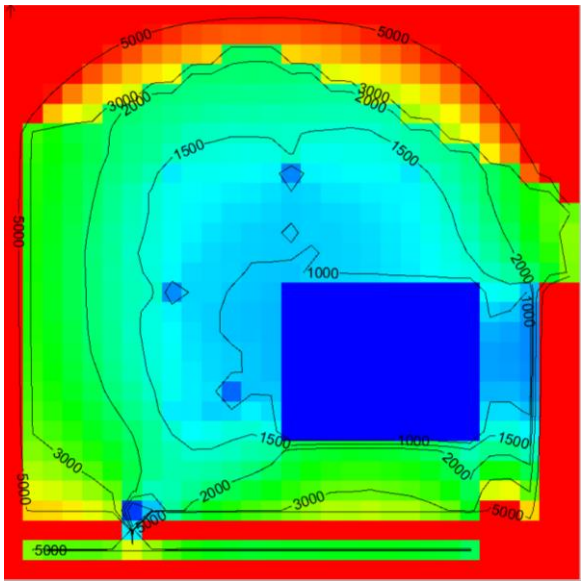
In summer time, increase solar altitude angle make daylight even more difficult to penetrate into the space. Perimeter of the lobby sets back from the level above, using the floor slab of second floor not only as its roof but also its overhang.



Summer Solstice, 3PM

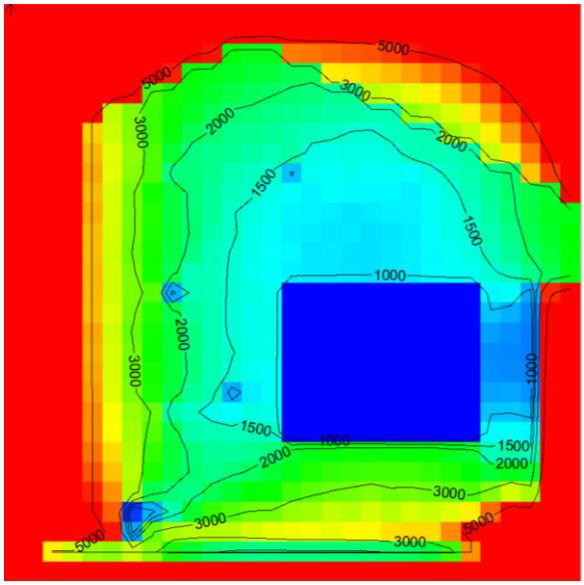


Fall Equinox, 10 AM

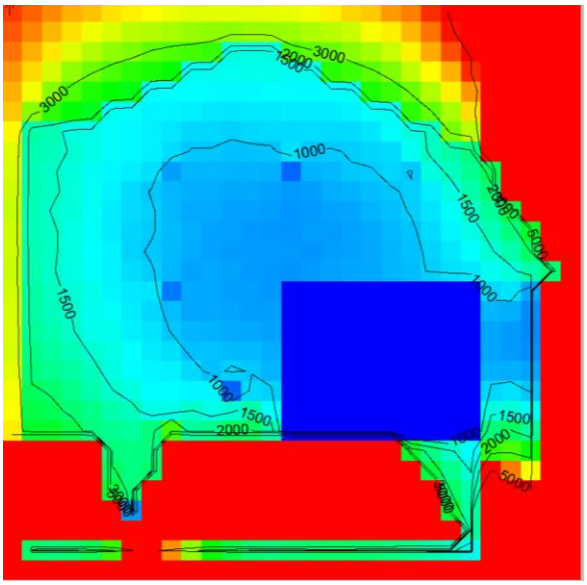


Fall Equinox, 12 PM

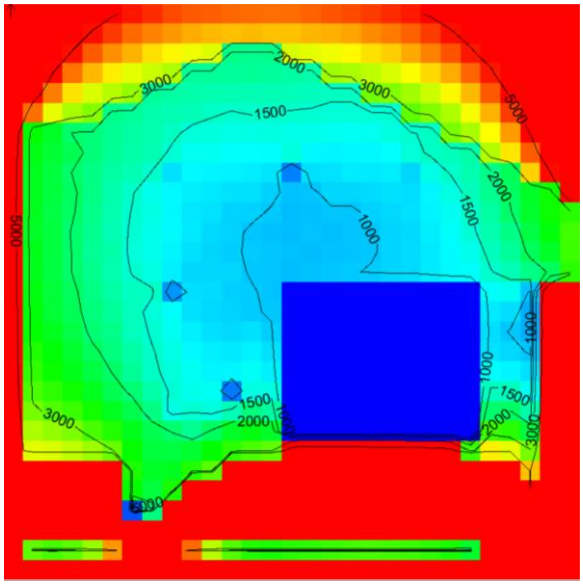
Daylight condition in fall does not show a huge difference compared to that in spring and summer time. It appears that west and north end of the lobby is as far as direct sunlight can reach. Thus we can apply photo sensor on lumianires in these area to greatly reduce power consumption.



Fall Equinox, 3PM

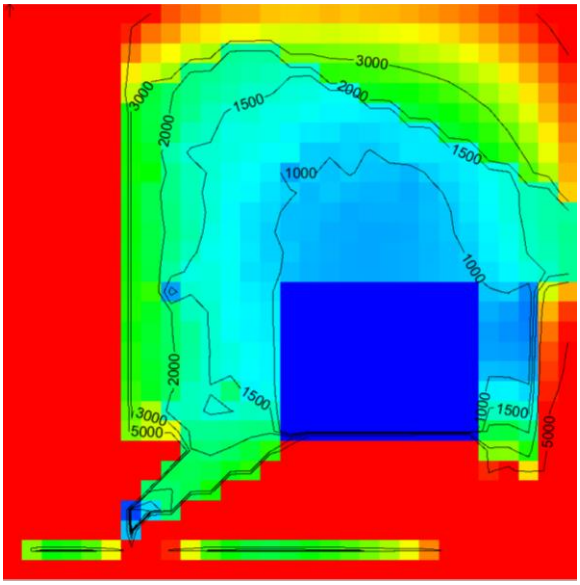


Winter Solstice, 10 AM



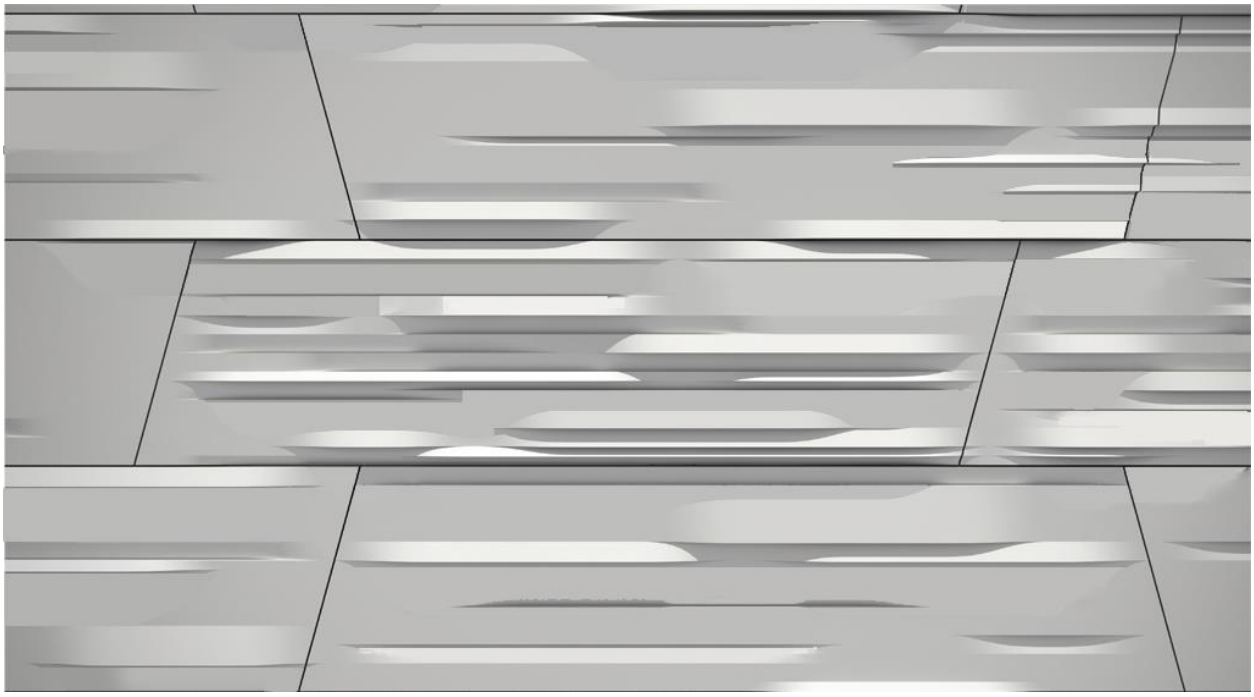
Winter Solstice, 12 PM

Daylight in winter time have a sharp altitude angle that allow direct sunlight to travel further. South side of the lobby end up in high illuminance level throughout the day. Normally this would be an issue that should be dealt with. However, south part of the lobby is in fact occupied by escalator and stairs, therefore the high illuminance will not affect the building operation too much and thus can be ignored



Winter Solstice, 3PM

Architectural Breadth

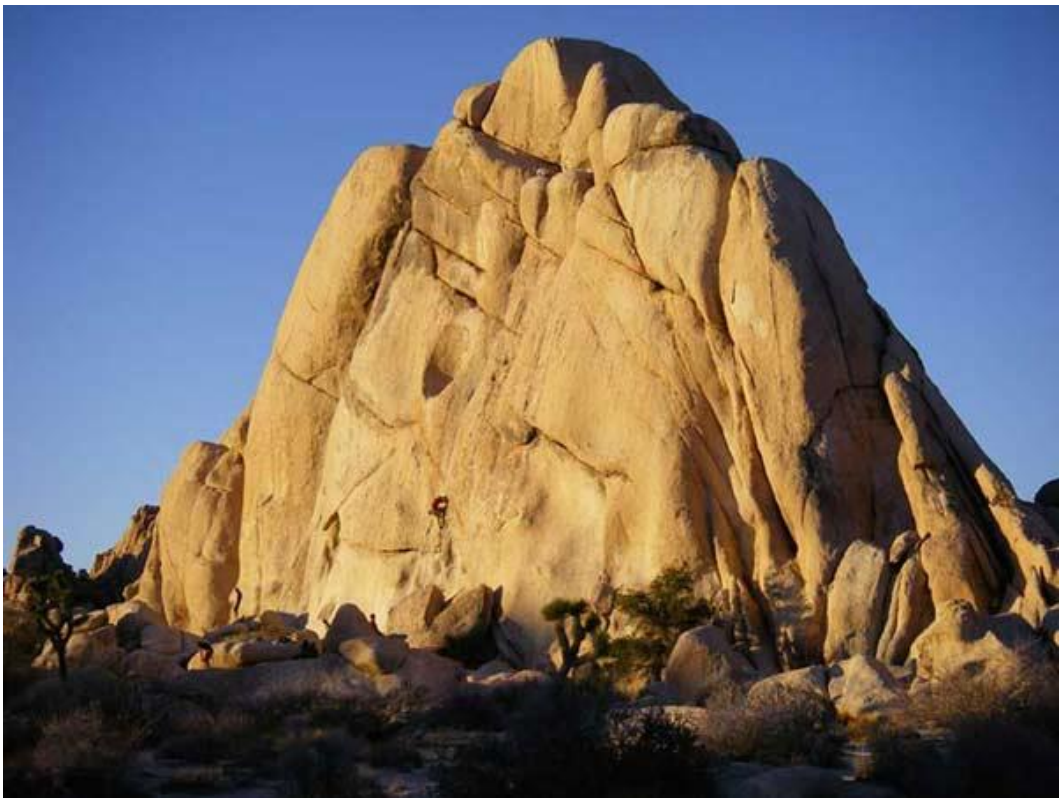


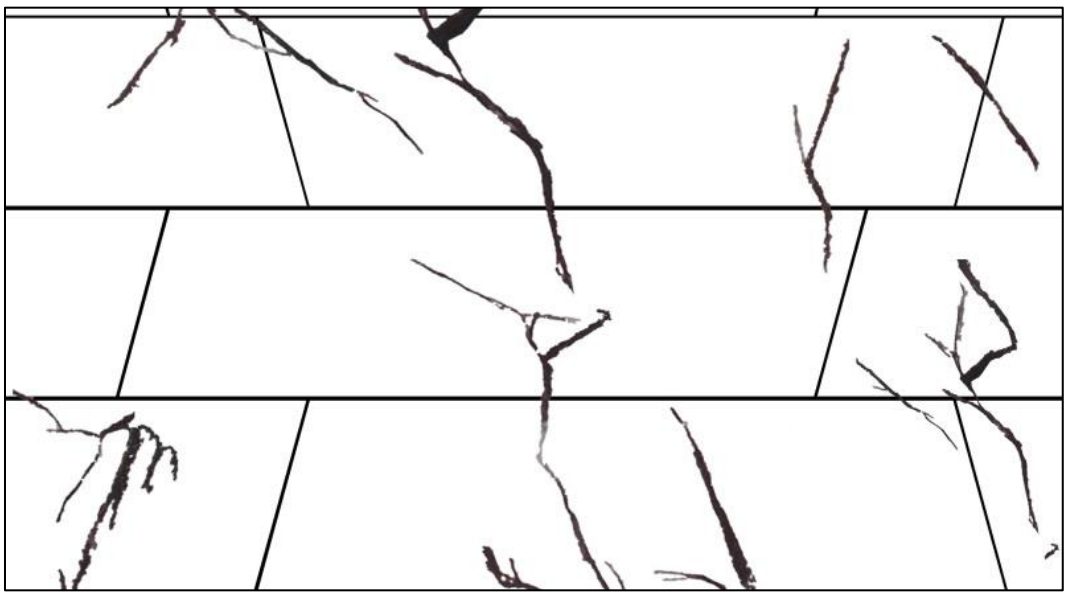
The iconic texture on museum's façade is one of its most impressive architecture features. This breadth study is intended to integrate façade deisng with landscape geology to create a three dimensional architectural element simulating realistic natural environment.

As mentioned earlier, the landscape plinth is a collection of typical Texas geology including dock cap, grassland, forest and wetland. Typical scenery from each environment will be selected as the origin façade texture design, allowing each façade to have a unique texture that reflects the geology it is facing to. Most texture proposed is abstract and difficult to create in 3D modeling program, therefore Photoshop will be the major to for this breadth study.

South Façade – Rock Cap

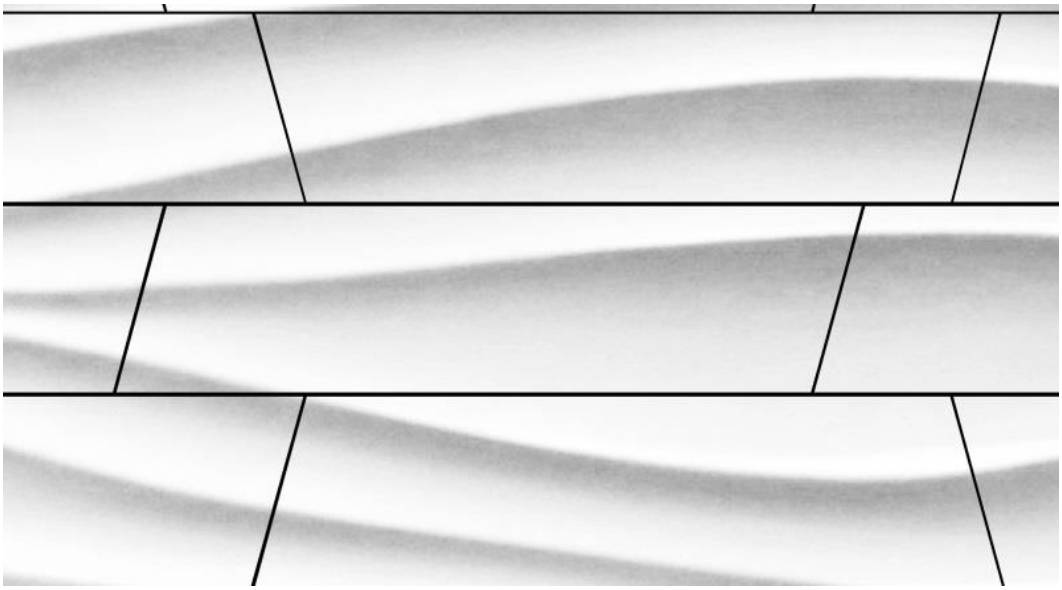
In a rock desert, even the hardest rock can be damaged by rapid temperature change between day and night as well as constant wind corrosion. Therefore, the façade is treated as a rock mountain and artificial cracks will be made to match with the geology.





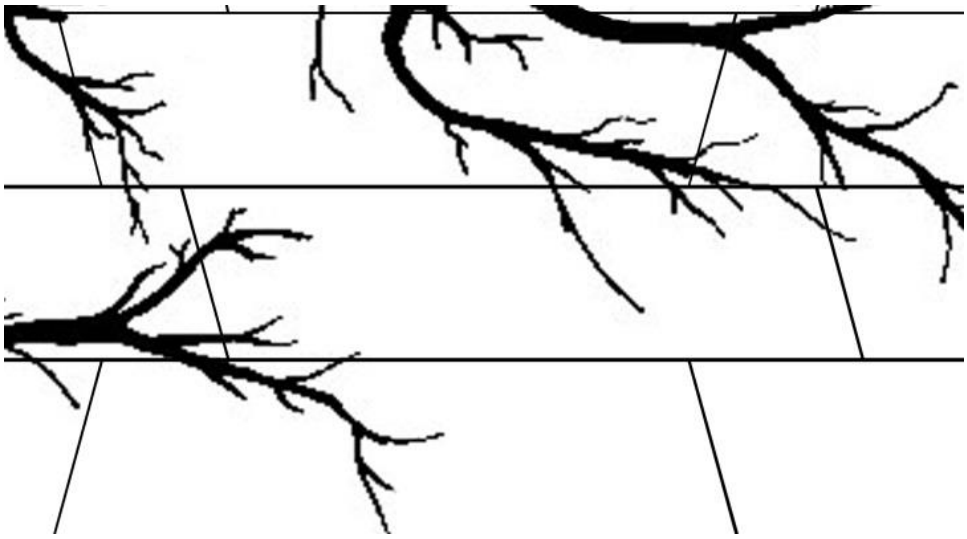
East Façade – Grassland

With proper weather and nutrition, grass can populate in a rapid speed and grow into huge crowds. East façade simulates the scenery in grassland when wind is flowing through. Horizontally curved lines will be used to manipulate the layer of grass swing toward identical direction.



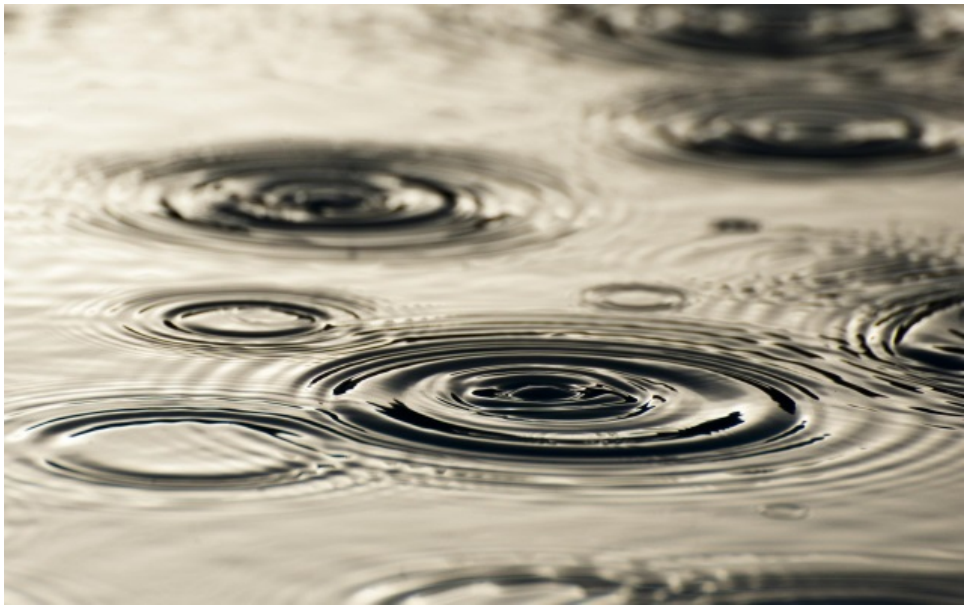
North Façade - Forest

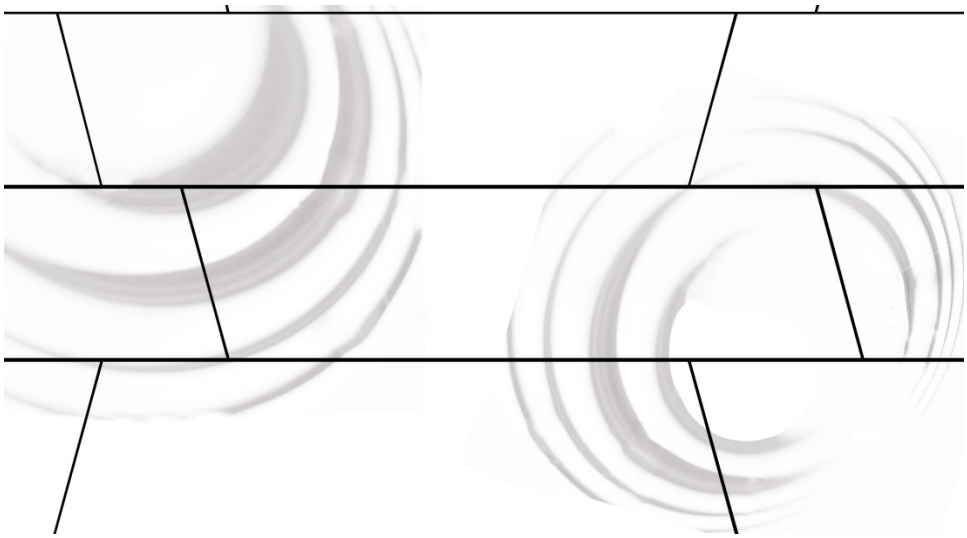
When talking about forest, tree is always the first concept came into people's mind. Façade on the north side of the building will use texture to simulate wood braches, creating a view of endless forest leading visitor into the interior space.



West Façade - Wetland

Rain is very common in wetland geology. Therefore the texture on west façade simulates a water pond hit by raindrops, causing waves radiating from multiple source and possible with some wave intersecting each other.

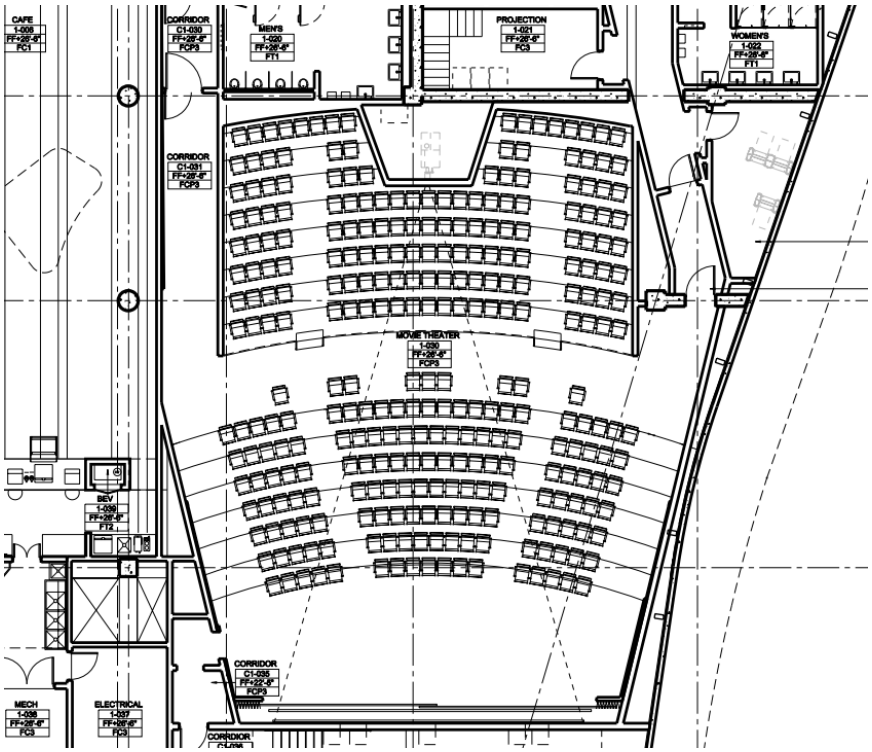


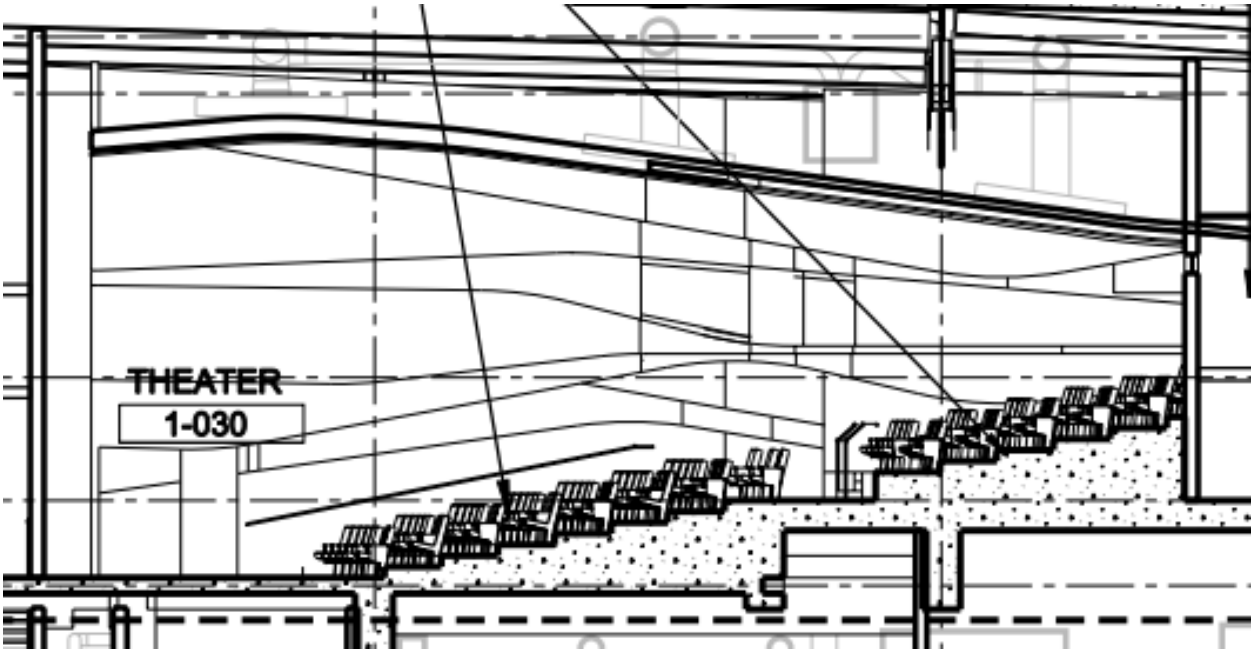


Note that North and South façade used textures with straight edges while East and West façade adopts curved lines, forming a symmetry relation suggesting that all the architectural elements are internally connected.

Acoustic Breadth

The major purpose of the theater space is to provide 3D movie shows. Acoustic performance in this space is closely related to user's experience. Lighting design in this space involves the customization of acoustic feature, thus it essential to reanalysis the space's acoustic property and make sure it is within an acceptable range.





Reverberation time is the most commonly applied standard for acoustic performance evaluation.

RT = 0.05*V/Sum(S* α)

V = room volume
S = surface area, per material
α = absorption coefficients

Floor, wall and ceiling area are calculated form the AutoCAD model, while the surface area of seated audience Assume a 60% occupancy, 5 ft^2 per seated seat and 2 ft^2 per unoccupied seat.

$A_{occupied}$ = 0.6 * 300 * 5 = **900 ft^2**
$Aun_{occupied}$ = 0.6 * 300 * 2 = **360 ft^2**

	Area	$S\alpha_{125}$	125 HZ	$S\alpha_{250}$	250 HZ	$S\alpha_{500}$	500 HZ	$S\alpha_{1000}$	1000 HZ	$S\alpha_{2000}$	2000 HZ	$S\alpha_{4000}$	4000 HZ
J+J Invision carpet tiles	4031	161.2	0.04	120.9	0.03	241.9	0.06	403.1	0.1	80.62	0.02	80.62	0.02
Fabritrak system with Knoll and Maharem fabric acoustic wall	3761	564.2	0.15	488.9	0.13	902.6	0.24	1692	0.45	3084	0.82	2407	0.64
Fabritrak system with Knoll and Maharem fabric acoustic ceiling	6028	180.8	0.03	241.1	0.04	663.1	0.11	1025	0.17	1447	0.24	2110	0.35
Occupied Seats	900	414	0.46	612	0.68	531	0.59	477	0.53	594	0.66	594	0.66
Unoccupied Seats	360	126	0.35	198	0.55	169.2	0.47	147.6	0.41	212.4	0.59	198	0.55
SUM S*α		1446		1661		2508		3745		5418		5389	
RT		2.39		2.08		**1.38**		0.92		0.64		0.64	

According to reference resource, a reverberation time from 1.2 to 1.5 at 500 HZ will be an efficient choice. The theater space successfully meets the criteria.

Summary

This project has explored possible alternative design solution for the Perot Museum of Nature and Science. Lighting design for each space was able to reflect the central concept of uniting nature, science and urban elements together to offer **entertainment, education** and **relaxation**. The classroom adopted suspended LED T8 tubes for a directional distribution, guarantees the energy efficiency of the design while also help to create the lighting theme of an underground cave. In the lobby space, however, an opposite strategy is applied. LED sphere luminaire was used above mesh ceiling, lighting up mechanical and plumbing equipment to make the building system transparent to visitors. Theater space uses carefully arranged linear luminaire to simulate an electronic theme, providing dramatic visual effect while also contributes to space navigation. Façade lighting is designed to highlight the iconic building texture at night while also preserve the museum's nighttime identity. Escalator lighting is designed to trick visitor's special sensation and offer them a unique sky ride experience.

Electrical depth study proved that all the proposed lighting design can fit on the current electrical system. Short circuit calculation also indicates that current system can resist short current even in the worst case scenario. Control strategy developed in each space helps to increase energy efficiency and improve user experience.

Daylighting breadth studied the efficiency classroom and lobby space. Both spaces are proved to have an excellent daylighting feature, while for classroom an additional shading system is added to block direct sun in the summer.

Architectural breadth proposed a façade design change that reflects corresponded landscape geology, thus integrating the landscape and the building mass as one exhibit.

Acoustic breadth analyzed reverberation time in the theater to check whether lighting design have affected the acoustic property. The result indicates that the theater can properly function as a movie theater.

Reference

ASHRAE Standard 90.1-2010. Atlanta, GA: American Society of Heating, Refrigerating and Air Condition Engineers, Inc. 2010

Houser, Mistrick, and Stefy. The IESNA Lighting Handbook 10th ed. New York, NY: Illuminating Engineering Society of North America, 2011

National Electric Code 2011, Quincy, MA: National Fire Protection Association, Inc. 2011

Metha, Johnson and Rocafort. Architectural Acoustics: Principles and Design. Prentice Hall PTR, 1999

Image Links

http://www.morphosis.com/

https://texasarchitects.org/v/article-detail/Coy-Talley-on-the-Landscape-Architecture-of-the-Perot-Museum/b3/

http://photographyblog.dallasnews.com/2013/06/today-in-dallas-photo-history-1936-texas-centennial-exposition-opens.html/

http://commons.wikimedia.org/wiki/File:Museum_of_Nature_%26_Science_(Fair_Park).JPG

http://www.architecturaldigest.com/architecture/2013-02/best-architectural-projects-slideshow_slideshow_item7_8

http://morphopedia.com/projects/perot-museum-of-nature-and-science-1

http://gallery.mobile9.com/topic/?tp=circuit&ty=wp&ii=3413

http://blog.alpineinstitute.com/2014/02/route-profile-joshua-trees-dappled-mare.html

http://fredturpin.wordpress.com/2012/02/29/wind-blowing-across-fields-of-the-heart/

http://www.nipic.com/show/4/79/5397132k512204e2.html

http://www.amazon.com/Vinyl-Wall-Mural-Decal-Branches/dp/B008CL4U3W

http://www.houzz.com/photos/5334641/3d-nature-marble-panel--3d-nature-marble-wave-panel--3d-stone-tile-modern-tile-other-metro

http://www.dreamstime.com/illustration/milk-drop.html

http://www.anypics.ru/tags/%F0%E0%E7%E2%EE%E4%FB/

http://matthewdurrphotography.com/2012/06/11/lens-review-nikon-35mm-f2-5-series-e/

Type	Unit	Lamp/Wattage	Manufacturer	Description	Location	Quantity
C1	Per 2'-0" lengths	LED 13 W	GE	LED T8 tube suspended 45 degrees from horizontal facing towards the center of the room. Suspention cable varies from 6' to 20' in length.	Classroom	7
C2	Per 4'-0" lengths	LED 22 W	GE	LED T8 tube suspended 45 degrees from horizontal facing towards the center of the room. Suspention cable varies from 6' to 20' in length.	Classroom	10
C3	Per 5'-0" lengths	LED 27 W	GE	LED T8 tube suspended 45 degrees from horizontal facing towards the center of the room. Suspention cable varies from 6' to 20' in length.	Classroom	4
C4	Per 4'-0" lengths	T5HO Fluorescent 57 W	COOPER	Neo-Ray recessed wallwasher	Classroom	4
C5	Each	LED 42 W	WE-EF	FLC 142 Surface mounted floodlight instaled inside the skylight structure to simulate daylight.	Classroom	3
E1	Per 4'-0" lengths	LED 20 W	ELECTRIX	L101 recessed linear LED, high output	Escalator Cartridge	32
F1	Per 3'-0" lengths	LED 45 W	PHILIPS	Vaya Linear LED with 10 deg narrow distribution	Façade	560
L1	Per 4'-0" lengths	T5HO Fluorescent 32 W	REGENT	FLOW pendant luminaire with direct light emission and translucent housing	Main Lobby	59
L2	Each	Compact Fluorescent 46 W	BEGA	L5211 pendant sphere luminaires with three-ply opal glass with satin matte finish. Integral electronic ballasts included. 1ft in diameter.	Main Lobby	31
L3	Each	Compact Fluorescent 62 W	BEGA	L5212 pendant sphere luminaires with three-ply opal glass with satin matte finish. Integral electronic ballasts included. 1.5ft in diameter.	Main Lobby	18
L4	Each	Metal Halide 70 W	WE-EF	FLC 132 floodlight mounted on track	Main Lobby	3
T1	Per 1'-0" lengths	LED 2.2 W	ELECTRIX	L101 recessed linear LED, standard output	Theater	925
T2	Each	Compact Fluorescent 18 W	Edison Price	DTT 13/6 recessed combination downlight.	Theater	21

GE
Lighting

WORLDWIDE PARTNER

LED T8 tubular lamps

DATA SHEET

Product information

The GE LED T8 range offers safe, reliable and affordable energy saving alternatives to standard Fluorescent T8 lamps.

Available in 2'/60cm, 4'/120cm and 5'/150cm lengths, GE LED T8s can be quickly fitted as a replacement into luminaires operating on electro-magnetic control gear or on electronic gear with a simple re-wire (for further details see intallation guide).

Features

- Energy saving up to 60% (on mains connection versus T8 fluorescent lamps on electro-magnetic gear)
- High light output up to 3000Lm
- Instant-on light
- Long lifetime: up to 50,000 hours L70
- High Power Factor: 0.9
- Wide 130° light distribution
- Compatible with existing installations

Specification Features

Long-life and high efficiency

- Up to 50,000 hrs rated lifetime, reduced maintenance cost
- High Efficiency, up to 111 lm/w, increased energy saving

High Quality lighting effect

- High uniformity of light, create elegant lighting atmosphere for retail & commercial applications
- Especially suitable for supermarket, high color rendering of fresh food to engage customers
- Environment friendly - no UV, no Hg

Application areas

- Office
- Hospitality
- Industrial
- Car Park

IEC Standards

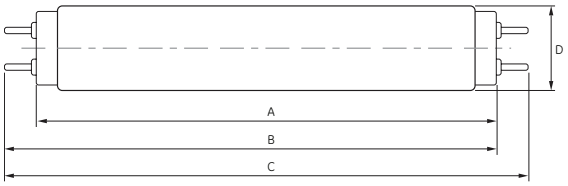
EN 55015	Limits and methods of measurement of radio disturbance characteristics of electrical lighting
EN 61000-3-2	Limits for harmonic current emissions (equipment rated current <=16A)
EN 61000-3-3	Limitation of voltage fluctuations and flicker in low voltage supply systems (equipment rated current <=16A)
EN 61547	Specification for equipment for general lighting purposes. EMC Immunity requirements
EN62493:2010	Assessment of lighting equipment related to human exposure to electromagnetic field
IEC 62471	Photo biological safety of lamps and lamp systems
IEC 60061-1	Lamp Caps
IEC 61195	IEC Based Safety Standard Requirements for Double-capped Fluorescent Lamps
IEC 60598-1	Luminaires – Part 1: General requirements and tests
IEC 60598-2	Luminaires – Part 2: Particular requirements (all sections)
IEC 62031	LED modules for general lighting-Safety specifications
IEC 61347-2-13	Particular requirements for DC or AC supplied electronic control gear for LED modules

GE imagination at work

Specification summary

Rated Wattage	Length (mm)	CCT (Kelvin)	CCT Steps	Product Description	Rated Luminous flux (lm)	Life B50 (hrs)	CRI (Ra)	Energy Efficiency Class	Pack Qty (pcs)	Product Code
LED T8 Energy saving range - G13 base										
9	600	4000	6	LED 9/T8 600MM/840/220-240V BX1/30	750	50 000	80	A+	30	90450
9	600	6500	6	LED 9/T8 600MM/865/220-240V BX1/30	800	50 000	80	A+	30	90451
18	1200	4000	6	LED 18/T8 1200MM/840/220-240V BX1/30	1550	50 000	80	A+	30	90455
18	1200	6500	6	LED 18/T8 1200MM/865/220-240V BX1/30	1650	50 000	80	A+	30	90456
LED T8 High output range - G13 base										
12	600	4000	6	LED 12/T8 600MM/840/220-240V BX1/30	1050	40 000	80	A+	30	90453
12	600	6500	6	LED 12/T8 600MM/865/220-240V BX1/30	1100	40 000	80	A+	30	90454
23	1200	4000	6	LED 23/T8 1200MM/840/220-240V BX1/30	2150	40 000	80	A+	30	90457
23	1200	6500	6	LED 23/T8 1200MM/865/220-240V BX1/30	2250	40 000	80	A+	30	90458
27	1500	4000	6	LED 27/T8 1500MM/840/220-240V BX1/30	3000	40 000	80	A+	20	90459
27	1500	6500	6	LED 27/T8 1500MM/865/220-240V BX1/30	3000	40 000	80	A+	20	90460

Dimensions



Maximum overall length (mm)	60cm (2ft)	120cm (4ft)	150cm (5ft)
A	600	1200	1500
B	597	1207	1507
C	604	1214	1514
D	28	28	28
Weight (g)	<210	<350	<450

Electrical and Photometric Characteristics

Nominal Voltage:	220-240V
Operating frequency:	50...60Hz
Power factor:	≥ 0,90
Ambient temperature range:	-20°C ...+40°C
Starting time:	< 0,5 s
Number of switching cycles:	80 000
Lumen maintenance at B50:	70%
Beam angle:	130°
Dimmable:	No

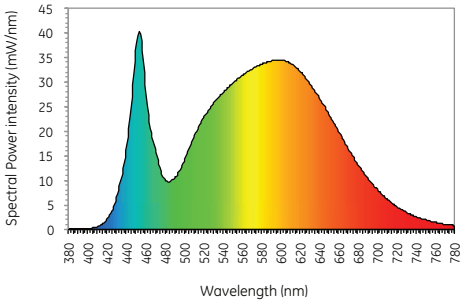
Operation and Maintenance

Store and use the lamps the same way as standard fluorescent lamps.

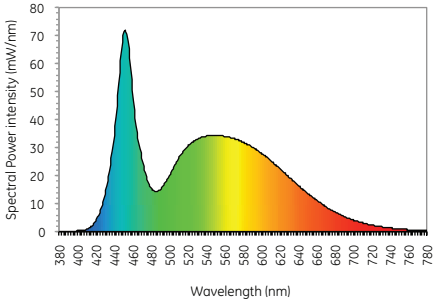
- Lamps should be kept free from contamination.
- Switch off mains supply before installing/removing lamp.
- Good condition of the lamp-holder contacts is important to ensure proper operation of lamp.
- For magnetic gear system ensure existing fluorescent starter is replaced with LED T8 starter (included in each pack)
- For direct wire please check the provided installation instructions
- Use in fully enclosed fixtures may affect life performance.
- Not for use in emergency lighting circuits

Spectral power distribution

Cool white - 4000K



Daylight - 6500K



NEO-RAY™

DESCRIPTION

23XR wall wash completes the Straight & Narrow family. Its precise optical reflector design provides wall illumination up to 10' in height with smooth gradiation from top to bottom of the wall. 23XR application is perfect for classrooms, conference rooms, corridor walls, arcades and galleries. 23XR features excellent photometrics and high efficiency while offering smooth wall wash free of striations and shadows. Runs are provided to the nearest foot and the light source is hidden from most viewing angles.

Catalog #		Type
Project		
Comments		Date
Prepared by		

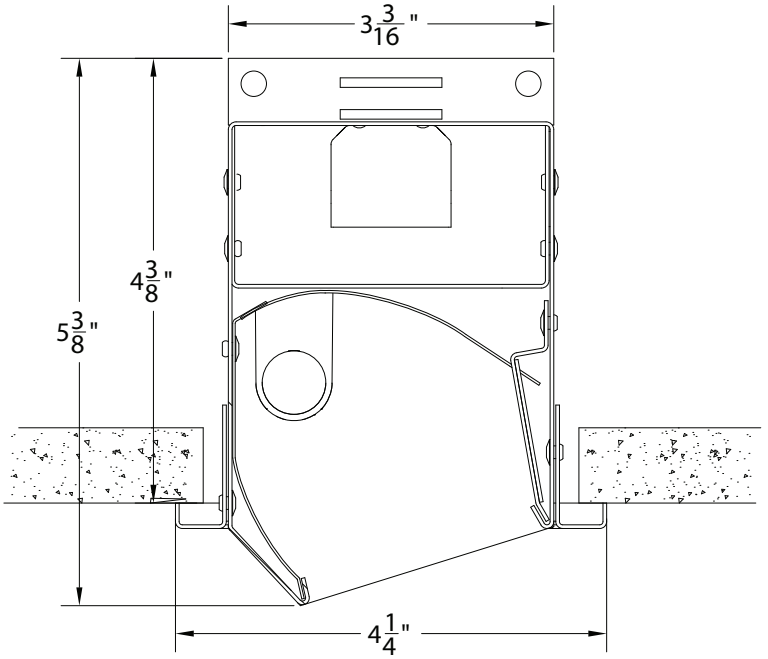
SPECIFICATION FEATURES

Construction
Housing is one-piece, die-formed, cold rolled steel. Standard 2', 3', 4'and 5' fixture lengths.

Electrical
120, 277, 347 or Universal Voltage electronic ballast. Fixtures and electrical components certified to UL and CUL standards. Note: Please consult factory, Fifthlight may not be available in some configured options.

Finish
Durable, low gloss, white, powder coat acrylic. Optional custom finish.

Mounting
Recessed.



WALL WASH
23XR
Gen II

1T5
1T5HO

Wall Wash
Direct-Indirect

Light Distribution:
Indirect = 1%
Direct = 99%

powered by fifthlight technology

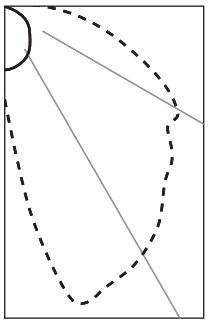
ORDERING INFORMATION

Sample Number: S23XR-1T5-ETG-4-U-EB-S92HT

Series	Mounting	Number of Lamps	Lamp Type	Ceiling Type	Length	Section	Voltage	Ballast	Switching	Emergency	Fusing
S23X= Series 23 Wall Wash	R= Recessed	1 = 1 lamp (not included)	T5 T5HO	ETG = 15/16" (exposed T-grid) FTG= 9/16" (exposed T-grid) STG = Slot T-grid SR = Sheet Rock (flanged) FSR= Sheet Rock (trimless)	2= 2' 3= 3' 4= 4' 6= 6' 8= 8'	D= Individual I= Intermediate B= Beginning of Run E= End of Run	120 = 120V 277= 277V UNV = Universal (120v-277v)	EB= Electronic Ballast DB= Dimming Ballast	SI=Single Switching	EM= Emergency Pack (consult factory)	GLR GMF

Notes:

1. Not all options available. Please consult your local Cooper Lighting Representative for availability.
2. Specification and Dimensions subject to change without notice.



23XR
1T5HO lamp
Efficiency 61.7%
Test#168P236

0 - - - - -
90 ——

Zonal Lumen Summary

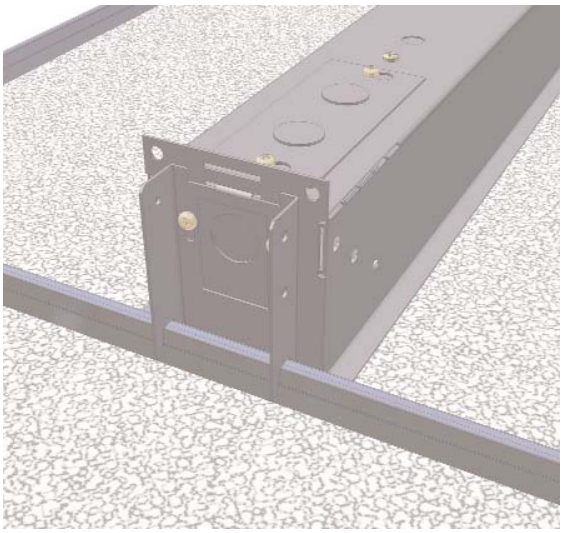
Zone	Lumens	%Lamp	%Fixture
0-30	650	13.0	21.1
0-40	1146	22.9	37.1
0-60	2174	43.5	70.4
0-90	3068	61.4	99.4
0-180	3086	61.7	100.0

Total Luminaire Efficiency = 61.7%

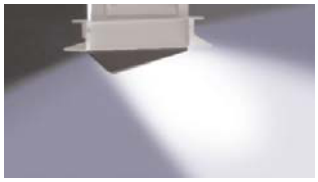
Candela

Angle	Along ∥	45°	Across ⊥
0	417	417	417
5	883	734	417
15	1999	1698	403
25	1912	1873	374
35	1768	1692	330
45	1530	1475	272
55	1344	1189	204
65	1143	968	132
75	746	661	63
85	419	310	9
90	222	144	2
95	46	6	2

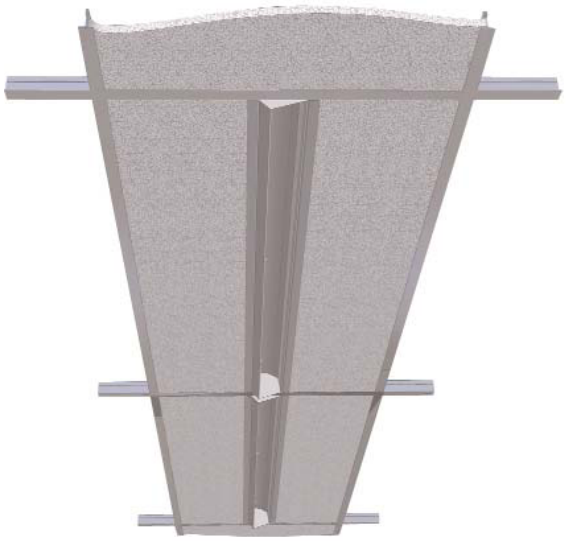
MOUNTING INFORMATION



Patent pending adjustable ceiling mounting system. Adjust to various ceiling grid types and enables end installation precise fit for integrated ceiling appearance. Access plate and pre-wired assembly allows for easy wiring.

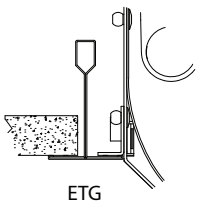


Ideal for vertical surfaces. The shape of the reflector was specially designed to produce uniform lighting on walls. The fitting's size is reduced. It uses high performance fluorescent lamps with low energy consumption. It is also quite easy to install.

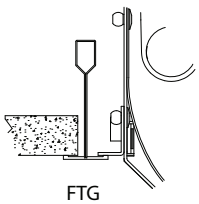


Recommended distance from fixture longitudinal axis and wall is 1' to 3'. Optimum performance distance is 2'. Fixture housing lengths are 3', 4' and 5' mounted individually in grid ceilings and in sheet rock can be mounted in continuous rows. Fixtures can be butted up against each other, end-to-end for continuous row mounting.

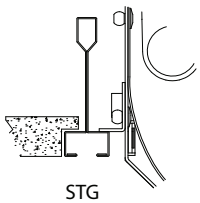
MOUNTING OPTIONS



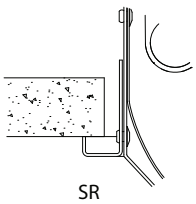
ETG
15/16" TEE GRID



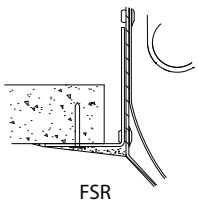
FTG
9/16" TEE GRID



STG
9/16" TEE GRID
(SLOTTED)



SR
SHEET ROCK



FSR
"FLANGELESS"
SHEET ROCK

PROJECT DATA

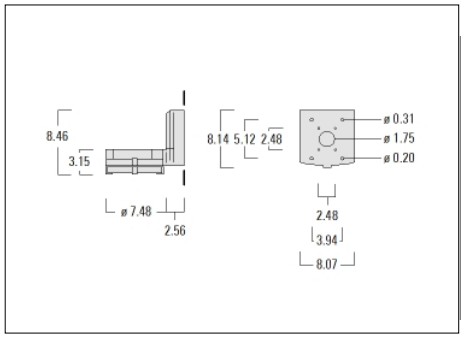
PROJECT	
DATE	
REFERENCE TYPE	
COMMENTS	
NOTE	

LOCAL WE-EF REPRESENTATIVE

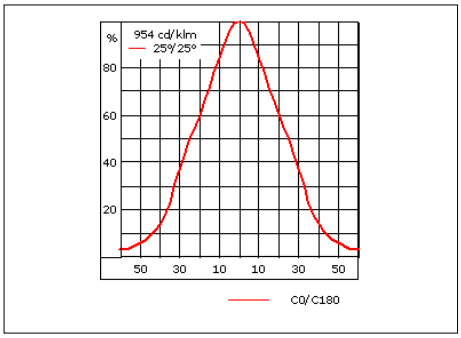
COMPANY	
TELEPHONE	
FAX	
EMAIL	

PRODUCT IMAGE

DIMENSIONS



LIGHT DISTRIBUTION



PRODUCT DESCRIPTION

DESCRIPTION	663-4622 FLC142 LED Wall Luminaires / Surface Mounted
BEAM TYPE	symmetric, wide beam
LAMP TYPE	24 LED white 36W (4000K)
LUMENS	3777
CONTROL GEAR	electronic gear

MAIN FEATURES

IP55. Surface mounted wallwasher. Suitable for installation over 4" recessed junction box in uplight or downlight position.

TECHNICAL DATA

MATERIALS:
Luminaire body and lens frame constructed from die-cast aluminum including PCS hardware. 5CE superior corrosion protection. Clear tempered glass lens. PMMA LED lens array. Silicone rubber gasket.

ELECTRICAL:
Integral [ECG] electronic 0-10 V dimmable driver in 120 or 277 volt. Specify voltage.
Ambient Temperature: Ta < 25 ° C

MOUNTING:
Suitable for installation over a standard 4” recessed junction box. Luminaire can be mounted as an uplight, or downlight.
Weight: 9.5 lbs.

FINISH:
Powder coat finish in Black RAL9004, White RAL9016, and Grey Metallic RAL9007. Specify finish. Consult WE-EF color chart for other color options.

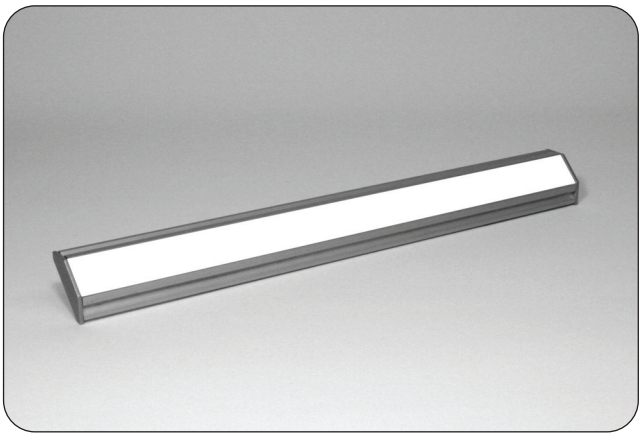
LISTINGS:
UL , c UL listed. Suitable for Wet locations.
International Protection Classification: IP55.

OPTICAL ACCESSORIES:
Internal optical accessories:
A maximum of (1) internal optical accessories possible.
665-8149 (IO-180-FLC142 LED (linear spread lens))

External optical accessories:
A maximum of (1) external optical accessory possible.
665-9241 (EG-FLC142 LED (wire guard)), 665-9242 (ES-FLC142 LED (glare shield)), 665-9244 (ET-FLC142 LED (snoot)).

FINISH:
Powder coat finish in Black RAL9004, White RAL9016, and Grey Metallic RAL9007. Specify finish. Consult WE-EF color chart for other color options.

Nominal Lumen		Actual Lumen		Total System Wattage
LED LUMENS	157.4 lm	LED LUMENS	120.7 lm	42.000
LEDs	24	LEDs	24	
TOTAL LUMENS	3777.0 lm	TOTAL LUMENS	2897.0 lm	
Tj	85°	Ta	25°C	



PROJECT NAME :

LUMINAIRE TYPE :

L101 LumiLine | Dry

Construction:

- Extruded aluminum housing with satin anodized finish
- Low profile design with lengths ranging from 12" to 96"
- Proprietary optics are UV stable and optimized for transmission
- Numerous stainless steel and aluminum mounting solutions

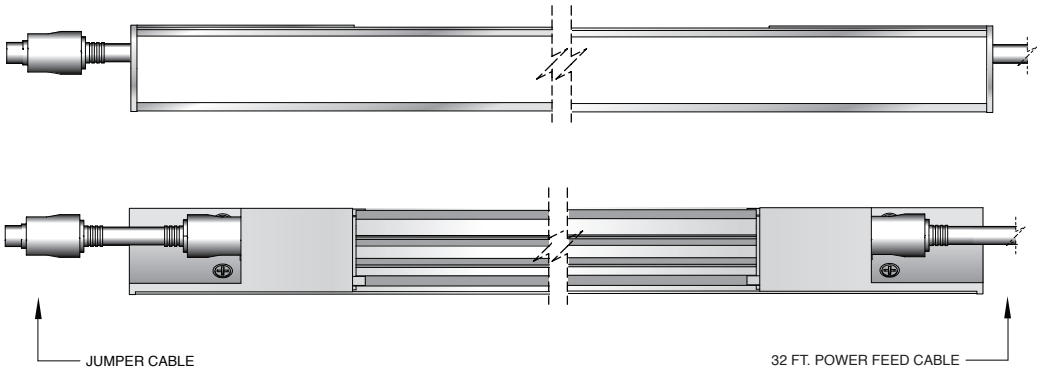
Electrical:

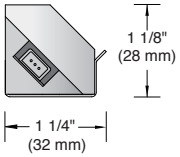
- Dimmable, high quality light availalble in either 3000K or 4000K
- Solid state low voltage luminaires powered with 24V DC
- Luminaires can be wired in series up to 32' with standard power and 9.75' with high power
- Electronic power supplies can be remotely mounted up to 32' **
- UL listed for dry locations

Performance:

- Average rated LED life of 50,000 hours @ 70% lumen output*
- IES files can be downloaded at www.electrix.com
- All values below are based on initial lumens per foot

Output	Watts/Ft	3000K white	4000K white
Standard	2.2 watts/ft	65 lumens/ft	84 lumens/ft
High	7.4 watts/ft	275 lumens/ft	354 lumens/ft



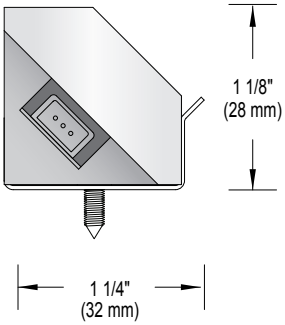


* To ensure proper performance, ambient temperature around luminaire should not exceed 140F. Architectural details should include ventilation around fixture.
** If EMI is a consideration, recommended remote driver distance is 15'

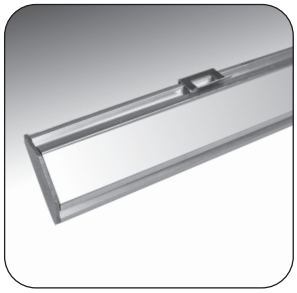
RoHS

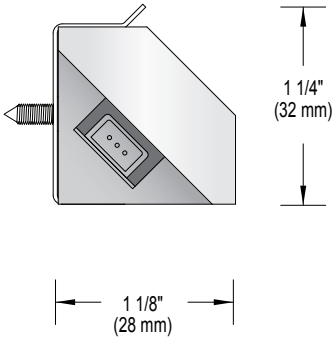
MOUNTING OPTIONS:

Horizontal Mount

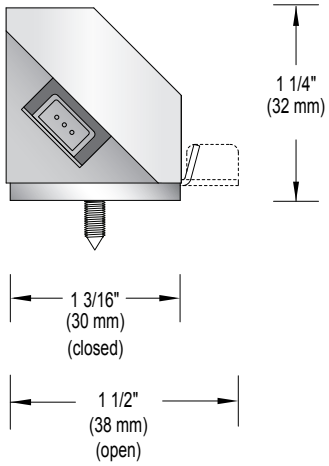


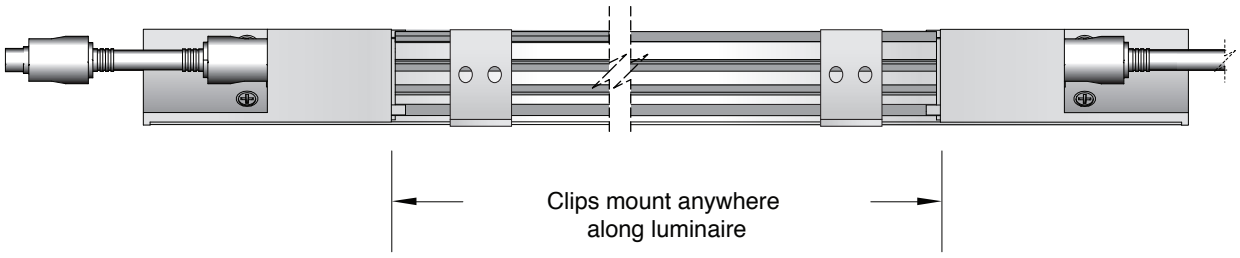
Vertical Mount





Quick Release Mount





PRODUCT INFORMATION:

PRODUCT	POWER	LENGTH	LED COLOR	LENS	MOUNT	JUMPER CABLE
L101	**02** - 2.2 watts per linear ft **07** - 7.4 watts per linear ft (White LED only)	**12** - 12" actual **24** - 23 7/8" actual **36** - 35 3/4" actual **48** - 47 1/2" actual **60** - 59 3/8" actual **72** - 71 1/8" actual **84** - 83" actual **96** - 94 3/4" actual	**W3** - 3000K White **W4** - 4000K White	**90F** - 90 degree Satine Lens **90C** - 90 degree Clear Lens	**H** - Horizontal Mount **QR** - Quick Release Mount **V** - Vertical Mount	**ST** - Straight 3.38” **FL** - Flex 3.75”

POWER CABLE ACCESSORIES:

LEADER FEED CABLE:

LFC-101-32: 32 ft. primary feed cable
One required per LED feed

JUMPER CABLE:

JC-L101-ST: 3.38" jumper cable for end to end feed (Straight runs)

JC-L101-FL: 3.75" jumper cable for end to end feed (Radius application)

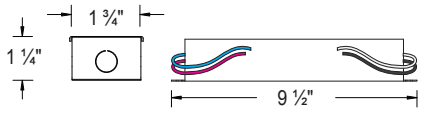
RoHS

LED POWER SUPPLIES - DRY LOCATION:

75W MAX POWER SUPPLY

MODEL: PS75

- output lead: 1W (min) to 75W (max)
- input voltage: 120-277V AC output voltage: 24V DC
- maximum remote driver distance is 32' **
- dimming requires a 0-10V control interface (by others)[1]
- drivers supplied with 6" input/output leads

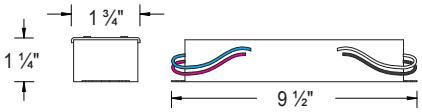


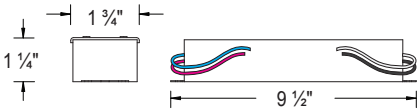
96W MAX POWER SUPPLY

MODEL: PS96

MODEL: PS96D dimmable

- output lead: 1W (min) to 96W (max)
- input voltage: 120V-277V AC output voltage: 24V DC
- maximum remote driver distance is 32' **
- dimming requires a 0-10V control interface (by others)[1]
- drivers supplied with 6" input/output leads



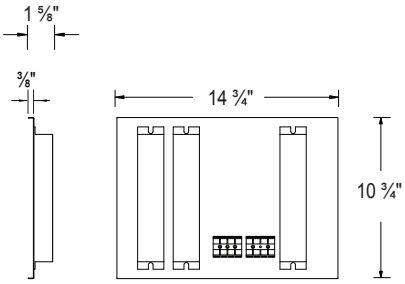


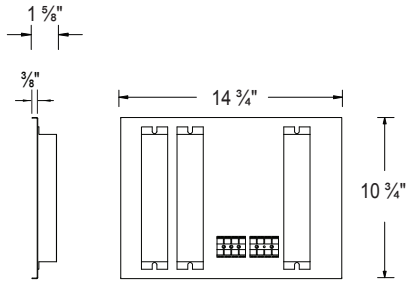
288W MAX POWER SUPPLY

MODEL: PS288

MODEL: PS288D dimmable

- output lead: three(3) 96W channels
- input voltage: 120V-277V AC output voltage: 24V DC
- maximum remote driver distance is 32' **
- dimming driver requires a 0-10V control interface (by others)[1]





** The remote mounting distance may be exceeded. However, precaution for site condition of electromagnetic interference (EMI) and voltage drop must be considered.

[1] Contact the factory for dimming wire diagram

Vaya Linear

BCP420 18xLED-HB/RD 100-240V 10 CE CQC

Vaya Linear - 18 pcs - LED High Brightness - Narrow beam angle 10°

With budgets under pressure, property owners and developers are looking, more than ever, for value for money when it comes to capital expenditures.Vaya Linear is a cost-effective and reliable fixture that minimizes the initial investment, while offering extreme flexibility to create grazing lighting effects. It features a discreet design and is available in two different lengths to suit the application. The robust Vaya Linear also offers a choice of two tones of white with a simple on-off switch, and changing colors with a standard DMX512 controller. It is extremely easy to install and to aim thanks to its adjustable mounting bracket.

Product data

• General information

Product family code	BCP420 [Vaya Linear]
Number of light sources	18 [18 pcs]
Lamp family code	LED-HB [LED High Brightness]
Light source color	RD [Red]
Light source replaceable	false [No]
Driver included	true [Yes]
Protection class IEC	CLI [Safety class I]
Ingress protection code	IP65 [Dust penetration-protected, jet-proof]
Mech. impact protection code	IK02 [0.2 J standard]
Optic type	10 [Narrow beam angle 10°]
Optical cover/lens type	GC [Glass clear]
Dimmable	Yes [Yes]
CE mark	CE [CE mark]
Lifetime to 70% luminous flux	50000 hr
CQC mark	CQC [CQC-mark]

• Electrical

Input voltage	100-240 V [100 to 240 V]
Input frequency	50-60 Hz [50 to 60 Hz]

• Initial perform. (IEC compliant)

Initial input power	45 W [45 W]

• Application conditions

Ambient temperature range	-40 to +35°C [-40 to +35 °C]

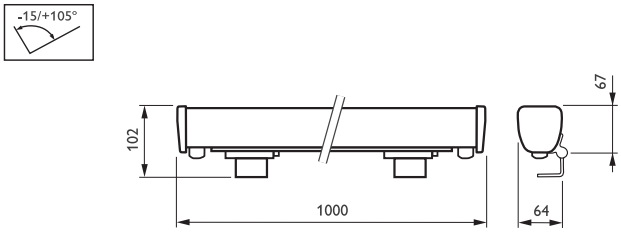
• Product Data

Order code	910503702444
Full product code	910503702444
Full product name	BCP420 18xLED-HB/RD 100-240V 10 CE CQC
Order product name	BCP420 18xLED-HB/RD 100-240V 10 CE CQC
Pieces per pack	0
Packs per outerbox	1
Bar code on outerbox - EAN3	8718291377177
Logistic code(s) - 12NC	910503702444
Net weight per piece	3.240 kg

IP65 IK02 CE

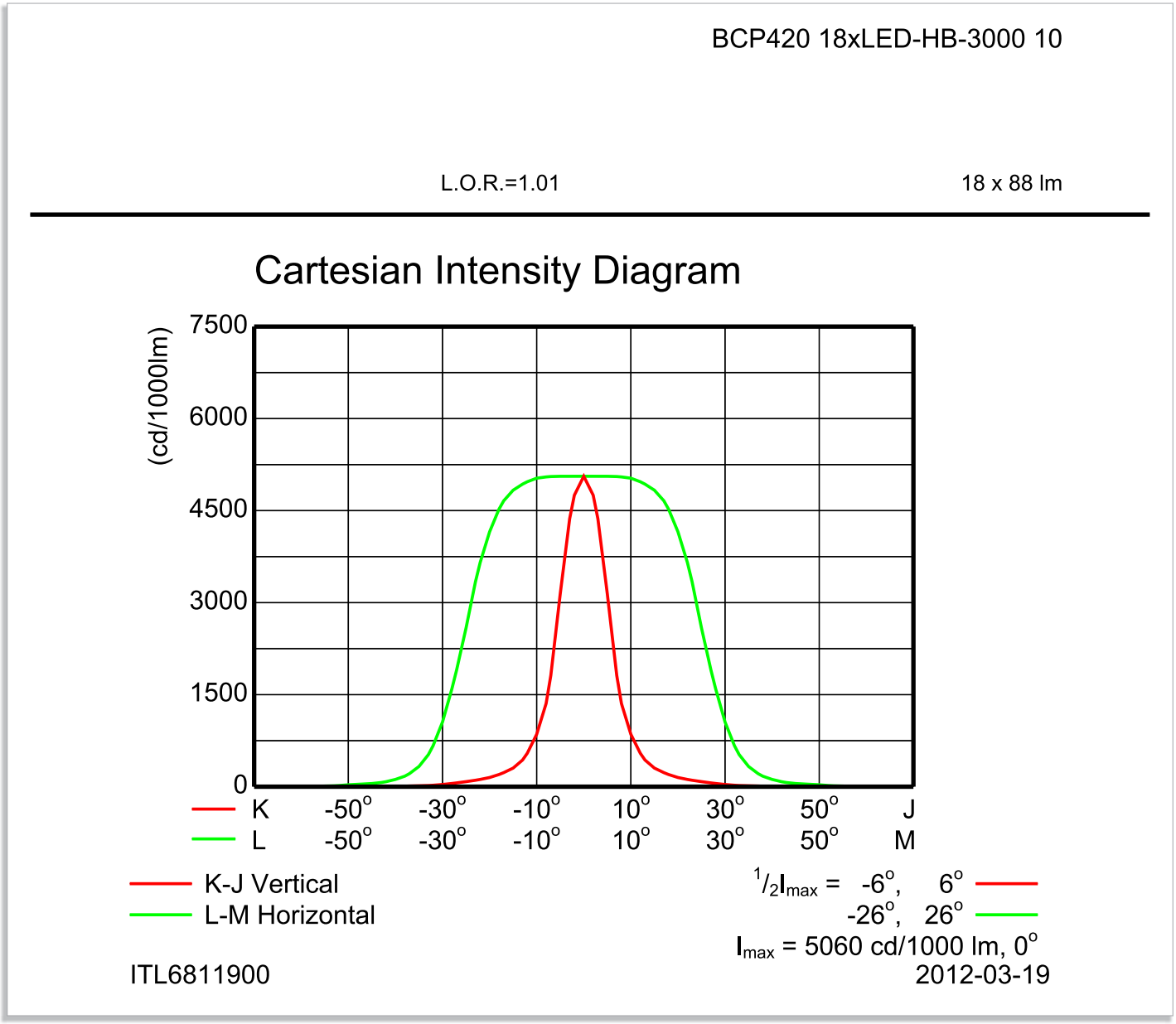
PHILIPS

Dimensional drawing



BCP420 18xLED-HB/RD 100-240V 10 CE CQC

Photometric data



BCP420 18xLED-HB-3000 10

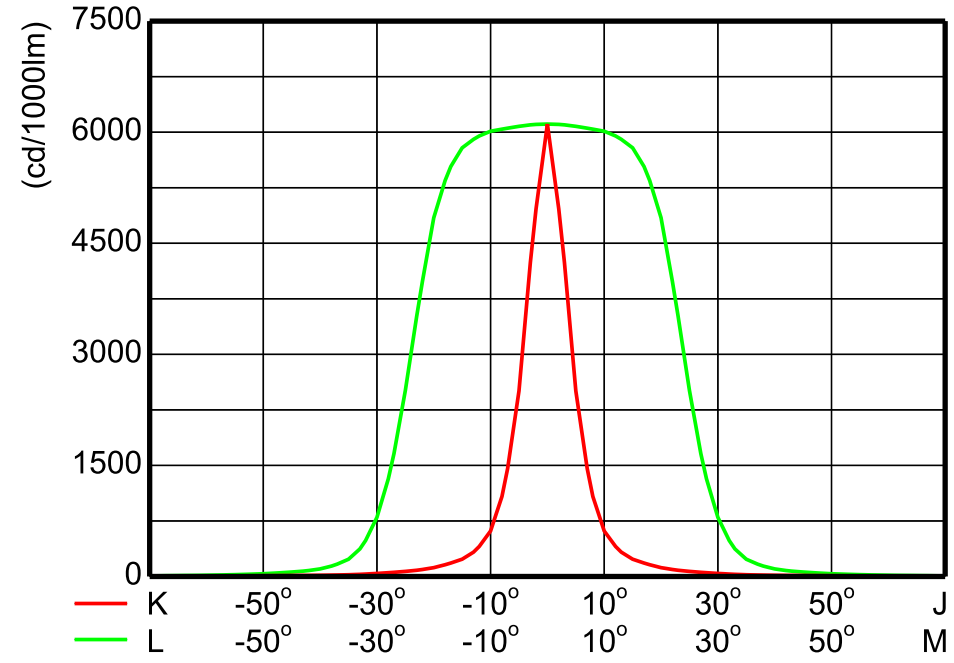
Photometric data

BCP420 18xLED-HB-4000 10

L.O.R.=1.01

18 x 85 lm

Cartesian Intensity Diagram



K-J Vertical

L-M Horizontal

$^1/_2I_{max}$ = -5°, 5°

-24°, 24°

I_{max} = 6110 cd/1000 lm, 0°

NVL1179517

2012-03-19

REGENT
LIGHTING

Flow LED.

Elegant shadow-free light.
To suit your requirements.

up to
102 lm / W

Maison de la Paix, Geneva, Switzerland; IPAS Architects SA; © Sciboz Gérald

The challenge.
Light for architecture.

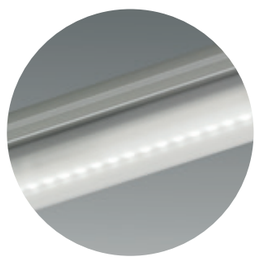
Good architecture is marked by the perfect interplay of all components. Lighting solutions should therefore be designed to support the architectural concept: optimum lighting quality based on the needs of the respective users. The lighting design should enhance the architecture without overplaying specific details. And not at all costs, but in the most efficient way possible.

The solution.
Pure light, optimum efficiency.

Light has never been so beautiful – the new Flow LED luminaire features timeless design, minimalist formal language, and uniform light distribution across the diffuser thanks to cutting-edge SLA Technology* (Spread Light Applicator) developed by Regent. The result: perfect uninterrupted lines of light and significant energy savings.

- can be integrated well into the architectural space thanks to uniform light distribution across the diffuser using cutting-edge SLA Technology*
- high energy efficiency with luminaire efficiency of up to 102 lm / W
- 3 different versions, each with a specific luminaire light output, e.g. xHE (extreme High Efficiency) for circulation areas and corridors
- lower investment required thanks to the 2-part batten measuring 2.4 metres

* Patent pending



Innovative LEDs deliver shadow-free lines of light

- LED modules can be removed and replaced without current interruption

- no visible screws

- can be integrated well into the architectural space thanks to uniform light distribution across the diffuser using cutting-edge SLA Technology* up to 102 lm / W
- 3 different versions, each with a specific luminaire light output, e.g. xHE (extreme High Efficiency) for circulation areas and corridors
- lower investment required thanks to the 2-part batten measuring 2.4 metres

* Patent pending

➔ WEBCODE: 015947
For further technical data please go to regent.ch and enter the web code

Product range overview.
Customised system dimensions available.

Lengths		Surface-mounted luminaire	Pendant luminaire
605 mm	xHE	●	●
	HE	●	●
	HPE	●	●
1190 mm	xHE	●	●
	HE	●	●
	HPE	●	●
2361 mm	xHE	●	●
	HE	●	●
	HPE	●	●
3532 mm	xHE	●	●
	HE	●	●
	HPE	●	●

xHE: extreme High Efficiency
HE: High Efficiency
HPE: High Performance Efficiency

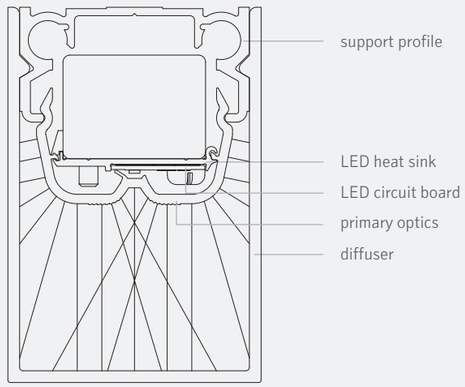
Flow LED.
Everything at a glance.

Flow LED ceiling or wall-mounted luminaires, 230 V, with passive cooling, up to 102 lm / W, colour temperature 4000 K or 3000 K, colour-rendering index CRI > 80, lifespan L70 > 50.000 h, direct and indirect lighting, even (vertical and horizontal) illumination of the diffusor by means of SLA Technology, three specific luminaire light outputs: for a 1.17-metre batten 1280 lm, 1540 lm or 2050 lm. Ceiling luminaire IP44 and pendant luminaire IP40. Diffusor and end components without visible screws. System batten luminaires with consistent xHE, HE or HPE luminaire light output level, or combinable without any difference in luminance. Pre-wired LED system batten luminaire made of polycarbonate with an aluminium LED circuit board with ICT (Instant Contact Technology), contact clips can be removed and replaced individually on site. Diffusor bracket made of anodized aluminium, plastic diffuser made of polycarbonate with a satin finish, internal wiring, halogen-free, integral electronic ballast. Available with DALI and emergency unit.

The features.

A clear line when it comes to lighting quality and efficiency.

SLA Technology* (Spread Light Applicator)



Perfect lighting – the perfect light source with SLA Technology*

Only an uncompromising product design can guarantee uncompromising indirect and direct lighting in application. To achieve optimum direct and indirect lighting, latest generation LEDs have been used and applied with specially developed SLA Technology* (Spread Light Applicator). This technology enables both direct and wide-beam light distribution from one and the same LED light source. Perfect lighting thanks to innovative lighting technology.

* Patent pending

Highest efficiency –
Light to work with using xHE (extreme High Efficiency).

The best lighting, but not at all costs: any application only needs a specific amount of light for optimum results. With Flow LED Regent offers 3 lumen packages for typical applications.

Direct comparison, LED vs. T5 in a corridor application

Optimum corridor lighting using Flow LED without lighting controls

	LED	**T5***
Dimension	L = 10 mx W = 2 mx H = 2.7 m	
Power per Unit	14 W – xHE	31 W*
Luminaire light output	1280 lm	2340 lm
Quantity	8 pcs	8 pcs
Total wattage	112	248
Pursuant to EN12464-1	yes	yes
At floor level	**143**	**238**
W / m²	5.6	12.4

* T5 - 28 W (+3 W BG) minimum (technologically) connected load

55%
energy savings

Contact

Hauptsitz Schweiz Regent Beleuchtungskörper AG, Dornacherstrasse 390, Postfach 139, CH-4018 Basel, Tel. +41 61 335 51 11, Fax +41 61 335 52 01, info.bs@regent.ch **Bern** Regent Beleuchtungskörper AG, Jupiterstrasse 15, Postfach 170, CH-3000 Bern 15, Tel. +41 31 940 10 10, Fax +41 31 940 10 11, info.be@regent.ch **Genève** Régent Appareils d'éclairage SA, Rue de Saint-Jean 30, CH-1203 Genève, Tél. +41 22 340 34 00, Fax +41 22 340 38 82, info.ge@regent.ch **Lausanne** Régent Appareils d'éclairage SA, Chemin du Rionzi 60, Case postale 432, CH-1052 Le Mont-sur-Lausanne, Tél. +41 21 642 02 02, Fax +41 21 648 21 19, info.ls@regent.ch **Lugano** Regent Illuminazione SA, Via al Mulino 22, CH-6814 Cadempino, Tel. +41 91 966 77 33, Fax +41 91 967 11 01, info.ti@regent.ch **Zürich** Regent Beleuchtungskörper AG, Luggwegstrasse 9, CH-8048 Zürich, Tel. +41 44 497 31 11, Fax +41 44 497 31 61, info.zh@regent.ch **Head Office International** Regent Beleuchtungskörper AG, Dornacherstrasse 390, P.O. Box 139, CH-4018 Basel Switzerland, Tel. +41 61 335 54 82, Fax +41 61 335 55 96, export.bs@regent.ch **Deutschland** Regent Licht GmbH, Plange Mühle 1, D-40221 Düsseldorf, Tel. +49 211 598 972 10, Fax +49 211 598 972 59, info@regent-licht.de **France** Régent Appareils d'éclairage Sàrl, Siège social 10, place Charles Béraudier, Immeuble l'Orient, F-69428 Lyon Cedex 03, Régent Appareils d'éclairage SA, Siège commercial, Dornacherstrasse 390, Case postale 139, CH-4018 Bâle Suisse, Tél. +41 61 335 54 83, Fax +41 61 335 55 96, info.fr@regent.ch **Israel** Regent Lighting Marketing Ltd., 4, Moshe Sharet St., IL-75704 Rishon Letzion, Phone +972 3 962 29 70, Fax +972 3 962 29 98, service@regentlighting.co.il **Italia** Regent Illuminazione s.r.l., Sede legale, Via Vittor Pisani 16, I-20124 Milano, Tel. +39 02 667 183 78, Fax +39 02 673 861 09, info.it@regent.ch **Österreich** Regent Licht GmbH, Karl-Farkas-Gasse 22, A-1030 Wien, Tel. +43 1 879 12 10, Fax +43 1 879 12 09, info@regent-licht.at **India** Regent Lighting Asia Private Limited, A-40, Ground Floor, Sector-80, Phase-II, Noida-201 305, Uttar Pradesh, India, Phone +91 120 473 3028 (North India) Phone +91 120 473 3031 (South & West India) info@regent-lighting.in

www.regent.ch

80.077.EN

LIMBURG Collection

Type:
LIMBURG Product #:
Project:
Voltage

The sphere · Pendant luminaires with high light output for fluorescent lamps

Material: Housing and canopy constructed of stainless steel with a #4 brushed finish (L5308), polished brass with chrome (L5215) plating, polished brass (L5219), or aluminum with a painted white RAL 9010 (L5211) finish. Black (L5308, L5215) or white (L5219, L5211) cable.

Glass: Hand blown, three-ply opal glass with satin matte finish. Enclosed glass. Minimum 75% transmission. Luminaire efficiency: 83.2%.

Electrical: One (1) 42W triple 4-pin GX24q-4 base compact fluorescent lamp (by others). GX24q-4 4-pin socket and electronic ballast with universal voltage, 120V through 277V.

Installation: Mounts directly to standard 4" octagonal wiring box.

U.L. listed, suitable for damp locations.

Weight: 9.7 lbs.

L = overall length of luminaire

s/steel	chrome	brass	white	lamp		lumen	A	L
L5308	**L5215**	**L5219**	**L5211**	1	42 W CF triple-4p	3200	13¾	79

BEGA/US
1000 BEGA Way, Carpinteria, CA 93013 (805)684-0533 FAX (805)566-9474

Revised 3/09

LIMBURG Collection

Type:
LIMBURG Product #:
Project:
Voltage:

The sphere · Pendant luminaires with high light output for fluorescent lamps

Material: Housing and canopy constructed of stainless steel with a #4 brushed finish (L5309), polished brass with chrome (L5216) plating, polished brass (L5220), or aluminum with a painted white RAL 9010 (L5212) finish. Black (L5309, L5216) or white (L5220, L5212) cable.

Glass: Hand blown, three-ply opal glass with satin matte finish. Enclosed glass. Minimum 75% transmission. Luminaire efficiency: 85.1%.

Electrical: One (1) 57W triple 4-pin GX24q-5 base compact fluorescent lamp (by others). GX24q-5 4-pin socket and electronic ballast with universal voltage, 120V through 277V.

Installation: Mounts directly to standard 4" octagonal wiring box.

U.L. listed, suitable for damp locations.

Weight: 12.1 lbs.

L = overall length of luminaire

s/steel	chrome	brass	white	lamp		lumen	A	L
L5309	**L5216**	**L5220**	**L5212**	1	57 W CF triple-4p	4300	15¾	81

BEGA/US
1000 BEGA Way, Carpinteria, CA 93013 (805)684-0533 FAX (805)566-9474

Revised 3/09

PROJECT DATA

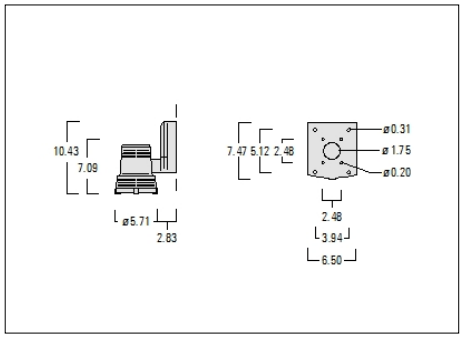
PROJECT	
DATE	
REFERENCE TYPE	
COMMENTS	
NOTE	

LOCAL WE-EF REPRESENTATIVE

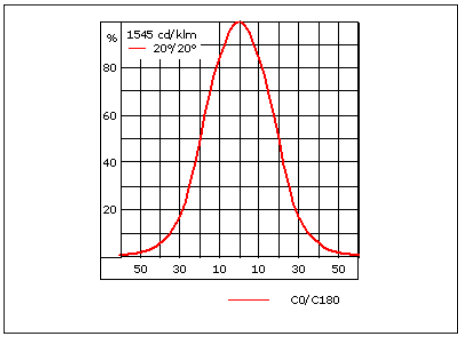
COMPANY	
TELEPHONE	
FAX	
EMAIL	

PRODUCT IMAGE

DIMENSIONS



LIGHT DISTRIBUTION



PRODUCT DESCRIPTION

DESCRIPTION	663-3261 FLC132 Wall Luminaires / Surface Mounted
BEAM TYPE	symmetric, medium beam
LAMP TYPE	CMH70 PAR30L/ FL/ med. base
LUMENS	5000
CONTROL GEAR	electronic gear

MAIN FEATURES

IP66. Surface mounted wall washer. Suitable for installation over 4" recessed junction box in uplight or downlight position.

TECHNICAL DATA

MATERIALS:
Luminaire body, lens frame and ballast housing constructed in die cast aluminum. Clear tempered glass lens. PCS hardware. Silicone rubber gasket. Anodized aluminum reflector.

ELECTRICAL:
Lamp holder: Medium base lamp holder, supplied with 250 ° high temperature leads, rated 600V. CMH70/ PAR30L/FL/ Medium base lamp, luminous flux: 5000 lm., provided by others. Integral [ECG] electronic MH ballast (ANSI C139/ M139/E) for 120, 277, or 347 V supply. Specify voltage.
Input watts: 80.0 W
Ambient Temperature: Ta < 25 ° C

MOUNTING:
Suitable for installation over a standard 4” recessed junction box. Luminaire can be mounted as an uplight, or downlight.
Weight: 8.0 lbs.

FINISH:
Powder coat finish in Black RAL9004, White RAL9016, and Grey Metallic RAL9007. Specify finish. Consult WE-EF color chart for other color options.

LISTINGS:
UL , c UL listed. Suitable for Wet locations.
International Protection Classification: IP66.

OPTICAL ACCESSORIES:
Internal optical accessories:
A maximum of (2) internal optical accessories possible.
665-8131 (IF-blue-FLC132), 665-8132 (IF-green-FLC132), 665-8133 (IF-red-FLC132), 665-8134 (IF-yellow-FLC132), 665-8136 (IO-180-FLC132 (linear spread lens)), 665-8137 (IO-360-FLC132 (flood lens)).

External optical accessories:
A maximum of (1) external optical accessory possible.
665-9231 (EG-FLC132 (wire guard)), 665-9232 (ES-FLC132 (glare shield)), 665-9233 (ET-FLC132) (snoot)).

DTT13/4

recessed compact fluorescent downlight/wallwasher

Spec Sheet

COMPACT FLUORESCENT
1-102

FEATURES

DTT13/4 is an efficient 4" aperture recessed low brightness downlight designed for use with a 13-watt compact fluorescent lamp. The fixture provides a shielding angle of 32°. One basic housing allows interchangeable use of the downlight and wallwash reflectors. This permits housings to be installed first and reflectors installed or changed at any time.

DTT13/4 uses a 13-watt, 4-pin lamp providing 900 lumens, and it consumes only 16 watts when operated at 120 volts. Compact fluorescent lamps have a 10,000-hour life, a color rendering index (CRI) of 85, and are available in a range of color temperatures as warm as 2700°K (nearly duplicating the color qualities of incandescent).

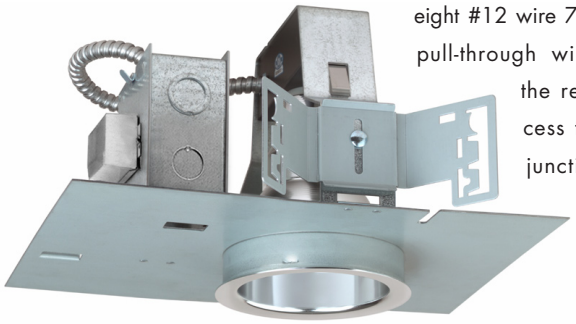
Reflectors are available in clear, natural aluminum in two finishes: **EvenTone**, our standard clear finish, partially diffuse, anti-iridescent and gently luminous in appearance; and **EasyTone**, diffuse and luminous. Additionally, reflectors are available in champagne gold, wheat, pewter and bronze. Wallwash (120°), corner wallwash (210°) and double wallwash (2x120°) reflectors are also available.

DTT13/4 includes a pair of mounting bars (¾" x 27" C channel). Specialty bars for wood joist and T-bar installations are available as accessories.

APPLICATIONS

Fixture is recommended for downlighting or wallwashing in offices, stores, residences, lobbies, corridors and reception areas.

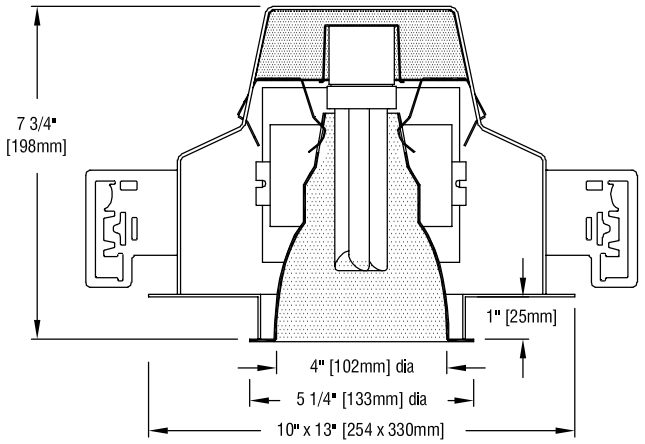
Fixture is c UL us listed for Damp Location (may not be suitable for some outdoor environments). Fixture is prewired with high power factor Class P electronic ballast, suitable for use in a fire rated ceiling, and approved for eight #12 wire 75°C branch circuit pull-through wiring. Removal of the reflector allows access to the ballast and junction box.



MODIFICATIONS AVAILABLE

Contact factory with quantity for pricing; orders may require shop drawing approval.

CHP-: fixture suitable for **Chicago Plenum**; add CHP- as prefix to Product Code.
CONC-: fixture suitable for poured-in-place **concrete**; add CONC- as prefix to Product Code.
EXP-: `European-style´ **install-from-below** fixture; add EXP- as prefix to Product Code.
+2"CLG: fixture suitable for installation in **2" thick ceiling** material; add +2"CLG to Product Code.
+DOD: fixture suitable for **high humidity** environments.
+MAR: reflector suitable for **marine** environments.



Requires ceiling opening of 4 15/16" (125mm) for Overlap or Flush Detail.
Requires ceiling opening of 5 3/16" (132mm) for Trim Flush Detail.

PRODUCT CODE

For complete product code, list basic unit and select one item from each following box.

Basic Unit DTT13/4

Reflector Type

Downlight	no suffix	Corner Wallwash	CWW
Wallwash	WW	Double Wallwash	DWW

Voltage

120 volt service	120	277 volt service	277

Reflector Color and Detail

	Overlap	*Flush*	*Trim Flush**
EvenTone Clear	VOL	VFL	VTF
EasyTone Clear	ECOL	ECFL	ECTF

Other reflector finishes are available on special order.

Standard reflector flange continues reflector finish. White painted flanges and custom painted flanges are available on special order. Add WF (white flange) or CCF (custom color flange).

Trim Flush reflector trim requires the use of a **plaster ring Accessory (see below).*

OPTIONS *Specify by adding to the basic unit.*

Emergency battery pack operates lamp in event of power outage. Not available with CWW reflector. Additional 4 ½" (114mm) height clearance required to remove EM pack through aperture. Not for outdoor application ..... – EM

⅛" (3mm) thick **clear acrylic shield**, spring-mounted in reflector. Available with downlight or WW reflector only ..... – PS

ACCESSORIES *Specify as a separate line item.*

Plaster ring allows use of 4 7/8" OD Trim Flush (-TF) reflector in sheetrock ceiling; 5 3/16" dia hole required.....TF RING/4

- Dimming ballast not available.
- A modified fixture suitable for 347-volt service is available on special order. Contact factory.
- Decorative reflector rings are available on special order. Contact factory.

EDISON PRICE LIGHTING
41-50 22ND STREET, LIC NY 11101 TEL 718.685.0700 FAX 718.786.8530 www.epl.com

DTT13/4

PHOTOMETRIC REPORT

Report No. 38787. Original Independent Testing Laboratories, Inc. (ITL) test report furnished upon request.

Luminaire ..... recessed compact fluorescent downlight with spun aluminum reflector, semi-specular finish
Lamp ..... 13-watt double-tube compact fluorescent, 4-pin, G-24q-1 base, 900 lumens
Efficiency 51.7%
Spacing Criterion..... 1.1

BALLAST INFORMATION

Voltage	*120*	*277*
Input Watts	18	18
Line Current (A)	.15	.07
Power Factor (%)	>98	>98
THD (%)	<10	<10
Min. Starting Temp* (°F)	0	0

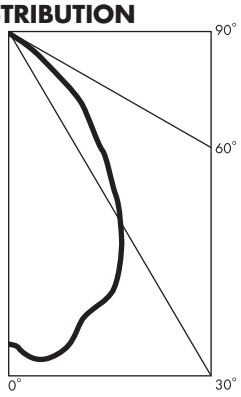
**Consult lamp manufacturers for specific temperatures.*

ZONAL LUMEN SUMMARY

Zone	*Lumens*	*%Lamp*	*%Fixture*
0 - 30°	222	24.6	47.7
0 - 40°	333	37.0	71.7
0 - 60°	463	51.4	99.6
0 - 90°	465	51.7	100.0
90 -180°	0	0.0	0.0
0 -180°	465	51.7	100.0

CANDLEPOWER DISTRIBUTION

Vertical Angle	*Candela*
0	296
5	312
15	276
25	247
35	179
45	108
55	54
65	1
75	0
85	0
90	0



LUMINANCE DATA

Vertical Angle	*Candela/m²*
45	5500
55	3390
65	85
75	0
85	0

To convert cd/m² to footlamberts, multiply by 0.2919.

COLOR MULTIPLIERS

EvenTone (V)	.95
EasyTone (EC)	.88
Champagne Gold (G)	.97
Wheat (WH)	.79
Pewter (P)	.81
Bronze (Z)	.58

COEFFICIENTS OF UTILIZATION – ZONAL CAVITY METHOD

Effective Floor Cavity Reflectance 20%

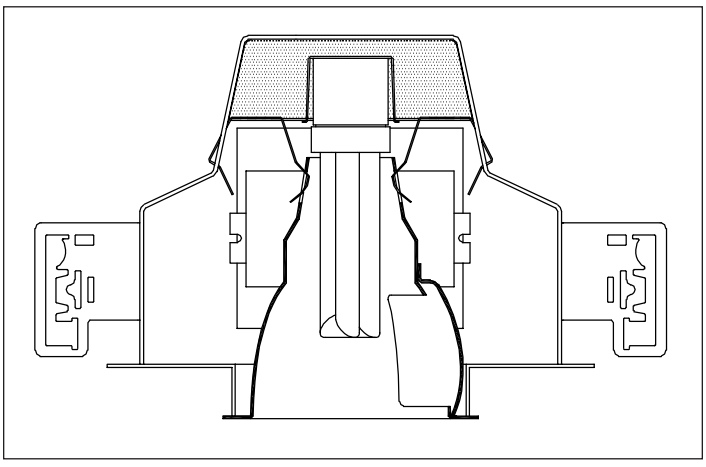
Ceiling Reflectance (%)	*80*				*70*				*50*			*30*			*10*			*0*
Wall Reflectance (%)	*70*	*50*	*30*	*10*	*70*	*50*	*30*	*10*	*50*	*30*	*10*	*50*	*30*	*10*	*50*	*30*	*10*	*0*
Room Cavity Ratio																		
0	62	62	62	62	60	60	60	60	58	58	58	55	55	55	53	53	53	52
1	58	57	55	54	57	55	54	53	53	52	51	51	50	50	50	49	48	47
2	55	52	49	47	53	51	48	46	49	47	45	47	46	44	46	45	43	43
3	51	47	44	41	50	46	43	41	45	42	40	44	41	40	42	41	39	38
4	48	43	39	37	47	42	39	37	41	38	36	40	38	36	39	37	35	34
5	45	39	36	33	44	39	35	33	38	35	33	37	34	32	36	34	32	31
6	42	36	32	30	41	36	32	30	35	32	29	34	31	29	33	31	29	28
7	39	33	30	27	38	33	29	27	32	29	27	32	29	27	31	28	26	26
8	37	31	27	25	36	31	27	25	30	27	24	29	26	24	29	26	24	23
9	35	29	25	23	34	28	25	23	28	25	22	27	24	22	27	24	22	21
10	33	27	23	21	32	26	23	21	26	23	21	26	23	21	25	22	21	20

DTT13/4 WW

WALLWASH INFORMATION

Distance From Ceiling (Feet)	*2' From Wall; 2' O.C.*		*2'6" From Wall; 2'6" O.C.*	
	Below Fixture	*Between Fixtures*	*Below Fixture*	*Between Fixtures*
1	5	5	2	2
2	9	11	5	5
3	14	14	8	8
4	12	12	9	9
5	11	11	8	8
6	8	8	6	6
7	6	6	6	6
8	5	5	5	5
9	5	5	3	3

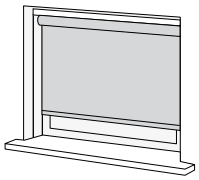
All vertical footcandles are initial values with no contribution from ceiling or floor reflectances. Computation performed with a total of five wallwashers.



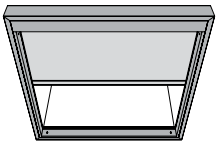
Lutron®—Roller and Tensioned Shade Selection Guide

Residence: _____ **Area:** _____ **Window(s):** _____

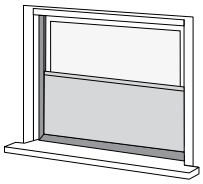
Step 1 Select Style



☐ Roller Shade

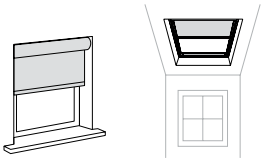


☐ Skylight/Angled

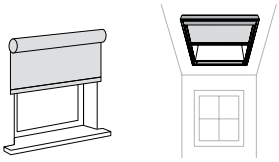


☐ Bottom-up

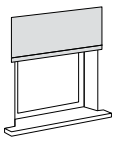
Step 2 Select Mounting Option



☐ Inside window jamb or window well

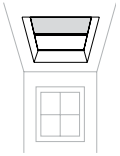


☐ Outside window jamb or window well



☐ Pocket mount* (Recessed into ceiling)

*Roller shades only



☐ Recessed into window well so frame is hidden*

*For skylight and bottom -up applications only

Step 3 Select Fabric Orientation

If specifying a skylight or bottom-up shade, skip to Step 4.

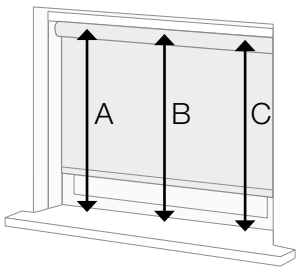
☐ Regular (with fabric closest to the glass)

☐ Reverse* (with fabric farthest from the glass)

*Recommended to clear door or window hardware.

Step 4 Measure Height and Width

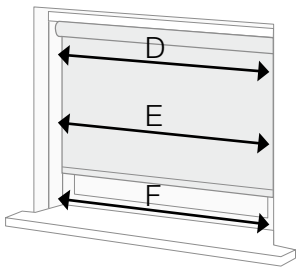
Measure to the nearest 1/8 of an inch.



A ____ inches

B ____ inches

C ____ inches



D ____ inches

E ____ inches

F ____ inches

Step 5 Select Fabric

☐ Fabric and Color Name (Note: not all fabrics are compatible with skylights and bottom-up)

_____

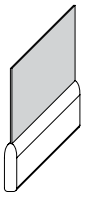
Fabric Model Number _____

☐ Custom Printed Material—Digital file must be provided as a .tif file at 100 ppi or higher.

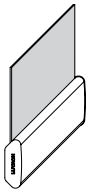
☐ Customer's Own Material (COM)—Please provide samples the size of the largest length and width indicated in Step 4.

Step 6a Select Bottom Bar

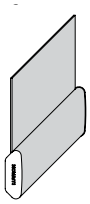
If specifying a skylight or bottom-up shade, skip to Step 6b.



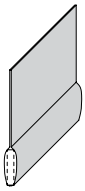
☐ Exposed



☐ Architectural exposed



☐ Architectural half wrap



☐ Sealed (No end cap)

Note: Fabric selected may not be compatible with all bottom bar options. Exposed bottom bar is not available with fabrics from the Lutron Coulisse Collection.

Step 6b Select Bottom Bar or Frame Color

☐ Clear Anodized

☐ White

☐ Black*

☐ Bronze*

☐ Custom Color _____

*Black and bronze have an added lead time for skylights, angled, and bottom-up shades.

Please note: Product options may vary depending on application and intended use. For more technical information, reference the Lutron shading solutions product guide (P/N 367-1455) located at **www.lutron.com** or work with your Lutron qualified installer. Product availability is subject to change.

Please contact your local Lutron sales representative for more information on ordering product.

LUTRON®

save energy with Lutron™

TROSIFOL® BG R10

TROSIFOL® BG R10 WITH MEDIUM ADHESION

Type	Colour	Film thickness [mm]	Water content [%]	Roughness R_Z* [µm]	Length of refrigerated roll [m]	Length of roll PE-interleaved [m]
BG R10	Clear	0.76	0.45	40	250/500	250/200

All values are typical averages.
*Value measured in accordance with EN ISO 4287

TROSIFOL® BG R10 WITH FLOAT GLASS*

Film thickness [mm]	Colour	Light transmittance	Light reflectance [8° Winkel]	Energy transmittance	g-value	Shading coefficient	UV transmittance
0.76	Clear	88	8	73	79	98	0.30

* LSG with 2 x 4 mm float glass

All Values in %. All values have been measured to EN 410:2011-04.

TROSIFOL® BG R10 WITH LOW-IRON FLOAT GLASS*

Film thickness [mm]	Colour	Light transmittance	Light reflectance [8° Winkel]	Energy transmittance	g-value	Shading coefficient	UV transmittance
0.76	Clear	90	8	82	84	106	0.41

* LSG with 2 x 4 mm low-iron float glass

All Values in %. All values have been measured to EN 410:2011-04.

TROSIFOL® BG R10

PHYSICAL DATA BG R10			
Properties	**Test method**	**Unit**	**Typical values**
Density	DIN 53479	g/cm^3	1.065
Refractive index	DIN 53491	-	1.482
Thermal conductivity	DIN EN 12939	W/mK	0.20
Thermal expansion coefficient	-	$1/K \times 10^{-4}$	2.20
Specific heat	DIN 52616	J/gK	1.85
Surface resitivity	DIN 53482	$\Omega \times 10^{11}$	2.0
Tensile strength	ISO 527	N/mm^2	> 23
Tensile elongation	ISO 527	%	> 280

Yucheng Lu

E-Mail: yil5167@psu.edu

School: 260 HAMILTON HALL, University Park, PA 16802. Phone: (814) 321-8939

Home: 283 Jingwu Road, Room 1906, Jinan, China 250021. Phone: 001(86)139-5416-6253

Education

The Pennsylvania State University, University Park, PA

- Integrated Master/Bachelor of Architectural Engineering, Lighting Option
- Minor in Architecture
- Graduation Date: May 2014
- Cumulative GPA : 3.54/4.0
- Engineer in Training upon Graduation

Building Information Modeling (BIM) Studio, Spring 2013

- Interdisciplinary collaborative studio designed to simulate realistic BIM project
- Winning project of the year judged by BIM experts invited from relevant fields

Schreyer Honors College Study Aboard program, London, England, Spring 2013

- Short term study aboard program focused on modern theatrical performance

Department Study Aboard program, Rome, Italy, Summer 2011

- 7 weeks international research on European Architecture / Daylighting Analysis

Employment

OVI - OFFICE FOR VISUAL INTERACTION INC, New York, NY, Summer 2013

- Prepared professional design documentations such as lighting plan, control diagram, luminaire schedule and calculation report
- Coordinate with manufactures for fixture customization and sample request

WE-EF LIGHTING INC, Pittsburg, PA, Summer 2012

- Modeled 3D REVIT luminaire libraries for 300+ lighting fixtures
- Performed lighting layout design for exterior lighting projects

Honors

Howard Brandston Student Lighting Design Competition 2013, Honorable Mention

Illuminating Engineering Society – Philadelphia Section Scholarship, Spring 2012

Gladys M. Baird Memorial Scholarship, Spring 2011

International Engineering Certification

Extracurricular

IES Annual Conference 2013, Los Angeles, CA

IALD Annual Conference 2012, Vancouver, Canada

Nittany Lights Landscape Lighting Design Practice, State College, Pa, Fall 2012

- Concept based lighting design for Penn State's signature statue Lion's Shrine

Habitat for Humanity, Birmingham, AL, Spring 2011

- 40 Hours volunteer construction service for tornado victims

Skills

AutoCAD	Autodesk Revit	Adobe InDesign
3ds MAX Design	AGI 32	Google Sketch up
Chinese	Japanese	